A DECISION MODEL TO PRIORITISE LOGISTICS PERFORMANCE INDICATORS

A thesis submitted for the degree of Doctor of Philosophy

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ABSTRACT

Performance measurement is an important concern that has recently attracted much attention in the logistics area from both practitioners and academics. The performance measurement of logistics companies is based upon diverse performance indicators. However, to date, limited attention has been paid to the performance measurement of logistics companies and, also, performance measurement processes have become more complex for logistics companies due to the existence of numerous performance indicators. In this regard, the way in which decision makers in logistics companies deal with some vaguenesses, such as deciding on the most important indicators holistically and determining interrelationships between performance indicators, has remained an issue that needs to be resolved.

This study, therefore, aims to offer a comprehensive decision model for identifying the key logistics performance indicators and determining the interrelationships among these indicators from logisticians' perspective. In line with this purpose, the research first presents a stakeholder-based Balanced Scorecard (BSC) model which provides a balanced view by including financial and non-financial performance indicators and a comprehensive approach as a response to the major shortcoming of the generic BSC regarding the negligence of various stakeholders. Then, a large number of performance indicators used in logistics are systematically examined under the proposed model, and the key indicators are selected through an online survey conducted in the Turkish logistics industry. Subsequently, since the performance measurement indicators are not independent of each other, it is critical to understand the causal relationships among different indicators. In such cases, group decision making techniques are capable of modelling such complexities. After a systematic comparison of these techniques, a realistic and easy-to-follow multi-criteria decision making technique, the Analytic Network Process (ANP), is revealed as a suitably powerful method to determine the interrelationships among the indicators.

Additionally, a case study approach based on the data obtained from three logistics companies is used to illustrate both the applicability of the model and the practicality of the ANP application. Furthermore, the sensitivity of the results about the case companies is also analysed with several relevant 'what-if' scenarios. Thus, real-life practices of three case companies are investigated with the proposed approach.

Consequently, this research proposes the BSC-ANP integration which provides a novel way and in-depth understanding to evaluate logistics performance indicators for the competitiveness of logistics companies. Thus, in order to address the aforementioned vaguenesses, the proposed model in this study identifies key performance indicators with the consideration of various stakeholders in the logistics industry to decide on the most important indicators, and evaluates the interrelationships among the indicators by using the ANP. The results of the study show that the educated employee (15.61%) is the most important indicator for the competitiveness of logistics companies and four prominent indicators (educated employee, managerial skills, cost, and

profitability) need to be primarily considered by logistics companies. In this way, with this integration, not only the performance indicators in logistics, but also different stakeholders of logistics companies are assessed by the ANP method. This means that the results of this research are not only useful for helping logistics companies to decide which indicators should be focused on to become more competitive, but also can be used as a reference model by different stakeholders in their decision-making processes in order to select the best logistics provider.

Keywords: Performance measurement; logistics performance indicators; balanced scorecard (BSC); analytic network process (ANP); multi-criteria decision making (MCDM); stakeholders

DEDICATION

I dedicate this thesis

to my parents,

Derman and Gül.

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DECLARATION

The research in this thesis was carried out in the Brunel Business School Department, Brunel University London, UK. I declare that this thesis is entirely my original work and has never been submitted previously for the award of any other academic degree or diploma in this or any other university. I also declare that all information in this thesis has been presented in compliance with academic and ethical rules.

Berk Kucukaltan

RESEARCH PAPERS ASSOCIATED WITH THIS THESIS

Journal Paper

- Kucukaltan, B., Irani Z., and Aktas, E. (2016). A Decision Support Model for Identification and Prioritization of Key Performance Indicators in the Logistics Industry. *Computers in Human Behavior*. (Revisions Submitted 3*** ABS List).

Conference Papers

- Kucukaltan, B., Aktas, E., Lu, K., and Topcu, I. (2015). *A Decision Model to Assess the Interrelationships among the Logistics Performance Indicators*. The 27th European Conference on Operational Research, Glasgow, UK.
- Kucukaltan, B., Lu, K., and Aktas, E. (2014). *Evaluation of Performance Factors for Logistics Companies: A Case Study in Turkey*. The 21st European Operations Management Association (EurOMA), Palermo, Italy.
- Kucukaltan, B., Lu, K., and Ali, M. (2013). *Performance Evaluation of Third-Party Logistics Providers in Istanbul Stock Exchange by Using ANP*. The 27th Annual British Academy of Management (BAM), Liverpool, UK.

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LIST OF ABBREVIATIONS

3PL	Third-Party Logistics
4PL	Fourth-Party Logistics
AHP	Analytic Hierarchy Process
ANP	Analytic Network Process
BOCR	Benefits, Opportunities, Costs and Risks
BSC	Balanced Scorecard
CEOs	Chief Executive Officers
CI	Consistency Index
CR	Consistency Ratio
CSCMP	Council of Supply Chain Management Professionals
DEA	Data Envelopment Analysis
DEMATEL	Decision Making Trial and Evaluation Laboratory
EFQM	European Foundation for Quality Management
IT	Information Technology
LODER	Lojistik Derneği (English: Logistics Association)
LPI	Logistics Performance Index
MADM	Multi-Attribute Decision Making
MAGDM	Multi-Attribute Group Decision Making
MAUT	Multi-Attribute Utility Theory
MAVT	Multi-Attribute Value Theory
MCDA	Multi-Criteria Decision Analysis
MCDM	multi-Criteria Decision Making
MODM	Multi-Objective Decision Making)
MÜSİAD	Müstakil Sanayici ve İşadamları Derneği (English: Independent Industrialists' and Businessmen's Association)

NGO	Non-Government Organization
RI	Random Index
SCM	Supply Chain Management
TOBB	Türkiye Odalar ve Borsalar Birliği (English: The Union of Chambers and Commodity Exchanges of Turkey)
TOPSIS	Technique for Order of Preference by Similarity to Ideal Solution
UTİKAD	Uluslararası Taşımacılık ve Lojistik Hizmet Üretenleri Derneği (English: Association of International Forwarding and Logistics Service Providers)
VIKOR	Vise Kriterijumska Optimizacija Kompromisno Resenje

CHAPTER 1 : INTRODUCTION

1.1 Chapter Overview

This chapter describes the author's motivation for conducting this research. The chapter starts by looking at the research background followed by a section explaining the research problem and motivation. It then presents the research aim and objectives based on the research questions. Furthermore, a brief overview of the structure of the research methodology and an outline of the thesis is given at the end of the chapter.

1.2 Research Background

Twenty years ago, logistics had not been much investigated but nowadays it has been attracting substantial interest from organisations due to the advancements of information technologies and increased demands (Chen and Wu, 2011). Besides its significance in practice, logistics has also become critical for academic studies as reflected in the rising number of studies in the field. Although various studies have been conducted in the logistics area, the literature review of this thesis revealed that two subjects have been mainly investigated by researchers, which are performance measurement (e.g. Kayakutlu and Buyukozkan, 2011; Liu and Lyons, 2011), and outsourcing decisions including third-party logistics (3PL) provider selection (e.g. Göl and Çatay, 2007; Jharkharia and Shankar, 2007; Cooper *et al*., 2012).

Providers of logistics services are usually referred to as 3PL providers (Mothilal *et al*., 2012) and 3PL provider selection (or logistics service provider selection) forms the basis of outsourcing decision problems in the area. There are two major reasons why researchers focus on the outsourcing subject. The first is the rising strategic role of logistics for organisations to adapt successfully to the dynamic changes in business environments (Meade and Sarkis, 1998; Çelebi *et al*., 2010). Secondly, a well-organised logistics system along with a good partnership strategy provides organisations with a competitive advantage (Çelebi *et al*., 2010). Hence, as a result of these rationales, evaluation and selection of logistics service providers within a supply chain has become a vital task for 3PL user companies since successful logistics management is mainly based on 3PL companies' performance (Aktas and Ulengin, 2005).

More specifically, during logistics operations, transportation management has a significant role for companies' success because the transportation has become the costliest element in logistics processes, especially in international trade (Daim *et al*., 2013) and managing this cost is a hard task due to radical changes occurring within the transportation industry (Vijayvargiya and Dey, 2010). Accordingly, this challenging task leads organisations to outsource their logistics operations to 3PL companies which results in augmentation of the significance of both the logistics industry and logistics provider companies existing in this industry.

Furthermore, performance evaluation is also a critical issue in logistics management and organisational performance evaluation is a key process to increase the efficiency of logistics companies (Wang *et al*., 2012). Despite there being numerous studies on performance measurement in the literature, the knowledge concerning how managers can decide which performance indicators to adopt remained shallow in performance measurement because researchers usually discussed generic guidelines rather than specific and actionable maps (Neely *et al*., 2000). Notably, in terms of the identification of the logistics performance indicators in logistics performance measurement, Chow *et al*.'s (1994) study was, presumably, the first effort to define logistics (or supply chain) performance by presenting some indicators to measure logistics performance; since then, most studies on logistics performance have emphasised the models and frameworks (Chia *et al*., 2009). Generally, researchers assess the performance of 3PL companies in order to select the most suitable logistics service provider by considering either different industry (e.g. textile or automotive industries) norms or individual company norms. However, it appears that there is a minimal amount of empirical research on performance measurement of 3PL providers (Rajesh *et al*., 2012) and developing a comprehensive as well as subjective performance evaluation model for the logistics industry has become significant and essential (Huang and Jhong, 2012). More particularly, performance measurement and evaluation of 3PL providers without any other industry-specific criteria received very limited interest from researchers in the logistics domain (e.g. Daim *et al*., 2013). For these reasons, one has to examine performance evaluation in the logistics field, especially for 3PL companies, by considering the logistics industry norms.

1.3 Research Problem and Motivation

Performance measurement, described as a multidimensional domain (Gutierrez *et al*., 2015), is a process of choosing performance indicators and generating a combined evaluation system including various indicators (Öztayşi and Uçal, 2009). Also, it is a strategic way to examine operations through the causal relationships between results and determinants (Garengo *et al*., 2005) as well as monitoring past actions in order to improve failures for future success. In the past, financial indicators were mainly used in performance measurement systems (Yang *et al*., 2009) but this causes short term bias without addressing operational excellence (Öztayşi *et al*., 2011). Since today's performance measurement includes both financial and non-financial indicators (Poveda-Bautista *et al*., 2012), choosing a suitable range of indicators in a balanced way has become essential in performance measurement systems (Yang *et al*., 2009).

Also, performance measurement is a key component of the strategic practices of logistics companies, especially 3PL companies which play vital roles in logistics and supply chain operations. Based on the literature review, as examined in Chapter 2, most of the studies with respect to 3PL performance evaluation or measurement have been conducted for selection purposes, and as Rajesh *et al*. (2012) highlighted, performance measurement and indicators pertaining to 3PL providers have received limited attention from both academics and practitioners.

That is to say, there is a small amount of research relating to how logistics companies handle performance management processes apart from the research gap relating to the knowledge of the obstacles for performance management from the perspective of logistics companies (Forslund, 2012). What is more, existing studies regarding the performance evaluation of logistics companies far from adequately reflect the total performance (Zheng, 2010). In this regard, it is necessary to develop a framework for implementing a strategic performance measurement system to 3PL providers (Rajesh *et al*., 2012). Consequently, the purpose of this study is to constitute a decision model in order to assess the logistics performance indicators from the logisticians' perspective. Hence, logistics companies can evaluate their performances in comparison with their competitors in the industry. By providing such a framework, a wide range of performance indicators can be required from different perspectives in order to have a comprehensive performance measurement outlook (Bhagwat and Sharma, 2009) and having a balanced set of these indicators to represent real-life solutions from multiple aspects can play a vital role, although it is difficult for organisations.

The difficulty in terms of the balanced outlook in the logistics performance measurement goes back a long way. In the early 2000s, Neely *et al*. (2000) noted that little attention had been given to the problem of developing a balanced performance framework, in addition to how performance measurement frameworks can be populated or how managers can decide which indicators to adopt in their performance measurement systems. In today's circumstances, this challenge has extended into a major problem and, recently, having too many indicators has become one of the most prevalent issues in supply chain performance measurement (Shaw *et al*., 2010). Since there are many performance indicators in the supply chain area, apart from the difficulty of using plenty of metrics in daily operations for firms, identifying which measures are important remains a problem for managers (Bhagwat and Sharma, 2009). Even if the managers attempt to cover a broad variety of measures, being faced with too many metrics also causes a lack of clarity (Youngblood and Collins, 2003) and requires substantial effort as well as high costs both for obtaining and analysing data (Sorooshian *et al*., 2013). Accordingly, practitioners should tend to seek answers of some questions concerning which measures they should use and when to use (Gopal and Thakkar, 2012), because many logistics organisations are run and managed without a formal set of performance indicators (Frazelle, 2002). That is to say, logistics companies have poor capabilities for the efficient adaptation of performance indicators (Forslund, 2012). This being the case, managers should seek a satisfactory balance of performance indicators presenting a holistic approach (Gutierrez *et al*., 2015). Such an approach can also help organisations to become more competitive in the industry. In this sense, the ideal model needs to enable performance evaluation in logistics from different aspects to reflect the accuracy of a real-life example. However, only a few papers have tackled logistics performance evaluation from multiple perspectives (Wang *et al*., 2012).

Besides the limited studies on the logistics performance measurement (Keebler and Plank, 2009), studies examining the competitiveness of logistics service providers as a focal point has also

remained largely under researched in the logistics and supply chain area (Liu *et al*., 2010a). This focus is essential because increasing demand and supply pressures result in a problem for logistics companies in terms of finding a way of competing successfully in rapidly changing business environments (Liu *et al*., 2010a). In order to understand their relative positions, logistics companies may want to know what their competitors do and what gaps exist between their own operations and best-in-class performers (Min, 2013). Since the logistics service industry needs theories and solutions with respect to its competitiveness (Wong and Karia, 2010), the proposed model based on the Balanced Scorecard (BSC) approach with the integration of the presented method, the Analytic Network Process (ANP), is used to serve this need.

In addition, defining suitable performance indicators in a balanced way is not the only challenge in the performance measurement of companies. Understanding the interactions and correlations among different indicators in performance measurement is another difficult duty for organisations (Thakkar *et al*., 2007) since, in practice, performance indicators are not always totally independent (Wu and Lee, 2007; Tsai *et al*., 2009) and interactive relationships exist between the indicators (Tzeng *et al*., 2007). However, interdependencies between indicators are rarely considered by researchers in performance measurement systems (Grosswiele *et al*., 2013). In a similar vein, Akyuz and Erkan's (2010) literature review analyses concluded that modelling the hierarchical structure and determining dependencies between diverse performance indicators are demanding and remain unresolved in the supply chain. From this point of view, it is indispensable for logistics companies to understand causal relationships between different variables (Wong and Karia, 2010). Accordingly, logistics managers can further try to find the answers to different questions such as how to prioritise the indicators and how to construct hierarchical relationships among the selected indicators (Qureshi *et al*., 2008). Yet, the dilemma here is that managers measure too much and spend much time and effort on quantifying all the facets of their companies which results in plenty of indicators (Carlucci, 2010). In such cases, multi-criteria decision making (MCDM) techniques accommodate answers to these questions in the performance measurement concept (Shaik and Abdul-Kader, 2014).

Thus, in order to overcome these major challenges regarding the identification of the key indicators and determining the interdependencies among these indicators, firstly it is important to indicate the pool of performance indicators and to identify the key performance indicators in the logistics industry. Then, providing a robust MCDM approach to analyse interdependencies among these indicators may help to resolve relevant issues as a response to the interrelationship problem.

Concerning the initial problem of defining key indicators, different performance measurement frameworks proposed by previous researchers are analysed in this research in order to provide a multidimensional framework including a balanced set of indicators. Among these frameworks, those developed after the mid-1980s have a more balanced perspective in view of the criticisms regarding the narrow focus of traditional frameworks (Garengo *et al*., 2005). Especially the BSC,

which has taken much interest from both practitioners and academics (Rajesh *et al*., 2012), helps managers to understand many interrelationships by providing a balanced view between financial and non-financial indicators (Chia and Hoon, 2000; Jothimani and Sarmah, 2014). Moreover, some authors have emphasised the importance of the causal relationships presented in the BSC and have suggested studying the interdependent relationships among both the BSC perspectives and performance indicators used under BSC perspectives for future research (e.g. Chia and Hoon, 2000; Yüksel and Dağdeviren, 2010). Consequently, what have been embedded in the suitable features of the BSC concept formed the basis of the main motivation to implement the BSC approach and to examine the dependencies among the perspectives as well as indicators.

On the other hand, regarding the interdependency problem, the nature of consideration of both a set of diversified indicators from multiple dimensions and the need to account for their interrelations resembles the MCDM process. To take the most effective action, decision makers in organisations have to deal with great uncertainty and complexity throughout this process. Since performance indicator selection is an MCDM problem for managers (Carlucci, 2010) and converting managerial opinions into actions, as well as assessing the dependencies among the indicators, requires multi-criteria evaluation; it is unavoidable to use an MCDM method to capture these interdependencies (Kayakutlu and Buyukozkan, 2011). Similarly, in transportation operations, increasing uncertainties and interrelationships among performance indicators lead researchers to explore MCDM methods (Shaik and Abdul-Kader, 2013). In these methods, the ANP is promising because it offers its users a more accurate and realistic performance score (Yurdakul, 2003). Another motivation for using the ANP method in the logistics industry is based on the research gap in the service industry concerning the applications of these methodologies, which are already proven in the manufacturing industry (Daim *et al*., 2013). Also, the use of the ANP method is seen as a promising future research regarding competitiveness of both the measurement systems and companies in the same industry (Poveda-Bautista *et al*., 2012).

In short, the main rationale for carrying out this research is to provide significant answers to the previously mentioned two problems of identifying the key performance indicators from hundreds of measures, and modelling and determining the interrelationships among the indicators to help logistics companies decide the measures on which they should focus and in which order they should prioritise the indicators to become more competitive in the industry. By doing this, it is also aimed to shed light on the research gap existing in logistics performance measurement in terms of the integration of the BSC and the ANP method. Thus, the proposed approach will also help to develop a better understanding of the challenging issue of developing a balanced model in the logistics performance measurement area with the holistic MCDM view.

Much information related to the above concepts and the relevant research studied in these areas will be comprehensively explored in the literature review. Yet, it is worth noting that reviewing the relevant literature in terms of logistics performance measurement, BSC-related studies in the

logistics field, and ANP studies in the logistics domain guided the researcher to investigate the assessment of performance indicators used in the logistics area with the integration of different stakeholders by using these approaches. In this way, both the importance of the performance indicators and various stakeholders in the logistics field are considered for the first time in the literature by using the BSC-ANP integration, especially from the logisticians' perspective. After deciding this integration, in order to provide a robust approach as a response to the aforementioned problems and to reflect the solutions in a strategic case country, the Turkish logistics industry was used as a case in this study. The main rationales for conducting the research in Turkey are explicated in Section 5.2.

Finally, the proposed model provides a theoretical basis upon the BSC concept to identify the performance indicators and, also, it offers a promising approach based on the ANP method to prioritise the performance indicators used for the logistics industry by considering their direct and indirect relationships. The research is proposed without having any other industry-specific point of view apart from the logistics area. By this way, the research aims to solve the prioritisation problem of the performance indicators for logistics companies which will help decision makers in logistics companies to decide which performance indicators to focus on in order to be more competitive in the industry. In addition, the results will help managers in industries other than the logistics industry during their logistics service outsourcing decisions, when selecting the best provider. Hence, the research will give practitioners, both in the logistics and in other industries, a better understanding of the prioritisation and assessment of the performance indicators involved in logistics performance measurement as well as the interrelationships among these indicators. Thus, the presented framework and the results can also be used as a basis for future research on the performance measurement of logistics companies.

1.4 Research Aim and Objectives

This thesis aims to provide a comprehensive decision model that identifies the most significant performance indicators for logistics companies from the literature and determines the relative importance of these indicators, from the perspective of logisticians, by assessing the interrelationships in a decision-making process. To achieve this aim, the author used a combination of the BSC approach and the ANP method supported by an online survey. By doing this, it is intended to develop a decision-making structure in order to solve a complex real life problem, which is multi-criteria in nature, and to prioritise the performance indicators through the ANP method.

Accordingly, the aim of the thesis will be achieved through these four objectives:

- To explore and identify significant performance indicators in the logistics industry;
- To propose a comprehensive model for the evaluation of both financial and non-financial performance indicators in the logistics area;

- To examine the interrelationships among the performance indicators in the model followed by the prioritisation of these indicators;
- To conduct a case study in the logistics industry in order to demonstrate both the applicability of the model and the ANP outcomes.

In order to achieve these objectives, this thesis addresses one main research question consisting of the five supportive sub-questions. The main research question is: *How can a decision model be formed by incorporating key logistics performance indicators and can help the prioritisation of these indicators by considering all interrelationships?*

The supportive questions under the main question are:

1) How can all stakeholders and the BSC approach be integrated and evaluated together in the decision-making process?
2) What are the most significant performance indicators in the logistics industry?
3) How can the interrelationships among the indicators be captured?
4) What are the relative priorities of the performance indicators in the logistics area?
5) How can 3PL companies provide better services and be more competitive in the industry?

1.5 Structure of the Research Methodology

In this research, different methods and research approaches were applied to achieve the research objectives. A mixed-method approach was used in this research to benefit from both quantitative and qualitative techniques. The research methodology design of this study relied on four phases as shown in Figure 1-1.

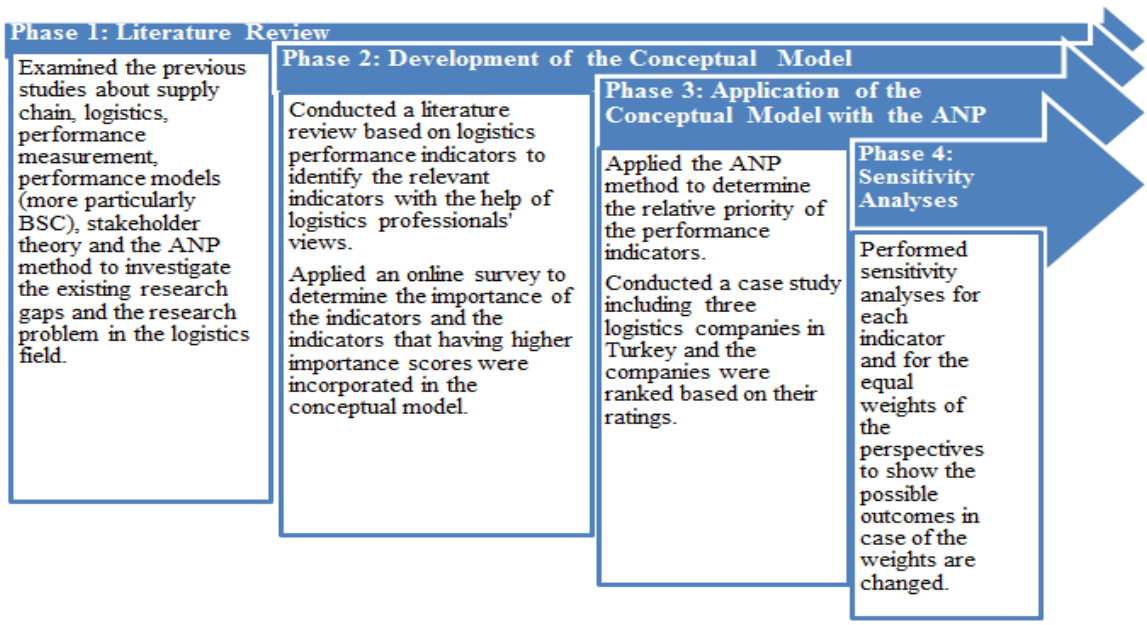


Figure 1-1: Phases of the research methodology

In the first phase, examination of the previous studies within a comprehensive literature review of the research area was conducted. Hence, initial information about existing studies was gathered and some research gaps in concern with the research problems were investigated. The literature review was conducted on the following subjects:

- Supply chain management (SCM) and logistics areas
- Performance measurement with focus on logistics
- 3PL selection studies
- Performance models used in performance measurement, particularly the BSC approach
- BSC-related studies in logistics
- The current status of the MCDM methods, in particular the ANP technique and its applicability in logistics field
- Studies on both the BSC and the ANP approaches together
- Stakeholder theory and fundamental studies about the stakeholder theory approach

Furthermore, the literature review of this thesis revealed that the BSC was the most suitable approach to develop a framework in the logistics industry. However, a major deficiency of the BSC approach, which is negligence of considering various stakeholders, needs to be addressed more in BSC models. Hence, this deficiency triggered the necessity to consider different stakeholders in the BSC approach of this research. Also, the causal relationships among the perspectives and the performance indicators used in the BSC approach need to be considered for a complex real-life problem.

In the second phase, an exploratory approach was incorporated to address the first and second research objectives. By considering both the research problem in logistics performance measurement and also demerits of the BSC approach, a stakeholder-based BSC model was proposed. Along with the systematic literature review for the inclusion of relevant logistics performance measures, a total of 43 performance indicators were identified based on the comprehensive literature review and discussions with practitioners and academics in the logistics field. Then, these 43 indicators were placed under the four perspectives of the presented model and the importance of each of these indicators was determined through an online survey by analysing 72 respondents' answers. The answers of the 72 professionals, who have different backgrounds in logistics field, were considered sufficient since the aim of the online survey was to highlight the most important indicators. Subsequently, the most significant 15 indicators were selected by using a cut-off value for each perspective and the prominent 15 indicators formed the conceptual model of this research.

In the third phase, as a response to the other research problem, interrelationships among the performance indicators were analysed by using the ANP method. The pairwise comparisons included in the ANP processes were assessed by three logistics experts from Turkey. At the end of the assessments, the ANP results gave the priorities of the performance indicators used in the

model. Thus, with the help of the ANP method, not only direct relationships but also indirect relationships occurring via higher degree of influences among the indicators were determined. Consequently, the third objective of this research is fulfilled at this stage. Moreover, in order to demonstrate the applicability of the research model, the obtained results from the ANP method were used in the ranking process of the selected three major logistics companies in Turkey. In the ranking process, these companies were assessed in terms of each indicator in the model. As a result, after all these stages within this third phase, both the practitioners and academics were enlightened regarding the relative priorities of the logistics performance indicators and the case companies' rankings. Thus, the latter stage in connection with the case study allows addressing the fourth objective of the research.

Finally, in the fourth phase, in order to draw some significant conclusions, which may be useful for both academics and practitioners, and to show how the final outcome of the case study is sensitive to changes, sensitivity analyses for each indicator were conducted. Later, an additional sensitivity analysis by considering equal weights for the perspectives was carried out. By this way, the 'what-if' scenarios and their possible outcomes were presented in case of some alterations occurring in the performance indicators' global weights. Hence, the robustness of the results found within the scope of the fourth objective was tested in this phase.

1.6 Thesis Outline

This thesis consists of eight chapters. A brief description for each chapter is as follows:

Chapter One: Introduction

This chapter provides an overview of the research background, identifies the research gap, highlights the challenging issues need to be considered, points out the motivation and contribution, and indicates the aim and objectives of this research. The chapter also summarises the structure of the research methodology and provides an outline of the thesis.

Chapter Two: The Need for a Balanced Scorecard Informed ANP Model for Logistics Performance Measurement

This chapter is constituted by two parts. In the first part, SCM and logistics, performance measurement-related studies in logistics, and selection studies are investigated while in the second part, the BSC principles and BSC-related studies in logistics, different stakeholders' consideration as a response to the weakness of the BSC, and the ANP method applications as well as with the BSC integration are examined in detail.

Chapter Three: Methodology

This chapter initially presents the philosophical stance and the research approach of this thesis. Then, the chapter describes the applied research methods such as an online survey, the ANP

method, and the semi-structured interview technique with their methodological backgrounds. Also, in this chapter, each step of each method is clearly clarified.

Chapter Four: Development of the Conceptual Model for Performance Measurement in Logistics

This chapter presents application of structuring the problem starting from the identification of the performance indicators, grouping of the indicators into the proposed BSC perspectives, and constitution of the conceptual model. Moreover, the chapter shows that the performance indicators included in the model based on the results of the online survey are emphasised by various authors in the literature.

Chapter Five: Testing of the Conceptual Model with the ANP Method: A Case Study in the Turkish Logistics Industry

This chapter aims to demonstrate the applicability of the combined BSC-ANP approach. Therefore, the implementation of the research problem in this chapter shows both applicability of the proposed model and validation of the ANP method in a real case study, the Turkish logistics industry. Moreover, the chapter indicates the semi-structured interview method application for major logistics companies listed in the Fortune Turkey magazine in order to obtain data in terms of each indicator used in the model. As a result, by considering these data, the ranking of three logistics companies is presented based on their current performances.

Chapter Six: Sensitivity Analysis

This chapter indicates 16 what-if scenarios for the three case companies in case of the weights of both the indicators and the perspectives in the model are changed. Fifteen of these scenarios represent the alterations in companies' ranking based on the different weights for each indicator while the last scenario shows the equal weights for the perspectives in the BSC model. As a consequence, in this chapter, the effect of different weights of indicators on the companies' ranking is presented in each scenario.

Chapter Seven: Discussion and Summary of Key Findings

This chapter shows the meanings and values of the results obtained in this research. Also, the findings of the relative studies examined in the literature are summarised and discussed in this chapter.

Chapter Eight: Conclusion

This chapter addresses the aim and objectives in line with the key findings and shows the academic as well as management and practical contributions along with the overall contributions of the research. Moreover, research limitations and a number of recommendations for future studies are presented.

1.7 Chapter Summary

In this chapter, the main motivation to conduct this research was explained in detail. Therefore, the chapter starts with the research background followed by the existing research problems and the motivations which were revealed from the literature. In addition, the research aim and objectives were described based on the identified research questions. Then, an overview of the structure of the research methodology was presented. In the last section, the thesis outline was summarised by giving a brief explanation of each forthcoming chapter's content.

CHAPTER 2 : THE NEED FOR A BALANCED SCORECARD INFORMED ANP MODEL FOR LOGISTICS PERFORMANCE MEASUREMENT

2.1 Chapter Overview

This chapter provides an overview of the published literature regarding the research topic which was outlined starting from the broad view of SCM and logistics as well as performance measurement in logistics, moving on to some specific subjects such as the emergence of the BSC among the other performance measurement frameworks, integration of the various stakeholders in the BSC approach, the ANP method applications in logistics, the combination of the BSC-ANP approach, and the need to use this combination in logistics. Also, throughout the literature review in this chapter, five databases, which are ABI/Inform, ScienceDirect, Scopus, Emerald, and Sage, were used consistently with some modifications of searched terms to the abstracts, title, and keywords. Especially, the abstracts were fundamentally searched for as a general approach.

Moreover, the chapter construction is based on the research gaps and motivations and, therefore, succeeding sections in this chapter explore the gaps and motivations emphasised in the previous sections. Thus, the significant outcomes of the reviews in this chapter conclude and emphasise the need for using the BSC-ANP combination in logistics, as indicated in the last section of this chapter.

2.2 Supply Chain Management and Logistics

2.2.1 Supply Chain Management

The supply chain management term first emerged in the 1980s. In the early 1980s, the centre point of the studies was the system integration of business operations whilst in the late 1990s, different frameworks and aspects of the SCM were focused on by researchers (Gundlach *et al*., 2006). However, in today's SCM, there are two distinctive streams, namely descriptive research which is conducted by the researchers from industrial marketing and purchasing, and prescriptive research which is based on the areas of operations management, strategic management, and logistics (Lamming *et al*., 2000; Gundlach *et al*., 2006).

Recently, SCM has been broadly practised by many companies (Gunasekaran and Kobu, 2007) and been examined in numerous studies where innumerable definitions were put forward. Although researchers tried to distinguish the SCM and logistics differences in previous studies, unclear boundaries remain between these terms for researchers and practitioners. SCM is more general than logistics and it is a cross-disciplinary network concept embracing many organisations from suppliers to end-users (Küçükaltan and Herand, 2014). It covers various concepts, theories, and methods from different disciplines, such as marketing, industrial economics, operations management, logistics, international business and organisational management, and information

technology (IT) (Gundlach *et al*., 2006). In other words, regarding the arguments highlighted by the Supply Chain Council, SCM is more comprehensive than logistics and it covers different business processes, players or activities (Mentzer *et al*., 2008). On the other hand, at a basic level, logistics explains what happens in the supply chain and, also, logistics functions, such as inventory management, supply, customer response, transportation, and warehousing link the elements remaining in the supply chain (Frazelle, 2002).

Moreover, in the literature, although some differences are mentioned in the definitions of the SCM, there are many commonalities among these definitions, such as integration, coordination, and a flow of operations (Gundlach *et al*., 2006). The commonly accepted definition of the SCM presented by the Council of Supply Chain Management Professionals (CSCMP) is as follows (CSCMP, 2015):

"*Supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies*."

Similarly, the Global Supply Chain Forum emphasised that SCM contains harmonization of all operational processes at any level beginning from suppliers who provide services, products, and information that add value for customers and other stakeholders (Lambert and Cooper, 2000). Based on these statements, especially focusing on the CSCMP's definition, it can be concluded that SCM is an integration system synchronizing the business processes across the whole supply chain from suppliers to customers. A typical supply chain consists of two main business processes, which are material management (or inbound logistics) and physical distribution (or outbound logistics) (Min and Zhou, 2002). From this point of view, the general concept of a supply chain system with the inclusion of these two processes is shown in Figure 2-1.

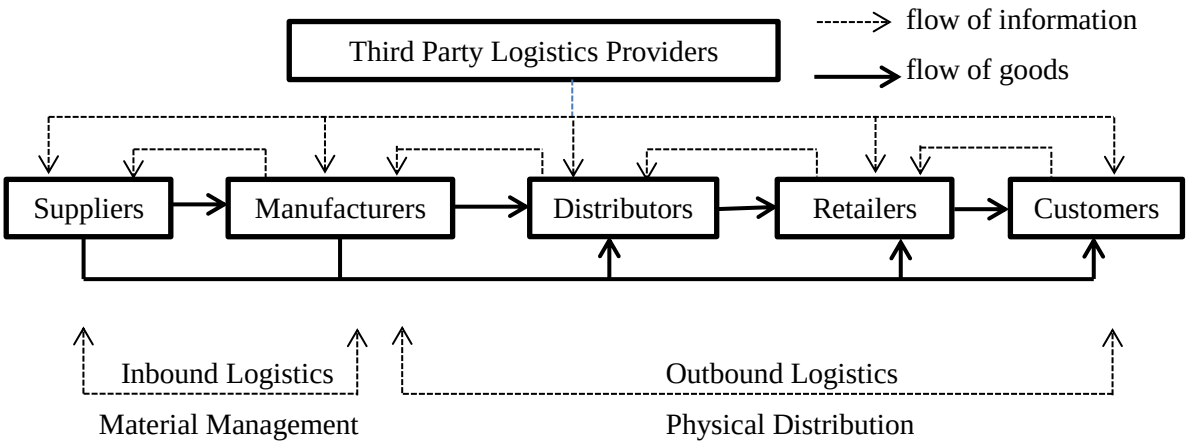


Figure 2-1: The supply chain system

Source: Min and Zhou (2002, p. 232)

As can be seen from Figure 2-1, there are various players in a supply chain system where each of these players has different roles. As explicitly indicated in the system, 3PL providers are essential players in SCM because they can both contribute to the growth of the supply chain scope and support increased supply chain integration (Fabbe-Costes *et al*., 2009; Forslund, 2012) as well as managing the flow of goods and information throughout the chain. This is also in line with Lambert *et al*.'s (1998) classification. According to this classification, there are two distinctive types in a supply chain, the primary and the supporting partners, and 3PL providers are members of the supporting partner group (Min and Zhou, 2002).

In this regard, since the logistics operations and the key actors in the logistics operations, which are 3PL providers, play a crucial role in the supply chain, they cannot be separated in the supply chain-related studies. Accordingly, by considering both these conditions and the previously mentioned research problems in the logistics field, the detailed information regarding logistics and 3PL providers will be explained in the following section.

2.2.2 Logistics

Logistics is part of SCM (Lambert and Cooper, 2000) and has attracted much attention since its early history. Apart from the old historical background, logistics is also a very critical discipline for our daily lives (Taylor, 2009). Basically, logistics is related to effective movement, storage of goods, and having some economic utilities associated with value creation through time and place conversion (Chase *et al*., 2006; Mentzer *et al*., 2008). Nowadays, since transportation-as a part of logistics operations-is the costliest element for organisations (Daim *et al*., 2013), businesses have tried to reduce their operational costs, more particularly their logistics costs. Under these circumstances, logistics has become a steadily important field to be focused upon in today's competitive environment in terms of meeting business needs (Tsai, 2006).

The origin of the logistics term comes from the 'logistique' word and it passed into the English language in the nineteenth century (Taylor, 2009). In the 1950s and 1960s, the logistics term was only being used in the military services (Frazelle, 2002). According to Taylor (2009), the first professional association in the logistics field was formed in 1963 with the name of the National Council of Physical Distribution Management, which became the Council of Logistics Management in 1985, turning into the CSCMP in 2004. Early logistics studies focused primarily on defining sub-functions of the logistics, such as warehousing, inventory management, inbound and outbound transportation, and managing these functions most efficiently, but in the 1980s and 1990s, new emerging concepts, such as electronic data interchange, interorganisational and interfunctional integration, and relationships were selected as key areas to be focused upon by researchers (Mentzer *et al*., 2008). On the other hand, in recent years, the logistics term has extended and moved further from the transportation and warehousing concepts to inclusion of various concepts (e.g. marketing, sales). That is to say, different concepts have been incorporated

in today's logistics term, and therefore, logistics has become a multi-disciplinary notion (Frazelle, 2002).

During the evolution of the logistics term, logistics management was mainly focused upon by researchers and various definitions of the logistics management were discussed in the literature. Yet, the widely accepted definition was published by the CSCMP as follows (CSCMP, 2015):

"*Logistics management is that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverses flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements.*"

Referring to the definition, it can be concluded that logistics is associated with different activities whose identification was categorised differently by various researchers. For instance, in Waters's (2007) book, it was pointed out that logistics covers diverse activities, such as transport, procurement, receiving, warehousing, materials handling, inventory management, order processing, recycling, distribution, information processing, and location decisions. On the other hand, Frazelle (2002) summarised these activities under five interdependent categories, namely inventory planning and management, customer response, supply, transportation, and warehousing. Additionally, he placed sub-activities under these five categories and proposed a framework as shown in Figure 2-2.

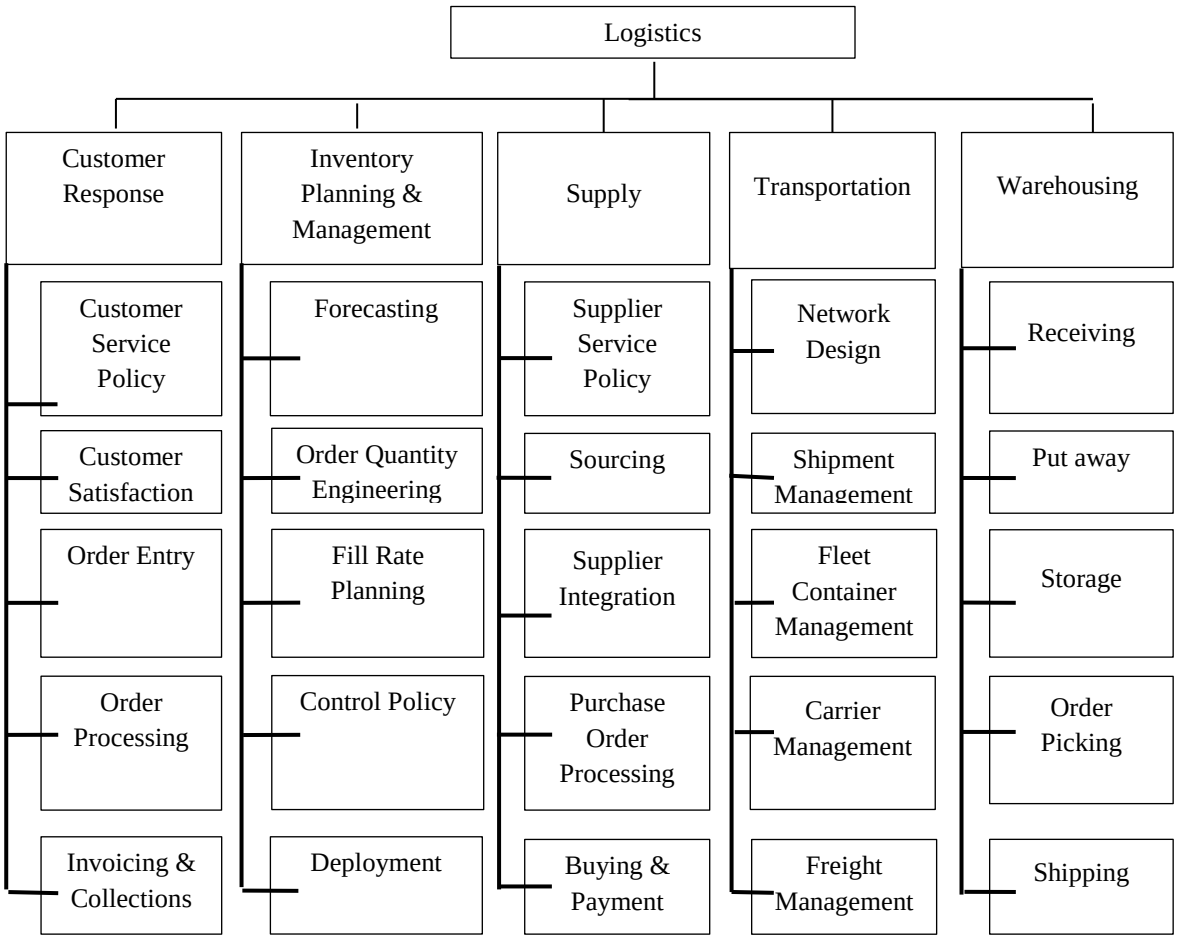


Figure 2-2: Logistics activities

Source: Modified from Frazelle (2002)

Generally, in early studies, the forward movement of goods (or products) was more emphasised within logistics operations. Yet, lately, apart from the forward logistics, the reverse logistics term has also started to be handled in the studies. Principally, reverse logistics has emerged as an outcome of the increasing proportion of products along the supply chain for reuse, repair, recycling or remanufacture purposes (McKinnon, 2007). The three main reasons to implement reverse logistics operations can be summarised as: economic advantages, ecological benefits, and judicial pressures through regulations (Tekin, 2013).

Either in forward logistics or in reverse logistics, the movement of goods can be managed by different transportation modes. There are five main modes used during transportation activities, namely: road, rail, air, water, and pipeline (Stock and Lambert, 2001; Davidsson *et al*., 2005). Most logistics activities and transportation modes are provided by 3PL service providers and, in some cases, by fourth-party logistics (4PL) service providers. According to LODER[1]'s definition, 3PL providers are the companies which fulfil at least three different logistics activities (e.g. warehousing, transportation and inventory management) existing in the supply chain (Keskin, 2008) while 4PL providers manage 3PL providers and act as a general contractor (Frazelle, 2002).

[1] Lojistik Derneği (Logistics Association)

Logistics managers play an important role to maintain these operations efficiently in these companies. Besides maintaining, considering the actual trends in the area in order to provide better services and to become more competitive in the field is indispensable for managers. According to Waters (2007), trends in the logistics industry can be exemplified as follows: improved communications and e-business, globalisation, satisfying more demanding customers, and responding to changes in the business area. The author also stated that to follow these trends, it is essential to plan and design a successful logistics strategy as well as understanding and balancing the demands of higher strategies, business environment, and internal features. In line with this view, it is worth noting that designing a successful strategy gives companies many advantageous opportunities for competition. Although finding a determined set of performance measures is crucial for a successful strategy and competitiveness, many logistics organisations are run and managed without a formal set of performance measures (Frazelle, 2002). This set of measures can be also used in the benchmarking processes for organisations, and by this way, companies can see their relative positions in the industry by comparing their own operations with their competitors (Min, 2013). Therefore, identification of a determined set of key performance indicators has an important place in logistics.

To sum up, logistics and logistics operations have an increasing trend in today's competitive environment. Being the costliest element, the transportation enhances the importance of logistics operations even more. Various activities are included in logistics operations and these are usually provided by logistics companies as they are crucial players in the supply chain. However, companies in the logistics industry are still managed without a determined set of performance indicators. Moreover, there is not much research regarding performance measurement of 3PL providers. As a consequence, logistics companies cannot benchmark their operations efficiently and this leads to diminish both the potential improvements in the logistics industry and the profitability of their customers. Therefore, logistics companies, more particularly the most active providers, which are 3PL providers, should focus on measuring their performances with a well-designed set of performance measures to increase their performances because, as Tekin (2013) stated, developments in logistics and transportation will advance international trade which, in turn, affects the region and country economy. For this reason, performance measurement of logistics companies has a significant role in the globalising world.

2.3 Performance Measurement and Its Implementation in Logistics

2.3.1 Evolution of Performance Measurement

Before exploring performance measurement related studies in logistics, it would be better to start from the definition of measurement and performance measurement as well as mentioning some relevant concepts used in performance measurement. Measurement is an instrument that allows monitoring and providing better understanding of processes and operations (McIntyre *et al*., 1998) while performance measurement, a tool to hold a complex system together, to formulate a strategy,

and to monitor the application of that strategy (Handfield and Nichols, 1999; Choy *et al*., 2008), has structured and behavioural characteristics (Weichhart *et al*., 2010). In other words, whereas measurement is used as an instrument to reach performance, performance measurement is a representation of the procedure of quantifying activity (Jothimani and Sarmah, 2014). Therefore, in accordance with the aim of this research, the performance measurement concept is focused in this thesis.

Although there are many studies conducted in performance measurement, no common definition has been established to date (Franco-Santos *et al*., 2007). Nevertheless, the most preferred definition of the performance measurement among researchers is, "*the process of quantifying the efficiency and effectiveness of action*" (Neely *et al*., 1995, p. 80). Besides, during quantification, performance measurement error needs to be minimised in order to obtain accurate results. In this respect, since performance measurement error is quantified as reliability (Foshay and Tinkey, 2007) the reliability theme is investigated in this research as well as considering the validity.

Additionally, performance measurement has close relationships with different concepts or activities, such as performance evaluation, performance management, and performance measurement systems. Regarding performance evaluation and management, Yu *et al*. (2007) pointed out that these two notions are used to compute a performance score by using a performance measurement framework. More particularly, performance evaluation is a structured review process helping organisations to reach their goals (Chen *et al*., 2011). On the other hand, as another concept, a performance measurement system is closely related to performance evaluation and management. However, performance measurement system is a mechanism organising, controlling and improving firms' resources besides indicating the firms' flexibility and responsiveness to the changes (Choy *et al*., 2008). Also, it is a multi-disciplinary approach including different theories (e.g. operational research) from other disciplines (Wang and Lalwani, 2007) and performance indicators constitute the core function of a performance measurement system (Yu *et al*., 2007).

Within a performance measurement system, performance indicators are interdependent allowing managers to evaluate the whole system from different perspectives (Weichhart *et al*., 2010). Therefore, as a whole system, a performance measurement system plays a key role in organisations not only affecting the success of the company, but also providing important information about the activities. Hence, each element or activity existing in a performance measurement system makes significant contribution for the whole performance measurement.

There are numerous theories concerning how performance measurement was first evolved but, in any event, performance management emerged as a research field in the early 1950s when academics and practitioners started to be interested in measurement as a response to their needs to quantify (Argyris, 1952; Ridgway, 1956; Shaw *et al*., 2010). Between the 1950s and 1980s, more financial-based measurement systems were dominating the performance measurement field, but towards to the late 1980s, academics and practitioners recognised the need to change these

traditional systems (Dixon *et al*., 1990; Nudurupati *et al*., 2011). This necessity is based on the fact that traditional systems were not always satisfactory due to their limitations in terms of not addressing operational activities and intangible assets, and having short term bias (Öztayşi *et al*., 2011). As a result of these, as Nudurupati *et al*. (2011) pointed out, the limitations of the traditional systems caused dissatisfaction and formed the basis of the performance measurement revolution which started between the late 1970s and early 1980s.

From the early 1980s to the 1990s, performance measurement frameworks were emphasised and most of the proposed frameworks focused on the description of attributes and classification of relevant indicators (Gaiardelli *et al*., 2007a). Accordingly, this led researchers to study the prevalent question in the mid-1990s of how balanced performance measurement systems are developed and established (Neely, 2005). Since the late 1990s, new dimensions, such as stakeholder satisfaction (Atkinson *et al*., 1997), corporate social responsibility, and sustainability have been considered in the performance measurement frameworks (Gaiardelli *et al*., 2007a). Thus, all of these processes and developments show that, although performance measurement is still relatively immature (Neely, 2005), it continues to grow with new aspects.

2.3.2 Performance Measurement in Logistics

Performance measurement has been used as a business tool to assess management performance and managing the capabilities of businesses as well as practicing business strategy (Yu *et al*., 2007; Shaik and Abdul-Kader, 2014). The proper usage of the performance measurement can allow highlighting occasions to improve, identifying problems, and providing corresponding solutions (Wireman, 2005; Horenbeek and Pintelon, 2014). Similarly, implementing performance measurement enables evaluation of their past activities, to determine their future targets, and to motivate the people (Öztayşi *et al*., 2011). From this point of view it is worthy of note that measuring is significant and essential for firms (Gunasekaran and Kobu, 2007) because as was stated in Kaplan's (1990) book, "no measures, no improvement".

There are two main purposes of a performance measurement system: defining important measures (filtering) and placing measures under an appropriate perspective (clustering) (Shaik and Abdul-Kader, 2014). Concerning the former purpose, defining both the correct measures and a strategy to measure performance is not an easy task for organisations. During the identification of such measures organisations can face some problems. For instance, in practice, organisations may fail to understand the performance measurement in a balanced approach (Lai *et al*., 2002) or even if they try to implement it in a balanced way, the poor definition of performance measures leads to misunderstanding among the people (Schneiderman, 1999; Nudurupati *et al*., 2011). In the sense of identifying the relevant number of measures with reference to the strategy, Shaw *et al*. (2010) expressed that having too many metrics is another issue in performance measurement. This being the case, the situation of using hundreds of measures, which are not compatible with business strategies, occurs for organisations (Hofman, 2006). In such cases, the identification of the

important measures remains a hard task for managers (Bhagwat and Sharma, 2009). Accordingly, managers should attempt to answer questions regarding what measures they should use and when to use them (Gopal and Thakkar, 2012). After solving these challenges, performance measurement can yield accurate results and become more beneficial.

As previously mentioned, a performance measurement system is a multi-disciplinary concept and covers performance measurement practices in different areas, such as logistics. Logistics performance is a rapidly increasing field of exploration (McIntyre *et al*., 1998) due to growing numbers of companies and the globalisation effect (Kumar, 2008). Since transportation appeared as the most costly element in operations (Daim *et al*., 2013), logistics performance measurement has been identified as an important concern for companies (Forslund, 2011). However, as Forslund (2011) pointed out, despite its importance, the application of logistics performance measurement is still a complex and challenging issue and, therefore, there is a need to measure the logistics performance.

On the other hand, 3PL companies are one of the actors operating in the logistics field. The growing request for logistics services gives a strategic role to the 3PL companies because 3PL providers offer competitive advantages to their customers (Jothimani and Sarmah, 2014) and, also, supply chains will not be effective unless 3PL providers measure their performances (Kayakutlu and Buyukozkan, 2011). However, it can be seen from the literature that there is limited empirical research on performance measurement and indicators regarding to 3PL providers (Rajesh *et al*., 2012). In other words, there is a small amount of research relating to how logistics companies manage performance management processes besides the research gap existing regarding the knowledge of the obstacles for performance management from the logistics companies' perspective (Forslund, 2012).

Before measuring the performance, deciding on the most important performance indicator remains another issue for logistics companies (Liu *et al*., 2010b). Both the significance of the logistics performance measurement and having too many indicators to evaluate for the performance has led researchers and managers to focus on multiple decision-making approaches. When there are a number of criteria to evaluate, decision-making plays an important role in performance measurement since it is one of the elements used to constitute the performance measurement structure (Simons, 2000; Shaik and Abdul-Kader, 2014). Therefore, these circumstances directed the researcher to investigate the MCDM techniques in this thesis.

During their measurement, 3PL providers may want to know what their competitors do and what gap there is between their current activities and best-in-class activities (Min, 2013). To fulfil this desire, a benchmarking approach, which forms the essential part of performance measurement (Lawson, 1995; Schmidberger *et al*., 2009), including some performance indicators (Yu *et al*., 2007) can be used for logistics providers (Jothimani and Sarmah, 2014). Also, the performance indicators should be benchmarked against competitors (Liu *et al*., 2010b). However, logistics

companies have poor capabilities for efficient implementation of performance indicators (Forslund, 2012). In this regard, it is essential to develop a framework consisting of a balanced set of measures for implementing a strategic performance measurement system to 3PL providers (Rajesh *et al*., 2012). So far, only few papers have dealt with logistics performance evaluation from multiple aspects (Wang *et al*., 2012). Having a balanced view is important for companies since managers should attempt to find a satisfactory balance of performance indicators presenting a holistic view (Gutierrez *et al*., 2015).

As emphasised in Yu *et al*.'s (2007) study, in the assessment of performance level and benchmarking, it is necessary to calculate performance scores by considering the priorities of each indicator and to find cause-and-effect relationships or correlations among the indicators. In order to analyse interdependencies among the performance factors, there is a clear need to apply an MCDM method to do this analysis (Kayakutlu and Buyukozkan, 2011). Yet, interdependencies among indicators have been rarely considered by authors during performance measurement system design (Grosswiele *et al*., 2013). From this point of view, it can be concluded that applying MCDM is an important step for both the performance assessment and benchmarking processes.

In the performance measurement literature, various MCDM methods are applied and different performance frameworks are studied by the authors. Among these methods, the main advantage of the ANP is that it provides more accurate and realistic results (Yurdakul, 2003) since it enables users to determine the cause-and-effect relationships among the indicators by considering higher degrees of influences in a network structure. The ANP has been utilised by many authors in performance measurement and evaluation (e.g. Sarkis, 1999; Yurdakul, 2003; Leung *et al*., 2006; Kayakutlu and Buyukozkan, 2011) and Kayakutlu and Buyukozkan (2011) highlighted that the ANP has a unique feature to consider these interdependent relationships when compared to other methods. Therefore, ANP-related studies in logistics area will be examined in this thesis. More information about the selection of the ANP method rather than another MCDM technique can be found in Section 3.7.2.

Regarding the proposed performance measurement frameworks in the literature, the BSC is used as a dominating performance measurement framework (Neely, 2005). The BSC is also related to the MCDM because the limitations of the BSC, such as making a decision on how many and which of the perspectives to have in the framework as well as the relationships among the perspectives remained in the multi-objective and multi-criteria evaluation problem (Wagner, 2002; Shaik and Abdul-Kader, 2014). Moreover, the BSC concept allows cause-and-effect relationships between the perspectives in its structure (Kaplan and Norton, 1996a). Further information concerning the BSC approach selection can be found in Section 2.7.

In light of this information, decision making, more particularly MCDM, plays an important role in performance measurement and evaluation. Also, there is a need for more quantitative focused performance measurement in the logistics and supply chain area in order to convert the qualitative

metrics into quantifiable indicators since determining and measuring key performance indicators is the most challenging issue for managers (Gunasekaran and Kobu, 2007). Therefore, both MCDM techniques, especially the ANP, and the performance measurement frameworks, by putting more emphasis on the BSC approach, will be scrutinised in this research.

2.4 Selection Studies as a Proxy of Performance Measurement

The current research is also related to 3PL selection because several indicators examined in this thesis have been used in 3PL selection processes. Additionally, in the case study section, performances of the selected 3PL providers are evaluated in terms of the performance indicators and this process resembles 3PL selection decision. Therefore, 3PL selection literature was included in the current research to reflect the existing studies from a selection point of view. In order to cover the relevant articles concerning 3PL selection, five keyword sets were used, namely: "3pl provider selection", "third party logistics provider selection", "3pl selection", "logistics provider selection-BSC" and "logistics provider selection". These keywords were searched in the previously mentioned five databases. During these processes, some articles in different fields (e.g. health sciences, medicine, chemical engineering, etc.), conference papers, working papers, and non-English articles were excluded from the search criteria because these articles are out of the scope of this research. After all these steps, a total number of 18 articles were found from the databases and all of these articles were accessed by the researcher. In addition to these, one more article was also found relevant during the cross-referencing activity. Finally, at the end of the search and review process, 19 articles were analysed in this section.

During the review of these articles, it was seen that most of the studies were researched in manufacturing contexts and the methods implemented in these studies varied. With regard to the methodological approaches of the studies within the manufacturing field, the Analytic Hierarchy Process (AHP) method was raised as the commonly applied technique. As an example of these studies, Perçin (2009) combined the modified Delphi and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) methods with the AHP technique. In his study, a Turkish automotive supplier company was used as a case study to clarify the methodological approach. In the Turkish context, another research was conducted by Göl and Çatay (2007) where they practiced the AHP method for a 3PL selection process implemented in Tofas-Fiat automotive company. The similar usage of the AHP approach, but as a single technique, was performed by Vijayvargiya and Dey (2010) to choose a suitable 3PL provider for a company in the automotive components industry in India.

Additionally, the searches showed that fuzzy approaches were also used by several authors in the manufacturing area. As an example, Li *et al*. (2012) first determined an evaluation model, and then used a fuzzy information-based method in their research. Afterwards, in order to show the applicability of the evaluation model, they proposed a case study carried out in an air conditioner manufacturer which wanted to select the most appropriate 3PL provider among the five

alternatives. Another research including fuzzy-based methods in the manufacturing industry was conducted by Wong (2012). In the research, the criteria weights were preliminarily generated by using the fuzzy ANP method and then preemptive fuzzy integer goal programming technique was employed to select the 3PL providers. In Perçin and Min's (2013) study, fuzzy linear regression and the AHP method was integrated with additional research techniques (quality function deployment, zero-one goal programming) and they presented a case study approach conducted in a Turkish automotive part manufacturer to select a suitable 3PL provider. On the other hand, in the manufacturing domain, not only fuzzy-based or AHP-related studies were discussed, but also a different technique was studied by Farzipoor Saen (2009). In the study, an approach based on the imprecise data envelopment analysis tool was used to evaluate 18 third-party reverse logistics providers by considering both cardinal (quantitative) and ordinal (qualitative) data. Hence, as can be seen in the studies above, various techniques are used to select 3PL providers in the manufacturing field but it can be concluded that the AHP was the commonly used method by researchers.

In addition to manufacturing, different industries were used as contexts by researchers. In the agricultural context, two papers, which are similarly studied by Xiu and Chen (2012) and Yu (2012), contained an integrated approach consisting of the AHP and the information entropy to select an appropriate 3PL provider for an agricultural products processing enterprise located in Heilongjiang province, China. In another context, the selection concern was studied in two papers focusing on the reverse logistics provider decision for a battery industry. For instance, Su *et al*. (2011) proposed the dynamic multi-attribute group decision making (MAGDM) technique under an intuitionistic fuzzy environment as well as practicing the fuzzy TOPSIS method to rank the alternative 3PL providers for a battery industry. Thus, they used different techniques during aggregation of the individual judgments. Likewise, in another study, Su *et al*. (2012) proposed the induced generalised intuitionistic fuzzy ordered weighted averaging operator regarding MAGDM problems to select the best third-party reverse logistics provider. A similar example of focusing on the reverse logistics operations was also handled by Azadi and Saen (2011) who applied a new chance-constrained data envelopment analysis technique to select the most suitable third-party reverse logistics provider among 12 candidates. Further, Liu and Wang (2009) studied 3PL selection for the Taiwanese semiconductor industry. In their study, an integration of three different techniques, namely the fuzzy Delphi method, fuzzy inference method, a fuzzy linear assignment approach, and a case study were proposed. In the case study part, eight 3PL companies were evaluated by their decision model with the integration of these methods. Based upon these studies, it can be seen that different MCDM techniques were used in various contexts for 3PL provider selection.

From a more general perspective, some researchers assessed 3PL utilisation in the supply chain context. For instance, Tezuka (2011) focused on the 3PL utilisation in the SCM area from the shippers' economic-based points of view and a conceptual framework was presented to evaluate

3PL utilisation. In another study, Jayaram and Tan (2010) identified four strategic criteria, namely information integration, 3PL selection criteria, 3PL performance evaluation criteria, and relationship building based on the extant theory as a conceptual foundation. They also tested the effects of these criteria on firm performance with the help of the survey approach. Thus, supply chain integration, including several players such as manufacturers/wholesalers/retailers with 3PL providers, was examined by the authors. A similar example regarding 3PL performance evaluation and selection was given in Vaidyanathan's (2005) study where the preparation of the evaluation list of the factors was initially considered and then, after the determination of the list of evaluation factors, a 3PL provider evaluation process was experimented in a Fortune 100 company. Also, interviewing potential 3PL providers during the selection processes was highlighted by the author. Thus, with regard to these studies examined in the supply chain area, it can be concluded that survey methods or different techniques, such as interviews or case studies are more commonly used than the MCDM techniques that were used in the previous specific industries.

On the other hand, there is a limited study pertaining to 3PL evaluation and selection from a logistics point of view. Based on the searches in this section, two studies were found related to the mentioned topics in logistics. In the former study, Xianlong and Yujie (2013) proposed an integrated approach including quality function deployment and AHP techniques and six selected transportation suppliers were assessed during the supplier selection process of a 3PL enterprise serving an automobile factory. Similarly, the AHP was used in the latter study conducted by Daim *et al*. (2013). In their study, 3PL provider selection without a specific industry perspective was studied for the first time in the international business literature with the AHP application and the authors evaluated four 3PL providers listed on the American Stock Exchange. In their decision model consisting of six criteria, they used different normalization techniques such as rating systems, percentages, and currency rates due to the different characteristics of the criteria. At the end of the normalization and the AHP processes for the criteria, they ranked both the decision criteria and the four selected 3PL providers. Ultimately, similar to studies conducted in other industries, these two studies, which were examined mainly in the logistics area, also showed the dominance of the MCDM approaches.

To sum up, by considering these examined studies, it can be concluded that MCDM approaches were widely used by researchers for 3PL selection decisions. These deductions are also matched with the outcome of Aguezzoul's (2014) study where 67 articles produced between 1994 and 2013 were reviewed within the context of 3PL selection in terms of the selection criteria and applied methods. The results revealed that the most commonly used criterion is cost and the extensively cited methodological approach is the MCDM followed by the statistical approaches, mathematical programming, and artificial intelligence. According to the author, although the MCDM approach dominates the area and can cope with the multiple and conflicting indicators, the MCDM methods do not consider the effect of business objectives and prerequisites of company stakeholders on the

evaluating indicators. Hence, stakeholders' needs were emphasised by the author and this puts a brick on the pathway for implementation of the stakeholders in the framework of this study.

As a conclusion, the importance of logistics provider selection has been progressively more identified by researchers but the 3PL selection always emulates the methods used in provider selection in manufacturing and fails to consider the nature of integration, network, and individual requests of logistics service chain (Xianlong and Yujie, 2013). Likewise, Daim *et al*. (2013) noted that there is a research gap in the implementation of the methodologies demonstrated in the manufacturing industry for the service industry. Thus, the need to use MCDM methods for the service industry, more particularly for 3PL provider evaluation within logistics industry, has appeared from the previous studies. Therefore, the ANP method, as an extension of the AHP under the group of MCDM techniques (Lin *et al*., 2011), was applied in this thesis to evaluate the performance indicators used by 3PL companies in the logistics industry. Moreover, since many performance indicators are used in logistics performance evaluation, which causes uncertainty regarding indicator values and ambiguity of the preferences involved in decision making, at present, there is still no 3PL selection mechanism which have been generally agreed (Li *et al*., 2012). Therefore, there is a need for a more comprehensive model in a 3PL selection area incorporating both tangible and intangible indicators as well as strategic (e.g. financial stability, long term relationship) and operational indicators (e.g. capacity, cost) because the 3PL selection studies are weakly theoretical (Aguezzoul, 2014). On these bases, the performance indicators will be assessed in a more comprehensive model, which is supported by the stakeholder-based BSC approach, in this research. In this way, the indicators and the ranking results of the indicators presented by this approach can be also used by 3PL provider user companies during their selection decisions.

2.5 The Concept of the Balanced Scorecard Approach

Recently, many frameworks have been developed in the performance measurement field and the BSC is one of the frameworks studied by many authors in the public and private sectors. The relative structure of the BSC concept in terms of principles and cause-and-effect relationships is summarised in the following sub-sections, respectively.

2.5.1 The Concept and Principles of the Balanced Scorecard Approach

The BSC was initially introduced by Kaplan and Norton in 1992 as a performance measurement system (Kaplan and Norton, 2001; Anthoula and Alexandros, 2011). After its early years, the BSC concept has been used as a strategic management system which converts a company's vision and strategy into a consistent set of performance measures (Kaplan and Norton, 1996a). The BSC approach was structured to keep both financial measures (or lagging indicators) and non-financial measures (or leading indicators) in the system (Kaplan and Norton, 2001) because focusing solely on financial measures is inadequate for guiding and assessing organisations and these measures are

not sufficient to show the actions to be taken today (Kaplan and Norton, 1996a). Explicitly, the BSC concept incorporates both intangible and tangible performance indicators. Incorporated performance indicators (including measures and sub-measures) to measure the targets are very critical in the BSC system where these indicators are organised coherently in the four perspectives: Financial, Customer, Internal-Business-Process, and Learning and Growth (Kaplan and Norton 1996a; Kaplan and Norton, 2001).

The Financial Perspective: This perspective represents an organisation's financial performance (Anthoula and Alexandros, 2011). The main question to be answered is: "*How do we look to shareholders*?" (Kaplan and Norton, 1992, p.72). Financial goals are typically relevant with profitability, and alternatively, with sales growth or generation of cash flow (Kaplan and Norton, 1996a). Numerous authors (e.g. Papalexandris *et al*., 2005; Thakkar *et al*., 2007; Grigoroudis *et al*., 2012; Rajesh *et al*., 2012; Tjader *et al*., 2014) considered the financial perspective in the BSC concept and several researchers (e.g. Anand *et al*., 2005; Yu *et al*., 2007) also highlighted the importance of the financial perspective in their studies.

The Customer Perspective: This perspective helps to look at any organisation from customers' eyes through some indicators such as service level, satisfaction and complaint rates (Anthoula and Alexandros, 2011). The basic question examined in this perspective is: "*How do customers see us*?" (Kaplan and Norton, 1992, p.72). From this point of view, organisations should consider customer value propositions and satisfaction by implementing this perspective. Various authors included the customer perspective in the BSC concept (e.g. Chia *et al*., 2009; Ravi *et al*., 2005; Rajesh *et al*., 2012; Poveda-Bautista *et al.*, 2012) and a number of authors (e.g. Leem *et al*., 2007; Falatoonitoosi *et al*., 2012) stressed its significance.

The Internal-Business-Process Perspective: This perspective is more relevant with the effectiveness of the internal processes and procedures of organisations (Anthoula and Alexandros, 2011). Furthermore, the perspective emphasises the assessment of these procedures to have the greatest influence on their customers' satisfaction and to meet their financial objectives (Kaplan and Norton, 1996a) by seeking an answer to: "*What must we excel at?*" (Kaplan and Norton, 1992, p.72). The perspective was studied in the BSC concept by various authors (e.g. Papalexandris *et al*., 2005; Yüksel and Dağdeviren, 2010; Hsu *et al*., 2011) and both the operational and innovation processes are incorporated in the structure of this dimension (Kaplan and Norton, 1996a).

The Learning and Growth Perspective: This is a perspective of the BSC concept reflecting the engagement of an organisation to grow and conform to changes (Anthoula and Alexandros, 2011). The question for this perspective is defined as: "*Can we continue to improve and create value?*" (Kaplan and Norton, 1992, p.72). Organisational learning and growth are derived from three sources, which are people, systems, and organisational procedures, and if there is a gap in these sources, organisations have to invest in reskilling employees, improving information technology and systems, and straightening organisational procedures (Kaplan and Norton, 1996a). The

perspective was incorporated in the BSC concept by many authors (e.g. Brewer and Speh, 2000; Thakkar *et al*., 2007; Grigoroudis *et al*., 2012) and it was highlighted as the most future oriented perspective (Lee and Moon, 2008).

In the BSC structure, these four perspectives are interrelated to each other by aiming different objectives towards the success of an organisation. The objectives and the interrelations of the perspectives existing in the generic BSC framework are indicated as follows:

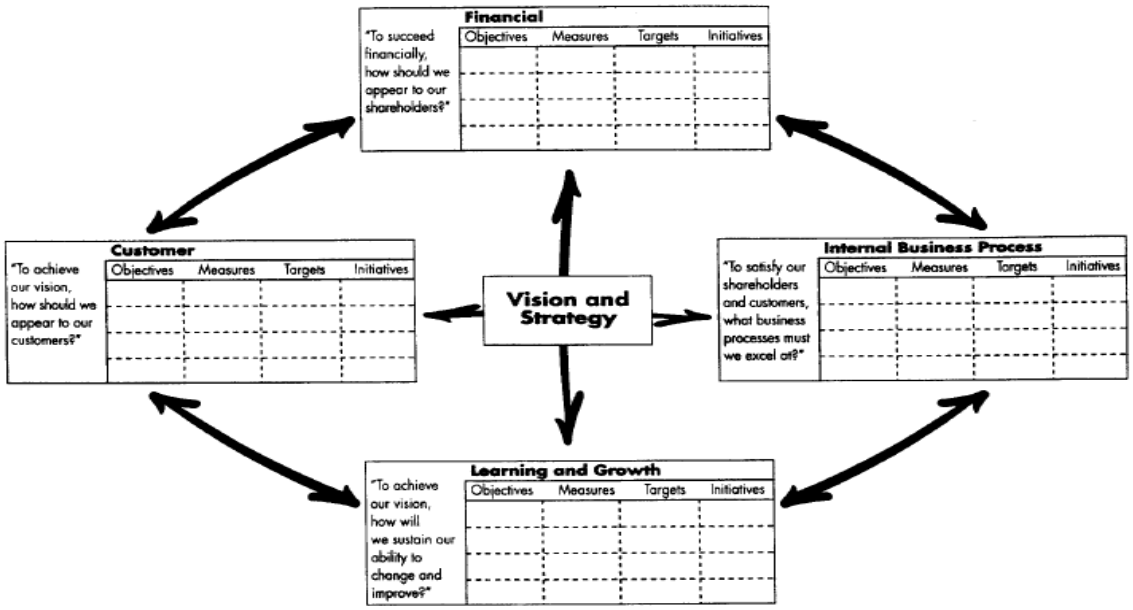


Figure 2-3: The generic BSC framework

Source: Kaplan and Norton (1996b, p. 76)

Figure 2-3 shows that the traditional financial perspective is complemented by three additional non-financial perspectives in the BSC structure. As can be seen in the figure, these perspectives are interrelated by considering the vision and strategy as a basis of the concept.

On the other hand, the numbers of both the perspectives and the measures to be used in the BSC are also significant elements to be carefully decided for the implementation of the approach. In this regard, it is worth noting that the BSC does not present a strict structure for researchers. As Kaplan and Norton (1996a) pointed out, the generic four perspectives should be considered as a template rather than a strict system for the BSC because fewer or additional perspectives can be needed depending on industry conditions and a business unit's strategy. Therefore, there are some studies using the extensions or variations of the BSC in the literature in order to compensate for the deficiencies of the BSC.

Moreover, the BSC concept enables the inclusion of both objective and subjective measures in a balanced way and a well-designed BSC should include a suitable mix of lagging (financial) and leading performance indicators (Kaplan and Norton, 1996a). Since, companies usually suffer from considering too many measures for their performance measurement systems, the BSC allows

managers to place more emphasis on a handful of the most crucial measures (Kaplan and Norton, 1992). Likewise, as Kaplan and Norton (1996a) noted, since today's most organisations have more than 16 to 25 measures, it is essential for them to distinguish the difference between the measures for monitoring organisations and the drivers enable competitive success. In a similar vein, it is suggested by Kaplan and Norton that the BSC approach should have a total of 14-16 measures with a maximum of four to six measures in each perspective (Hubbard, 2009).

Apart from academic studies, the BSC approach is also applied by various organisations in practice. Since it allows different types of indicators in its fruitful structure, the BSC helps managers to understand different interrelationships which are useful to make decisions and to solve problems (Kaplan and Norton, 1992). In this way, the BSC enables managers to monitor and modify the application of their companies' strategies (Kaplan and Norton, 1996a). Two other commonly used scorecards in practice are: the stakeholder scorecards, which identify the major stakeholders of the organisations; and, the key performance indicator scorecards, which are most supportive for teams and departments when there is a strategic programme at a higher level (Kaplan and Norton, 2001). However, these types of scorecards remain out of the scope of this research since, in this thesis, it is intended to provide various logistics performance indicators from multiple perspectives.

2.5.2 Cause-and-effect Relationships in the Balanced Scorecard Approach

The BSC approach has a principle of presenting cause-and-effect relationships among perspectives. The cause-and-effect relationships in the BSC concept describes the hypotheses of the strategy and shows how improvements in intangible merits affect financial outcomes via two or three intermediate stages existing in the chain of these relationships (Kaplan and Norton, 2001). The main structure of the cause-and-effect relationships among the perspectives is depicted in Figure 2-4.

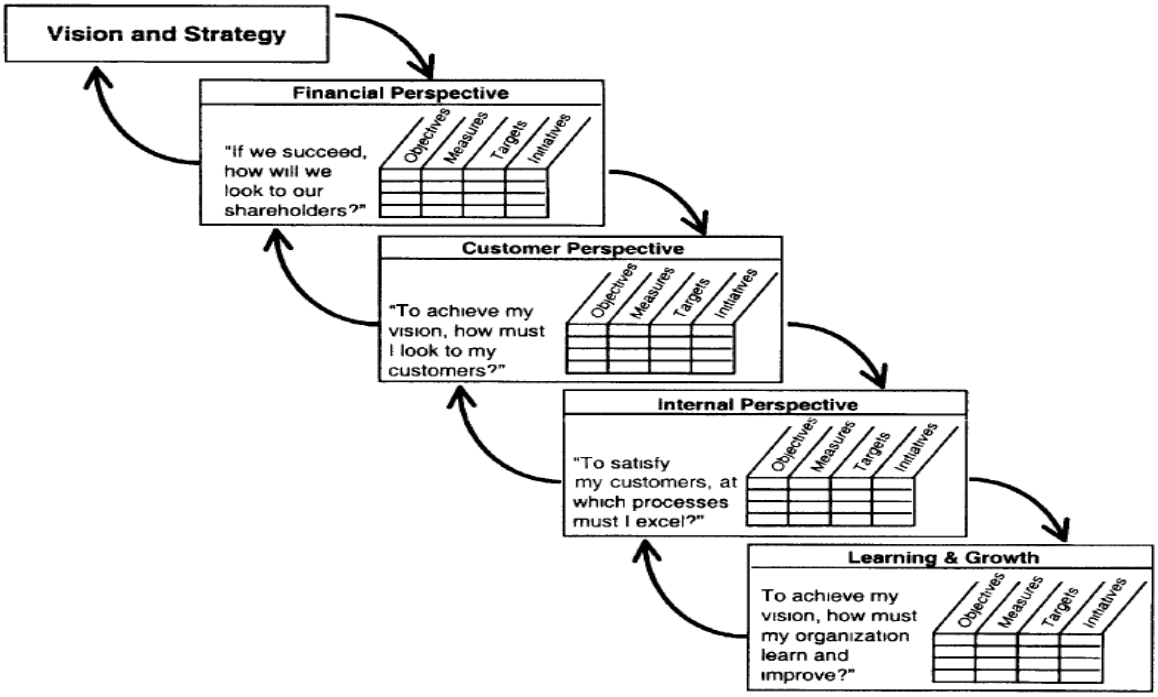


Figure 2-4: The cause-and-effect relationships in the BSC concept

Source: Kaplan and Norton (2001, p. 91)

The causal relationship of the BSC concept shown in Figure 2-4 is used as a foundation of the strategies for organisations and is defined as a 'strategy map'. In other words, the BSC is a framework used as a map by describing and implementing the strategy. Based on Kaplan and Norton's comments, the learning and growth forms the basis of this map and enables improvements in the internal business process, which in turn helps customer satisfaction and then influences the financial improvement of organisations (Anthoula and Alexandros, 2011).

To sum up, the cause-and-effect relationships represent both the sequence and interrelationships between the perspectives. Accordingly, the indicators included in the perspectives should also carry the same characteristics with this structure since these relationships are used in the strategies of organisations. In the same manner, Kaplan and Norton (1996a, p. 149) noted that "*Every measure selected for a Balanced Scorecard should be an element of a chain of cause-and-effect relationships that communicates the meaning of the business unit's strategy to the organization*". They further pointed out that with the help of the feedback obtained from these causal relationships, managers can assess both the validity of a unit's strategy and the quality of its implementation by periodic reviews. From this point of view, it can be concluded that the BSC concept complies with the dynamic nature of the business environment by its advantageous features, such as providing interrelationships and allowing cause-and-effect relationships. Therefore, the BSC concept appeared as a suitable concept to meet the objectives of this research.

2.6 Balanced Scorecard-related Studies in the Logistics Field

The BSC is the most commonly applied performance measurement system today and presents a balanced view of company performance by including both leading and lagging indicators (Johnson, 2007). As in many other industries, the BSC approach is also used in several studies conducted in the logistics area. In order to determine the BSC-related studies existing in the logistics industry, the following keyword pairs, "Balanced scorecard-logistics" and "BSC-logistics" were used within the five databases. During these processes, some articles in different fields (e.g. health sciences, medicine, chemical engineering, chemistry, agricultural and biological sciences, biochemistry, genetics and molecular biology, etc.), conference papers, personal reports, and non-English articles were excluded from the search results because these articles are out of the scope of this research.

After these phases, a total of 28 articles were obtained from the databases, but three of them were not accessible by the researcher via the university database system. Also, during the reviews of the 25 articles, eight articles did not match the scope of this research because either the BSC approach was not evaluated together with the logistics concept, or only one of these two notions was the main focus in these studies. Hence, at the end of the reviews, 17 articles were analysed in this section by considering both the BSC approach and the logistics concept together.

During review of the articles in this section, it can be seen that most were conducted in the logistics field by focusing on either a performance concept for logistics companies or different operational concepts existing in logistics, such as reverse logistics, humanitarian logistics, and freight villages. Regarding the first matter, which is the inclusion of studies focusing on the performance evaluation, several studies can be exemplified in this scope. For instance, Chia and Hoon (2000) initially stressed that the performance of an organisation is often measured by financial indicators but there is a need for a balanced measurement approach including non-financial indicators. By having this aim, they used a case-based approach to show the adaptation of the BSC in two leading logistics companies in Singapore by interviewing the chief executive officers (CEOs) and senior-managers of the companies, as well as conducting a 7-point Likert scale questionnaire with them. In their research, the authors mainly focused on several parameters (organisation's strategies and objectives, communication of strategies and objectives, usefulness of the BSC, and recommendation of the BSC to the others in their divisions and business units) and they aimed to differentiate the perception of the BSC between the CEOs and managers. Their results showed that the senior-managers may not be totally aware of the organisation's vision and strategies and, for that reason, the BSC approach helped them to understand in a more balanced view rather than emphasising solely on the financial measures.

In a similar vein, Rajesh *et al*. (2012) emphasised that measuring organisational performance should go beyond including solely financial indicators. Hence, they pointed out the need for a performance framework to implement a strategic performance measurement system for 3PL providers. From this point of view, the authors applied a three-stage method, which are the expert

opinion method, the modified Q-sort method, and the Delphi analysis, in order to develop a BSC-based framework in a 3PL context. Furthermore, they showed the adoption of the generic framework to the 3PL industry with a 3PL case company, which was a leading warehouse provider located in India. Yet, in their study, the authors considered mainly five critical functions/departments (corporate, transportation, facility structure, information and communication, and supply chain) and included the aimed strategy items under the perspectives of the BSC approach for these selected functions/departments.

In another research studied by Janeš and Dolinšek (2010), the problem of determining the relationships between enablers and results in the concept of the European Foundation for Quality Management (EFQM) model was initially identified and, in order to solve this problem, a model was established by the authors. In their research, the EFQM model was viewed as a compass of companies' every day operations and the four perspectives of the BSC were linked as a supporting tool to monitor the performance of the companies in terms of all management levels. Yet, although the authors conducted a case study of the Luka Koper Group, only a part of their studies was indicated in the paper since the research was still being carried out. Based on these three articles, it can be concluded that considering not only financial indicators, but also non-financial indicators, is essential for a balanced performance evaluation systems of logistics companies.

Concerning the latter matter, which is the inclusion of different operational concepts in logistics, diverse studies in relation to the BSC approach can be found in the literature. As an example, in the reverse logistics operations context, it can be seen that there are three similar studies conducted by Shaik and Abdul-Kader. In these studies, the authors combined the BSC and the performance prism approach by taking advantage of their strengths. In 2012, Shaik and Abdul-Kader (2012) designed a BSC-based framework, which incorporated 24 performance measures under six perspectives (financial, process, innovation and growth, stakeholder, environment, and social), by also considering the performance prism norms. In their study, the identified performance measures were prioritised by using the AHP and, then, a comparison between a reverse logistics enterprise and other reverse logistics companies in the industry was performed with the help of a rating system. After all these processes, the overall comprehensive performance measurement index of a reverse logistics enterprise was calculated by using the multiplication of the rating system with the predetermined weight of each measure obtained through the AHP.

Likewise, despite some differences in terms of major dimensions and some drivers, the same six perspectives were implemented in another study by Shaik and Abdul-Kader (2013). Under these six perspectives, the defined performance metrics were fewer and some were different compared to their previous study published in 2012. Nevertheless, the same processes were followed during the implementation of both the AHP method and the estimation of the index of a reverse logistics enterprise.

A further study by Shaik and Abdul-Kader (2014) included the same six perspectives and the 24 performance measures in their framework, as in their study of 2012. However, in this study, apart from the perspectives, they extended the framework with the help of the performance prism approach by placing seven indicators for strategies, seven indicators for processes and six indicators for capabilities. They then examined the framework by the Decision Making Trial and Evaluation Laboratory (DEMATEL) method to describe the strength of the relationships among the measures, indicators, and perspectives. Thus, the combination of BSC and performance prism approaches were illustrated in these three studies conducted in reverse logistics concept. During the implementation of these two approaches, it can be observed that the BSC-based framework was mainly formed by the authors since the performance prism does not allow casual relationships between the performance indicators and it is not a perspective-based framework (Shaik and Abdul-Kader, 2013).

In the humanitarian logistics concept, two sets of research conducted by McLachlin *et al*. (2009) and Schulz and Heigh (2009) were found. McLachlin *et al*. (2009) studied the adaptation of the contemporary logistics techniques and practices used in the business logistics context to humanitarian relief logistics. Moreover, apart from emphasising the adaptability of the BSC approach to the humanitarian logistics context, they also pointed out that the limited usage of the performance measures was expanded in the business logistics context through the BSC approach. In the latter study, Schulz and Heigh (2009) shared a "Development Indicator Tool", which was developed by the International Federation of Red Cross and Red Crescent Societies, to monitor and improve the performances of their logistics units. They used a descriptive approach based on the concepts of continuous improvement and the BSC. In their study, it was shown that the four traditional BSC perspectives were implemented as a basis phase for the development of the tool, emphasising the significance of integrating key stakeholders for the success of designing the performance measurement and management process.

In addition to these studies, one research was found in freight villages and sustainability concepts conducted by Wu and Haasis (2013). In their research, the authors highlighted the significance of the sustainability of freight villages and of the implementation of the sustainability-based BSC approach. Furthermore, they proposed a roadmap by organising some features of the knowledge management process and, in order to support the success of this roadmap, both stakeholders and human ability (on the basis of the learning and growth perspective) concepts were involved as key elements of the roadmap. As stressed by the authors and also similarly indicated in humanitarian and reverse logistics concepts, more emphasis on the consideration of various stakeholders in the targeted comprehensive framework was given in this thesis.

On the other hand, some articles found in these searches were either in different contexts, such as the manufacturing and automotive fields by considering logistics operations or in the whole supply chain context by containing all the entities in the chain. In the former type of articles, the BSC

approach was commonly implemented for analysing the logistics operations. For instance, Czuchry *et al*. (2009) focused on the implementation of supplier parks in the automotive industry by using a framework based on a combination of the BSC and National Baldrige Quality Award approaches in order to improve logistics and manufacturing operations. In another article studied by Kokune *et al*. (2007), the BSC approach was remapped onto the collaboration strategy map and a fact-based collaboration modelling approach was proposed along with some field observations. Subsequently, a case study was conducted to develop a strategy for the complete car logistics process of a Japanese automobile enterprise.

In another example, Grando and Belvedere (2008) analysed the adoption of modern performance measurement systems within the operations department of Ducati Motor Holding by including various units such as logistics, manufacturing, etc. They aimed to understand the reason of adopting these systems in the operations department and the benefits produced by these systems. Therefore, three different scorecards were developed for the case company based on different goals. Their results showed that the integrated performance measurement system, which was the BSC in their case study, contributed to the operational improvements of the company.

Moreover, Liberatore and Miller (1998) integrated the activity-based costing system and the BSC approach as a complementary decision support tool to evaluate a firm's logistics strategy. In their study, the activity-based costing system was fundamentally used to provide valuable input for the evolution of a channel strategy while the BSC was the main concept to monitor and manage the firm's performance. Both of these approaches were used by the authors to contribute to the firm's mission, objective and strategy approach. For the prioritisation of the performance indicators placed under the BSC concept, they used the AHP method as a quantitative technique to link the BSC to the mission, objective and strategy approach.

In addition to these studies, Ravi *et al*. (2005) formed a framework based on the conventional BSC perspectives adapted into four reverse logistics determinants and analysed three alternative reverse logistics concepts for end-of-life computers with the help of the ANP method. In addition to the ranking of the alternatives, the authors illustrated both the advantages of the ANP method and the implementation of the BSC-ANP combination in a case study conducted in a small PC manufacturing company.

As a result of these five studies, it can be seen that logistics operations were incorporated into the assessments by considering the BSC approach, although the logistics industry was not selected as a focal context. Thus, it is worthy of noting that the BSC approach can also be preferred to analyse logistics operations in different fields (e.g. manufacturing, automotive).

In the latter type, which is constituted by the studies in the whole supply chain context, Chia *et al*. (2009) empirically examined the perceptions of senior managers on what they measure in terms of performance indicators, and what they understand from performance measurement in a BSC

concept. They initially designed a survey including the four perspectives of the BSC approach which they conducted in 113 companies from various industries, in which the percentage of the logistics companies were the highest (46%), operating in the supply chain of Singapore. Their results showed that financial measures were the primary focus of the respondents and, therefore, the authors pointed out that a more balanced view should be adopted by the supply chain entities by using the BSC approach. This result was also in line with the findings of Chia and Hoon's (2000) study conducted in the logistics industry. Therefore, we can conclude that during the time period of these two studies, the perception of the managers did not change and the general understanding concerning performance measurement in terms of mainly considering financial measures in the supply chain is similar as in the logistics context.

With a similar survey technique, Hult *et al*. (2008) studied both supply chain orientation and firm performance enhancements by using the data obtained from 129 firms listed in the databases of Dun and Bradstreet Information Services. They presented, in their results, that logistics and value-chain coordination are the two powerful indicators in the supply chain orientation framework. Furthermore, they found that all BSC perspectives, which reflect the overall firm performance, were affected by the supply chain orientation. Thus, the capability of the BSC concept with regard to supply chain orientation was shown by their results.

In addition to the above studies in the supply chain context, Shaw *et al*. (2010) reviewed the literature in terms of four areas, namely supply chain performance management, performance management, environmental management, and benchmarking. Their results showed that there is a relationship between logistics and the environment, as well as between logistics and the supply chain, more specifically within the environmental SCM. Also, it was highlighted in their study that the BSC and performance prism approaches are the most promising performance measurement frameworks but the BSC is the most widely accepted framework providing a high level strategic view.

As a consequence of all the studies discussed in this section, it can be seen that the BSC was selected as the commonly used approach and was implemented with different methods by researchers. Yet, the general view proposed by several authors (e.g. Chia and Hoon, 2000; Chia *et al*., 2009) showed that a more balanced view, including both financial and non-financial indicators, is needed for the BSC implementation. Since the BSC presents cause-and-effect relationships (Kaplan and Norton, 1996a), it is important to use a method conforming to the BSC nature by containing interrelationships among the perspectives and the indicators. In such cases, multi-criteria evaluation helps to understand these relationships (Shaik and Abdul-Kader, 2013). However, as can be observed from these studies, the use of the MCDM approach with the BSC concept remains limited. In particular, the application of this combination is very scarce in the logistics field. Thus, by considering both the reviewed studies in this section and the aim of this research as a response to the research problems, it was decided to apply the BSC approach with a

powerful MCDM technique, the ANP method. As Ravi *et al*. (2005) noted, the rationales behind this application are due to the suitability of the ANP method in terms of including both quantitative and qualitative characteristics, allowing interdependent relations within a network structure, being unique by providing the synthetic scores for relative ranking of alternatives, and requiring the attention of the decision maker to obtain the best possible solution in a complex multi-criteria decision environment. Therefore, the ANP method was found to be the most suitable technique in order to show real-life solutions more accurately (Yurdakul, 2003).

Moreover, as emphasised in previous studies (e.g. Shaik and Abdul-Kader, 2013; Wu and Haasis, 2013; Shaik and Abdul-Kader, 2014), different stakeholders were covered in the proposed BSC concept of this research. Thus, a more comprehensive framework would be provided and the commonly mentioned deficiency of the BSC regarding the negligence of considering all stakeholders and their satisfaction (Shaik and Abdul-Kader, 2013), would be addressed. The inclusion of diverse stakeholders will be examined in detail in Section 2.8.

2.7 Comparison of the Balanced Scorecard Approach with Other Alternative Performance Measurement Frameworks

In this section, generally, the rationale for choosing the BSC approach rather than another performance measurement framework will be explained in detail. Concordantly, the alternative frameworks will be initially introduced; then, the comparison of these frameworks with the BSC concept will be discussed in the first part. In the remaining sections, the benefits and limitations of the BSC concept will be explained.

2.7.1 Other Frameworks in Performance Measurement

For many years, organisations have employed performance measurement frameworks during the identification of the indicators in order to evaluate their performances appropriately (Kennerley and Neely, 2002). Measuring an organisation's performance is significant and vital because by doing so, it is possible to understand how a business performs and how the performance can be improved in order to provide better services to the stakeholders (Johnson, 2007). For determining how well the performance is, including suitable performance indicators in the frameworks becomes crucial for organisations. In a similar vein, Booth (1997, p.28) emphasised the importance of using indicators (or measures) with the following statement:

"*They represent the corporate view reality and are the means by which top management:*

- *translate their strategic thinking into guidelines for action;*
- *pass this message down through the organization;*
- *plan the business and not just financially*".

There are different types of indicators (e.g. financial and non-financial) used in the performance measurement frameworks and some of these frameworks are more financial-based in terms of the incorporated indicators. However, the frameworks developed after the mid-1980s have a more

balanced view in contrast to the traditional performance measurement systems where financial indicators are mainly emphasised (Garengo *et al*., 2005). As summarised in Table 2-1, the commonly studied multidimensional performance measurement frameworks discussed by various authors (e.g. Booth, 1997; Santos *et al*., 2002; Neely, 2005; Gaiardelli *et al*., 2007b; Pongatichat and Johnston, 2008) were examined to a significant extent by the researcher in this study.

Table 2-1: Different multidimensional performance measurement frameworks

Multidimensional Performance Measurement Frameworks	**References**
The Balanced Scorecard	Booth, 1997; Santos *et al*., 2002; Neely, 2005; Gaiardelli *et al*., 2007b; Pongatichat and Johnston, 2008
The Performance Prism	Santos *et al*., 2002; Gaiardelli *et al*., 2007b; Pongatichat and Johnston, 2008
The Performance Measurement Matrix	Neely, 2005; Gaiardelli *et al*., 2007b
The Performance Pyramid	Santos *et al*., 2002; Neely, 2005; Gaiardelli *et al*., 2007b; Pongatichat and Johnston, 2008
The Results and Determinants Framework	Santos *et al*., 2002; Neely, 2005; Gaiardelli *et al*., 2007b; Pongatichat and Johnston, 2008
The European Foundation for Quality Management	Booth, 1997

By considering the scope of this study, five indicative performance measurement frameworks, as noted below, were selected from Table 2-1 for further consideration. The rationale behind this is based on the similar studies in the literature which stress the importance of these five frameworks. For instance, Gaiardelli *et al*. (2007b) highlighted the same five frameworks indicated in this research as balanced and multidimensional frameworks. In the reverse logistics context, by having a similar purpose with this thesis, Shaik and Abdul-Kader (2014) examined five performance measurement frameworks, three of which were the same (balanced scorecard, performance prism, results and determinants framework) but two (EFQM excellence model and Malcolm Baldrige National Quality Award) were different. Along the same lines as Kennerley and Neely's (2002) study, these two different frameworks were also excluded in this research because, as they pointed out, these frameworks are not designed as performance measurement frameworks even if they contain a broad view of performance. Hence, the five commonly mentioned frameworks in the literature which were considered in this research are:

- ✓ the balanced scorecard,
- ✓ the performance prism,
- ✓ performance measurement matrix,

- ✓ the performance pyramid,
- ✓ the results and determinants framework

The BSC-which has been used as the most extensively applied performance management system in recent years (Johnson, 2007)-was proposed by Kaplan and Norton (1992, 1996a). This framework is the most popular model both in practice and in academic studies (Garengo *et al*., 2005) and, conceptually, it has similar usage to the Tableau de Bord developed in France in the early 20th century (Kennerley and Neely, 2002). Four perspectives, namely, financial, customer, internal process, and learning and growth (Rajesh *et al*., 2012) are presented in the BSC approach and cause-and-effect relationships among the perspectives are also pervaded in the BSC concept (Kaplan and Norton, 1996a). On the other hand, the BSC concept does not consider different stakeholders and their satisfaction (Shaik and Abdul-Kader, 2013). Yet, in addition to the fact that the BSC was revealed from the literature as a robust framework, also due to its diverse advantageous characteristics, as will be explained in the next section, the BSC was implemented as a suitable concept for this research.

The performance prism framework, developed by Neely *et al*. (2002), is a three-dimensional prism containing five interrelated perspectives, namely stakeholder satisfaction, strategies, processes, capabilities, and stakeholder contribution (Garengo *et al*., 2005). Although the performance prism has a stakeholder centric view (Kennerley and Neely, 2002), it does not provide much information about how the performance measures are going to be applied and does not present the casual relationships among the measures (Shaik and Abdul-Kader, 2014). Apart from these shortcomings, it is also not a perspective-based framework (Shaik and Abdul-Kader, 2013). Therefore, only the strengths of this approach were considered in order to deal with the insufficiencies of the BSC concept. In this way, the weaknesses of these both approaches were compensated.

The performance measurement matrix, proposed by Keegan *et al*. (1989) as a two-by-two matrix, integrates four clusters, namely external, internal, non-cost, and cost. On the one hand this framework offers simplicity and flexibility (Garengo *et al*., 2005), on the other hand it does not reflect the links between different facets of business performance, which is one of the strengths of the BSC concept (Neely *et al.*, 2001; Shaw *et al.*, 2010). For this reason, the performance measurement matrix was not considered as a suitable framework for this research.

The performance pyramid model, introduced by Lynch and Cross (1991), consists of four layers, where strategic targets (placed on the top) are translated from company vision by using a top-down process (Garengo *et al*., 2005). Also, both externally and internally focused performance indicators are cascaded throughout the framework. While the pyramid model links together the hierarchical and horizontal business process perspectives (Shaw *et al*., 2010), the limitation of the pyramid is that it does not consider the continuous improvement concept (Ghalayini and Noble, 1996). Since the continuous improvement is essential and significant for a framework, the performance pyramid model was not considered in this research.

The results and determinants framework was offered by Fitzgerald *et al*. (1991) for service industries only. The framework consists of six dimensions divided into two main groups, which are results (competitiveness, financial performance) and, determinants (quality of service, flexibility, resource utilisation and innovation) (Garengo *et al*., 2005). In this framework, the causality concept shows that there is a need to identify performance drivers in order to reach preferred outcomes (Kennerley and Neely, 2002). Since the results and determinants framework is not process oriented (Garengo *et al*., 2005) and has a limited usage for service industries only, it was not chosen as a suitable framework for this research.

To sum up, the comparison of these frameworks revealed the appropriateness of the BSC approach for this research. Accordingly, the BSC concept was chosen as a suitable concept for this research and the rationale of this choice is based upon a number of reasons. Firstly, several authors emphasised the importance of the BSC concept compared to other models. For instance, Garengo *et al*. (2005) listed some factors, namely strategy alignment, strategy improvement, focus on stakeholders, balance, process orientation, depth, breadth, dynamic adaptability, causal relationships, and clarity and simplicity in order to compare the performance measurement frameworks. By considering these factors, Shaik and Abdul-Kader (2014) emphasised that from the five frameworks they investigated (the BSC, the EFQM excellence model, the Malcolm Baldrige National Quality Award, the results and determinants matrix, and the performance prism), the BSC and performance prism frameworks are the only models that address all these factors. However, as the disadvantages of the performance prism were previously noted, it does not present the casual relationships among the factors and it is not a perspective-based model (Shaik and Abdul-Kader, 2014). With respect to the BSC, in addition to the previously mentioned features, the BSC has also a compatible nature with the top management strategy (Akyuz and Erkan, 2010). Thus, these arguments formed the preliminary motivation to choose the BSC framework as the most convenient concept for this research.

Secondly, being a dominating model (Neely, 2005) and having the most significant effect on the performance measurement field (Marr and Schiuma, 2003) triggered the decision to opt for the BSC concept for this research. Moreover, in addition to simple applicability and clarity of the BSC, the easiness and intuitive rationale of the BSC have been major contributors to its extensive adoption for organisations (Kennerley and Neely, 2002), and therefore, as Neely (2005) stated, the BSC concept has been particularly adopted by rising numbers of organisations. This feature is also a reason to choose the concept because the intended model should be usable in practice. As a result, the BSC approach was decided among all the performance frameworks in order to make significant implications both in the academic field and in practice. Yet, since the main shortcoming of the BSC is based on the fact that not considering all stakeholders and their satisfaction (Shaik and Abdul-Kader, 2013), the favourable part of the performance prism regarding the incorporation of various stakeholders is utilised for the proposed model of this research. More explanation about the benefits and limitations of the BSC concept can be found in the following sub-sections.

2.7.2 Benefits of the Balanced Scorecard Approach

Using the BSC approach enables to benefit from many advantages offered for both the researchers studying performance measurement and practitioners. The benefits of the BSC can be summarised as follows:

- The BSC approach, as a comprehensive model, presents a suitable framework to translate business objectives into a set of reasonable performance indicators (Poveda-Bautista *et al.*, 2012) and produces a high level strategic view of corporate performance (Shaw *et al*., 2010).
- The approach helps managers to understand, clarify and operationalise the vision and strategy of their organisations (Chia *et al*., 2009; Shaik and Abdul-Kader, 2014; Chia and Hoon, 2000; Rajesh *et al*., 2012).
- The approach enables consideration of both financial and non-financial indicators (Poveda-Bautista *et al.*, 2012; Chia *et al*., 2009; Shaik and Abdul-Kader, 2014, Chia and Hoon, 2000; Rajesh *et al*., 2012).
- The BSC concept, which still lies at the heart of today's performance management system, seeks the balance between some notions, such as short- versus long-term, internal versus external focus, different levels in an organisation, four perspectives of the concept, multiple views of the stakeholders (Akyuz and Erkan, 2010).
- The approach allows cause-and-effect relationships with a balanced performance view (Shaik and Abdul-Kader, 2013).
- The BSC concept brings different functions together, such as finance and accounting, marketing, operations management, human resources and innovation works (Marr and Schiuma, 2003). Therefore, it has a multi-functional structure integrating different disciplines.
- The approach contains many significant features, such as simplicity, clear objective description, comprehensiveness, transmission of the tactics between enterprises, and the linkage between departmental and individual aims (Fan *et al*., 2013).

2.7.3 Limitations of the Balanced Scorecard Approach

Besides the benefits, the BSC approach is not free from criticism and there are some limitations of the BSC concept which can be summarised as follows:

- The generic BSC model does not consider various stakeholders (e.g. employees, suppliers, community) (Hsu *et al*., 2011; Neely *et al*., 2001) and their satisfaction (Shaik and Abdul-Kader, 2013; Shaik and Abdul-Kader, 2014).
- In a BSC model, there can be too many/few metrics or unattainable indicators (Shaik and Abdul-Kader, 2014). Therefore, there is no certain rule for the right number of performance indicators (Epstein and Wisner, 2001; Shaw *et al*., 2010).

- The BSC concept excludes people and suppliers besides ignoring regulations, competitive environments, and both environmental and social aspects of industry (Barber, 2008).
- Several researchers (e.g. Shaw *et al*., 2010; Hsu *et al*., 2011) argued about the deficiency of the BSC approach in terms of the sustainability.

2.8 Considering Different Stakeholders in the Balanced Scorecard Approach

In order to address the major deficiency of the BSC concept, which is mainly considering customers rather than all stakeholders, the 'customer' perspective of the generic BSC approach was replaced with the 'stakeholders' perspective in this research. Thus, the generic 'customer' perspective will be extended to include various stakeholders other than simply customers. By having this purpose, this section will be presented in two parts. In the first part, the significance of stakeholders and their satisfaction will be explained. Additionally, the contribution of incorporating various stakeholders in the BSC concept will also be investigated. In the second part, stakeholder theory will be examined and, based on the theoretical principles, the rationale of including eight stakeholders by considering the scope of this research will be demonstrated.

2.8.1 Significance of the Stakeholders and Their Satisfaction

Performance measurement is an important area where all stakeholders' expectations are taken into account and gives a strategic map to follow for the organisations. Basically, performance measurement assesses how an organisation is managed and focuses on how to provide a value to customers and other stakeholders (Moullin, 2002; Moullin, 2007). Therefore, performance measurement plays a significant role in value transferring for companies.

Identifying stakeholders and their needs constitutes the first step of the performance measurement process. In a similar manner, Shaik and Abdul-Kader (2012) noted that the process starts with the firm's requirements and uses data obtained from both the firm's stakeholders and the market. Hence, starting the performance measurement process from the identification of stakeholders and advancing the strategies to satisfy stakeholders is crucial for organisational success.

Moreover, stakeholder consideration and stakeholder perspective implementation to the performance measurement systems have been highlighted by some researchers. For instance, in Grando and Belvedere's (2008) study, the most notable requirements (e.g. being consistent with corporate strategy, being integrated for the cause-effect links between performances) that a performance measurement system should have were listed, and in this list, emphasising relevance to various stakeholders of a company was highlighted as one of these requirements. McLachlin *et al*.'s (2009) study, which focuses on the humanitarian relief logistics and not-for-profit supply chain contexts, emphasised the essential coordination between supply chain managers and their stakeholders. In a marine transportation context, Wibowo and Deng (2012) highlighted the necessity of considering stakeholders and stressed that recognising the requirements of a shipping task includes determination of the need of various stakeholders.

In a similar manner, Garengo *et al*. (2005) emphasised the adaptation of a stakeholder perspective in performance measurement systems conducted by some researchers in the literature. They also stated that stakeholder orientation is becoming more critical and, recently, the interest given to stakeholders has increased dramatically. Additionally, they pointed out that performance measurement systems need to establish stakeholders' needs and firms need to stay aligned to maximise stakeholder satisfaction. In a similar vein, Striteska and Spickova (2012) expressed that the success of the dynamic business environment depends on meeting the changing demands of all stakeholders. According to the authors, since organisations cannot form a self-centred performance measurement system, they need to assess their performance by considering their stakeholders. This assessment type has an advantage for firms because considering expectations of all stakeholders leads companies to be more competitive in their industries. In parallel to this, as Anderson and McAdam (2004) indicated the suggestion of the Royal Society of Arts, Manufacturer and Commerce, the future competitive success will depend on the consideration of all stakeholders' requirements. Besides these, firms and their stakeholders have a mutual interactive relationship and satisfying the stakeholders by meeting their expectations forms the basis of a strong relationship (Shaik and Abdul-Kader, 2014). This also shows the capability of the enterprise in terms of its current and future ability to fulfil stakeholders' demand (Shaik and Abdul-Kader, 2012; Shaik and Abdul-Kader, 2014).

In the performance measurement field, the proposed frameworks, as previously mentioned, are applied to help growth of companies' competitiveness. Starting from the development of the first framework, different views have been adopted on frameworks in order to comply with the demands of a changing business environment. Yet, since the 1990s, stakeholder satisfaction has been considered as one of the new dimensions in performance frameworks (Atkinson *et al*., 1997; Gaiardelli *et al*., 2007a). In a similar vein, Hubbard (2009) noted that a more stakeholder-based aspect has gradually occurred to prevail since the early 1990s.

Among the frameworks developed in the 1990s, the BSC has been commonly used by researchers to provide future competitive success to organisations. However, although the BSC approach is based on the stakeholder theory (Hsu *et al*., 2011; Hubbard, 2009), it does not include employees, suppliers and community contributions (Mooraj *et al*., 1999; Anand *et al*., 2005; Hsu *et al*., 2011) and this causes an inadequacy to the approach (Atkinson *et al*., 1997; Anand *et al*., 2005). In other words, the BSC approach does not reveal the interest of all of the stakeholders (Striteska and Spickova, 2012). Besides not considering all stakeholders and their requirements (Shaik and Abdul-Kader, 2013), neither does it present other responsibilities of an enterprise in terms of environment and society, which lead to the necessity of different perspectives to identify and reorganise the BSC approach (Shaik and Abdul-Kader, 2012).

As a response to these weaknesses of the BSC approach, incorporating stakeholders in the BSC concept for a strong performance measurement has been discussed by several authors. For instance,

in the logistics domain, Shaik and Abdul-Kader (2014) denoted that a stakeholder perspective allows stakeholder orientation and motivates decision makers as well as policy makers to focus on achieving objectives by providing value to the stakeholders (e.g. suppliers, intermediaries, investors, customers, employees, and regulators). Therefore, the stakeholder perspective was adopted in their BSC-based framework by considering different stakeholders' satisfaction. In other studies by Shaik and Abdul-Kader (2012, 2013), they similarly included a stakeholder perspective in their BSC-based framework for performance measurement of a reverse logistics enterprise and the AHP method was practiced to determine the weights of performance indicators. Another illustration was presented by Hsu *et al*. (2011) for a semiconductor industry. In their study, the 'stakeholders' perspective was implemented in their sustainability BSC model and they determined the relative weights of the sub-stakeholder indicators (e.g. employee satisfaction, customer satisfaction, community investment etc.) as well as the other indicators in their model through the ANP method. In the same way, including different stakeholders in the BSC as another dimension was also pointed out in Wu and Haasis's (2013) study which is about the sustainability of the freight villages. In their paper, they proposed a roadmap and the elements (e.g. human ability, stakeholders' involvement) for the success of this roadmap rather than presenting an empirical analysis.

As can be seen from these studies, a number of authors incorporated various stakeholders rather than only customers in a different perspective of the BSC. In this regard, since the BSC is based on the stakeholder theory and considering all stakeholders are crucial for the competitive success of organisations in the performance measurement process, the 'stakeholders' perspective was adopted in the BSC model of this study instead of the 'customer' perspective in order to address diverse stakeholders more comprehensively. Meanwhile, it is worthy of note that this adaptation is not harmful for the nature of the BSC approach in practice since many companies customise the BSC concept based on their own circumstances (Hubbard, 2009). Similarly, in academic studies, several researchers made some alterations (adding/replacing) on the perspectives of the BSC by considering the necessities of their research problems (e.g. Hsu *et al*., 2011; Shaik and Abdul-Kader, 2014). As a matter of fact, Kaplan and Norton (1996a) also stated that the four perspectives should be considered as a template and, if necessary, additional perspectives may be added. Thus, in this study, eight stakeholders existing in the logistics context were incorporated in the BSC approach (see Section 2.8.2), under a separate perspective in addition to the financial, internal process, and learning and growth perspectives.

Hence, through this alteration, the research question regarding inclusion of all stakeholders is addressed better. By this way, the proposed model can be used as a role model both by different stakeholders in the logistics industry during their logistics company selection decisions and by logistics companies which aim to assess their operations in order to become more competitive in the industry. This proposed approach also complies with the suggestion of Kleijnen and Smits

(2003) because they stated that sharing BSC metrics by all stakeholders (managers, employees, customers, suppliers, banks, etc.) is a solution that helps to make a performance problem simpler.

Concerning stakeholder satisfaction, various papers were examined in the literature. The studies reviewed in the literature usually emphasised and focused on stakeholders' satisfaction (e.g. Donaldson and Preston, 1995; Strong *et al*., 2001; Chun and Davies, 2006; Shaik and Abdul-Kader, 2014). Furthermore, according to Freeman and McVea (2001), the rationale of the stakeholder approach proposes that managers must satisfy all stakeholders, who have a stake in the business, with the formulation and implementation of the processes. Likewise, Hubbard (2009) noted that the stakeholder theory evaluates firm performance against the expectations of various stakeholder groups, such as employees and their representatives, customers, governments, and suppliers. Consequently, as emphasised in many studies, since satisfying the stakeholders is one of the crucial targets for organisations, the 'satisfaction' term was used and examined in this research for each of the stakeholders. In the next section, more information about stakeholder theory and the included stakeholders in the model will be given in detail.

2.8.2 Stakeholder Theory and the Selected Stakeholders for the Logistics Industry

The 'stakeholder' term initially emerged from the management literature in an internal memorandum at the Stanford Research Institute in 1963 (Freeman, 1984). The main intention of using the term was initially to extend the concept of stockholder which is as a group of people to whom the management is responsible. As time progressed, the stakeholder term was examined more by researchers, and in the 1980s, Freeman developed the stakeholder approach as a framework in the strategic management literature by including four management terms, namely, systems theory, corporate planning, corporate social responsibility, and organisation theory. As a supportive argument, Freeman (1984) noted that theories in the 1980s were incoherent with both the types and quantity of changes occurring in the business area. Therefore, the stakeholder approach was considered by Freeman as a response to this problem by extending the stockholder term in the strategic management concept.

In the stakeholder literature, there are different approaches to define the stakeholders both from a narrow view and from a broader view (Mitchell *et al*., 1997). The classic definition created by Freeman (1984, p. 46) is as follows:
"*A stakeholder in an organization is (by definition) any group or individual who can affect or is affected by the achievement of the organization's objectives*".

As can be seen in this definition, organizations or firms have some interrelationships with stakeholders. In terms of the managerial view of firms, four sets of stakeholders, namely owners, customers, employees, and suppliers were initially taken into account by Freeman (1984). The representation of the stakeholders from the managerial point of view can be seen in Figure 2-5.

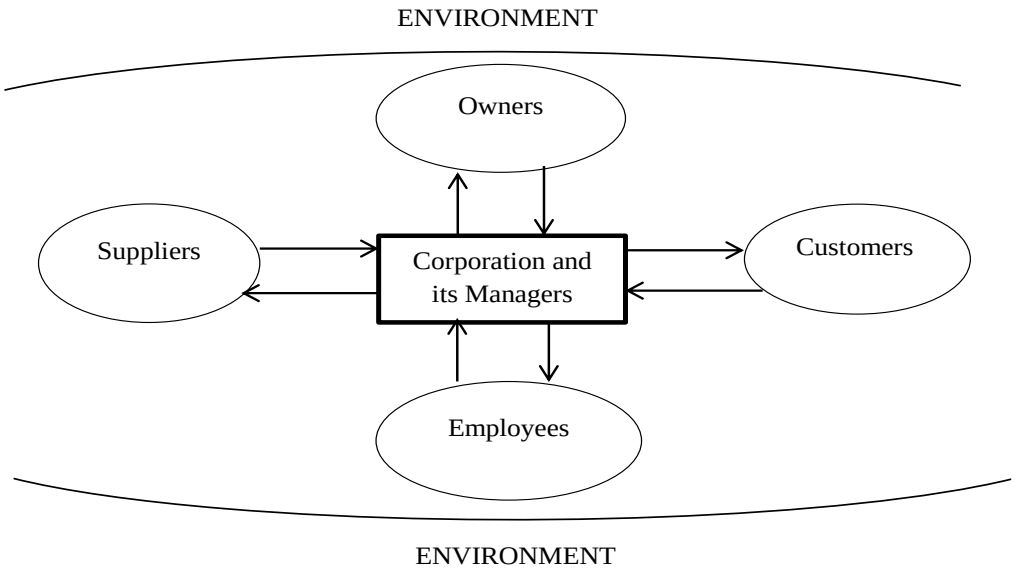


Figure 2-5: The managerial view of firms
Source: Freeman (1984, p. 6)

In addition to these, some external factors such as governments, competitors, consumer advocates, environmentalists, special interest groups/social interest groups, and media were also taken into consideration by Freeman (1984) in addition to these internal factors within the firm environment. Eventually, the traditional stakeholder framework was extended with the integration of these external factors. After keeping both internal and external factors, the stakeholder concept was developed including different stakeholders of the firms in today's environment. However, Freeman (1984) remarked that the stakeholders represented in this developed concept are examples of the stakeholders' categories. Moreover, it was stated that this resulting stakeholder concept (or map) including these categories can be used as a starting point and a checkpoint of a typical firm. Thus, by considering these statements, it can be concluded that different stakeholder groups can be included in a stakeholder framework based on the business environment and the structure of an organisation.

On the other hand, the stakeholder definition and its scope are not free from criticism. For instance, the commonly mentioned authors, Donaldson and Preston (1995), depicted two contrasting models for the corporations. The former is an input-output model while the latter is the stakeholder model, as shown in Figures 2-6 and 2-7, respectively.

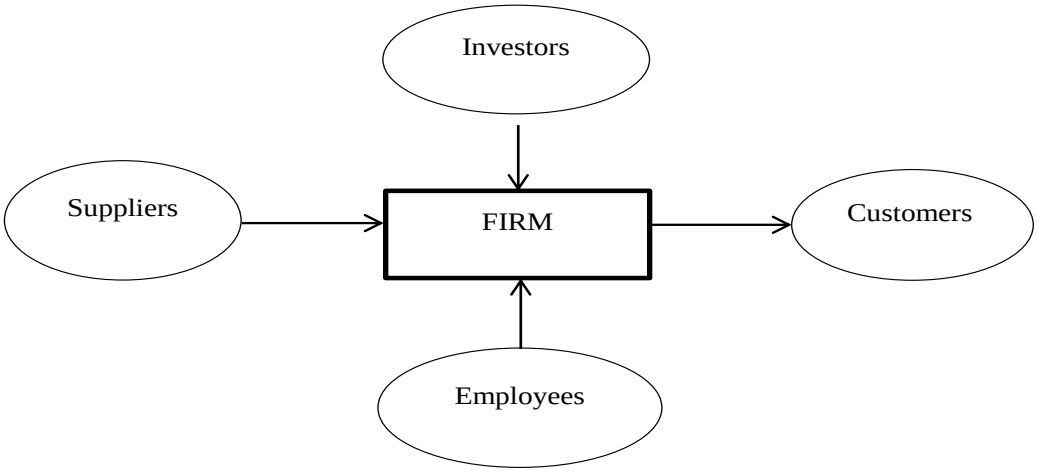


Figure 2-6: Contrasting model: An input-output model
Source: Donaldson and Preston (1995, p.68)

In the first model, four stakeholders were included by the authors whereas the second model, which is the stakeholder model of the authors, has been commonly indicated as the main stakeholder model by different authors (e.g. Kampf, 2007; Law, 2011) in the literature. As exhibited in Figure 2-7, their proposed stakeholder model consists of eight stakeholders, namely, governments, investors, political groups, suppliers, customers, trade associations, employees, and communities. Due to the existing interrelationships between the firms and their stakeholders, the relationships are drawn in both directions in the model.

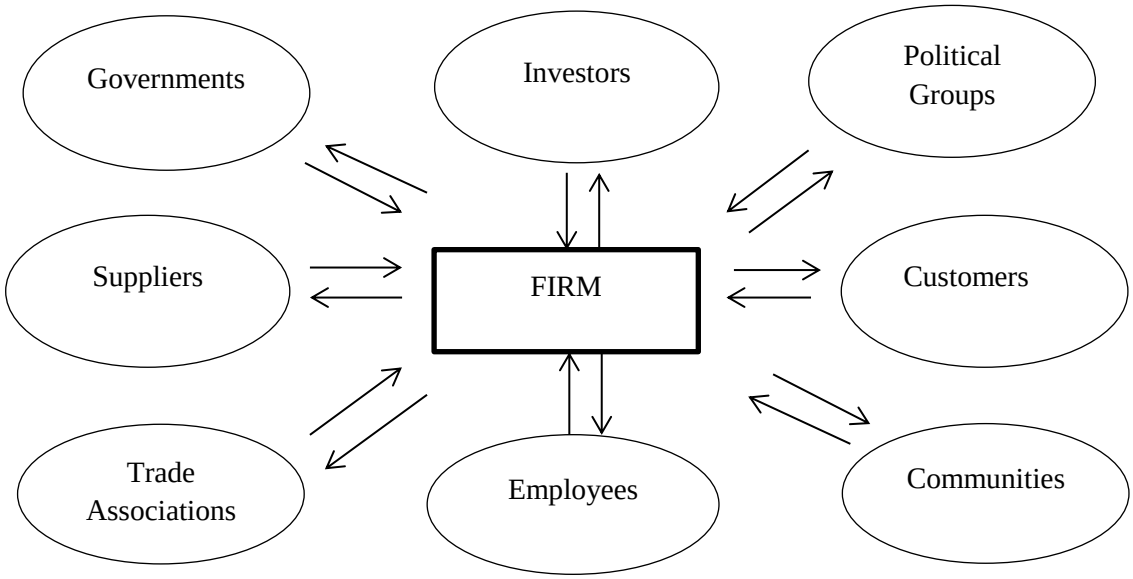


Figure 2-7: Contrasting model: The stakeholder model
Source: Donaldson and Preston (1995, p. 69)

Additionally, Donaldson and Preston (1995) criticised the inclusion of some actors in the stakeholder definition. According to the authors, two stakeholders, who are the competitors and the media, either do not match with the stakeholder concept or represent an influence without having any stake. More specifically, they stated for the competitors that "*In any event, in the normal*

course of events, competitors do not seek benefits from the focal firm's success; on the contrary, they may stand to lose whatever the focal firm gains" (Donaldson and Preston, 1995, p. 86). Regarding the media, the authors pointed out that some influencers, such as the media have no stakes in the companies and, therefore, they implied the role of the media as an influencer. Moreover, they claimed that "*The theory does not imply that all stakeholders (however they may be identified) should be equally involved in all processes and decisions*" (Donaldson and Preston, 1995, p. 67). Thus, from this point of view, the media and the competitors were not included as stakeholders in this research.

In addition to these arguments, some researchers (e.g. Fassin, 2009; Mishra and Dwivedi, 2012; Mishra and Mishra, 2013) illustrated the original stakeholder theory model in their studies as shown in Figure 2-8. According to these authors, the original stakeholder theory most commonly includes seven categories, namely government, competitors, customers, employees, civil society, suppliers, and shareholders.

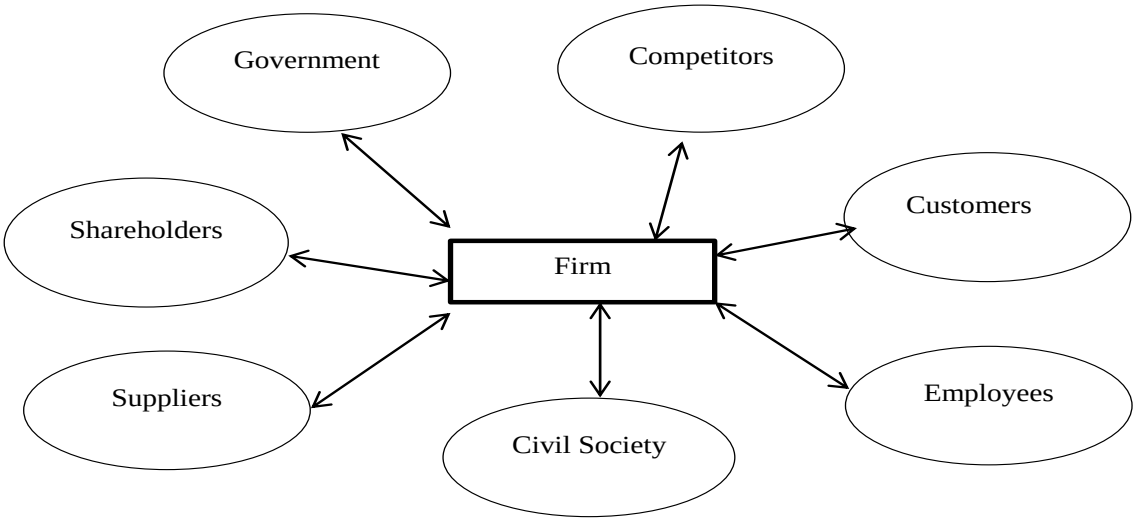


Figure 2-8: The original stakeholder model
Source: Fassin (2009, p. 115)

Following these approaches and definitions, during the preparation of the 'stakeholders' perspective for the stakeholder-based BSC model of this research, some stages for the identification of stakeholders were followed, which included: examining the illustrated stakeholder models in different papers, scrutinizing feasible criticisms on Freeman's (1984) stakeholder concept, reviewing relevant studies considering the stakeholder concept with the commonly used stakeholders, and considering the Turkish governmental structure. Ultimately, at the end of these stages, eight stakeholders, namely customer, community, employee, supplier, environmental group, government, investor/financier, and non-government organization (NGO) were determined as the main stakeholders complying with the scope of this research.

With regard to some stakeholders, various opinions were taken into account by the researcher in order not to miss any parties. For instance, regarding the usage of the terms financier and investor together to cover owners, some references were found from the literature. In this regard, Freeman (1994) noted that he adopted the 'financiers' term with other stakeholders based on some correct arguments about the misnomer of the 'owners' term. Similarly, in another study of Freeman (1984, p.6), it was stated that "*Ownership became more dispersed, as banks, stockholders and other institutions financed the emergence of the modern corporation*". Also, Donaldson and Preston (1995) showed the investors as stakeholders in their commonly cited model. Therefore, instead of the 'owners', the 'investor/financier' term was used in this research.

Additionally, although it was not incorporated explicitly in the previous stakeholder approaches, the unignorable roles of NGOs in the stakeholder concept are vital for the significance of this research. The importance of the NGOs was commonly expressed by several authors in the literature. Besides, by considering the Turkish government structure and the relevant studies, NGOs were considered as a necessary stakeholder in this research since, in the Turkish government structure, NGOs include different types of organisations, such as trade unions, foundations, associations, professional organisations, chambers of commerce, etc. (Resmi Gazete, 2012; Ankara Ticaret Odası, 2015; e-devlet, 2015). Accordingly, in order to involve different types of organisations existing in the previous stakeholder models, NGOs were included in this research as a major stakeholder group covering these different organisational structures. As a result, eight stakeholders, as shown in Table 2-2, were considered suitable in the 'stakeholders' perspective.

Table 2-2: Eight stakeholders included in the survey

THE STAKEHOLDERS PERSPECTIVE	
Customer Satisfaction	Environmental Group Satisfaction
Community Satisfaction	Government Satisfaction
Employee Satisfaction	Investor (Financier) Satisfaction
Supplier Satisfaction	Non-Government Organization Satisfaction

2.9 Applications of the ANP Method in the Logistics Field

In this section, the terms "ANP-logistics" and "Analytic Network Process-logistics" were searched within peer-reviewed articles from the five databases excluding conference papers and different research fields which are out of the scope of this research (e.g. medicine, agricultural and biological sciences, biochemistry, genetics and molecular biology, neuroscience etc.). Additionally, English and Turkish languages were considered during the searches. Moreover, although some articles appeared in these searches, they were not analysed in this review because they were not related to either logistics or 3PL providers. For instance, one of the eliminated papers included the logistics regression method, and due to the 'logistics' keyword, it appeared in our search even though it was

not related to the logistics industry or logistics operations. Furthermore, several articles were not accessed by the researcher.

The search results showed that previous researchers applied the ANP as a single technique or as part of the hybrid approach either in the logistics industry or in different industries considering logistics processes. Moreover, the results exhibited that the application of the ANP with fuzzy values, such as the fuzzy ANP method and other combinations containing the fuzzy ANP, were also considered in previous studies. In conclusion, at the end of these processes, 32 articles were examined in this section of this research.

Among the 32 articles examined, four studies including the ANP as a single technique were found relevant within the logistics area. For instance, Zang *et al*. (2013) used the ANP method to choose the best municipal solid waste logistics systems among the alternatives (current logistics, new logistics, advanced new logistics) within a reverse logistics process and these three alternative systems were ranked in the study based on some criteria grouped under three main clusters (collection, disposal, transfer) by using the ANP method. In another study, Meade and Sarkis (1998) noted that the ANP's application is very rare for logistics strategy analysis in a supply chain environment and, therefore, they used ANP to evaluate three logistics systems for an enterprise operating to continue a competitive logistics strategy. Thus, they proposed an analytical system for managerial decision making through a modelling approach that had not been fully explored by researchers or practitioners in logistics.

In a more particular study conducted by Kayakutlu and Buyukozkan (2011) in the logistics field, performance factors in logistics operations for two logistics companies were assessed by the ANP method. According to the authors, there is an inevitable need to use a multi-criteria technique to convert managerial opinions into quantitative data and to analyse interrelationships among performance factors. Therefore, the ANP method was chosen by the authors due to its unique features to capture the interdependencies. In the marine logistics domain, Wang (2013) stressed the significance of proper marine information systems. In the research, nine performance factors within three dimensions (services, safety and technology, and charge) were considered in the marine information system concept and these factors were evaluated by using the ANP method. According to the weights of the factors, the performances of the three main information systems in Taiwan were assessed. Hence, as can be seen from these studies, the ANP method was only used either for evaluating some systems and strategies or assessing performance factors for case companies rather than the whole logistics industry.

Apart from the logistics field, the ANP method was applied as an individual method in different fields but still logistics operations or 3PL companies were analysed as a substantial part of these studies. That is to say, 10 articles utilising solely the ANP method in various industries were found during the literature review.

In the electronic manufacturing industry, Çelebi *et al*. (2010) used the ANP method to select the best logistics partnership strategy among three alternatives for a small electronic appliances manufacturer operating in Turkey. Likewise, the best logistics partner among three alternatives for air cargo shipment processes of an electronic components producer company was determined by the ANP method in Yang *et al*.'s (2010) research. In a similar way, logistics partner selection in the outsourcing decision context was also considered by Jharkharia and Shankar (2007) and the ANP technique was implemented to rank the alternatives for the selection of the most appropriate logistics service provider of a case company besides weighting the criteria used in the decision model. Another research studied by Singh and Sharma (2014) was based on a case study technique with four ancillary automotive companies. In this research, the data collected from these companies were analysed by the ANP method in order to prioritise both the three flexibility alternatives (manufacturing, supplier, customer) and the criteria (containing logistics and inventory control) examined in their model. These four studies enable the conclusion that the ANP method was mainly used for selection purposes, especially 3PL selection or prioritisation of alternatives in different industries.

Moreover, the application of the ANP in different fields (e.g. manufacturing, automotive, photovoltaic etc.), as the only method, was also evaluated in the reverse logistics concept. An example of this is the study carried out by Cheng and Lee (2010) who applied the ANP method to outsourcing reverse logistics activities for TFT-LCD manufacturers in order to analyse the service capabilities of the potential 3PL providers. With a similar approach, Hsueh and Lin (2014) performed the ANP to rank both the criteria and the four strategy alternatives for performing the sorting process of reverse logistics in the downstream photovoltaic industry. In another study, Ravi *et al*. (2005) emphasised the importance of integrating the ANP and BSC approaches for the reverse logistics concept and the ANP method was used to select the best reverse logistics operation type for a computer manufacturer company. A similar example of ANP-BSC combination was also performed by Hernández *et al*. (2012) to investigate the impact and influence of reverse logistics programmes on corporate performance. In their study, applicability of the ANP method in two case studies for both the Brazilian automotive and Brazilian publishing industry was presented. Accordingly, these studies show that the ANP is a versatile technique applicable to ranking and selection problems in different industries.

Furthermore, using the ANP as the only technique was also carried out in a general supply chain environment by some authors. In these studies, Wadhwa *et al*. (2007) utilised the ANP to prioritise both the elements included in the actor-based framework and the supply chain flexibility alternatives (inclusion of logistics flexibility) examined in their decision model for developing agility in enterprises. Choudhury *et al*. (2004) implemented the ANP for a pharmaceutical company in order to attain coordination in a supply chain by considering production planning and logistics which leads to an effective dispatch policy. In their study, the ANP was used to resolve the relative impact of branching and manufacturing locations on the various factors and vice versa. As we can

see from these studies, the ANP is also applicable to problems that involve more than one company.

Up to this point, studies implementing solely the ANP method were reviewed. Yet, apart from using the ANP method as a single technique, it was also combined with different techniques in the logistics area by considering the fact that a combination may strengthen the weaknesses of the methods. For instance, Büyüközkan and Öztürkcan (2010) used a combined approach comprised by the DEMATEL and the ANP to evaluate three six sigma projects for a logistics company in Turkey. In the ANP part, they calculated the weights of the criteria included in their decision model. Likewise, Kengpol and Tuominen (2006) integrated three methods: ANP, Delphi, and Maximise Agreement Heuristic, to assess alternative IT proposals for five logistics companies in Thailand and the ANP was used to rank the criteria in the decision model of their study. In another study by Kengpol and Tuominen (2009), the ANP was used with a cost-benefit analysis to improve information quality in a medium-sized logistics company operating in the Thai fashion retail industry. Lastly, Lee (2010) analysed the logistics service strategies of the case of Taoyuan airport in Taiwan based on ANP, fuzzy SWOT (strength, weakness, opportunity, threat) and fuzzy AHP tools, and the ANP was used for evaluation of the alternative eight strategies by ranking them based on their weights.

On the other hand, the integration of the ANP method with several techniques in other industries rather than the logistics field was more commonly considered by researchers. Generally speaking, in these studies, the manufacturing industry was the main area of focus and the ANP method was combined with other MCDM techniques. For instance, to choose a global manufacturing and logistics strategy for a semiconductor company, several methods, such as DEMATEL, ANP, Vise Kriterijumska Optimizacija Kompromisno Resenje (VIKOR), Delphi technique, grey relational analysis were used by Tzeng and Huang (2012) and the ANP method was utilised to calculate the weights of the defined criteria obtained from the literature. In another DEMATEL-ANP combination study, Lin *et al*. (2013) determined the weights of both 15 criteria (including the global logistics aspect) and the six dimensions to choose a suitable supply chain strategy among 10 alternatives by using the ANP method while the DEMATEL was used to identify the relationships between the factors.

In the electronics industry, these combinations were used to select the best logistics company among the alternatives. As an example, in the study of Chen and Wu (2011), the ANP method was used with the Delphi technique to select the most appropriate logistics service provider for the Taiwanese electronics industry in the Southeast Asia. Likewise, Chen *et al*. (2013) applied different techniques, such as ANP, TOPSIS method including the grey incidence approach, and the entropy technique to select a suitable reverse logistics service provider for an electronic manufacturing enterprise in Fujian. In their study, the ANP method was used to determine the dependencies of the evaluation factors as well as the subjective weights of these factors. In another logistics provider

selection research, which is based on the AHP and ANP combination, an appropriate third-party reverse logistics provider selection for an Indian automobile components manufacturing company was studied by Govindan *et al*. (2013) who used the ANP to rank seven alternative providers.

In addition, the reverse logistics concept was also highlighted by other researchers, including the ANP as part of their studies. Tuzkaya *et al*. (2011) studied a multi-objective model, including ANP, fuzzy TOPSIS and genetic algorithms, for the reverse logistics network design by presenting a case study of the Turkish white goods industry and the ANP method was used to calculate the weights of the selected criteria after the identification of the interdependencies among these criteria. In another research, a reverse logistics project for a computer hardware company was selected by the combination of the ANP and zero-one goal programming methods in Ravi *et al*.'s (2008) study where the ANP method was used to capture both the interdependencies among the projects and the criteria as well as to weight the projects.

Besides using the ANP technique by itself, fuzzy values were adopted into the ANP method by several researchers to utilise the fuzzy ANP technique because according to some authors (e.g. Tuzkaya and Önüt, 2008; Tadić *et al*., 2014), fuzzy approach is useful to cope with ambiguity and vagueness problems caused by incomplete information or qualitative indicators. In these studies, Tuzkaya and Önüt (2008) implemented the fuzzy ANP in the logistics area for a chosen logistics-service provider company in order to select a transportation mode. In a similar context, Özgen and Tanyas (2011) focused on a specific issue concerning the joint selection of Turkish customs broker agency and international road transportation firms. In their paper, the best combination among three alternatives was determined by the fuzzy ANP method based on 27 criteria placed under six clusters in the decision model. Apart from operational purposes, the fuzzy ANP method was used by Tadić *et al*. (2014) as one of the methods to obtain the weights of the criteria used for the selection of the best city logistics concept in Belgrade.

In addition to these studies including the fuzzy ANP as a single method, a hybrid model consisted of fuzzy ANP and fuzzy DEMATEL was adopted by Kuo (2011) to decide the most convenient seaport among the selected five alternatives in the Pacific Asia region. What is more, not only in the logistics field, but also in different industries, especially in the manufacturing field, the fuzzy ANP method was also examined by various authors either as an individual technique (e.g. Onut *et al*., 2011) or as a part of multiple techniques (e.g. Wong, 2012).

Although the fuzzy approach was adopted in the ANP method and studied by several authors in the literature, using the ANP technique without fuzzy values is found more significant for this study because fuzzy logic is hard to scale to larger problems (Wang *et al*., 2009) and, in this study, the performance indicators were comprehensively examined and analysed within the whole logistics area. Additionally, applications of the AHP and ANP methods including their fuzzy implementations were presented in Sipahi and Timor's (2010) literature review study. In their

study, the authors noted that the ANP method is more suitable to provide a flexible model in problem solving of real world cases and it will be more popular in the future. In addition, since fuzzy applications are the worst among all methods (Saaty, 2008) and as it has difficulty in giving valid answers in decision making (Saaty, 2006), fuzzy set theory was not applied in this research.

Furthermore, based on the studies reviewed in this section, it can be concluded that there is a limited usage of the ANP method in the logistics context, more particularly the application of the ANP method as the only technique. Further arguments for the reason of using the ANP method are indicated in the literature. For instance, Wadhwa *et al*. (2007) pointed out that ANP is a relatively new tool and a few papers about implementing ANP have been published in the business decision area. More specifically, for modelling strategic decision, the ANP, which has become a popular technique, has been effectively utilised in logistics applications (Meade and Sarkis, 1998; Çelebi *et al*., 2010). Moreover, in the logistics area, as Kayakutlu and Buyukozkan (2011) noted, the factors influencing the strategies cannot be mutually eliminated, and therefore, the ANP has become a single outstanding method for assessing the performance factors. In a similar way, Hernández *et al*. (2012) stated that dependence analysis among the elements in the model enhances the reliability of the results, and for this reason, the ANP method provides the best results. Based on these arguments, the ANP was emphasised as an effective and a realistic approach to be implemented in a logistics context.

In addition to these arguments, there are some other rationales in terms of not using a hybrid approach including the ANP for this study. For instance, the accuracy of the presented results may not be as strong as using the ANP as an individual technique. In parallel to this, individual methods are analysed by more researchers rather than integrated methods in supplier evaluation and selection literature (Ho *et al*., 2010). Additionally, the importance of performing the ANP method with a BSC model approach was highlighted in the literature. Since the ANP allows aggregating the preference of the respondents regarding the factors, adopting different approaches, such as the BSC was suggested by Cheng and Lee (2010) as a further study. Likewise, Ravi *et al*. (2005) demonstrated for their study and noted that a combination of the ANP and BSC approach provides a more realistic and precise solution due to the fact that the BSC is a holistic framework and the ANP has a network structure considering both hierarchical and horizontal relations.

In conclusion, by considering these aforementioned matters, the ANP method was applied in this research in order to evaluate logistics performance indicators placed under four proposed BSC perspectives. In the next section, the studies integrating the BSC approach and the ANP method are explored in detail.

2.10 Integrating the Balanced Scorecard Approach and the ANP Method

During the literature review of this section, “Balanced scorecard-Analytic Network Process”, “BSC-ANP”, “Balanced scorecard-ANP”, and “BSC-Analytic Network Process” keyword pairs

were searched within peer-reviewed articles revealed from the five databases excluding the conference papers and different research fields (e.g. medicine; biochemistry, genetics and molecular biology; psychology, etc.) since these studies are out of the scope of this research. Additionally, English and Turkish languages were both considered during the searches. However, some of the articles found after these searches were not analysed in this review because either they were not related to these two concepts or some could not be accessed by the author. Furthermore, since one of the articles which appeared in these searches was later retracted from the journal, it was also excluded from the review of this research. Hence, at the end of these processes, 31 articles were evaluated for this research.

The remainder of this section is examined in two parts. In the first part, since the BSC perspectives have been used in various ways within different fields by performing some techniques, usage of the four generic perspectives of the BSC approach in different industries is investigated. By considering this usage, papers are also classified based on either containing the ANP method as the only tool or using the ANP method as part of a hybrid approach. In the second part, studies including a customised BSC approach by adopting different perspective(s) in the BSC concept are explored based on both their implemented industries and their methods.

2.10.1 Existing Studies Implementing the Generic Balanced Scorecard Concept and the ANP Method

The majority of the 31 articles includes conventional (or similar to the conventional with slightly different names) BSC perspectives with the integration of either the ANP as a single technique or a hybrid approach containing the ANP. Regarding the hybrid approach studies, Chang (2013) used the BSC model by integrating ANP and TOPSIS to select an optimal new product development project for a Taiwanese company operating in the century-old food industry. According to the author, perspectives and criteria in the BSC are interrelated and, therefore, the ANP method was used by the author to solve this interrelation problem as well as to weight the criteria in the model. In another food industry-related study, Thakkar *et al*. (2007) highlighted several problems existing in the performance measurement environment, such as difficulties of measurement in organisations, and the fact that companies rarely define the interactions between the performance measures. To address these challenges, they presented a BSC model for the Indian food sector and the relationships among indicators were obtained through the interpretive structural modelling method whose outcome was used as an input for the ANP method in order to determine the weights of the indicators.

Chen *et al*. (2011) studied the evaluation of the hot spring hotels in Taiwan and used the BSC approach as a performance evaluation model since, as they pointed out, it is an effective performance evaluation technique. As a methodological approach, they applied the DEMATEL-ANP combination and the ANP was performed to determine and prioritise the weights of the criteria in their model. In addition to these studies, Wu *et al*. (2009a) evaluated performance

indicators and four alternative banks within a wealth management concept by using the BSC-ANP combination supported by the Delphi technique. The authors also discussed for their study that this combination can provide decision makers with a more balanced, precise and realistic presentation of performance challenges.

Up to this point, several studies implementing the hybrid approach and the generic BSC concept were reviewed. Based on these papers, although the ANP method was a part of the hybrid method, it was mainly used to identify the relationships of the BSC perspectives as well as to weight and prioritise the indicators used in these perspectives.

Besides using in a hybrid concept, the ANP usage as the only method with the BSC approach was also studied by several researchers in various fields. For instance, since the perspectives and the criteria are interrelated, Liao and Chang (2009) implemented the BSC and ANP approaches to help TV-shopping companies in Taiwan for selecting their key capabilities effectively while Poveda-Bautista *et al*. (2013) applied the same combination in the advertising industry of Venezuela in order to prioritise the weights and to rank the selected three case companies. In another study by Poveda-Bautista *et al*. (2012), competitive indicators and three companies in the plastic industry of Venezuela were assessed by the combination of BSC-ANP approach. Moreover, they suggested using this combination for future studies in other industries. Likewise, the same combination was implemented by Ravi *et al*. (2005) to evaluate the reverse logistics operations of a computer manufacturing company and they stated that the combination of BSC-ANP provides more realistic and precise representation for their problem solution.

Similarly, the significance of the ANP implementation for the BSC concept was also highlighted in De Felice and Petrillo's (2013) study, in which the BSC approach was utilised with the ANP method in order to assess the key performance indicators for the fashion industry. They emphasised the usefulness of the ANP in a BSC assessment because the BSC does not clarify how to weigh dimensions in a performance measurement process while containing a number of relevant dimensions. Furthermore, according to them, the BSC-ANP combination is a very promising research area to assess enterprises' performances.

As another example of this combination, Liu and Tsai (2007) focused on performance evaluation for the research and development in Taiwan's high-tech industry based on the BSC model. In their study, firstly performance indicators were categorised for evaluation, and then the ANP method was applied both to analyse the interrelations among the indicators and to determine their weights. As a last example, Shiue and Lin (2012) focused on the environmental concerns and an evaluation model was constituted based on the BOCR (benefits, opportunities, costs, risks) and BSC models to assess recycling strategies in the solar energy industry. They chose the ANP method due to its suitability in providing solutions in a complex MCDM field. However, the BSC approach in their model was analysed within the BOCR process, especially in the risk cluster. Therefore, the BSC was not assessed extensively in their research.

In addition to these studies, in the education area, both the hybrid and the single ANP method usage with the BSC concept can be observed. As an example of the hybrid approach, Wu *et al*. (2011) assessed extension of education centres of three universities at Taoyuan County in Taiwan based on the BSC framework by using ANP, DEMATEL and VIKOR techniques. In their study, the ANP was applied to calculate weights of the performance indices existing in the evaluation framework. As an example of the usage of the ANP as the only method, Chen *et al*. (2009) proposed a BSC-based framework in order to evaluate the knowledge management of a technology university in Taiwan compared to its competitors by using the ANP method which was decided due to some advantageous features, such as its suitability to assess the consistency of decision makers for the pairwise comparisons as well as enabling the use of tangible and intangible indicators.

Likewise, Atafar *et al*. (2013) presented a study including the implementation of the BSC and ANP approaches in an Islamic Azad University in Iran and the university performance was evaluated based on the four perspectives of the BSC framework. They also noted that the BSC is an MCDM problem involving various elements even though not many MCDM methods can handle the interdependencies among these elements. From this point of view, the ANP method was found as a suitable technique by the authors to cope with the interdependency problem. In the same context, Zolfani and Ghadikolaei (2013) assessed performances of five private universities in Iran by using three methodologies, namely DEMATEL, ANP and VIKOR. In their study, DEMATEL was performed to establish cause-and-effect relationships in their BSC-based model while ANP was used to calculate the weights of the criteria and VIKOR was applied to rank universities.

Furthermore, studies focusing on the traditional (or similar) perspectives of the BSC were also conducted in the manufacturing industry by using either the ANP individually or hybrid techniques. For instance, Leung *et al*. (2006) showed implementation of the BSC with AHP and ANP methods to overcome these problems in a consumer electronics manufacturer. They also noted that the ANP is a technique that can be used to implement a wide range of BSC frameworks since it is a versatile method considering interdependencies among the criteria. Another example of a hybrid approach is Tseng *et al*.'s (2011) study where green performance assessment was focused. Their hybrid methodology consisted of fuzzy set theory with ANP and the importance-performance analysis in order to overcome the issue of finding a proper method for capturing dependency among the aspects in the implementation process of the BSC. Their aim to use the ANP was to calculate the weights of both the aspects and the green performance criteria for printed circuit board firms in Taiwan.

In another study, Yüksel and Dağdeviren (2010) highlighted some raised deficiencies of the BSC approach and noted that relative weights or significance of the performance indicators, and measuring business performance with a holistic quantitative strategy are some of these deficiencies of the BSC tool on a methodological basis. In their study, four BSC perspectives, which were placed under three strategies defined to achieve the business vision of a manufacturing firm in

Turkey, were assessed by using the fuzzy ANP method. However, using fuzzy values in the AHP and ANP were criticised by Chen *et al*. (2008), who focused on solving a new product development mix problem for a manufacturer of small-sized home appliances in China. They criticised the use of fuzzy values since the fuzzy AHP/fuzzy ANP is very complicated. Along the same lines, Lee *et al*. (2008) applied the BSC-ANP approach to compare the evaluation performance of product mix after selecting the most suitable product mix for a well-known manufacturer of home appliances in China. In another study, Bhattacharya *et al*. (2014) formed a green supply chain measurement framework embedded in a BSC concept for a UK-based carpet-manufacturing firm and linked to the fuzzy ANP technique. Yet, since there is room to develop for presenting more technical support for suppliers, the authors suggested including a more efficient collaborative decision making process (e.g. a fuzzy approach containing the quality function deployment and the ANP) for future research.

Overall, previous studies conducted in the BSC concept have revealed the suitability of the ANP technique regarding interdependent relationships and prioritisation of performance indicators. Therefore, these arguments stimulated consideration of the BSC-ANP combination, which is based on the quantitative approach (Hong *et al*., 2012), to deal with the research problems of this thesis. Moreover, the possible advantages of using this combination were also emphasised in the literature. For instance, the BSC-ANP integration helps to overcome some traditional problems of the BSC implementation, such as dependency of the measures, and the practice of including subjective (e.g. customer satisfaction) and objective measures together (e.g. rating) (Leung *et al*., 2006). Additionally, the nature of the BSC is to accept the conflict between the measures and implementing the ANP method makes the results more valuable and realistic (Thakkar *et al*., 2007). According to Tjader *et al*. (2014), performing the ANP method alone without the BSC approach, would possibly miss some important decisive factors and, therefore, it is essential and important to use the ANP method with the BSC approach to solve the actual problems. They also noted that the BSC-ANP combination not only offers various distinctive advantages over other models and methods, it also supports decision makers in a wide range of ways, such as (Tjader *et al*., 2014, p. 622):

- "*Establishing relationships between and within different dimensions,*
- *measuring the strengths of those relationships and interactions,*
- *determining the overall impact of different dimensions and individual elements of a dimension on the strategies studied,*
- *deriving priorities for the dimensions, the components of the dimensions, and the strategies considered,*
- *allocating resources according to those priorities, and*
- *assessing the sensitivity of strategy priorities to changes in the priorities of the dimensions and their components.*"

To sum up, previous studies examined in this section showed that the ANP method was implemented in the BSC approach either as a single technique or as a method in a hybrid approach. In both cases, the ANP method was mainly used to determine the interrelationships among the factors in decision models and/or to compute the relative weights of the factors. By considering the need of analysing interrelationships among the performance indicators and perspectives, the BSC-ANP combination offered the most advantageous approach for the scope of this research.

2.10.2 Studies on a Customised Balanced Scorecard Approach Including the ANP Method

The four generic perspectives of the traditional BSC concept have been customised differently by various researchers. As a result of this customisation, various perspectives were adopted into the BSC models of the studies. Additionally, some of these studies contain hybrid approaches including the ANP while the rest consisted only of the ANP method.

From the hybrid studies, Wu *et al*. (2009b) presented an evaluation model including four perspectives of the BSC approach and utilised the conjoint analysis with the ANP method. They divided the financial perspective into two parts in their model, namely outpatient financial performance and inpatient financial performance by keeping the other BSC perspectives as they are. Rabbani *et al*. (2014) incorporated three perspectives, namely social, economic, and environmental, into their sustainability BSC framework by keeping the internal process and learning and growth perspectives of the original approach. In their study, a hybrid MCDM approach was used including the ANP and fuzzy complex proportional assessment techniques for the oil companies in Iran and the ANP was used both to determine the interrelations and relative weights of the criteria.

In another study, Tsai *et al*. (2009) stressed the importance of the socially responsible investment and proposed a sustainability BSC framework with a case study conducted in the Taiwanese electronics industry. They implemented a three-stage approach consisting of DEMATEL, ANP, and zero-one goal programming methods, and in their proposed model, the original 'customer perspective' was replaced with the 'customer/stakeholder' perspective due to the interaction between a company and its external stakeholders, such as government, NGOs, and communities. In a similar vein, replacement of the original 'customer perspective' was also considered by different researchers. As an example, Hsu *et al*. (2011) presented a sustainability BSC framework for the Taiwanese semiconductor industry by using the fuzzy Delphi method and the ANP technique to evaluate the relative importance of the 25 selected performance measures for the whole industry. They made some alterations in the traditional BSC structure by replacing 'financial' and 'customer' perspectives with 'sustainability' and 'stakeholders' perspectives to deal with the inadequately addressed issue of corporate social responsibility. As they indicated, since there is a deficiency of the original BSC approach about considering different stakeholders, the 'stakeholders' perspective was adopted in their study and the results after the ANP processes were found satisfactory. Likewise, in the research of Tseng (2010), which was based on a case research studied in a private

university of science and technology in Taiwan, the 'student aspect' was used instead of the 'customer perspective', and the ANP method was applied to convert dependencies among the factors into the weights.

As can be seen from these studies, the BSC model was customised by the researchers. More particularly, the studies discussed above showed that the researchers mainly followed a more comprehensive approach rather than including only customers. Furthermore, the ANP method was used in these studies as part of a hybrid technique in order to investigate interdependencies among the criteria and to determine their relative weights.

Besides using the ANP method as part of a hybrid approach, it was also used as the only technique in different studies including changes in the structure of the perspectives of the traditional BSC concept. It is worth noting that most of the evaluation methods present disintegrated results with a shortcoming of a global aspect (Oh *et al*., 2009) and most of the systems do not have enough aggregation technique (transforming the elementary performance expressions into global) for complex issues (Grabot, 1998; Berrah *et al*., 2004). From this point of view, Oh *et al*. (2009) presented a model in a case study carried out in the Korean telecommunications industry by considering the BSC, whose perspectives were changed to some extent for the telecom service evaluation, and they proposed only the ANP method to provide a more global aspect.

In another example, the usage of the 'customer' perspective of the traditional BSC approach was replaced with the 'service' perspective in Pan *et al*.'s (2014) study while the other generic perspectives were kept the same in the model. In their study, they formed an index system for supplier selection of a maintenance, repair and overhaul/operation enterprise with the help of the BSC model and the weights of the indexes were determined by using the ANP method. Quezada *et al*. (2014) renamed the generic 'customer' perspective with the 'clients' in their study conducted in a small printing company. In order to establish the causal relationships of a strategy map of a BSC and to find the priorities of the relationships, they used the ANP method and, then, they determined the 'important' relationships in their strategy map.

Hence, in light of this information, one can conclude that some alterations can be made in the traditional perspectives of the BSC approach. As can be seen from the previously examined studies, the common approach among the researchers is to extend the 'customer' perspective to include other stakeholders since it was considered a deficiency of the BSC approach by various authors. This replacement is also not against the theoretical structure of the BSC concept because, as previously mentioned in Section 2.5.1, Kaplan and Norton (1996a) indicated that the four generic perspectives are organised as templates.

To conclude, in this study, the ANP method is used as the only method, as explained in Section 2.9, to define the interrelationships among both the perspectives and the indicators used in the stakeholder-based BSC model as well as to determine their global weights for the logistics

industry. Meanwhile, the 'stakeholders' perspective was used instead of the 'customer' perspective in order to deal with the weakness of the traditional BSC approach by considering various stakeholders. Hence, with the integration of different stakeholders and diverse sets of indicators from multiple aspects, a more comprehensive model was proposed in this research and the BSC-ANP combination was performed to address the research problems of this thesis.

2.11 The Need for a Balanced Scorecard-ANP Synthesis in the Logistics Field

Based on the aforementioned information obtained from the existing studies in the literature in terms of the BSC-ANP combination, the same integration is examined in the logistics industry in this section. For the literature review of this particular combination, "Balanced scorecard-Analytic Network Process-logistics", "BSC-ANP-logistics", "Balanced scorecard-ANP-logistics", and "BSC-Analytic Network Process-logistics" terms were searched, and at the end of these searches, three articles were revealed from the five databases. Among the three papers, two were conference articles while only one was a peer-reviewed journal article.

Regarding the two conference papers, Leem *et al*. (2007) studied modelling performance metrics to measure the performance of logistics centres in the Korean context by using the BSC and the ANP approaches. In their study, instead of the generic learning and growth perspective, the 'employee' perspective was adopted. In other respects, Kashi and Franek (2014) examined the AHP/ANP applicability in a manufacturing firm and the practical applications of these two methods were used to indicate a comparison of the traditional BSC and another form of the BSC concept which was extended by multi-attribute decision making (MADM) techniques. However, in their study, the performance criteria were not placed or assessed by using the BSC perspectives. Moreover, neither the BSC approach was used mainly in their study nor the logistics industry was considered as the context.

On the other hand, with respect to the only journal paper emerging from the searches, Ravi *et al*. (2005) presented a framework containing the BSC perspectives under four main dimensions, namely: economic factors, legislation, corporate citizenship, and environment and green issues. In their research, reverse logistics operations for end-of-life computers were analysed and a case study applied in a small PC manufacturing company was conducted to show the applicability of the proposed model with the ANP method. Ultimately, besides assessing both the dimensions and the criteria used in their decision model, they evaluated three alternatives for conducting reverse logistics operations by the ANP technique. However, such an approach does not indicate the evaluation of performance indicators for the logistics industry, especially from logisticians' perspective.

As a conclusion, as can be seen from these three studies, assessing logistics performance indicators from logisticians' perspective was not applied in the literature. More particularly, none of the existing research evaluated the logistics performance indicators for logistics companies through the

BSC-ANP synthesis. Therefore, in this research, the BSC model and the ANP method were integrated to evaluate the performance indicators used in logistics from logisticians' perspective without having any other industry-specific view. Thus, the presented results can be used by logistics companies to decide which performance indicators would be used to increase their competitiveness in the industry and to analyse their operations in order to become more competitive. Additionally, as a result of the inclusion of various stakeholders in the model, different stakeholders of logistics companies can also take an advantage of the results of this study during their 3PL provider selection decisions. Hence, both decision makers in logistics companies and the stakeholders of these companies can use the result of this study as a reference.

2.12 Chapter Summary

In this chapter, a review of the published literature relevant to the research topic was presented. The literature review covered various areas, such as logistics, performance measurement in logistics, performance measurement frameworks, the BSC approach and BSC-related studies in logistics, the ANP method-related studies in logistics, the stakeholder theory and its usage in the logistics industry, and the need for the BSC-ANP combination in logistics by considering various stakeholders. Moreover, in this chapter, five databases were used to search the related studies in the sections. Yet, although the same databases were used throughout this chapter, each section was separately examined by using different keywords concerning the section subject.

Additionally, this chapter discussed the different performance measurement frameworks in the literature. The comparison of the presented frameworks showed that the BSC, which is the dominating model in the performance measurement, is the most appropriate model since it contains cause-and-effect relationships as well as containing both financial and non-financial indicators. Thus, the BSC model was considered a valuable and powerful approach to advance the understanding of both identification of key performance indicators and determination of the interrelationships among the indicators which were the purposes of this thesis. However, a few researchers showed the implementation of the BSC in the logistics area. In addition, it was revealed from the literature that the studies focusing on the integration of the stakeholders in the BSC framework to deal with the major shortcoming of the BSC concept remained very limited in the logistics field. Particularly, only a handful of research studies in the logistics context attempted to consider the stakeholder perspective in the BSC approach. Therefore, apart from the logistics and performance measurement literature, the stakeholder theory-related studies as a part of the strategic management area were also investigated in this chapter. By doing so, a more comprehensive and robust BSC model was aimed to be proposed in this thesis.

In summary, the chapter was organised in a sequence of showing motivations and gaps revealed from each preceding section for the succeeding sections. Thus, the rationale for coming up with an idea of integrating the BSC approach with the ANP method was constituted based on the deductive method as a response to the need to tackle the previously mentioned problems in the logistics

industry. In this respect, Table 2-3 summarises the key points determined in the literature review in parallel to the purpose of this thesis, reference studies regarding these key points, and the gaps to be addressed through this research.

Table 2-3: Key points, references, and the gaps to be addressed in the literature

Sections in the Thesis	Key Points	References	Gaps to be addressed
Selection Studies as a Proxy of Performance Measurement	3PL evaluation and selection from a logistics point of view	Daim *et al*., 2013; Xianlong and Yujie, 2013	- Considering stakeholders' needs in a framework, particularly in conjunction with the MCDM approach in the logistics domain and for the competitiveness of logistics companies - Proposing a comprehensive model with a strong theoretical basis for 3PL selection in logistics incorporating both tangible and intangible indicators as well as strategic and operational indicators
Balanced Scorecard-related Studies in the Logistics Field	Studies focusing on the performance concept for logistics companies (without different operational concepts, such as reverse logistics or humanitarian logistics)	Chia and Hoon, 2000; Janeš and Dolinšek, 2010; Rajesh *et al*., 2012	- Proposing a more balanced view, including both financial and non-financial indicators, for the BSC implementation in logistics companies - Using a powerful MCDM method conforming to the BSC nature by containing interrelationships among both the perspectives and the indicators, particularly for the competitiveness of logistics companies

			- Considering various stakeholders and their satisfaction in the BSC concept comprehensively for the logistics industry
Considering Different Stakeholders in the Balanced Scorecard Approach	Examining different stakeholders rather than only customers in a perspective within the logistics domain as a response to the major deficiency of the generic BSC concept	Shaik and Abdul-Kader, 2012; Shaik and Abdul-Kader, 2013; Shaik and Abdul-Kader, 2014	- Examining various stakeholders in a BSC perspective to a significant extent for the logistics industry and for the context of competitiveness of logistics companies
Applications of the ANP Method in the Logistics Field	Studies including the ANP as a single technique within the logistics area	Kayakutlu and Buyukozkan, 2011; Meade and Sarkis, 1998; Wang, 2013; Zang *et al*., 2013	- Assessing performance indicators with the help of the ANP for the competitiveness of logistics companies by considering the entire logistics industry norms - Integrating the ANP method and the BSC approach for the competitiveness of logistics companies
	Combining the ANP method with different techniques within the logistics area	Büyüközkan and Öztürkcan, 2010; Kengpol and Tuominen, 2006; Kengpol and Tuominen, 2009; Lee, 2010	

At the end of the reviews, this research found a great need to bridge a knowledge gap stemming from the absence of a comprehensive BSC-based framework including various stakeholders in which to highlight the key logistics performance indicators and to prioritise them by considering interrelationships in a network structure with the help of a more realistic MCDM method, the ANP. In this regard, the proposed framework can be used by both the decision-makers in logistics companies and their stakeholders.

CHAPTER 3 : METHODOLOGY

3.1 Chapter Overview

This chapter elaborates the research methodology outlined in Chapter 1 by providing justifications for the research philosophy, approach, design, and data analysis methods used in this thesis in the pursuit of the research aim and objectives. There are three main stages including different types of methods performed in this research.

In the first stage, different questionnaire types were examined and the internet and intranet-mediated type questionnaire was found more suitable for this research. After this decision, the Internet-based survey was explained in more detail because the online survey, which will be explained in Chapter 4, was conducted to investigate and highlight the most important performance indicators in logistics industry.

In the second stage, a group decision making approach was introduced to deal with the previously mentioned research problems and, also, an overview of the MCDM techniques was provided with a comparative approach. After comparison of various group decision making techniques, the ANP appeared as the powerful and realistic method for the purpose of this study. Thus, the ANP method processes are explained after the questionnaire type selection and group decision making sections.

In the final stage, three interview techniques revealed from the literature were explored. Depending on the main features of these techniques, a particular emphasis was given to discuss the semi-structured interview type since it was more appropriate to demonstrate the applicability of the model and to validate the ANP outcomes.

As a result, in this chapter, the philosophical stance and the research approaches are preliminarily clarified as the foundations of this research. Then, after constructing the research on these stances, it is shown that different research methods based on these mentioned three stages were applied to meet the aim and objectives of this thesis. Lastly, the ethics in this research is explained in terms of the methods applied in this research followed by the chapter summary.

3.2 Research Philosophical Paradigms

In this study, the philosophical paradigm is based upon two alternatives, which are positivism and interpretivism. Before the classification of these philosophical paradigms, it is significant to give a logical explanation of the terms.

Research philosophy includes significant inferences, which will form the basis of the research strategy and the methods of a study, about how we view the world (Saunders *et al*., 2009). According to Saunders *et al*. (2009), two major ways of thinking about the research philosophies are ontology and epistemology. However, as similarly discussed in Healy and Perry's (2000) study,

Guba (1990, p.18) noted that the philosophical paradigms can be characterised by way of answering the following three questions:

"(1) *Ontological*: What is the nature of the "knowable"? Or, what is the nature of "reality"?

(2) *Epistemological*: What is the nature of the relationship between the knower (the inquirer) and the known (or knowable)?

(3) *Methodological*: How should the inquirer go about finding out knowledge?"

The differentiation of the research philosophies and their comparisons based on their different orientations with regard to ontology, epistemology, and data collection techniques are shown in Table 3-1.

Table 3-1: Comparison of research philosophies

	Positivism	**Realism**	**Interpretivism**
Ontology: *the researcher's view of the nature of reality or being*	External, objective and independent of social actors	Is objective. Exists independently of human thoughts and beliefs or knowledge of their existence (realist), but is interpreted through social conditioning (critical realist)	Socially constructed, subjective, may change, multiple
Epistemology: *the researcher's view regarding what constitutes acceptable knowledge*	Only observable phenomena can provide credible data, facts. Focus on causality and law like generalisations, reducing phenomena to simplest elements	Observable phenomena provide credible data, facts. Insufficient data means inaccuracies in sensations (direct realism). Alternatively, phenomena create sensations which are open to misinterpretation (critical realism). Focus on explaining within a context or contexts	Subjective meanings and social phenomena. Focus upon the details of situation, a reality behind these details, subjective meanings motivating actions
Data collection techniques most often used	Highly structured, large samples, measurement, quantitative, but can use qualitative	Methods chosen must fit the subject matter, quantitative or qualitative	Small samples, in-depth investigations, qualitative

Source: Modified from Saunders *et al*. (2009)

In respect of these three orientational ways, different identifications can be found in the literature. Briefly, ontology is concerned with the nature of social entities (Bryman, 2004) and is the 'reality' that researchers examine (Healy and Perry, 2000) whereas epistemology is relevant to the enquiry of what is (or should be) regarded as agreeable knowledge in a field of study (Bryman and Teevan, 2005). That is to say, ontology is relevant with 'being' while epistemology is concerned with

'knowing' (May, 1993). On the other hand, methodology is the technique used by the researcher to examine this reality (Healy and Perry, 2000).

In other respects, with reference to the philosophical approaches, a concise summary will be given for each. Firstly, positivism is a reflection of a philosophical stance of the natural scientist (Saunders *et al*., 2009). In a positivist approach, a researcher, who is independent regardless of the subject of the research (Remenyi *et al.*, 1998), uses a highly structured methodology (Gill and Johnson, 2002) and conducts research in a value-free way as well as emphasising a number of quantifiable observations which leads researchers to use statistical analysis (Saunders *et al*., 2009). Moreover, in this approach, causal relationships can be also determined (Mentzer and Kahn, 1995).

On the other hand, as a contrasting way to positivism (Bryman and Teevan, 2005), interpretivism requires to catch the subjective meaning of a social action or a movement for the social scientist (Bryman, 2004). In the interpretivist philosophy, a researcher understands differences from his/her point of view and he/she interprets the reality and the social roles of individuals with his/her own set of meanings (Saunders *et al*., 2009).

Realism is a philosophical position providing an alternative account of the nature of scientific enquiry (Bryman and Teevan, 2005). The objects in the reality have an independency of the human mind (Saunders *et al*., 2009).

In the light of this information, it can be seen that different philosophical approaches have been used in previous studies. Yet, as Guba (1990) stated, all such belief systems or paradigms were constructed by humans and, therefore, there can be some errors and weaknesses. Similarly, Saunders *et al*. (2009) noted that it would miss the point to think that one philosophy is better than another because to decide which is better depends on the research question(s) of a study. In this study, the logistics field, which is one of the areas being influenced by these research philosophies, has been focused by the researcher, and Mentzer and Kahn's (1995) research showed that all logistics research has been mainly studied within the positivist paradigm. Likewise, Näslund (2002) pointed out that quantitative methods, which belong mainly to the positivist paradigm, have been dominating the logistics field while qualitative techniques, which are more interpretive and subjective, have been less applied in the area. Within this scope, they argued that logistics needs qualitative research, such as action research case studies.

Consequently, apart from these arguments, as a result of the given research problems and questions in Chapter 1, the main research philosophy of this whole research is based upon positivism and there is a rationale to impose the positivist philosophy to this study. For instance, the aim of the research is to evaluate the performance indicators and to give a better understanding of the impact of these performance indicators on competitiveness in the logistics field by presenting their prioritisation. Furthermore, the research focuses on the concepts, theories, and practices incorporated in the logistics area. As positivism includes some features, such as considering causal

relationships, containing structural methodology, and involving quantifiable observations, adopting a positivist stance would help this research both to investigate the significance of the performance indicators to be used during the constitution of the conceptual model and to calculate the relative importance of the indicators used in this model.

On the other hand, within the methodology part, using both quantitative (online survey and the ANP method) and qualitative (semi-structured interview technique) methods led the researcher also to follow interpretivism for this study because, as indicated in the features of interpretivism, some subjective judgments were incorporated during the assessments by the experts, the research sample of the case study part was small, and the interview technique were conducted with different case companies. Thus, the research also takes some benefit from the interpretivist approach in line with Näslund's (2002) emphasis on considering also the interpretivist approach and qualitative techniques in logistics studies.

3.3 Research Approaches

A research approach is the route of conscious scientific thinking (Peirce, 1931) and all research approaches possess a common aim, which is advancing knowledge, while following distinctive paths (Spens and Kovács, 2006). The choice of a research approach has been discussed by different authors (e.g. Perry, 1998; Bryman, 2004; Spens and Kovács, 2006) but the nature of the research subject and emphasis of the research are probably the leading factors to choose an approach for studies (Saunders *et al*., 2009).

There are two main research approaches commonly used in the literature: deduction and induction (Saunders *et al*., 2009). Researchers can hardly distinguish the processes of these approaches since the approaches are linked to each other (Perry, 1998) and there is no rigid division between them (Saunders *et al*., 2009). Additionally, some authors consider abductivism as a third research approach. For instance, it was discussed in Kirkeby's (1990, cited in Spens and Kovács, 2006, p. 377) research that a researcher uses a new theory or framework to an existing fact in the abductive approach where the aim is to suggest new theories. Also, it was exemplified in Spens and Kovács's (2006) study that adopting theories from other disciplines in the logistics field complies with this approach. Although abductivism is mentioned as a different approach by some researchers, since the main two approaches constitute the basis of a research approach for a study, as researched commonly in the literature, a particular interest will be given to the deductive and inductive approaches extensively in this section.

A deductive approach is frequently discussed as an advanced and dominant research approach both in general (Kirkeby, 1990, cited in Spens and Kovács, 2006, p. 376) and in logistics studies (Spens and Kovács, 2006). According to Spens and Kovács (2006), the process of a deductive research usually starts by scanning a theory and continues by deriving some reasonable conclusions which help to form hypotheses or propositions to test empirically. In other words, in a deductive

approach, a theory and hypothesis (or hypotheses) are established, and then, a research strategy is planned to test the defined hypothesis (or hypotheses) in order to examine the outcomes which may cause a modification of the theory (Saunders *et al.*, 2009). After all of these steps, the new knowledge is originated based on the prior knowledge and derived conclusions. From this point of view, the sequence of the deductive approach is shown in Figure 3-1.

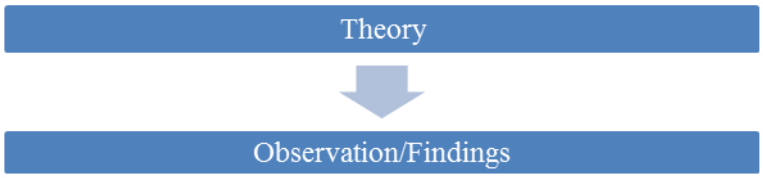


Figure 3-1: The sequence of the deductive approach
Source: Bryman (2004, p. 10)

On the other hand, the inductive approach is used for a theory building strategy rather than theory testing as in a deductive approach (Perry, 1998). In other words, an inductive approach starts by collecting data, and then proceeds by developing a theory based on the results of data analysis (Saunders *et al.*, 2009). Thus, the sequence of this approach starts from facts and moves to the theory (Andreewsky and Bourcier, 2000). The progression of the inductive approach is depicted in Figure 3-2.

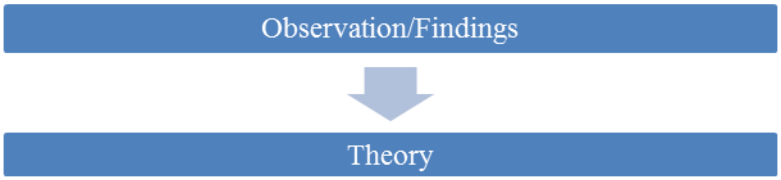


Figure 3-2: The sequence of the inductive approach
Source: Bryman (2004, p. 10)

Even if the approaches are clearly defined by researchers, the choice of a suitable approach cannot be easy for researchers since, in practice, the distinction of these two approaches is not as clear as it is shown in these figures. For this reason, in order to distinguish these approaches more easily, the major differences of both approaches in terms of what they emphasise are highlighted in Table 3-2.

Table 3-2: The major differences between deductive and inductive approaches

Deduction emphasises	Induction emphasises
scientific principles	gaining an understanding of the meanings humans attach to events
moving from theory to data	a close understanding of the research context
a highly structured approach	a more flexible structure to permit changes of research emphasis as the research progresses
the collection of quantitative data	the collection of qualitative data
researcher independence of what is being researched	a realisation that the researcher is part of the research process
the necessity to select samples of sufficient size in order to generalise conclusions	less concern with the need to generalise
the need to explain causal relationships between variables	
the application of controls to ensure validity of data	
the operationalization of concepts to ensure clarity of definition	

Source: Modified from Saunders *et al*. (2009, p. 127)

Following the aforementioned information presented in Table 3-2, this study has similar features with the deductive approach. For instance, the constitution of the research process is moved from a theory to data analysis. Moreover, quantitative data, based on the positivist stance, were collected for fulfilling the aim of this research, which is to explain the causal relationship among the performance indicators in the logistics field. Therefore, the deductive approach is used as a main emphasis in this research.

3.4 Research Methods: Qualitative Research, Quantitative Research, Mixed-Methods

Qualitative and quantitative methods are two widely used data collection methods in business and management studies and focusing on numeric or non-numeric data is a way of distinguishing these methods (Saunders *et al*., 2009). Qualitative methods, which follow inductivist, constructionist, and interpretivist approaches (Bryman and Teevan, 2005), use or produce non-numeric data while quantitative methods, which follow generally positivist approaches (Healy and Perry, 2000), use or produce numeric data.

More specifically, qualitative methods are used in exploratory research to provide some understandings about specific problems, opportunities, theories or models (Hair *et al*., 2003) and by using these methods, a rich amount of data can be obtained (Bryman, 2004). Qualitative research, which is mainly based on words rather than numbers, contains various methods, such as

ethnography/participant observation, qualitative interviewing, focus groups, language-based methods, and the collection and qualitative examination of texts and documents (Bryman and Teevan, 2005). There are some advantages and disadvantages of using these research methods, as shown in Table 3-3:

Table 3-3: Advantages and disadvantages of qualitative methods

Advantages	Disadvantages
Economical and timely data collection	Lack of generalizability
Richness of the data	Inability to distinguish small differences
Accuracy of recording marketplace behaviours	Lack of reliability and validity
Preliminary insights into building models and scale measurements	Difficulty finding well-trained investigators, interviewers, and observers

Source: Hair *et al*. (2003, p. 214)

On the other hand, the latter common research method used in numerous studies is a quantitative method which is applied as a synonym for any data collection approach (e.g. questionnaire) or numerical data analysis procedures (e.g. graphs, statistics) (Saunders *et al*., 2009). The quantitative method is reviewed as the dominant strategy and can be explained with some features, such as involving numerical data collection as well as establishing a deductive relationship between theory and research, preferring a natural science approach (especially positivism), and including an objectivist inception about social reality (Bryman and Teevan, 2005).

Moreover, quantitative methods are more associated with descriptive and causal research designs than exploratory outline by focusing on the inclusion of both standard questions and predetermined response choices in questionnaires or surveys (Hair *et al*., 2003). Therefore, in quantitative research, it is necessary to measure a concept, which can provide either an explanation of a definite view (independent) or can be explained by something (dependent) (Bryman and Teevan, 2005). As a result of using quantitative research techniques, decision makers can make precise predictions, gain some insights about the existing relationships, and verify or validate the relationships (Hair *et al*., 2003).

Besides, mixed-methods can be also applied by combining qualitative and quantitative research methods (Greene *et al*., 1989) which leads researchers to use inductive and deductive logic (Teddlie and Tashakkori, 2009). Using the mixed-method approach allows researchers some advantages. For instance, since every method has different biases and weaknesses, the mixed-method approach neutralises the weakness of each data form (Creswell, 2014). Thus, as a result of this neutralisation, the 'method effect' can be eliminated (Saunders *et al*., 2009).

The influence of the mixed-method approach has been examined by numerous authors in different fields. As an example, Näslund (2002) emphasised that it is important and essential to use a combination of both quantitative and qualitative approaches to advance the research in logistics.

Likewise, Dubey *et al.* (2015) highlighted the importance of applying the mixed-method approach in logistics and SCM since authors in the area have been using either quantitative or qualitative methods. In a similar vein, in the current research, both the online survey and the ANP method represent the quantitative component of this study while the case study part, incorporating semi-structured interviews, constitutes the qualitative component of this research. In this regard, by utilising the advantages of both methods, the mixed-method research design is proposed in this thesis as a methodological strategy.

3.5 Research Design and Research Method

A research design provides a framework for data collection and analysis while a research method is a technique to collect data (Bryman and Bell, 2015). In business research, since there is no single best method, the choice of method depends on the research problem, the research design, and the aim of the research (Ghauri and Grønhaug, 2005).

According to Ghauri and Grønhaug (2005), research methods are rules and procedures to solve research problems. As addressed in previous chapters, the research problems of this research were revealed from the literature and triggered the need to conduct this study. Based on the research problems, the purpose of this study is to identify the key logistics performance indicators comprehensively as well as to prioritise them by considering the existing interrelationships without having any other industry-specific view. In order to accomplish this purpose, the research method representing the mixed-method approach and its position in the research design are presented in Figure 3-3.

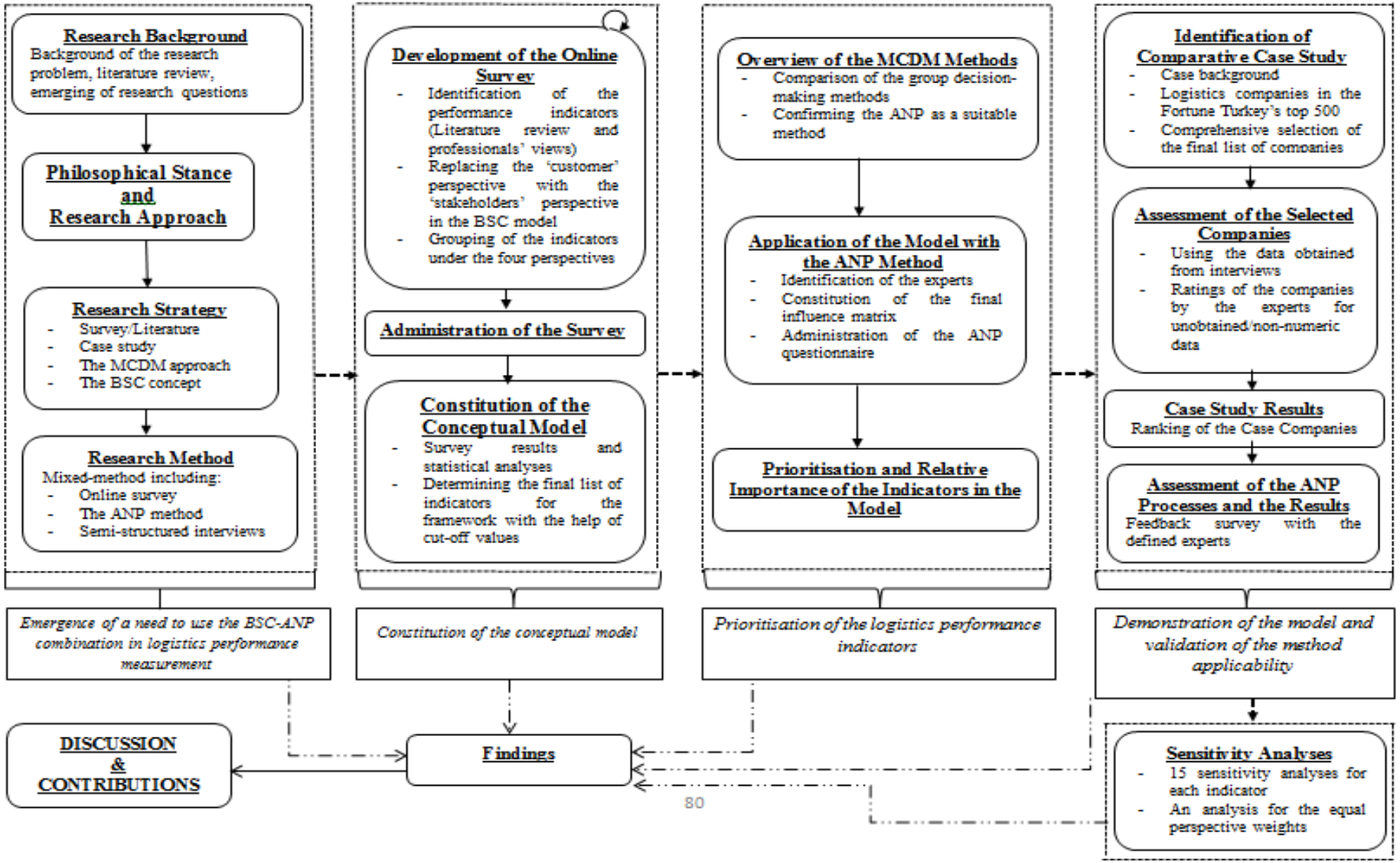


Figure 3-3: Research design

The procedures indicated in Figure 3-3 were used as the main phases to tackle the previously mentioned research problems and were followed as guidelines throughout the research. In the next section, the initial phase, which is the selection of a suitable questionnaire type, will be explained in detail.

3.6 Questionnaire Type as a Survey Instrument

Survey is the most commonly used tool for empirical studies in social sciences (Bortz and Döring, 2002, cited in Grant *et al*., 2005, p. 140), more specifically, in logistics and SCM studies (Grant *et al*., 2005). Surveys include various methods to collect raw data from large groups of people and questionnaire is one of these methods (Hair *et al*., 2003).

A questionnaire is a way of collecting data from many respondents that enables researchers to analyse some information. Questionnaires can be applied for descriptive or explanatory purposes. Descriptive research allows describing the variability in different cases while explanatory research allows explaining relationships between variables (Saunders *et al*., 2009). In a questionnaire design, there are some rules or procedures to follow. Firstly, in order to conduct a questionnaire, researchers primarily need to decide a questionnaire type that they want to apply because there are different questionnaire types used by researchers. After determining a questionnaire type, some major steps in a survey process, such as choosing suitable question type(s) based on research aim and questions, considering time length to distribute a survey, and assessing reliability/validity of a questionnaire need to be appraised by researchers. In the following sub-sections, each of these major steps will be elucidated in detail.

3.6.1 Questionnaire Types

Questionnaires are categorised differently based on how they are administrated. Saunders *et al*. (2009) indicated that there are two main categories for questionnaire types and each category consists of several sub-categories, as shown in Figure 3-4. According to them, the first main category is self-administered type, including Internet and Intranet-mediated questionnaires, postal questionnaire, and delivery and collection questionnaire sub-categories whereas the second main category is interviewer-administered questionnaire type containing telephone interview and structured interview sub-categories.

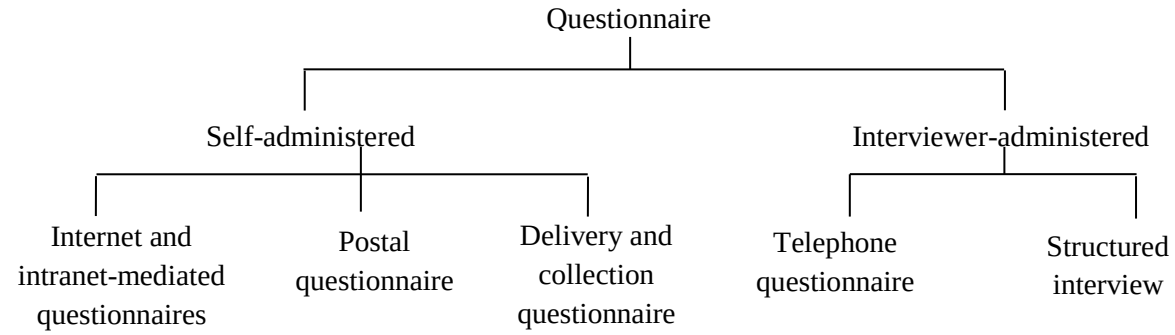


Figure 3-4: Questionnaire types

Source: Saunders *et al*. (2009, p. 363)

In the first category, self-administered questionnaires are generally completed by respondents and these type of questionnaires can be delivered and/or received by using different sources, such as the Internet (Internet-mediated questionnaires) or intranet (intranet-mediated questionnaires), post or mail (postal or mail questionnaires), and delivering or collecting by hand to each respondent (delivery and collection questionnaires) (Saunders *et al*., 2009). In the latter category represented by the interview-administered types, respondents can be reached by using telephone as in the telephone questionnaires or can be met face-to-face at a scheduled time and day as part of the structured interview (Saunders *et al*., 2009).

Despite the fact that there are various types of methods as shown in Figure 3-4, today, traditional survey methods, such as interviews, and postal questionnaires have been revolutionised by new IT-based surveys (e.g. e-mail surveys, Web-based surveys). Besides, traditional survey methods have been named as "offline" methods, whilst technology-based methods including computerised conformity have been referred to "online" survey methods (Hair *et al*., 2003). Yet, although there has not been much study examining technology-based survey methodologies in recent years (Grant *et al*., 2005), it is essential for logistics researchers to be aware of the new opportunities provided by advanced information technologies (Walton, 1997).

In this section, based on the information provided by previous researchers and by following the comprehensive comparison process for the presented types, the Internet and intranet-mediated type (or can also be named as the Internet survey) revealed as the prevailing and the most suitable type in terms of the representation of the survey, speed, large population access, and cost advantages. Therefore, for the purpose of this research, this questionnaire type will be explained in detail. In other words, the researcher took advantage of the unique features of the Internet-type survey since it provides new potentials to researchers not available in traditional methods (Hewson *et al*., 2003).

According to Hair *et al*. (2003), the Internet survey is an online survey method categorised under self-administrated questionnaire and is placed on a website. Concordantly, different researchers (e.g. Hewson *et al*., 2003; Saunders *et al*., 2009) remarked that Internet and intranet-mediated type questionnaires are conducted in two ways, either through email or through a website. According to

Saunders *et al*. (2009), the first depends on a list of addresses to be sent whereas the latter, the website, enables respondents to access the questionnaire via a hyperlink.

The importance and advantages of conducting a questionnaire through a website are emphasised by some researchers. For instance, Grant *et al*. (2005) noted that the Web allows users to undertake research by using an email or a web-based survey. Within this context, Witmer *et al.* emphasised that in the application of a website-based questionnaire the respondents can remain anonymous, can have equal importance, and cannot make amendments to the questionnaire (1999, cited in Saunders *et al*., 2009, p. 398). Additionally, Schmidt (1997) highlighted that conducting a survey on the Web gives respondents some advantages, such as reaching a large number of respondents, saving time and money, and increasing respondent motivation due to its dynamic and interactive nature while there are also some disadvantages of using this tool, such as incomplete responses, unacceptable and incorrect data, duplicate submissions, and security problems.

To sum up, by paying regard to the scope of this research, the self-administered type was revealed as being more suitable in this research. Moreover, by taking into account all the information, in order to reach more respondents and by considering some criteria such as cost, time length, easiness to analyse responses, the Internet-based online survey prepared on a website was used as a data collection method for the questionnaire part of this research.

3.6.2 Question Types in Questionnaires

During the preparation of a questionnaire, question types need to be considered carefully since clear wording of questions enables reliable results. Questions in a questionnaire can be either open (can be named as open-ended) or closed (can be named as closed-ended) or can be both types (Saunders *et al*., 2009). In the open question type, no answer choice is provided to the respondents (Dillman, 2007) and the answer is based on the comments of respondents. On the other hand, the closed question type, which is faster and easier to answer compared to the first type, enables respondents to choose an answer from different alternatives (Saunders *et al*., 2009). Moreover, in the closed question classification, there are six question types, namely list, category, ranking, rating, quantity, and matrix (Saunders *et al*., 2009). Since the list and rating categories were applicable for the purpose of the questionnaire part of this research, only these two categories will be described.

In the list questions category, researchers need to be sure to cover all possible choices because this category offers respondents a list of answers, any of which they can choose (Saunders *et al*., 2009). In the latter category, rating questions, which are commonly used in questionnaires, often implements the Likert-scale tool usually with four-, five-, six- or seven-point scales (Saunders *et al*., 2009). The order of the scales or answers is another parameter affecting the data analysis process and when both the scales and answers are in the same order for all questions, it can be much easier to analyse the scales for researchers. Additionally, questions in a questionnaire can be

translated from different languages. In such cases, more care is needed as the wording of questions and answers should offer the same meaning to all respondents (Saunders *et al*., 2009).

During the preparation of questions in a questionnaire, the online questionnaire can also be conducted and different categorical answers can be used in this questionnaire type, such as text boxes, check boxes, and list boxes that allow respondents to choose one answer for a question (Saunders *et al*. 2009). Different online survey providers can be used to conduct a survey and these providers enable users to analyse their data in several formats, such as Excel, SPSS, Fixed Field Text or XML.

In the survey part of the current research, the categorical questions, which were determined based on similar studies in order to include all possible choices, were asked to respondents in the "job titles" and "working years" sections. The rest of the survey was designed by using rating type questions in order to receive a score for each indicator. Thus, the 5-point Likert scale, which is more common in studies (Saroar and Routray, 2015), was applied in the rating type questions.

3.6.3 Questionnaire Process

Correct design and administration are significant stages for the success of a questionnaire. Saunders *et al*. (2009) placed more emphasis on the importance of the layout, covering letter, pilot testing, reliability/validity, closing and administration in a questionnaire process. Therefore, in this section, clarification regarding the questionnaire process will be given in this order.

The layout of a questionnaire, which affects the response rate and clarity of responses, is a significant start-up phase where respondents can be encouraged to answer the questions. Dillman (2007) highlighted that one of the best ways to obtain a clear response is to keep the visual look of questions simple. In order to make a layout attractive in terms of some features (e.g. appearance, wording of a question), different templates can be used more quickly through some software tools, such as Snap™, Sphinx Development™ and SurveyMonkey.com™ (Saunders *et al*., 2009).

On the other hand, the cover letter is essential for a questionnaire and is the first interface when respondents are faced with a questionnaire. In the cover letter, some information about the research (e.g. the aim, name and general information of the researcher) is expressed. Moreover, Dillman (2007) discussed that introduction of a questionnaire with the explanation of a research aim and the necessity of the relevant respondents' answers should be indicated on the first page with a covering letter.

In addition, pilot testing is a necessary step prior to conducting a questionnaire. According to Saunders *et al*. (2009), the purpose of the pilot test is to check the clarity of questions in order to obtain the correct answers from respondents and to assess the possible validity and reliability of a questionnaire. To check the representativeness of questions, the pilot test can be fulfilled either by asking an expert as well as a group of experts, which is an example of the content validity, or by

asking friends and family members since it represents the face validity (Saunders *et al*., 2009). At the end of the pilot test, suitability, clarity and representativeness of questions in a questionnaire are tested by the selected person or group of people. After the required changes carried out in a pilot test, based on the provided opinions, the final version of a questionnaire can be administered to the preliminarily decided sample of the population for data collection.

By following all this information, in this research, the questionnaire draft and the cover letter were primarily prepared by using the Qualtrics survey software[2] and were checked by five professionals including three academics and two practitioners. Then, a pilot study was conducted including six professionals from both academic and practical areas. By considering the feedback obtained during the pilot test, some alterations (e.g. rearranging sequences of questions, clarifying definitions of indicators) were fulfilled and the final draft of the questionnaire was prepared by the researcher.

3.6.4 Time Length for Questionnaires

Time is an important constraint for questionnaires and before conducting a survey, time allowance needs to be considered carefully by researchers. In a questionnaire process, pilot surveys and the data analysis, which have usually been disregarded, are both critical to the success and the quality of a study (Richardson *et al*., 1995). During these steps, completing a questionnaire should not take too long. Similarly, the importance of time was emphasised by Saunders *et al*. (2009) who highlighted that a questionnaire taking more than two hours to complete might be discarded by the relevant respondent.

As a result, reasonable time length needs to be taken into account by researchers in a questionnaire design and at the data analysis stage. For this reason, in this research, 11 days were spent for both the questionnaire design and the pilot test. After all preparations, the administration of the online survey was carried out within 20 days.

3.6.5 Reliability and Validity in Questionnaires

Reliability and validity are two components measuring data quality of a questionnaire and there are plenty of definitions regarding these notions (Presser *et al*., 2004). Principally, reliability is concerned with achieving the same results or the degree of the same results after repeated experiments, while validity is related to the critical relationship between a variable and a concept (Carmines and Zeller, 1979). In other words, reliability is concerned with consistency whereas validity is related to accuracy of a survey instrument (Fink, 1995).

More specifically, reliability is an essential instrument to check the robustness and consistency of questionnaires. According to Litwin (1995), there are three common analyses for reliability, namely test-retest, internal consistency, and alternative-form. Test-retest, which is the most common reliability form, is measured by having the same test to the same respondents at two

[2] http://www.qualtrics.com/

different time periods when all conditions are similar or equivalent (Litwin, 1995). Internal consistency, which is most commonly calculated by Cronbach's alpha, measures consistency of either single items in a sub-group of questions or consistency of all questions in a questionnaire (Saunders *et al*., 2009). The final form to measure reliability is the alternative-form. This form includes differently worded items to measure the same question or groups of questions that the items must be different only in terms of their wording but not their vocabulary level (Litwin, 1995).

On the other hand, validity is another crucial instrument in surveys that presents the actuality of the extent to which a questionnaire reflects what researcher's intent to measure. There are different forms of validity and researchers often discuss four types of validity: which are face, content, construct, and criterion (Fink, 1995). Fink (1995) noted that the face validity is concerned with how a measure seems on the surface in terms of using appropriate language and asking all the needed questions. Content validity reflects an examination of a set of reviewers, who have some knowledge about the particular subject of a questionnaire on appropriateness of items, and these reviewers assess a questionnaire in terms of the content to be included or omitted (Litwin, 1995). Construct validity is set to indicate that a survey distinguishes people who do and do not have particular features (Fink, 1995). According to Litwin (1995), criterion validity is a measure to present how meaningful the scale or survey tool is in practice. Also, criterion validity, which is sometimes named as predictive validity, is relevant with the capability of the measures or questions to make correct estimations (Saunders *et al*., 2009) and the degree of this validity type depends on the correlation between the test and a criterion (Carmines and Zeller, 1979).

Based on this information, the content and face validity types were used for the validation process of the survey part of this research. Regarding reliability, Cronbach's alpha scores were calculated for each perspective in the framework by using the SPSS software, as will be explained in Section 4.2.4.3.

3.7 Towards Decision-Making Approach

3.7.1 Group Decision-Making

Decision-making, which is the most often used activity by all people in life, has the aim of helping individuals to make better decisions based on their own beliefs (Saaty, 2005). Group decision making has constituted the basis of MCDM techniques and a decision made by a group of related decision makers provides more realistic judgments than a single decision maker does. Also, group decision-making may prevent the bias risk being introduced by a single decision maker (Horenbeek and Pintelon, 2014) and in the group decision making process, relevant experts (more than one), who have different level of authorities, experiences, and opinions on a particular topic, are identified. As a result, different judgments of experts affect the result differently. Therefore, it is more beneficial to use a mathematical approach to combine these judgments rather than to arbitrarily make a consensus (Saaty, 2013).

There are various decision-making approaches used by researchers. Among these, the ANP, as well as the AHP, is a descriptive decision-making technique enabling reciprocal judgments that can be combined by the geometric mean of the scores designated by each expert involved in decision-making (Saaty, 2005). The significance of considering reciprocal judgments and using the geometric mean approach was also emphasised by several authors. For instance, according to Saaty (2009), if the individuals in a group have different strengths of importance, first their judgments are increased to the power of their priorities, and then the geometric mean is generated. Moreover, whilst the geometric mean is used to satisfy the reciprocal property, as shown by Aczél and Saaty (1983), the arithmetic mean does not satisfy the reciprocal relation (Gasiea, 2010). Hence, it has been proved that the geometric mean is the only way to be used in reciprocal relations within the group decision-making approach (Saaty and Vargas, 2006; Saaty, 2009).

As a summary, making a decision is a complex process and how to combine the judgments into a single answer is a hard task. Therefore, group decision-making within an MCDM approach is significant to provide meaningful and realistic results. Since the ANP is one of the MCDM techniques and suitable for the group decision-making in terms of its main features (e.g. allowing interdependencies) (Raisinghani *et al*., 2007), the ANP method was examined in this study as part of the group decision-making.

In the next subsections, two important steps are explained regarding the group decision making process as indicated in Saaty's books (e.g. Saaty and Vargas, 2006; Saaty, 2009). The first step is how to aggregate individual judgments, and the second is how to construct a group choice from individual choices.

3.7.1.1 How to Aggregate Individual Judgments

In group decision making, experts provide judgments which should be mathematically synthesised as a group decision in line with the preferences of individuals. Various conditions are considered to aggregate the individual judgments provided by the experts. By considering the function $f(x_1,...,x_n)$ to synthesise the judgments provided by n judges, it satisfies the following conditions (Saaty and Vargas, 2006, p. 24):

- *"Separability condition (S): $f(x_1,...,x_n) = g(x_1)...g(x_n)$, for all $x_1,...,x_n$ in an interval P of positive numbers, where g is a function mapping P onto a proper interval J and is a continuous, associative and cancellative operation. [(S) means that the influences of the individual judgments can be separated as above.]*
- *Unanimity condition (U): $f(x,...,x) = x$ for all x in P. [(U) means that if all individuals give the same judgment x, that judgment should also be the synthesized judgment.]*
- *Homogeneity condition (H): $f(ux_1,..., ux_n) = uf(x_1,...,x_n)$ where $u>0$ and x_k, ux_k $(k=1,2,...,n)$ are all in P. [For ratio judgments (H) means that if all individuals judge a ratio u times as large as another ratio, then the synthesized judgment should also be u times as large.]*

- *Power conditions (P_p): $f(x_1^p,..., x_n^p)= f^p(x_1,..., x_n)$. [($P_2$) for example means that if the kth individual judges the length of a side of a square to be x_k, the synthesized judgment on the area of that square will be given by the square of the synthesized judgment on the length of its side.]"*

After carrying out these conditions to aggregate individual judgments, a group choice should also be obtained from the individual preferences. The explanation of producing a group choice based on the individual preference is given in the following sub-section.

3.7.1.2 How to Construct a Group Choice from Individual Choices

For the construction of a group choice from individual choices, it is essential to follow a series of rules or conditions in order to gather the individual judgments as a representation of the group preferences as a whole (Saaty, 2010; Gasiea, 2010). According to Saaty (2010, p.236), an aggregation series of rules representing a group preference becomes satisfactory, if:

> *"1) It responds, at least not negatively, to changes in individual preferences,*
> *2) It reflects the collective opinion of the individuals, and*
> *3) It provides ranking for the various alternatives of a decision that the group faces."*

When a group of individuals, a set of alternatives, which is higher than two, and individuals' ordinal choices for the alternatives are provided, Arrow (1963) proved with his impossibility theorem that it is not possible to form a rational group choice from ordinal individual choices that satisfy the four conditions noted below, that is, at least one of these conditions is violated (Saaty, 2009, p. 40):

- *"**Decisiveness**: the aggregation procedure must generally produce a group order.*
- ***Unanimity**: if all individuals prefer alternative A to alternative B, then the aggregation procedure must produce a group order indicating that the group prefers A to B.*
- ***Independence of irrelevant alternatives**: given two sets of alternatives which both include A and B, if all individuals prefer A to B in both sets, then the aggregation procedure must produce a group order indicating that the group, given any of the two sets of alternatives, prefers A to B.*
- ***No dictator**: No single individual preferences determine the group order."*

By using the absolute priority scales within the ratio scale approach of the AHP, as also used in the ANP, it is possible to construct a rational group choice fulfilling these four conditions mentioned above because, in such a case, individual preferences are cardinal rather than ordinal (Saaty and Vargas, 2006; Saaty, 2009). The reasons of this possibility to construct a rational group choice are explained in Saaty's (2009) book as follows (Saaty and Vargas, 2005, cited in Saaty, 2009, p. 40-41):

"a) Individual priority scales can always be derived from a set of pairwise cardinal preference judgments as long as they form at least a minimal spanning tree in the completely connected graph of the elements being compared; and

b) The cardinal preference judgments associated with group choice belong to an absolute scale that represents the relative intensity of the group preferences"

Accordingly, in addition to the reasons of creating possible rational group choice, essential conditions and procedures to be considered for the construction of a group choice from individual preferences are also indicated in this section. In the next section, an overview of the MCDM techniques will be examined in detail.

3.7.2 Overview of MCDM Methods

In the early 1970s, MCDM was initially introduced as a promising and significant area (Carlsson and Fullér, 1996) and, since then, it has been used by numerous researchers. Basically, MCDM, or multi-criteria decision analysis (MCDA), is a discipline aiming to assist decision making which includes various conflicting assessments (Andriana, 2015). Also, MCDM is a powerful decision making tool to construct a problem clearly and systematically (Wu *et al*., 2010).

MCDM techniques are used when there is a presence of multiple, and usually conflicting, decision criteria (Öztayşi and Uçal, 2009) and when an important decision cannot be decided in a straightforward manner (Wu *et al*., 2010). In this way, MCDM methods are used to overcome the barriers of using a single criterion in the decision making field (Banville *et al*., 1998). Furthermore, in the nature of MCDM, expert preference and subjective judgments are mainly considered just as in daily life where people generally focus on multiple criteria rather than a single criterion when they make a decision. Therefore, since human beings are excessively involved in decision analysis processes, a rational approach should incorporate human subjectivity (Ertuğrul and Karakaşoğlu, 2009).

Moreover, the general characteristics and practicality of the MCDM (or MCDA) approach was highlighted by several researchers. For instance, the following facts pointed out by Čančer and Mulej (2006, p. 1063-1064) provide some information concerning the applicability of the MCDM approach to solve complex problems:

- "*the MCDA methods do not replace intuitive judgment or experience and they do not oppress creative thinking; their role is to complement intuition, and to verify ideas and support problem solving;*
- *in MCDM we take into account multiple, more or less conflicting criteria, in order to aid decision making;*
- *in this type of decision-making process, we structure the problem;*

- *users can compare different methods and assess their convenience in problem solving. The most useful approaches are conceptually simple and computer supported; and*
- *the aim of MCDM is to help decision makers learn about the problem, express their judgments about the criteria's importance and preferences concerning alternatives, confront other participants' judgment, understand the final alternatives' values, and use them in problem-solving activities.*"

Additionally, MCDM is considered by many authors in the literature (e.g. Farahani *et al*., 2010; Torfi *et al*., 2010; Öztayşi and Uçal, 2009; Lai and Hwang, 1994; Triantaphyllou, 2000) as a combination of two main groups, which are MODM (multi-objective decision making) and MADM.

The first group, MODM, is associated with problems in which alternatives have not been predetermined (Lai and Hwang, 1994) and the decision space is continuous (Triantaphyllou, 2000). MODM mostly deals with both preferences related to the decision maker's objectives and the connections between objectives and attributes (Torfi *et al*., 2010). There are various techniques examined in this group and some characteristics of these techniques are summarised by Farahani *et al*. (2010, p.1690) as follows:

- *"A set of quantifiable objectives.*
- *A set of well defined constraints.*
- *A process of obtaining some trade-off information.*"

On the other hand, MADM tackles decision problems in which, usually, a limited number of alternatives have been predetermined (Farahani *et al*., 2010) and the decision space is discrete (Triantaphyllou, 2000). The aim of the MADM is to obtain the optimum choice which has the highest satisfaction degree for all related attributes (Yang and Hung, 2007). In MADM techniques, decision makers choose/prioritise/rank a limited number of actions (Lai and Hwang, 1994). Numerous methods are included in the MADM group. Among these methods, both the AHP and the ANP methods are examined by many authors (e.g. Nguyen *et al*., 2014; Lahby *et al*., 2012) and, in a similar vein, this research mainly focuses on the MADM group within the MCDM approach. Also, the multi criteria decision approach is applied in both the comparison of the performance indicators and the case study part of this research since it is impossible without applying a multicriteria approach to overcome the heterogeneity problem of the measurement units which makes it difficult to evaluate and compare performances of different companies (Yurdakul, 2003).

Besides, there are diverse MCDM techniques (e.g. DEA, TOPSIS, DEMATEL) in the literature and each of these techniques has different limitations. For instance, Rastar *et al*. (2013) pointed out some disadvantages of the Data Envelopment Analysis (DEA) technique, such as it does not have the measuring of probability of preventing errors, it is used to measure the relative performance rather than the absolute, and it is hard to conduct statistical analyses. According to Wu *et al*.

(2014), if the number of the decision making unit is relatively small, there may be numerous efficient units, and the DEA cannot show the real case. Regarding the TOPSIS, Li and Wan (2014) noted that apart from the fact that the method can only cope with the single format of attribute ratings, it cannot also be used if the element weights are not completely unknown or partially known. In terms of the DEMATEL technique, it may require geometrically grown performance by analysts when too many indicators are involved (Dou *et al.*, 2014) and the integrated mechanism to obtain group judgment is unclear (Li *et al.*, 2013).

As a summary of these techniques, Velasquez and Hester (2013) examined advantages, disadvantages, and the areas of applications of different MCDM techniques. Based on their analyses, disadvantages of the other methods, which will be explained as follows, highlighted the necessity to use the ANP method for this research. For instance, some techniques (e.g. Multi-Attribute Utility Theory (MAUT), DEA) are not suitable for this research since there is no input or input/output relationship among the indicators in the model or there is no precise data regarding some indicators. Also, in this thesis, correlations and trade-offs among the indicators should be considered in the model and, therefore, several methods (e.g. TOPSIS, AHP) were eliminated for this study. Moreover, some do not always provide either realistic results (e.g. Simple Additive Weighting (SAW)) or a clear method for indicator weights (e.g. Preference Ranking Organization Method for Enrichment of Evaluations (PROMETHEE)). Additionally, the goal programming technique was not considered due to the fact that it is a branch of the optimization method (Chai *et al*., 2013) and involves multiple goals as well as minimizing the deviation from the expected goals (Tsai *et al*., 2009).

Another comparison of the group decision-making methods summarised by Couger (1995) was included in Saaty and Vargas's (2006) study as shown in Tables 3-4 and 3-5. Although the comparison was not so much about summarising and comparing all MCDM methods extensively, it is useful when evaluating the group decision making techniques.

The comparison was performed mainly based on the technical structure and subject matter of the methods. In this comparison, the methods were grouped under three categories (structuring, ordering and ranking, structuring and measuring) and were compared in terms of the 16 criteria examined under six main headings. During the comparison of the methods for each criterion, the methods were rated with some statements, such as low, medium, high, very high, and not applicable (N/A). A brief explanation of the main headings and rationales of the given rates for AHP/ANP methods, particularly the ANP, pertaining to 16 criteria are summarised below.

Group maintenance, as presented in the initial heading in Table 3-4, covers some terms, such as leadership effectiveness, learning, and also ensures member satisfaction and morale within a group (Peniwati, 2007). In terms of *leadership effectiveness*, the AHP/ANP are rated high since they deliver collaborative tools to increase communication effectiveness, inconsistency measures to ensure validity of the result, a balanced set of ideas as well as obtaining the group judgments while

regarding *learning*, they are rated very high owing to the fact that they provide a highly structured summary of description regarding a problem (Saaty and Vargas, 2006).

The necessity for problem abstraction exists in every decision-making process (Peniwati, 2007) and problem abstraction is shown as another heading in Table 3-4 consisting of *scope* and *development of alternatives*. Although the AHP/ANP do not contain a technique to expand problem abstraction, they are rated medium in *scope* since an analysis increases problem abstraction and they are assumed to use techniques, such as Delphi, and nominal group technique (Saaty and Vargas, 2006). With respect to *development of alternatives*, the very high rate in this criterion, as given to the AHP/ANP, represents if a method is based on challenged assumptions and generates alternatives systematically or if it is essential that alternatives satisfy certain resources to ensure the validity of the result (Peniwati, 2007).

Structure is a different heading to assess the methods shown in Table 3-4. According to Peniwati (2007), the structure can be broad when there are many criteria independent to each other while it can also be deep, if each criterion is broken down into sub-criteria. Moreover, the author also noted that when there is no constraint for the number of the criteria in the problem structure, the methods are rated starting from high in terms of *breadth* and *depth*.

Analysis, which refers to examination and measurement of elements, is another heading exhibited in Table 3-4. Regarding the analysis heading, the very high rate in *faithfulness of judgments*, as given to the AHP/ANP, shows that a method reveals basic judgments (Saaty and Vargas, 2006) whereas the same rate in *breadth and depth of analysis (what if)* indicates that a method enables careful thinking and examination (Peniwati, 2007).

Fairness is another heading used to evaluate the methods in Table 3-5. Fairness in group decision making is related to several circumstances, such as treating alternatives fairly (high) or not fairly (low) by considering consistency with the impossibility problem intrinsic, using the concept of unequal treatment of the individuals (e.g. assigning weights based on their knowledge), and addressing fairness to other actors with problem analysis (Peniwati, 2007). With respect to *cardinal separation of alternatives*, the ANP is rated very high due to the fact that it has a feedback system that enhances accuracy of the result whilst regarding *prioritizing group members*, both the AHP and the ANP are rated very high since the decision of what notion of fairness is appropriate belongs to the decision-maker (Saaty and Vargas, 2006). With regards to *consideration of other actors and stakeholders*, the AHP/ANP are rated high and, according to Peniwati (2007), the high rate in this criterion represents that a method addresses the problem both clearly and quantitatively.

Applicability is a concept that relates to the impact of the results on practice (Booth and Brice, 2004). On the other hand, validity is related to accuracy of a survey instrument (Fink, 1995) while truthfulness is a good approach to gain trust (Bower, 1997). As can be seen in Table 3-5, the applicability, validity, and truthfulness heading consists of five criteria. *Scientific mathematical*

generality is the first criterion in this heading which is evaluated based on some indicators, such as the inclusion of problem analysis, and involvement of axiomatization with mathematical rigour (Peniwati, 2007). With respect to this criterion, the AHP/ANP are rated high, and Saaty and Vargas (2006) noted the rationale of this rating for the AHP method that it is generalisable without additional assumptions. The same interpretation can also be made for the ANP method since these two methods lie behind the same fundamental approach. Another criterion, a*pplicability to intangibles*, is assessed based on several indicators (e.g. containing problem analysis, quantification of intangibles) and the very high rate in this criterion, as given to the AHP/ANP, means a method's measurement is applicable for intangibles and provides an evaluation of relative importance of intangibles (Peniwati, 2007). As regards *psychophysical applicability*, the very high rate, as can be seen for the AHP/ANP, explains that a method produces measurement of responses to physical stimuli (Saaty and Vargas, 2006) whereas the high term in *applicability of conflict resolution*, as is the case for the AHP/ANP, indicates that a method must have an approach as well as normative standards, must find the ideal solution for a group conflict, and must show that it can work well in practice (Peniwati, 2007). Regarding *validity of the outcome (prediction)*, both the AHP and the ANP are rated high. Although Saaty and Vargas (2006) expressed the reasons (e.g. dependence on absolute scales obtained from pairwise comparisons, providing a structured approach to validate the meaningfulness of the comparisons) to assign the high rate for the AHP in terms of this criterion, the same interpretation can be also made for the ANP method since they follow the same fundamental approach.

Table 3-4: Comparison of group decision making methods

	Group Maintenance		Problem Abstraction		Structure		Analysis	
Method	Leadership Effectiveness	Learning	Scope	Development of Alternatives	Breadth	Depth	Faithfulness of Judgments	Breadth and Depth of Analysis (What if)
Structuring								
Analogy, Association	Low	Medium	Medium	Low	NA	NA	NA	NA
Boundary Examination	Medium	Medium	High	Low	NA	NA	NA	NA
Brainstorming/Brainwriting	Low	Low	Low	Medium	NA	NA	NA	NA
Morphological Connection	Low	Medium	High	Very High	NA	NA	NA	NA
Why-What's Stopping	Medium	Medium	High	Very High	High	High	NA	NA
Ordering and Ranking								
Voting	Low	Low	NA	NA	Low	Low	Low	Low
Nominal Group Technique	Medium	Medium	Medium	High	Low	Low	Low	Low
Delphi	Medium	Medium	Medium	High	Low	Low	Low	Low
Disjointed Incrementalism	Medium	High	Medium	Medium	High	Low	Medium	Medium
Matrix Evaluation	Medium	Medium	Medium	Low	High	Low	Medium	Medium
Goal Programming	Low	Low	Medium	Low	High	Low	Very High	Medium
Conjoint Analysis	Low	Low	Medium	Low	Low	Low	Very High	Medium
Outranking	Medium	High	Medium	High	High	Low	Medium	High
Structuring and Measuring								
Bayesian Analysis	Medium	High	Medium	Low	Low	Low	Very High	Medium
MAUT/MAVT	Medium	High	Medium	High	High	Low	High	High
AHP	High	Very High	Medium	Very High	High	High	Very High	Very High
ANP	High	Very High	Medium	Very High	High	Very High	Very High	Very High

NA=Not Applicable

Source: Saaty and Vargas (2006, p. 264)

Table 3-5: Comparison of group decision making methods (Cont'd)

	Fairness			Applicability, Validity, and Truthfulness				
Method	Cardinal Separation of Alternatives	Prioritizing Group Members	Consideration of Other Actors and Stakeholders	Scientific Mathematical Generality	Applicability to Intangibles	Psychophysical Applicability	Applicability to Conflict Resolution	Validity of the Outcome (Prediction)
Structuring								
Analogy, Association	NA	NA	NA	NA	NA	NA	NA	NA
Boundary Examination	NA	NA	NA	NA	NA	NA	NA	NA
Brainstorming/Brainwriting	NA	NA	NA	NA	NA	NA	NA	NA
Morphological Connection	NA	NA	NA	NA	NA	NA	NA	NA
Why-What's Stopping	NA	NA	NA	NA	NA	NA	NA	NA
Ordering and Ranking								
Voting	Low	Low	NA	Medium	NA	NA	NA	Low
Nominal Group Technique	NA	NA	NA	Medium	NA	NA	NA	Low
Delphi	NA	NA	NA	Medium	NA	NA	NA	Low
Disjointed Incrementalism	NA	NA	Medium	Low	Low	Low	NA	Medium
Matrix Evaluation	NA	NA	Medium	Low	Low	Low	NA	Medium
Goal Programming	High	NA	Low	Medium	Medium	NA	NA	Low
Conjoint Analysis	High	NA	NA	Medium	Medium	NA	NA	Low
Outranking	High	High	Low	Medium	Medium	Medium	NA	Medium
Structuring and Measuring								
Bayesian Analysis	High	NA	Low	High	Medium	Low	NA	Medium
MAUT/MAVT	High	High	Medium	High	Medium	Medium	Medium	Medium
AHP	High	Very High	High	High	Very High	Very High	High	High
ANP	Very High	Very High	High	High	Very High	Very High	High	High

NA=Not Applicable

Source: Saaty and Vargas (2006, p. 265)

In these tables, the ANP is placed in the "structuring and measuring" category with the Bayesian analysis, the MAUT/MAVT (Multi-Attribute Value Theory), and the AHP methods. The Bayesian analysis uses probabilities and depends on statistical calculations of these probabilities when possible while MAUT/MAVT relies on interval scales and aims to maximise a decision maker's utility or value (preference) (Cho, 2003). On the other hand, the AHP, which depends on a hierarchy structure (Tzeng *et al*., 2005), shows that rank preservation (the ranking of the existing alternatives remain the same or be allowed to change after a new alternative is added or an old one is removed) is sufficient but not essential (Cho, 2003). As a result of these comparisons, the ANP appears as the most remarkable and suitable method compared to other group decision making methods in terms of the indicated 16 criteria. Also, by considering the disadvantages of the other MCDM techniques, which are not included in these tables, the ANP becomes an outstanding method. Therefore, the ANP method was used as an MCDM technique in this study.

In conclusion, based on the reviewed literature, MCDM (or MCDA) can be identified as an appropriate and satisfactory approach for the complex problem structure by considering multiple criteria. More particularly, the ANP method, as both an MCDM and an MADM technique, is the most remarkable and suitable method for analysing interdependencies among the indicators in a network structure compared to other methods used in group decision making. Besides methodological advantages, it conforms to some approaches, such as value engineering and the BSC, which contain strong multicriteria components although they are developed without any formal links with MCDA (Belton and Stewart, 2002). Additionally, in terms of the incorporation of various stakeholders, Banville *et al*. (1998) argued that significant alteration can occur on MCDA when the full use of the stakeholder concept is combined with MCDA and any decision-aid method because, according to the authors, the stakeholder concept can be integrated into any MCDA approach. Hence, it can be concluded that MCDM (or MCDA) has a strong relationship with the stakeholder concept, which was considered as part of the BSC approach in this research. Thus, this shows that the chosen approach and method are also in line with the scope of the study based on the strong methodological stance. As a result, both due to methodological dominance and the consistent structure of the MCDM approach with the BSC approach as well as the stakeholder concept, the ANP method was implemented in this study.

3.8 The ANP Method

The ANP is a general form of the AHP method (Saaty, 2013) and was proposed, developed and implemented by Saaty (1996) (Liou and Chuang, 2010; Saaty and Vargas, 2006). The ANP is a comprehensive decision making tool that can accommodate both tangible and intangible factors in a model (Ravi *et al*., 2005). Furthermore, the ANP method enables modelling more dynamic and complex environments affected by changing external drivers (Meade and Sarkis, 1998). Besides, as a distinct from the AHP method, the ANP method includes a supermatrix approach (Saaty, 1996; Saaty and Vargas, 2006) and, therefore, it is also called a "Supermatrix" in the literature (Yurdakul,

2003). While the AHP method allows a strict top-down hierarchical structure (Aragonés-Beltrán *et al*., 2008; Kayakutlu and Buyukozkan, 2011), the ANP method includes feedback[3] (Poveda-Bautista *et al.*, 2012; Saaty, 2013) and dependencies both within and among the clusters in the network structure (Saaty, 1999; Ravi *et al*., 2005). Thus, the ANP is schematised by a network rather than a strict hierarchy as in the AHP. Since the ANP method goes beyond the strict hierarchy, this concept of the ANP provides real life answers. As a result of these, the applicability of the ANP method has become broad in different decision making tasks (Hsu *et al*., 2011).

The ANP structure comprises of both clusters (components) and elements placed in the clusters. Regarding the goal of a study, the clusters are constituted by considering the objectives of the research. On the other hand, alternatives are organised within an alternative cluster, which may or may not be included in the network structure. In this respect, Saaty (2009) noted that there is no particular arrangement order for both the clusters and the elements in the ANP structure, and also, the alternative cluster may or may not include feedback to other clusters.

Moreover, relationships in the network structure of the ANP method are shown by some signs. Depending on the relationships among and within the clusters, loops and/or arcs are used in the network structure. Arcs are presented when there is an influence or connection between criteria in different clusters (in case there is a feedback, it is shown with two ways) while the loop is the meaning of the influence between two criteria within the same cluster.

In order to practice the ANP method, several stages can be followed. For instance, Saaty (2005, 2008, 2009) highlighted the outline of the ANP steps consists of 12 basic stages but these stages can vary depending on how researchers explain them in detail. Based on the four studies of Saaty (1999, 2005, 2008, 2009), these stages of the ANP method can be summarised as the following major stages: constitution of the network model; making pairwise comparisons, obtaining priority vectors and checking consistency/inconsistency; formation of supermatrices; the synthesis; and sensitivity analysis. In this study, since the alternatives are not included in the network model, as non-alternative decision models were also similarly studied by some researchers (e.g. Hsu *et al*., 2011; Kayakutlu and Buyukozkan, 2011; Yang *et al*., 2009), the synthesis part for alternatives is excluded from the ANP phases and the alternatives are evaluated separately after the interviews (see Chapter 5). Hence, four major stages formed for this study are as follows: network model constitution; pairwise comparisons, priority vectors and consistency/inconsistency establishment; formation of supermatrices; and sensitivity analysis. The following sections will explain the structural phases of the generic ANP method, which cause a differentiation for the ANP method from the AHP method.

[3] The feedback structure is more likely a network structure and does not contain the linear top-to-bottom form of a hierarchy (Saaty and Vargas, 2006)

3.8.1 Development of the Network Model

In general, a network system comprises of components and elements placed in these components (Saaty and Vargas, 2006). The first action of the network construction is to determine the components (clusters), criteria (elements), and sub-criteria (if there are any) in the network model by considering the objectives and the aim of the study. Once the clusters and the criteria are determined for the network model, the criteria are placed in the relevant clusters in the network system. The next phase is identification of interrelationships within and among the clusters by the experts. The existing relationships between criteria in the same cluster are shown with a looped arc on the top of the cluster (inner dependence) whereas the relationships between the clusters are represented with arcs when there are influences between criteria in different clusters (outer dependence) (Saaty, 2008). Additionally, in the network system, the influence can be transmitted from one cluster to another (outer dependence) or can be transmitted through an intermediate cluster by following a path which can be like a cycle shape (Saaty, 2009).

Moreover, after identification of the interrelationships within and among the clusters, the influence strengths of the criteria are assessed with respect to a control criterion. In this stage, decision makers should take into account the strength of the dominance between two criteria (or elements) with respect to a control criterion, which is mutually influenced by these two factors. As in the AHP method, the importance or the dominance of the influence is a main concept in the ANP method, which is represented by two types of questions considered by the decision makers in order to decide the strength of the dominance (Saaty, 2009, p. 47):

> *"1) Given a criterion, which of two elements is more dominant with respect to that criterion,*
>
> *2) Which of two elements influences a third element more with respect to a criterion?"*

In the decision making, 'influence' is a key idea and the term 'influence' is applicable in different areas in the real world (Saaty, 2009). In this sense, while asking the strength of the dominance, the 'influence' term approach is commonly preferred by numerous authors (e.g. Gasiea, 2010; Saaty, 2005). Apart from the selection of the term, it is important to note that having an idea of either a criterion 'influencing' another criterion or a criterion 'influenced by' another criterion is also very crucial in the study in order to be consistent and make the same sense in the entire research. Throughout this research, the 'influence' term is used with the intent of the 'influencing' idea as a direction of influence.

During the construction of a network, identifying connections among the components is crucial and essential because without the connection, there cannot be any influence or communication (Saaty and Vargas, 2006). That is to say, the construction of the network model has a key role for a well-designed ANP model since the overall weights of both the clusters and the criteria are determined based on the identified influences among and within the clusters. However, there are different types

of nodes in the ANP structure and the number of these nodes can vary in any ANP model. For instance, one of these nodes has the role of being a source node while another is a sink node. A source node is the starting point of the influence (importance) path whilst a sink node is the last point of the influence (importance) path (Saaty, 2008; Saaty, 2005; Saaty and Vargas, 2006). As seen in Figure 3-5, no arrow goes into a source and no arrow leaves a sink whereas arrows go to and leave the transient nodes. Taking into account all of these, the full network systems can contain all these elements, such as source nodes, loops, sink nodes, arcs or bidirectional arcs, and intermediate nodes. The types of components in the ANP network and their connections are exhibited in Figure 3-5.

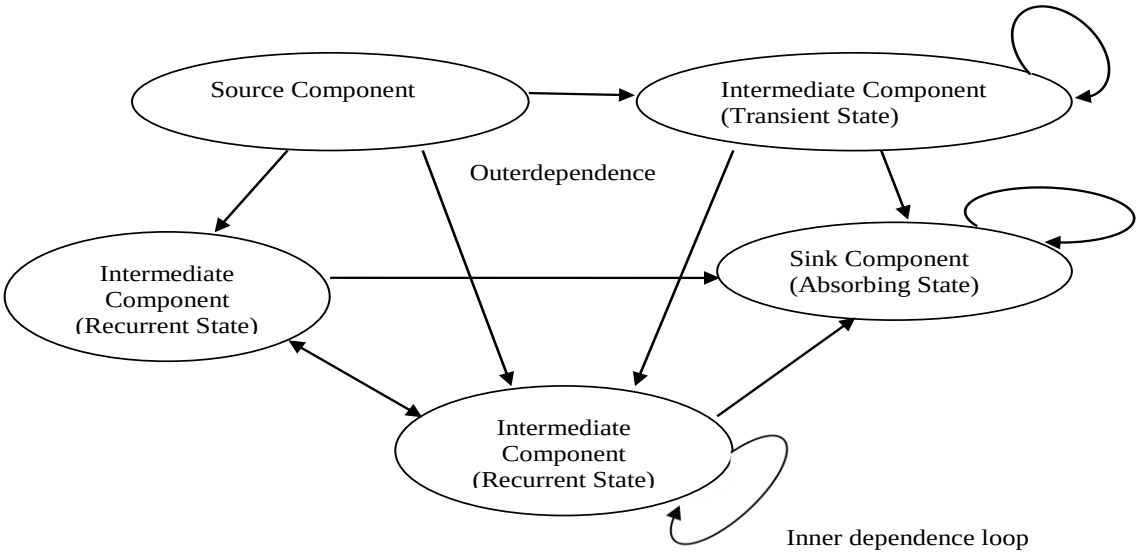


Figure 3-5: Full network system of the ANP
Source: Modified from Saaty (2009)

In order to determine the influences within and among the clusters, it is essential to construct an influence matrix which enables experts to identify the dependency between two criteria. This procedure can only be made with the experts who should complete, separately, each cell of the matrix. In this way, the influence matrix converts the influential relationships into a matrix with the allocation of 0 and 1 values by the experts (Poveda-Bautista *et al*., 2012). The value of 1 in the influence matrix represents the dependency or influence of one criterion on another (Saaty, 2005) and 0 value shows that the criterion listed on the left of the matrix has no influence over the criterion listed on the top of the matrix (Saaty, 2005). At the end, the influence matrices obtained from each expert are used to aggregate their opinions in order to generate the final influence matrix. Thereby, the final influence matrix is a representation of the majority of the experts' judgments. After establishing the final influence matrix, pairwise comparisons among and within the clusters are performed by using Saaty's 1-9 scale, as will be explained in the following section.

3.8.2 Pairwise Comparisons, Priority Vectors and Consistency

After the constitution of the network model, the next phase is the measurement stage involving pairwise comparisons, determination of the relative importance of the criteria, and consistency checks. Comparative judgments are made on pairs of elements to make accuracy certain (Saaty, 2005) and homogeneous elements are used in the pairwise comparisons of the ANP method. During the comparisons, clusters, elements (or criteria), and alternatives are compared in turn.

In any pairwise comparison, it is necessary to choose a measurement scale. Although different kinds of scales, such as nominal scale, ordinal scale, ratio scale, and absolute scale exist in mathematics, the fundamental scale of the AHP and ANP methods is based on a scale of the absolute numbers (Saaty, 2009) as shown in Table 3-6.

Table 3-6: The fundamental scale of the ANP method

Intensity of Importance	Definition	Explanation
1	**Equal Importance**	Two activities contribute equally to the objective
2	Weak	
3	**Moderate importance**	Experience and judgment slightly favor one activity over another
4	Moderate plus	
5	**Strong importance**	Experience and judgment strongly favor one activity over another
6	Strong plus	
7	**Very strong or demonstrated importance**	An activity is favored very strongly over another; its dominance demonstrated in practice
8	Very, very strong	
9	**Extreme importance**	The evidence favoring one activity over another is of the highest possible order of affirmation
Reciprocals of above	**If activity *i* has one of the above nonzero numbers assigned to it when compared with activity *j*, then *j* has the reciprocal value when compared with *i***	A reasonable assumption
Rationals	**Ratios arising from the scale**	If consistency were to be forced by obtaining *n* numerical values to span the matrix

Source: Saaty and Vargas (2006, p. 3)

The presented fundamental scale translates the human judgments into numerical values and helps to assess the comparisons. The even numbers (e.g. 2,4,6,8) in Table 3-6 are commonly indicated as intermediate values in different ANP studies.

During the pairwise comparisons, some terms-such as importance, preferable, or likely-can be used in the pairwise questions but, more generally, dominance and the level of dominance between two elements are aimed to be measured (Saaty, 2009). Each judgment in the comparison denotes the dominance of an element in the column on the left over another element in the row at the top of the

pairwise comparison matrix (Saaty, 2005). The level of the dominance is measured by using the 1-9 scale as shown in Table 3-6 and in order to attain a number from this fundamental scale in the comparisons, the following generic question must be answered by the experts (Saaty and Vargas, 2006, p. 12-13):

"*Given a control criterion (subcriterion), a component (element) of the network, and given a pair of components (elements), how much more does a given member of the pair influence that component (element) with respect to the control criterion (subcriterion) than the other member?"*

Similarly, in a simpler way, Saaty (2009, p. 10) showed the basic question for all pairwise comparisons as: "*How many times more dominant is one element than the other with respect to a certain criterion or attribute?"* During the pairwise comparisons of the ANP method, an identified question is asked to all individuals in a group, and the geometric mean method, which is the unique way to combine the individual judgments, is used to obtain a group judgment (Saaty, 2005). In a similar vein, since the individuals have different priorities of importance, the geometric mean method was used in this research to reach a consensus among the decision makers.

On the other hand, the comparison process requires many pairwise comparisons in a network structure. For a set of *n* elements in a comparison matrix, it is necessary to make *n* (*n*-1)/2 comparisons and the diagonal divides the comparison matrix into two parts: the comparisons of the elements with themselves, and reciprocals (Saaty, 2005). Later, each entry is placed in the corresponding cells of comparison matrices and the vector of priorities for the elements is calculated when the judgments are consistent. In the case of consistency for the judgments, there are two ways to obtain the priority vectors (Saaty, 2009, p.5); *"…by dividing the elements in any column by the sum of its entries (normalizing it), or by summing the entries in each row to obtain the overall dominance in size of that alternative relative to the others and then normalizing the resulting column of values*."

Assume that there are n elements in a judgment matrix *A*, given in (1), and every element in the matrix is represented by a_{ij}. An expert is asked to make the pairwise comparisons by using the fundamental scale. The illustration of a matrix of *A* is as follows (Roh, 2012, p.101):

$$A = \begin{pmatrix} a_{11} & \cdots & a_{12} & \cdots & a_{1n} \\ \vdots & & \vdots & & \vdots \\ a_{21} & \cdots & a_{22} & \cdots & a_{2n} \\ \vdots & & \vdots & & \vdots \\ a_{n1} & \cdots & a_{n2} & \cdots & a_{nn} \end{pmatrix} \quad (1)$$

a_{ij} indicates the relative importance of the element *i* compared to the element *j*. In the judgment matrix, inverse comparison is shown by a_{ji} and it is reciprocal. The reciprocal value is calculated by $a_{ji} = 1/a_{ij}$ and $a_{ii}=1$ (Saaty, 2009). For instance, if both elements have the equal importance, then

a_{ij}=1. If element i is strongly important than element j, then a_{ij}=5 and a_{ji}=1/5. The entries a_{ij} are described by the following rules (Saaty, 2005, p.351):

"Rule 1. If $a_{ij}=a$, then $a_{ji}=1/a$, $a>0$.

Rule 2. If A_i is judged to be of equal relative intensity to A_j then $a_{ij}=1$, $a_{ji}=1$; in particular, $a_{ii}=1$ for all i."

The pairwise comparisons of the compared elements lead to the following consistent reciprocal matrix (Saaty, 2009):

$$\begin{array}{c} \\ w_1 \\ A_1 \\ A_2 \\ \vdots \\ A_n \end{array} \begin{array}{c} \begin{array}{cccc} A_1 & A_2 & \dots & A_n \end{array} \\ \begin{array}{cccc} w_1 & w_2 & \dots & w_n \end{array} \\ \begin{bmatrix} w_1/w_1 & w_1/w_2 & \dots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \dots & w_2/w_n \\ \vdots & \vdots & \dots & \vdots \\ w_n/w_1 & w_n/w_2 & \dots & w_n/w_n \end{bmatrix} \end{array} \quad (2)$$

In the matrix, as shown in (2), the vectors of the weights are denoted by *w*. Instead of assigning two numbers in a judgment matrix, the ratio of w_i/w_j is used and a single number drawn from the 1-9 fundamental scale is assigned to represent the ratio of $(w_i/w_j)/1$, which is the closest integer approximation to (w_i/w_j) (Saaty, 2009).

After determining the comparative importance of the elements in a comparison matrix, the mathematical process continues with the normalization process and finding the relative weights for each matrix. In real-life, it is very unlikely for pairwise comparison matrices to be consistent (Saaty, 2009) and these inconsistencies cause small perturbations of the eigenvalues (Saaty, 2005). Hence, all of these yield the following equation:

$$Aw=\lambda_{max}w \quad (3)$$

In the equation (3), λ_{max} denotes the largest eigenvalue of *A* and *w* is the relative right eigenvector (Kayakutlu and Buyukozkan, 2011). In the case of consistency for all pairwise comparisons, then $\lambda_{max}= n$ (Saaty, 2005; Roh, 2012), where *n* represents the number of the rows/columns in the matrix (Saaty, 2004; Gasiea, 2010). Due to the ANP requirements, the matrix *A* must be consistent and the consistency is defined for the *A* matrix whose entries satisfy $a_{ij}.a_{jk} = a_{ik}$, where i,j,k=1,…,n (Saaty, 2009).

As previously mentioned, consistency is essential in human thinking and in order to support our thinking, we need actual knowledge about the world (Saaty, 2009). Yet, if we were consistent all the time, we would not accept new information or change our old beliefs. Therefore, we need to admit some inconsistency to gain new knowledge while, at the same time, we need to keep the inconsistency under acceptable limits, which is 10% for the ANP method (Saaty, 2009).

In the AHP and ANP studies, the overall inconsistency should be around 10% and the requirement of 10% cannot be reduced to some other scores such as 1% or 0.1% without minimizing the impact of inconsistency (Saaty, 2008; Saaty, 2009). Similarly, Saaty (2009, p. 11-12) first emphasised both the importance of inconsistency for new information and the acceptable amount of inconsistency, and then underlined their importance with the following statement:

"*This means that inconsistency must be large enough to allow for change in our consistent understanding, but small enough to make it possible to adapt our old beliefs to new information. This means that inconsistency must be precisely one order of magnitude less important than consistency, or simply 10% of the total concern with consistent measurement. If it were larger it would disrupt consistent measurement and if it were smaller it would make insignificant contribution to change in measurement."*

During the inconsistency determination, the Consistency Index (CI) is needed to be checked and the CI of a comparison matrix is calculated by using the following equation (Saaty, 2008):

$$CI = (\lambda_{max} - n)/(n - 1). \quad (4)$$

Here, it should be noted that the CI formula (4) is relevant to the statistical root mean square error. Moreover, by using the CI and the appropriate one of the following set of numbers presented in the Random Index (RI) table (Table 3-7), the Consistency Ratio (CR) is obtained (Saaty, 2009), as presented in (5). By doing so, the CR score indicates whether the evaluations of a pairwise matrix are consistent enough.

$$CR=CI/RI \quad (5)$$

Table 3-7: Random index

Order	1	2	3	4	5	6	7	8	9	10
R.I.	0	0	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49

Source: Saaty (2005, p.374)

After the calculations, if the CR score is found less than or equal to 0.1 then the judgments are accepted as consistent (Saaty, 2008) but if the CR is more than 0.1, the decision maker needs to revise his/her judgments in order to reduce the inconsistencies (Saaty, 2005; Harker, 1987). In cases where the CR is more than 0.1, one can do the following phases (Saaty, 2004, p. 24):

"1) Find the most inconsistent judgment in the matrix,

2) Determine the range of values to which that judgment can be changed corresponding to which the inconsistency would be improved,

3) Ask the decision maker to consider, if he can, changing his judgment to a plausible value in that range. If he is unwilling, we try with the second most inconsistent judgment and so on. If no

judgment is changed the decision is postponed until better understanding of the criteria is obtained."

Calculation of the eigenvectors and CRs can be time consuming, and therefore, some software packages (e.g. Expert Choice, SuperDecisions) can be used for these calculations. After these stages, three supermatrices are generated by these software packages to reach the relevant results.

3.8.3 Formation of Supermatrices

The priority vectors obtained from pairwise comparisons represents the influence of an element on another element in the system and if there is no influence, '0' is assigned as an influence priority (Saaty, 2009). Yet, during the calculation of the priority vectors, only the elements having non-zero influence are pairwise compared (Saaty and Vargas, 2006) and then the calculated priority vectors are each entered as part of some columns in the supermatrix system (Saaty, 2005; Saaty, 2009).

The supermatrix concept shows the influence priority of an element on the left of the matrix on another element at the top of the matrix (Saaty, 2005; Saaty, 2009). Figure 3-6 presents the supermatrix structure of a network.

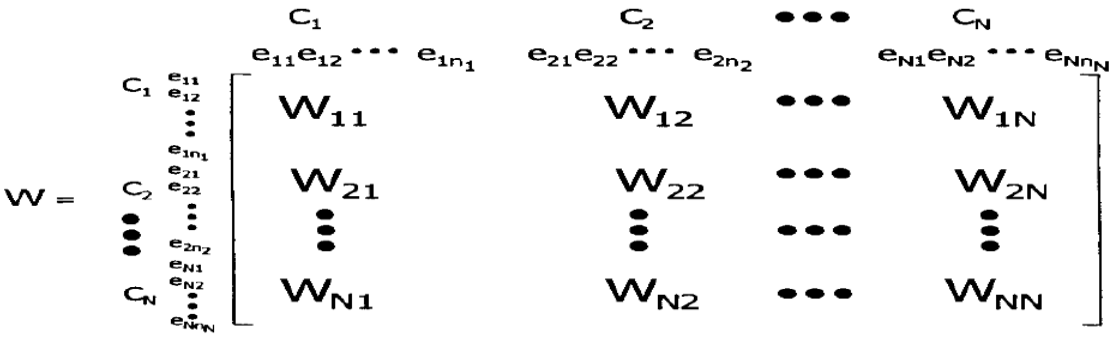


Figure 3-6: The supermatrix structure

Source: Saaty (2009, p. 52)

Assuming that the component shown by C_h, h=1,…, m, and that it contains n_h elements which are indicated as e_{h1}, e_{h2},…, e_{hm_h} (Saaty and Vargas, 2006). Moreover, this figure also shows the entries (W_{11},…, W_{NN}) within the supermatrix since these entries exhibit influences between the components in the supermatrix.

In a typical ANP network, there are three supermatrices: unweighted, weighted, and limit supermatrices. More explanations for each of these supermatrices are as follows:

* The unweighted supermatrix: Different priorities obtained from different pairwise comparisons enables to constitute this supermatrix (Saaty, 2005), which is used to form the weighted supermatrix with the help of the cluster matrix.

The cluster matrix is also necessary for a network since the clusters must be compared to determine their relative influence on each other (Saaty, 2005). The cluster matrix is performed to weight the unweighted supermatrix in order to make it column stochastic. The process starts with the establishment of the links when the source cluster is linked to nodes in the target cluster and the same process is repeated for all clusters in the network (Saaty, 2005). After all these processes, the cluster matrix, which represents the influence of clusters on each other, is achieved to be used for generating the weighted supermatrix from the unweighted supermatrix.

* The weighted supermatrix: The weighted supermatrix is achieved by multiplying all the entries in a block of the component at the top of the supermatrix by the corresponding component weight estimated in the cluster matrix (Saaty, 2005). For instance, the first entry of the vector in the cluster matrix is multiplied by all the elements in the first block that falls in that corresponding column in the unweighted matrix, the second by all the elements in the second block of the column and so on (Saaty and Vargas, 2006). After the repetition of these weighting processes for all columns, the sum of each column in the weighted supermatrix is equal to 1 and thus the matrix becomes column-stochastic.

  The stochasticity is essential for the supermatrix because its columns are made up of several eigenvectors and sums of the supermatrix columns do not show unity without the stochasticity. If all elements of a component (or perspective) have zero influence on all elements in the second component (or perspective), then the priority of influence of the first component on the second must be equal to zero but this is not valid when some or all the elements of the first component have an influence on some or all the elements of the second component (Saaty and Vargas, 2006). Therefore, the renormalization of some columns is necessary and cluster matrix is used in order to obtain the stochastic matrix.

* The limit supermatrix: It is obtained when the weighted supermatrix is transformed into the limit matrix by raising the weighted supermatrix to the power 2^{k+1}, where k here is an arbitrarily large number (Meade and Sarkis, 1999), until it converges (Saaty, 2005). In the limit supermatrix, all row values converge to the same value.

The main reason to raise the supermatrix to powers is to capture the transitivities of influences in all possible paths of the supermatrix because, apart from the direct influences shown by the weighted supermatrix, an element can influence a second element indirectly via its influence on some third element and then by the influence of that one on the second (Saaty and Vargas, 2006). In a network system, there can be many potential elements in length of the influence and one must take these possibilities into consideration. The one-step indirect influences via a third element are obtained by squaring the weighted supermatrix and two-step indirect influences via a third element

influencing a fourth element which, in turn influences the second are obtained from the cubic power of the matrix and so on (Saaty and Vargas, 2006).

3.8.4 Sensitivity Analysis

Sensitivity analysis is a part of the ANP method stages and has been conducted after obtaining the results at the end of the limit matrix. Sensitivity analysis shows how different criteria weights may affect the final results of the ranking or the prioritisation of the alternatives in a decision model. Such analysis is concerned with "what-if" kinds of questions (Kirytopoulos *et al*., 2008; Saaty, 2005) and helps to see some answers of the different "what-if" scenarios due to the special interest. Conducting this analysis allows decision makers to monitor and demonstrate how the final outcome of a decision model is stable, robust and sensitive to changes (Cooper *et al*., 2012; Saaty and Vargas, 2006). At the end of the sensitivity analysis, the evaluation method of a model can gain more rationality (Kuo, 2011) and achieved results can become accurate (Önüt *et al*., 2010). Thus, decision makers may take advantage of conducting these different scenarios in order to make accurate decisions in case of possible changes in the weight of indicators. To experience the sensitivity analysis in ANP research, different software programs, which are the 'Expert Choice' and the 'SuperDecisions', can be used by researchers. However, since the proposed decision model of this study does not contain the alternative cluster, sensitivity analyses could not be performed by these programs but were carried out by MS Excel. More details on the sensitivity analyses of the proposed decision model can be found in Chapter 6.

3.8.5 Benefits and Limitations of the ANP

Choosing the ANP method offers some advantages to researchers. Several advantages pointed out by some authors can be summarised as follows:

- It enables consideration of both interdependency (Ravi *et al*., 2005; Bayazit, 2006; Jharkharia and Shankar, 2007; Raisinghani *et al*., 2007; Kayakutlu and Buyukozkan, 2011; Wang *et al*., 2009; Hsu *et al*., 2011; Poveda-Bautista *et al*., 2012) and feedback (Raisinghani *et al*., 2007; Bayazit, 2006; Wang *et al*., 2009; Poveda-Bautista *et al*., 2012) in the network system,
- It offers weights associated with the importance of each performance indicator (Cooper *et al*., 2012; Ravi *et al*., 2005),
- It provides managerial understanding regarding the relative impact of each indicator on the performance (Cooper *et al*., 2012; Hsu *et al*., 2011),
- It allows incorporating both quantitative and qualitative indicators (Bayazit, 2006; Raisinghani *et al*., 2007; Hsu *et al*., 2011),
- It provides more realistic results (Bayazit, 2006; Yurdakul, 2003; Hsu *et al*., 2011),
- It helps to make accurate predictions (Bayazit, 2006; Yurdakul, 2003; Kayakutlu and Buyukozkan, 2011),

- It is simple and easy to use (Yurdakul, 2003),
- It allows modelling of both complex (Saaty, 2013; Saaty, 2004; Meade and Sarkis, 1998; Ravi *et al*., 2005; Poveda-Bautista *et al*., 2012) and dynamic environments (Meade and Sarkis, 1998),
- It is a flexible and extendable method (Raisinghani *et al*., 2007).

These benefits are utilised in this research during the evaluation of the indicators used in the framework. For instance, interrelationships among the indicators were considered relying on the final influence matrix determined by the defined experts. Also, the comparisons of the indicators were assessed by the experts who provide weights for the indicators on a scale of 1-9 based on their knowledge and information in the field. Ultimately, the results show the relative importance and rankings of the indicators which help managers to understand the impact and priority of each performance indicator. Thus, managers can make a decision to emphasise the correct indicators by using the results obtained from this research because the method represents the actuality with more realistic results. Additionally, the results provided in this research can be used as a starting point because the method is flexible and, therefore, it enables the addition/removal of some indicators in the decision model.

Besides these advantages, the ANP method is not free of criticism and some limitations of the ANP are denoted briefly as follows:

- It requires many comparisons (Cooper *et al*., 2012; Bayazit, 2006; Ravi *et al*., 2005),
- It requires considerable discussion and brainstorming meeting sessions (Ravi *et al*., 2005),
- Acquiring the data is very time intensive in the ANP method (Ravi *et al*., 2005),
- The pairwise comparisons are based on the subjective judgments of the experts (Ravi *et al*., 2005; Saaty, 2008),
- Pairwise comparisons can be complex to understand for experts, if they are not familiar with the method (Poveda-Bautista *et al*., 2012),

Yet, these disadvantages are tried to be minimised in this research. For instance, the experts were aware of how to perform the ANP method before participating in this study since they took part in some ANP-related studies. Nevertheless, some materials, such as articles and books were provided and the methodological steps were explained to the experts in detail. Also, the design of the comparisons and the questionnaire were carefully prepared in order to save time and make more efficient comparisons.

3.9 Overview of Interview Types and Semi-Structured Interview

Across many disciplines, interview is one of the most extensively used data collection methods, especially for qualitative data (DiCicco-Bloom and Crabtree 2006; Whiting, 2008). In an interview research, survey design plays a key role and the questions in the survey should help to collect the necessary data. There are various categorisations of interviews, but a widely used categorisation

contains three types, namely structured, semi-structured, and unstructured (or in-depth) interviews (Saunders *et al*., 2009).

A structured interview includes predetermined and standard types of questions (Saunders *et al*., 2009) which stress constant response categories (Roh, 2012). This interview type enables the analysis of answers with some statistical techniques because it helps to obtain quantifiable data from the respondents. Also, in this type, being a neutral and unbiased interviewer are important factors and, therefore, the interviewer should ask questions to each of the respondents with the same tone of voice (Saunders *et al*., 2009). Since additional questions cannot be asked, survey design or preparation is a very significant phase of the structured interview method. Moreover, it is very likely to use specific and closed types of questions in this type of interview (Saunders *et al*., 2009). As a summary, the characteristics of the structured interview were stated by Matthews and Ross (2010, p. 221) as follows:

- *"Follow a common set of questions for each interview.*
- *Ask the questions in exactly the same way, using the same words, probes etc for each interview.*
- *Present the participant with a set of answers to choose from."*

The semi-structured interview, which is a non-standardised interview type, is a qualitative research method (King, 2004; Saunders *et al*., 2009) and is used as an exploratory research tool (Matthews and Ross, 2010). In this type of interview, the interviewer usually has a framework and prepares a set of formal and limited questions on particular themes in order to follow these questions as a guideline during the interview (Bryman, 2008). Yet, it is worth to note that it is not necessary to follow exactly the same order of the questions on the guidelines (developed by examining previous studies) for each interview although similar wording styles will be exercised during the interviews (Ghauri and Grønhaug, 2002). Before fulfilling semi-structured interviews, a minimum number of questions between 10 and 15 is prepared in advance (World Bank, 2013).

Furthermore, the semi-structured interview method is more flexible than the structured interview because it allows adding or excluding some questions during the interview. According to Matthews and Ross (2010, p.221), semi structured interviews:

- *"Follow a common set of topics or questions for each interview.*
- *May introduce the topics or questions in different ways or orders as appropriate for each interview.*
- *Allow the participant to answer the questions or discuss the topic in their own way using their own words."*

Additionally, asking probing and open-ended questions are some of the ways to be used in semi-structured interviews. Similarly, Saunders *et al*. (2009) noted that semi-structured interviews contain open-ended questions and some types of questions beginning with 'what', 'how', 'when'

and ‘why’ can be asked in this interview type as well as the usage of some probing questions starting with ‘can’. Also, they emphasised that if the open question does not help to gain the relevant response, probing of the theme with the help of some complementary questions may be applied. In fact, further explanations concerning the topic are obtained by probing questions, and during probing questions, the reflection of the interviewee’s expression can be used by paraphrasing his/her words (Saunders *et al*., 2009). Similarly, Whiting (2008) underlined that in order to gain more insight into the interviewee’s knowledge, probing questions are frequently used by interviewers.

Besides using the semi-structured interview as a single research method, it can also be practiced in mixed method studies in which semi-structured interviews may be used after obtaining the results of a questionnaire in order to explore some subjects within the research topic as well as validating the findings of the structured questionnaire (Tashakkori and Teddlie, 1998; Bryman, 2006; Saunders *et al*., 2009). To sum up, based on DiCicco-Bloom and Crabtree’s (2006) research, the key features of semi-structured interviews are highlighted by Whiting (2008, p.36) as:

- *“Scheduled in advance at a designated time.*
- *Location normally outside everyday events.*
- *Organised around a set of predetermined questions.*
- *Other questions emerge from dialogue.*
- *Usually last from 30 minutes to several hours.”*

Lastly, another qualitative data collection method is the unstructured interview. In unstructured interviews, the interviewee is almost completely free to talk about attitudes, standpoints, and reactions on specified research topic(s) (Ghauri and Grønhaug, 2002; Roh, 2012). The main aim in this interview type is to gain the subjective opinions of the interviewee (Roh, 2012). Hence, this is an informal interview type (Saunders *et al*., 2009) where interviewers do not need to determine some questions as in structured interviews, but they should have a clear idea about the subject that they want to explore in depth. At the end of unstructured interviews, new ideas and opinions can appear. According to Matthews and Ross (2010, p.221), unstructured interviews:

- *“Focus on a broad area for discussion.*
- *Enable the participant to talk about the research topic in their own way.”*

In order to use interview techniques in the most convenient cases, some circumstances should occur because these circumstances help to make the interview method an advantageous data collection method. By considering Jankowicz (2005) and Easterby-Smith *et al*.’s (2008) studies, the necessary circumstances to conduct the interviews are pointed out by Saunders *et al*. (2009, p.324) as follows:

- *“ where there are a large number of questions to be answered;*
- *where the questions are either complex or open-ended;*

- *where the order and logic of questioning may need to be varied."*

As noted above, the last two circumstances are the most appropriate cases to implement semi-structured or unstructured (in-depth) interviews. Similarly, Matthews and Ross (2010, p.322) stated that the data collected by either semi-structured or unstructured interviews have some characteristics, such as:

- *"The questions may not always be worded in the same way and different follow-up probes and prompts may be used to suit each situation.*
- *The answers to questions are varied.*
- *The answers to questions are often in the words (or actions) of the participants.*
- *The overall structure of the data may vary from case to case; for example, questions may be addressed in a different order and some questions may not be answered in every case."*

As a comparison of these three interview types, while structured interview is a quantitative type method, the other two types, namely semi-structured and unstructured interviews, are evaluated as qualitative interview type methods. Byrne (2012) emphasised that qualitative interviewing, which includes open-ended and flexible questions, is a useful research technique and provides some values, such as interpretation, experience, and opinions of interviewees which cannot be obtained easily in a formal questionnaire. From this point of view, it can be concluded that in order to reach much information about a particular theme, qualitative interview methods can be used in studies. However, it should be noted that collecting and analysing the data for these interview types is time consuming and the idea obtained from these methods cannot be statistically generalised due to the limited number of interviews conducted on a particular topic (Saunders *et al*., 2009).

Based on the aforementioned information, the semi-structured interview method was used in this research because probing and open-ended questions were needed to be asked during the interviews in order to explore the actual processes of the case companies. Accordingly, the appropriate question types (e.g. 'What', 'Can') were followed during the formally administrated interviews rather than standard types of questions as happens in a structured interview. Thus, since the semi-structured interview was used in this research, the reliability and validity of this interview type should be discussed in detail.

Silverman (2006) argued that comparing the analysis of the same data by a number of researchers can help to enhance the reliability for interview and text based studies. Similarly, Saunders *et al*. (2009) emphasised that reliability is related to whether similar knowledge would be revealed from several researchers' analyses while a high level of validity is based on clear questions, meanings of the answers probed, and the topics discussed from several aspects. According to the authors, preparation is a significant criterion both to demonstrate the credibility of the interview and to obtain the confidence from the interviewees. They also underlined that during the preparation, several key points should be considered, such as knowledge level, information level provided to the

interviewee, appropriateness of location, appropriateness of the researcher's image at the interview, nature of the opening comments to be made when the interview starts, approach to questioning, nature and impact of the interviewer's attitude during the interview, demonstration of mindful listening skills, scope to test understanding, approach to recording data, cultural differences and bias. Also, they noted that before the interview, to provide some information about the topics (or themes) to be addressed in the interview is a valuable strategy for reliability and validity. As a summary, with reference to their explanations, some criteria, such as to choose a silent location, to be careful about the appearance, to be neutral in order to avoid bias, to have a conversation before the interview in order to enhance the confidence of the interviewee, and to ask clear questions during the interview are very significant factors affecting the accuracy of the data and the credibility of the qualitative interviews.

As a result, all these matters were mainly considered in the interview phase of this research. Moreover, in this research, two scholars and one practitioner was selected to check the questions before conducting the interviews and to check the meanings, clarity and order of the interview questions. Consequently, based on the feedback from these professionals, the interview questions were edited before the interviews and the final draft was prepared to conduct with the case companies.

3.10 Ethics in the Research

Ethics is very important in research where the researcher should consider the rights of the respondents throughout the data collection. In addition, the voluntary participation of participants is essential in studies. Besides, the collected data should be used for the benefit of the research only and maintaining the anonymity of participants during the research is also crucial for ethical responsibility (Khan and Ede, 2009).

In order to meet the ethics conditions, in this research, two sets of ethical approvals for the online survey and for the interviews conducted with both companies and the experts were received separately from the Research Ethics Committee of Brunel Business School. In these applications, the contents of the survey and the interviews were examined by the committee. In the online survey, on the first page, information regarding the research, such as the purpose, the need of their voluntary participation, the confidentiality of their answers, contact details of the researchers, and the estimated duration of the survey was provided to the respondents. With regard to the interviews with companies and experts, the interviewees were informed that the collected data were to be used for academic purposes only and their identities would remain anonymous. Moreover, with the interviewees' permission, the obtained information was noted during the interviews.

As a result, to maintain the confidentiality and anonymity of participants, information about the respondents participating in the online survey, the identities of the experts, and the interview transcriptions conducted with both companies and experts are not presented in this thesis.

However, more details regarding the remaining contents of the online survey and the interviews can be found in the next chapters.

3.11 Chapter Summary

The purpose of this chapter was to justify the use of appropriate methodological approaches for this research. Therefore, in this chapter, the methodological stance of the research approach produced from relevant theories was described. Underpinning this, the following points were followed:

- Philosophical stance of the research (positivism and interpretivism)
- Research approaches (deductive)
- Research methods (mixed-method approach)
    - Questionnaire types (online survey)
    - Appraisal of group decision making techniques and their comparisons
    - Rationale and justifications for choosing the ANP method
    - Overview of the interview techniques (semi-structured interview).

The chapter outlines classifications of these points. From these classifications, three key methodological approaches were mainly performed in this research: the online survey, the ANP method, and the semi-structured interview.

In the online survey part, various questionnaire types were examined and the significance of conducting an online survey was highlighted. In the section on the ANP method, different group decision techniques were compared and the ANP was revealed as the most promising and powerful method to prioritise the logistics performance indicators as well as determining the interrelationships among the indicators. In the semi-structured interview stage, three types of interviews were investigated and the semi-structured interview was found more applicable among the other interview techniques in order to demonstrate both the applicability of the model and the method outcome. The rationales behind choosing these three main methodological approaches are based on the aim and objectives of this research that deal with the research problems in logistics performance measurement. Finally, the chapter was concluded with the ethics in this research in terms of these methods.

CHAPTER 4 : DEVELOPMENT OF THE CONCEPTUAL MODEL FOR PERFORMANCE MEASUREMENT IN LOGISTICS

4.1 Chapter Overview

The aim of this chapter is to define and address the key logistics performance indicators. The chapter begins with the identification of various logistics performance indicators used in performance measurement, especially the indicators affecting competitiveness in the logistics industry. These indicators were initially revealed based on the systematic literature review. Yet, due to several reasons (e.g. overlapping, etc), some of the criteria were eliminated and, at the end, the initial list was established by the researcher. Additionally, the initial list and further processes were also assessed by five professionals comprised of three academics, and two practitioners in the logistics industry. After approximately three iterations to reach consensus, 43 performance indicators were confirmed by these professionals as the significant logistics performance indicators which formed the final list of indicators. Thus, by pulling together the insights of the reviewed literature and the professionals' views, a decision model was started to be developed through a comprehensive approach.

Moreover, in this chapter, the identified 43 indicators were placed under the four perspectives of the proposed BSC model, and then the online survey was conducted with 72 professionals from different segments of the Turkish logistics industry. Results from the survey concerning the mean values of the indicators were presented separately for each perspective. In addition, SPSS software was used to check the reliability of each perspective. After these processes, in order to highlight the most important indicators, the researcher determined a cut-off value for each perspective. Hereby, the indicators remained above these values, which are 15 from the four perspectives, constituted the conceptual model of this research. In the last section of this chapter, the existing studies in the literature and the BSC-related studies are examined to support the presented 15 indicators in the proposed model.

4.2 The Online Survey

Throughout the online survey phase of the research, a systematic process is followed. In this process, firstly, the literature regarding performance indicators used in the logistics field was carefully examined and the initial list based on the existing studies was generated by the researcher. After the initial list, five professionals (three academics and two practitioners) checked whether some indicators were missed or not. Then, these professionals added some indicators when there was a need to include these indicators or removed some of the indicators if there were some overlapping or inappropriate indicators in terms of the research scope. The process with professionals lasted until there was a consensus. After the consensus was reached, the final list of the performance indicators was generated. The representation of this whole process is shown in Figure 4-1.

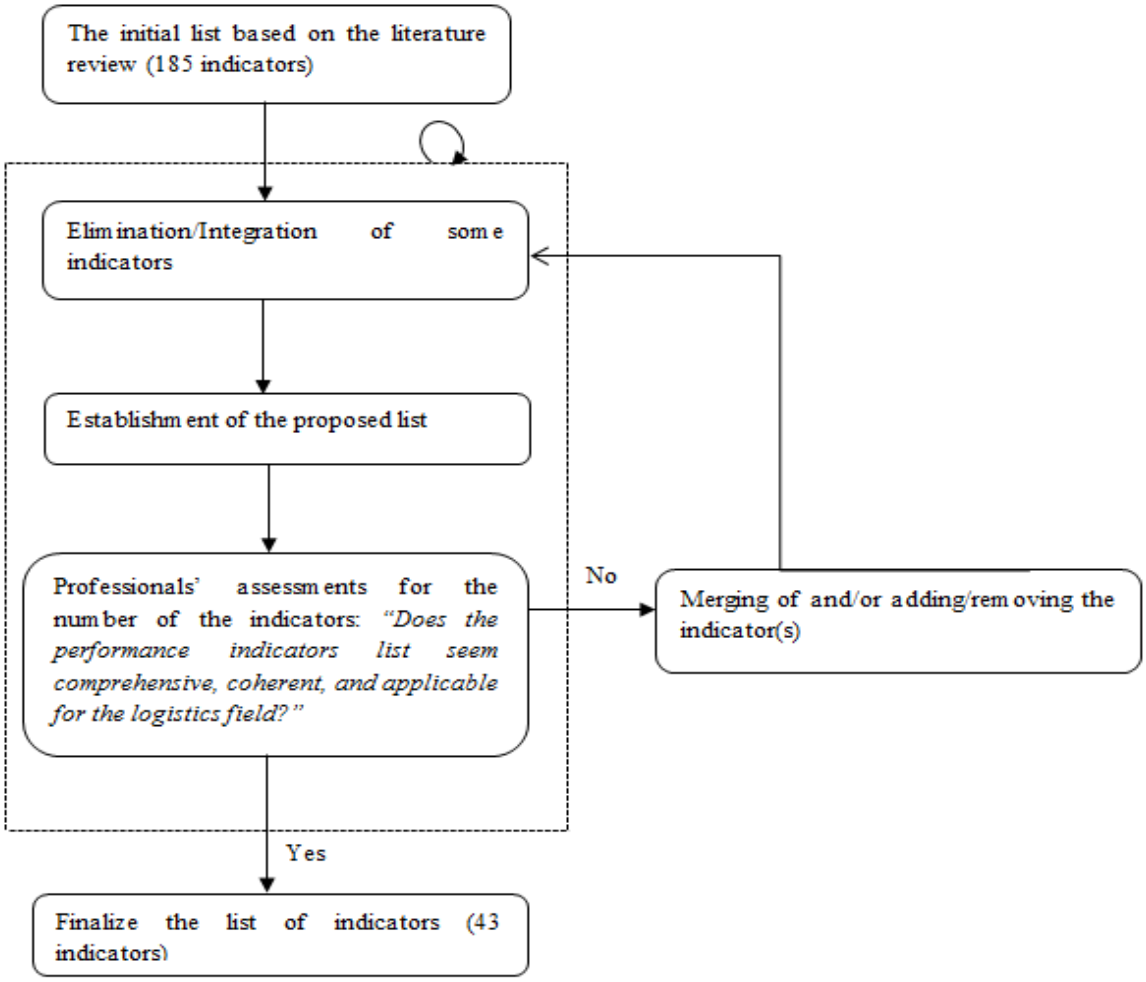


Figure 4-1: Online survey process for elicitation of the indicators

4.2.1 Identification of Competitive Performance Indicators with Literature Review

There are many performance indicators in the literature. Some of these indicators are related to the logistics field whereas some are industry-specific and more suitable for other sectors. During the identification of the key logistics performance indicators, a systematic approach was initially practiced to address the performance indicators used in this research.

Firstly, during the identification process of the performance indicators, several keywords with their different combinations were used by the researcher. The representation of these keyword combinations is shown in Table 4-1.

Table 4-1: Keyword combinations used in the databases

"performance measur*"-"logistics"-"service provider*"
"performance metric*"-"logistics"-"service provider*"
"performance factor"-"logistics"-"service provider*"
"performance indicator"-"logistics"-"service provider*"
"KPI"-"logistics"-"service provider*"

The keywords for our research were selected based on the researcher's perspective as similarly stated in Gopal and Thakkar's (2012) study. Moreover, each keyword combination was searched for mainly within title, keywords, and abstracts (similar to Favaretto *et al.*, 2009) of the articles indexed in the determined five academic databases: ScienceDirect (as used by Sipahi and Timor, 2010; Chai *et al*., 2013; Colicchia *et al*., 2013), Emerald (as used by Blasini and Leist, 2013; Chai *et al*.,2013), Sage (as used by Blasini and Leist, 2013), Scopus (as used by Gopal and Thakkar, 2012; Colicchia *et al*., 2013), and ABI/Inform (as used by Anand and Kodali, 2008). Moreover, the following processes were pursued to pick relevant articles:

- Firstly, peer-reviewed international journal articles were chosen (similar to Selviaridis and Spring, 2007; Gopal and Thakkar, 2012) in order to serve the related research communities better by obtaining a high level of relevance. Thus, similar to Chai *et al*. (2013), conference papers, several articles studied in other fields (e.g. medicine; agricultural and biological sciences; biochemistry, genetics and molecular biology, etc.), which are out of accordance with the scope of this research, master's and doctoral dissertations were excluded. Additionally, different language-based articles published apart from both in English (similar to Sipahi and Timor, 2010) and in Turkish were excluded.
- Secondly, repeated articles found during the searches were eliminated and not examined a second time (similar to Gopal and Thakkar, 2012).
- Lastly, in addition to the appeared articles after these searches, the researcher also returned to reference lists of key articles by using the cross-referencing technique (similar to Marasco, 2008; Colicchia *et al*., 2013), and thus the potential related papers that were not designated during the searches were included for this investigation part of the literature.

After these phases, although two studies could not be accessed, the researcher started to form a pool of performance indicators, approximately 185, based on subjective interpretations since there is no certain amount of performance indicators shown in some articles.

Afterwards, several processes during the literature review were followed by the researcher simultaneously with the guidance of professionals' assessments, as will be explained in Section 4.2.2. For instance, several studies (e.g. Gunasekaran and Kobu, 2007; Gunasekaran *et al.*, 2001;

Inemek and Tuna, 2009; Rajesh *et al*., 2012; Chow *et al*., 1994; Taylor, 2009), that either reviewed the literature in terms of the performance indicators in the literature or focused on the inclusion of performance indicators used in the logistics area, were examined in order to be guided on the direction of a right approach to be followed. Moreover, stakeholder theory-related studies (e.g. Freeman, 1984; Donaldson and Preston, 1995; Mishra and Dwivedi, 2012; Freeman, 1994; Shaik and Abdul-Kader, 2014) were analysed in order to provide a comprehensive stakeholder-based BSC concept. Additionally, a variety of articles studied both in logistics (e.g. Yan *et al*., 2008) and in supply chain (e.g. Göl and Çatay, 2007) were reviewed in order to determine the common and significant logistics performance metrics. Lastly, various studies which have similar aims with this research were examined by the researcher. However, during these processes, the researcher faced several challenges. As an example of these challenges, in the literature, most of the performance indicators were examined for the whole supply chain or for supplier selection purposes. Therefore, it was hard to identify the logistics performance indicators among the pool of indicators. Besides that, the remaining problems in this research can be also indicated as follows.

One of the problems in performance measurement systems is that in addition to having too many isolated and unsuited measures, there are a small number of articles focusing on performance measures and metrics in logistics and the supply chain (Gunasekaran and Kobu, 2007). Another problem is that performance metrics differ from context to context (Gopal and Thakkar, 2012) and 3PL terminology is overlapping (Selviaridis and Spring, 2007). As a third problem, application of the BSC approach in logistics and SCM has been limited (Gunasekaran and Kobu, 2007). Hence, since the papers considering only logistics indicators are very limited in the literature, the preliminary number of performance indicators used in this research was scrutinised based on the aforementioned processes for the BSC-based model of this study.

While gathering all these indicators, an elimination stage was conducted in order to reach a plausible and manageable number of indicators by covering all relevant indicators used in logistics performance measurement. Meanwhile, starting from the initial list to the final list of indicators, professionals' views were also taken into account. From this point of view, some of these indicators found in the literature were excluded in this research. The rationale of this kind of elimination was also pointed out in Gunasekaran and Kobu's (2007) study where performance measures and metrics used in logistics and SCM were reviewed. Also, they stated that some metrics in the literature are exactly the same with each other whilst some of the metrics are practically the same with different names. Moreover, the authors experienced that several measures overlapped with some other measures. Therefore, during the further review of performance indicators used in this research, overlapped indicators, practically similar indicators with different names, and indicators more likely related to the supply chain were decided to be removed at the end of the discussions with the professionals. Moreover, since some indicators can be broadly defined (Wilding and Juriado, 2004), these indicators were also excluded from the analysis. In addition to these, some indicators were combined, as in Joshi *et al*.'s (2011), since these indicators

were more specific and would already be included in a counted indicator. The sample of these eliminated indicators and their categorisation are presented in Table 4-3 in order to illustrate the development process of the final list of indicators as a whole. The reasons for these eliminations with their examples can be summarised in the following steps developed by the researcher:

- ✓ Several metrics (e.g. after-sales services) are more likely related to the whole supply chain rather than the logistics industry,
- ✓ Scopes of some indicators (e.g. risk) can be interpreted either too broad that can cause ambiguity or too narrow/specific (e.g. transportation cost) to be included because the factors in the survey were diligently selected with much effort in order to present them coherently at the same level,
- ✓ Some indicators (e.g. personnel training and employee training) either refer to the same meaning or are being used with a similar conception although the written names of the indicators are different in several studies,
- ✓ Some of the indicators (e.g. price) are more likely related to supplier selection topics, but our purpose is to address the important indicators used in the logistics industry without having any other industry-specific point of view.

These elimination reasons can be exemplified by showing several references for some indicators. For instance, some authors (e.g. Wang *et al*., 2006; Larson and Gammelgaard, 2001; Krauth *et al*., 2005; Sink *et al.*, 1996) mentioned that logistics services include various activities such as transportation, information systems, warehousing and so on. Since more specific elements within these general activities are taken into account in the survey model of this research, 'variety of services' was not included in this research.

Likewise, after-sales service was assessed by several authors (e.g. Cavalieri *et al*., 2007; Gaiardelli *et al*., 2007a) as a pyramid shape performance measurement system consisting of many layers (business level, process level, activity and organisational unit level, development and innovation level) and these layers include more specific metrics (e.g. responsiveness, customer satisfaction, cost, etc.), which were already included in the list of indicators in this research.

Similarly, various authors examined risk as a performance indicator but it was found too broad to be included in the survey model of this research at the end of the discussions with the professionals. In a similar vein, Wagner and Bode (2008) highlighted that risk is hard to describe and has many different meanings, measurements and commentaries regarding the research area. For example, in the supply chain literature, risk is related to some notions, such as damage, loss and so on (Harland *et al*., 2003; Wagner and Bode, 2008). Therefore, the risk as a performance indicator was excluded from the list of indicators since the risk concept was evaluated in the survey model by using the two representative notions, which are damage and loss.

Ultimately, it can be interpreted that choosing a proper indicator to be fit in a model is a crucial phase for studies. In a similar manner, some authors emphasised the importance of the indicator selection and the number of indicators to be used in the BSC approach. Tjader *et al*. (2014) stated that it is not possible to include every measure in the dimensions of the BSC approach and, therefore, the final decision of choosing the measures was left to the decision-makers in their BSC-ANP based research. Similarly, Kaplan and Norton (1996a) noted that at the present time, most corporations are sceptical about the sufficiency of a BSC approach with less than two dozen measures for measuring the firms' operations. The authors expressed that companies should have hundreds or thousands of measures to monitor whether their operations work as expected or not but, according to the authors, these measures are not the drivers of competitive success which help to define a strategy for the competitive superiority, contrarily these measures are necessary to enable companies to operate. In other words, the authors explained that the indicators which help to diagnose and monitor whether organisations remain in control should be distinguished over other indicators designed for enhancing the competitiveness. Thus, based on these views, it can be concluded that not all measures can be included in the BSC and not every measure can be assessed as a driver for the competitive success. For these reasons, the indicators incorporated in the survey model were included carefully in this research.

As previously mentioned, in order to provide a holistic approach, professionals' views were also considered during the determination of the final list of the performance indicators. The next section will give more details concerning the professionals' views during the identification of the indicators for the BSC-based survey.

4.2.2 Identification of Competitive Performance Indicators with Professionals' Views

Choosing the relevant performance indicators is a key step for evaluation of a performance system. In addition to the literature-related processes explained in the previous section, during the process of defining and selecting the appropriate performance indicators, a number of interviews with company managers and academics in the logistics field were also conducted to extend or arrange the initial list of indicators. From the initial list to the final list of the indicators, several rounds of feedback, obtained from five professionals (three academics and two practitioners), were taken into account with the help of e-mail, telephone, and face-to-face communication in order to determine the commonly used important performance indicators complying with the scope of this research.

The professionals are experienced in logistics and have valuable knowledge about the whole logistics processes. The professionals involved were reached through several sectoral associations in Turkey (e.g. UTİKAD[4], LODER) and some academic contacts whose studies were known by a large number of people in the logistics field.

[4] Uluslararası Taşımacılık ve Lojistik Hizmet Üretenleri Derneği (Association of International Forwarding and Logistics Service Providers)

In order to obtain feedback from these professionals, the following question was asked by the researcher: *Does the performance indicators list seem comprehensive, coherent, and applicable for the logistics field?* By doing so, first, the initial list was sent to them to check whether there are some additional significant indicators to be included. In this phase, they were also asked to remove any indicator (or indicators) where necessary. Then, during the following processes, the same strategy with the new list of indicators after each round was followed until reaching a consensus. On one hand, while all these rounds enabled professionals to merge some indicators with a broader indicator name (e.g. flexibility to changes), on the other hand, these processes also helped to identify new indicators for the survey. For instance, some indicators (e.g. equity ratio) were added by the professionals during these rounds. After approximately three iterations, the consensus was reached based on the feedback provided by the professionals.

In addition to these, the included indicators were also aimed to be used in the performance evaluation process of the selected companies in the case study part of the research to present the applicability of the model in practice. For this reason, the performance indicators defined in this study should also be in line with the performance measurement systems of the companies. Moreover, according to the professionals' opinions, keeping the number of the indicators at a manageable level was found vital for the success of the survey because including too many factors could result in lack of clarity. This opinion was also consistent with Zheng's (2010) study in which it was stated that the number of indicators should be as few as possible for a performance evaluation system. Therefore, there was a need to select significant indicators by establishing several criteria. In this regard, during the selection process, the performance indicators to be included in the survey were determined by considering the following six criteria suggested by Caplice and Sheffi (1995) for the evaluation of logistics performance systems: comprehensive, causally oriented, vertically integrated, horizontally integrated, internally comparable, useful. Shaik and Abdul-Kader (2013, p.502) summarised these six criteria based on the original paper of Caplice and Sheffi (1995) as follows:

"(1) Comprehensive- the measurement system captures all relevant constituencies and stakeholders for the process;

(2) Causally oriented- the measurement system tracks those activities and indicators that influence future, as well as current, performance;

(3) Vertically integrated- the measurement system translates the overall enterprise strategy to all decision-makers within the organisation and is connected to the proper reward system;

(4) Horizontally integrated- the measurement system includes all pertinent activities, functions and departments along the process;

(5) Internally comparable- the measurement system recognises and allows for tradeoffs between the different dimensions of performance; and

(6) Useful- the measurement system is readily understandable by the decision-makers and provides a guide for action to be taken."

Besides emphasising these criteria while choosing performance indicators for this research, several studies both from logistics and other fields were also considered as example papers for the indicator number determination process of this research because one of the objectives of these studies was to reduce the number of the factors to generate the final list of indicators, as applied in this research. In these studies, the authors used either some methods, such as the Delphi, nominal group technique or conducted surveys to generate the final list of indicators. The illustration of these studies, based on the approach that they defined the initial list, the initial factor numbers, their research methods to reduce the factors, and the final factor numbers are summarised in Table 4-2.

Table 4-2: Summary of some similar studies aiming to reduce the number of factors

Authors (Years)	**Defining the Initial List**	**Initial Factor Numbers**	**Research Method**	**Final Factor Numbers**
Gasiea (2010)	Literature review and 13 experts contacted on LinkedIn	31	Online survey	31
Bruno *et al*. (2012)	Ha and Krishnan's (2008) framework	30	Interviews	12
Yeo *et al*. (2011)	Literature review	38	Survey	18
Chen and Wu (2011)	Literature review and support of the experts in Delphi Method	30	Delphi method	18
Tjader *et al*. (2014)	Top executives of the case firm	35	Nominal Group Technique	17
Poveda-Bautista *et al*. (2012)	Face-to-face workshops with the experts	47	Face-to-face workshops with the experts	17
Yu *et al*. (2007)	Literature review	45	A questionnaire survey/a semi-structured interview survey with the experts	26 / 16

As can be seen from the table, there are several studies aiming to reduce the number of factors. Among these papers, Gasiea (2010) firstly defined 31 criteria based on both previous studies and research focusing on similar problems in addition to feedback from 13 experts contacted on LinkedIn. Then, an online survey including the 31 criteria for the rural telecommunications infrastructure selection problem was conducted; all of these criteria were then included in the final

model of the research. Bruno *et al*. (2012) preliminarily listed 30 criteria by considering Ha and Krishnan's (2008) framework in order to evaluate the suppliers within the railway industry, and then 12 criteria were kept in the final model at the end of the interviews with their customer committee members. In another study, Yeo *et al*. (2011) firstly analysed the literature to generate an initial list of attributes. Afterwards, they administered a survey to 30 logisticians in North East Asia in order to measure the competitiveness of the ports. At the end, 18 out of 38 determinants were chosen. Similarly, Chen and Wu (2011) began with the literature review to provide the number of the indicators in order to select the suitable 3PL provider for the electronic industry and 30 indicators (including two additional criteria at the second round of the Delphi) were considered at the beginning of the research. At the end of the Delphi method and after determining a cut-off value to reduce the number of the indicators, 18 indicators were finally included in their decision model.

On the other hand, in some of these papers, both the BSC approach and the ANP method were used together. For instance, Tjader *et al*. (2014) implemented a nominal group technique to collect different opinions and 35 performance metrics were included in the first list by a committee in a general contractor company. Then, 17 of these metrics were chosen by the committee for the final model of their study in order to determine the firm-level IT outsourcing strategy. Likewise, face-to-face workshops of the experts were held in Poveda-Bautista *et al*.'s (2012) research, which was practiced in the plastic industry of Venezuela, and 47 performance metrics were initially considered for the BSC model. At the end of the second session of the workshops, 17 competitiveness metrics were selected for their final BSC model.

Lastly, there is also an example about the usage of the BSC and the AHP approaches together in these studies. For instance, Yu *et al*. (2007) studied the performance measurement system for the Korean construction companies. The authors firstly identified 45 performance indicators based on their literature review and, then, 26 indicators were selected by applying a questionnaire survey to 23 construction companies registered on the Korean Stock Exchange. Finally, a semi-structured interview survey was conducted with five experts in the performance management of construction companies, and ultimately, 16 performance indicators were kept in the final list of their research.

As a conclusion, after these two stage processes, including the literature review and professionals' views, the competitive performance indicators for the logistics industry were analysed. At the end, 43 performance indicators commonly used in the logistics industry were found applicable and sufficient for this research because including too many metrics can overwhelm a decision maker which results in a lack of clarity (Youngblood and Collins, 2003). This is also coherent with the suggestions of Thakkar *et al*. (2007) as they pointed out that performance measurement systems should identify and keep a few key performance indicators. Also, the similar aimed studies presented in Table 4-2 showed that the final number of the indicators decided in this research is reasonable for the survey. As a result, by considering the scope of this research, the 43 identified

indicators were found suitable to be used in the BSC model of this research. Moreover, all these indicators were organised under the four perspectives of the proposed BSC-based survey as can be seen in the next section.

4.2.3 Grouping of the Indicators into the Proposed Balanced Scorecard Perspectives and the Pilot Test

After the identification of the 43 performance indicators for the proposed BSC-based model of this research, the next step was to organise these indicators under a relevant BSC perspective. Grouping of the indicators was performed either before conducting the survey or after the survey in the previous studies in the literature. Therefore, as grouping of the indicators before conducting a survey was also carried out in several studies (e.g. Wu *et al*., 2009c; Chen and Wu, 2011; Hsu *et al*., 2011; Rajesh *et al*., 2012), all 43 performance indicators were placed into the BSC perspectives through the comprehensive literature review and the consensus of the professionals in the logistics field. Since the main aim of the online survey was to highlight the important indicators in the industry and owing to the fact that there is no strict rule for placing the indicators under the perspectives, reaching the importance scores of the indicators was primarily considered more important rather than deciding which indicator should be placed under which perspective. Nevertheless, during the grouping phases, the related literature for each indicator was analysed in order to place the indicators in a more suitable perspective. In other words, before placing the indicators under the corresponding BSC perspectives, various studies about the indicators regarding the BSC approach principles (if not found, similar studies) were carefully examined. After examination, the professionals checked the suitability of the indicator in the perspective, and then each indicator was placed under a relative perspective of the model (see Table 4-3).

Table 4-3: Development and placement of the final 43 and the sample of eliminated performance indicators under the proposed BSC perspectives

Financial Perspective	*Learning and Growth Perspective*	*Internal Process Perspective*	*Stakeholders Perspective*
Cost	IT Infrastructure	On-time delivery	Customer satisfaction
Profitability	Managerial skills	Circumstance of delivery	Employee satisfaction
Sales growth	Educated employee	Transport capacity	Government satisfaction
Equity ratio	Social media usage for brand building	Warehouse capacity	Supplier satisfaction
Return on investments	Past performance	Research and development capability	Investor (financier) satisfaction
Cash flow	Willingness for information sharing	Geographical location	Community satisfaction
Revenue growth	Order entry methods	Ethical responsibility	Environmental group satisfaction
Accounts receivable turnover	Relationships with other stakeholders	Responsiveness to changes	Non-government organization satisfaction
Market share	Cultural match	Flexibility to changes	~~Trade association satisfaction~~
Interest coverage ratio	~~Employee training~~	Purchase order cycle time	
~~Gross revenue~~	~~Personnel training~~	Accuracy of forecasting	
~~Transportation cost~~	~~Electronic communication during transportation~~	Value-added activities	
~~Return on asset improvement~~		Quality system certifications	
		Effectiveness of delivery invoice methods	
		Quality of delivery documentation	
		Environmental awareness/understanding	
		~~Quantity and delivery date flexibility~~	

		~~Quality~~	
		~~Speed~~	

After grouping the indicators, there was a necessity to identify the importance scale for the indicators to fulfil the aim of the survey. To do so, in the scale construction, a 5-point Likert scale was used for the whole survey. Yet, owing to the fact that many verbal expressions have been used by different authors in 5-point Likert scale-related studies, several statements were examined in order to make the interpretations easier for the respondents. Finally, the verbal identification of the 5-point Likert scale questions was taken verbatim from Jiang and Klein's (1999) study. The main reason to use this study's Likert scale questions was the explanation of the numbers with the statements which addresses the importance of the indicators with a reasonable order. In the survey, the 5-point Likert scale was used and the questions were prepared in two languages (English and Turkish) in order to make the expressions more easily understood by the respondents. Thus, the 5-point Likert scale of the survey was identified as follows:

1- Not Important, 2- Slightly Important, 3- Somewhat Important, 4- Important, 5- Very Important

Furthermore, before conducting the survey, content validity and face validity were established within the pilot study phase. During the pilot test, in addition to checking several studies in the literature, interviews with both practitioners and academics in the logistics area were also conducted regarding the structure and content of the survey because Rajesh *et al*. (2012) stated that interviews with practitioners and academics are usually used for content validity. In their study, the content validity phase was fulfilled with the help of two academics, a doctoral student, and through a structured interview with a practitioner for the further re-evaluation process. In another study, two potential respondents were used in the content test process of Björklund and Forslund's (2013) web-based survey research followed by an interview with these respondents to obtain feedback concerning the structure and content of the survey. Furthermore, in Gasiea's (2010) online survey, two staff members in the same school within a university were included for the pilot test stage before publishing the survey. In addition to these studies, Daugherty *et al*. (2009) included three academics with relevant research experience, two consultants, and one executive from the electronics sector for the content and face validity.

In conclusion, following previous works on assuring validity, five professionals from both the practice and academic field in the logistics area assessed the practicability of the Likert scale questions, representativeness of the 43 performance indicators, the clarity of the survey draft in terms of some bench marks, such as readability, content, and translation. By also taking into account the received opinions from six professionals (from both academic and practice) in the pilot test, the survey was slightly modified, and then prepared to be sent to the respondents.

4.2.4 Distribution and Outcome of the Online Survey

In this section, the distribution and outcome of the online survey will be explained in detail. Before conducting the survey, the grouped indicators, the perspectives, and the 5-point Likert scale statements were prepared on an online survey website. The survey, shown in Appendix A, was prepared both in English and Turkish because showing English meanings could help respondents to understand some statements from their first meanings. The main reasons for using online survey were to reach a large number of respondents, to save time and money, to reduce unanswered questions, and to increase motivations of the potential respondents with visual support. The distribution processes and the results of the online survey will be explained in the following sections.

4.2.4.1 Distribution of the Online Survey

The survey was built through an online survey software service provider, Qualtrics. The survey link was initially sent to several academics in Turkey, who have experience on logistics and SCM, several practitioners, who work in some companies listed in the Fortune Turkey, and several government officers working in the logistics industry. The survey was distributed to the respondents using several sources, such as business networking sites (e.g. LinkedIn) as in Gasiea's (2010) research and/or social networking sites, and existing personal contacts of the researcher (similar to Man, 2006; Vondey, 2010). The existing contacts were either employees at major logistics companies in the industry or academics working on logistics-related research. Additionally, several respondents were willing to help the distribution of the survey to their personal connections in the Turkish logistics field. Some requisite information, such as the appropriate demographic features of the potential respondents, the aim and importance of this study, and the structure of the survey, were clearly explained in detail to these avid respondents in order to reach accurate results and a large number of eligible people in the industry. The technique used for this purpose is called 'snowball sampling', which is a non-probability sampling (or non-random sampling) method (Saunders *et al*., 2009).

The snowball sampling technique is a process which starts by identifying a few members of the population and asking these members to name other people, who have similar relevant characteristics with them, and then contacting these named people, and so on (Chadwick *et al*., 1984; Kalton and Anderson, 1986; Saunders *et al*., 2009). According to Li and Walejko (2008), snowball sampling is based on the multiplicity sampling technique which commonly enables use of some relationships such as friends, relatives, and neighbours. More specifically, they pointed out that snowball sampling uses the interconnectivity within networks to reach more suitable people. To this end, the snowball sampling technique was also used in this part in order to reach more relevant people in the Turkish logistics sector since it is hard to contact with some particular occupational groups (e.g. government officers) in the industry.

Finally, 72 people from the Turkish logistics industry answered all the questions within twenty days (from 7.12.2013 to 24.12.2013). The online survey distributed to the respondents is presented in Appendix A.

With a similar purpose, Chang (2013) undertook a questionnaire to determine the most important criteria to include in their BSC-based decision model and 34 senior executives from century-old Taiwanese food businesses answered the questionnaire. In a similar way, in order to reduce the complexity of using too many measures in a decision model, Liao and Chang (2009) initially used a questionnaire by considering the responses of 40 executives in their TV-shopping sector-based study before performing the ANP method. Similarly, Gasiea (2010) conducted an online survey about the rural telecommunications infrastructure and 62 answers were collected from around the world. Moreover, it was noted by the author that the response rate was adequate because the purpose of the survey was used to highlight the most important factors and to ignore the least important metrics before assessing dependencies among the criteria in their decision model. From the same point of view, 72 people from the Turkish logistics industry were deemed sufficient for this study because, as previously mentioned, the main rationale behind this survey was to emphasise the importance of the performance indicators under the BSC perspectives and to highlight the most important indicators for the logistics industry.

4.2.4.2 Results of the Online Survey

The survey results are based on the answers of 72 people who have different backgrounds in the Turkish logistics industry. The first part of the survey was related to their backgrounds and their working years. The rest of the survey comprised the 43 performance metrics and their importance degrees.

The results were obtained through the online software service provider and the outcomes were extracted from the software to MS Office programs to produce better designed diagrams. Respondents were categorised by their different professional backgrounds and the demographics of the respondents are shown in terms of their job titles in the first two figures (Figures 4-2 and 4-3). More specifically, in Figure 4-2, percentages of the respondents are shown in a pie chart while in Figure 4-3 the exact numbers of respondents participated in the survey are indicated.

According to the results of Figure 4-2, people from the ‘officer/specialist’ category has the highest number of respondents with the 29% followed by the categories of ‘other management positions’ (27%), ‘academicians’ (15%), ‘engineers’ (15%), ‘government officer/policy makers’ (8%) and ‘high level management’ (6%), respectively. Different categories of the respondents show that the participants were familiar with the indicators and they were able to provide valuable information concerning the importance of the indicators.

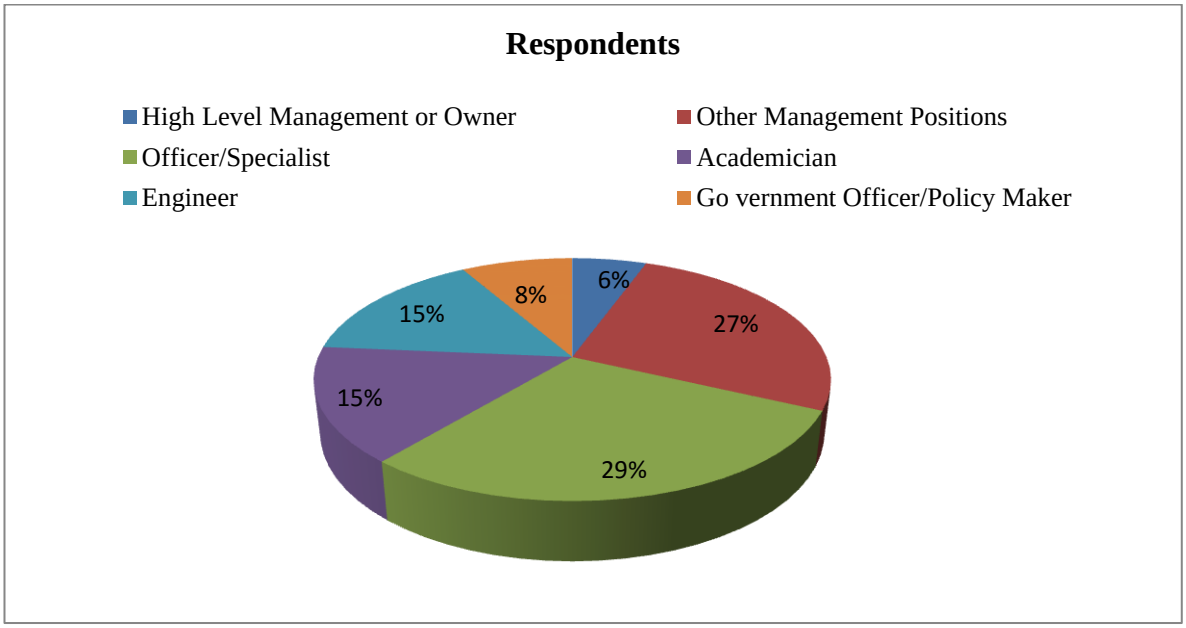


Figure 4-2: Demographics of the respondents in the online survey

In addition, Figure 4-3 shows that 21 out of 72 respondents are from the 'officer/specialist' category. The ranking of the other categories can be arranged in a descending order as: 'other management positions' (19), 'academicians' (11), 'engineers' (11), 'government officer/policy makers' (6), and 'high level management' (4) categories, respectively.

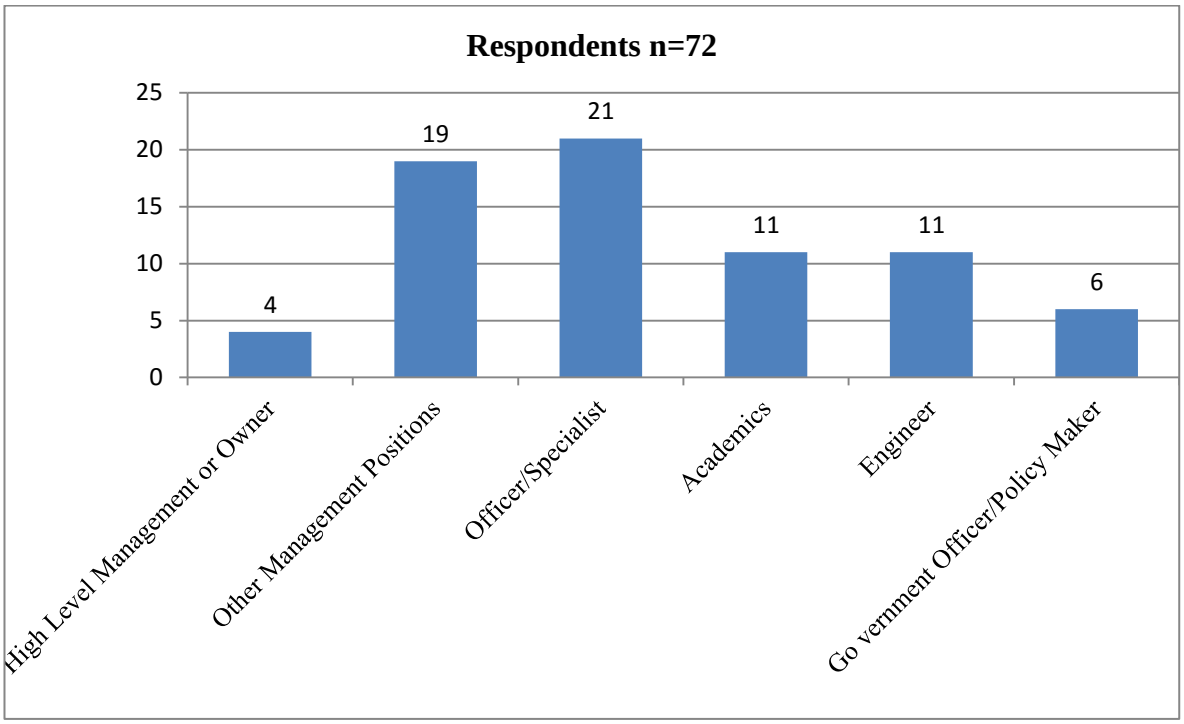


Figure 4-3: The number of the respondents for each job title category

Moreover, a question regarding working years of the respondents were also asked to the participants in order to analyse their experience and knowledge levels. The results obtained from the 72 respondents are shown in Figure 4-4.

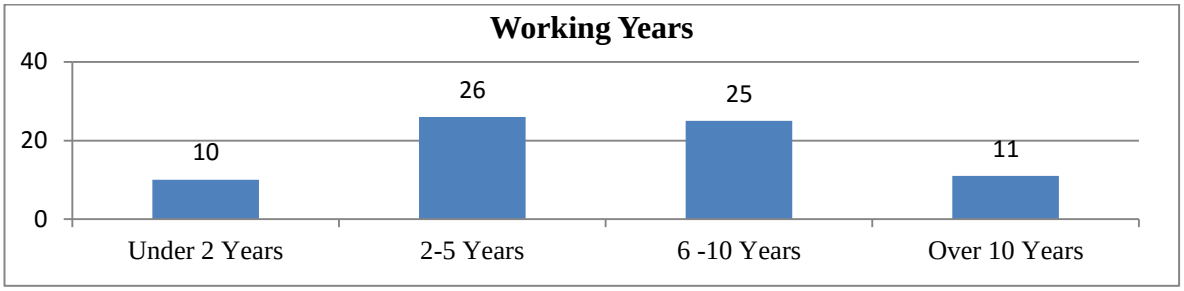


Figure 4-4: Working years of the respondents in the online survey

As seen in Figure 4-4, the majority of the respondents (around 86%) have more than two years of experience; more particularly, the participants are mostly from the '2-5 years' and '6-10 years' categories. According to this figure, the working years of the 11 respondents out of 72 are over 10 years, while only 10 respondents have less than two years of experience. Based on these presented results, it can be concluded that the survey was completed by experienced and knowledgeable professionals in the Turkish logistics industry.

In the second part of the survey, there are 43 scaled questions to determine the degree of importance of the performance indicators grouped under four perspectives of the proposed model. The ranking results of the performance indicators in each perspective are reported between Table 4-4 and 4-7. In these tables, the mean values of the indicators based on the answers of the 72 respondents are ranked in descending order for the perspectives. Thus, the indicators with the highest mean value in each perspective are placed at the top in the rankings. The results of the financial perspective consisting of 10 indicators are shown in Table 4-4.

Table 4-4: Financial perspective results

Performance Indicators	Mean Values
Financial Perspective	
Cost	4.85
Profitability	4.79
Sales growth	4.56
Equity ratio	4.36
Return on investments	3.49
Cash flow	3.47
Revenue growth	3.46
Accounts receivable turnover	3.36
Market share	3.18
Interest coverage ratio	3.18

The results in this table shows that the most important indicator is cost with the 4.85 mean score, which is followed by profitability (4.79), sales growth (4.56), and equity ratio (4.36). The three least important indicators are interest coverage ratio (3.18), market share (3.18), and accounts receivable turnover (3.36). The relative importance of the indicators in the financial perspective shows that all of these indicators are more than "somewhat important" for the industry.

The second perspective is the learning and growth perspective including nine performance indicators. The ranking of these indicators is shown in Table 4-5.

Table 4-5: Learning and growth perspective results

Learning and Growth Perspective	**Mean Values**
IT Infrastructure	4.85
Managerial skills	4.69
Educated employee	4.68
Social media usage for brand building	4.17
Past performance	3.26
Willingness for information sharing	3.25
Order entry methods	3.18
Relationships with other stakeholders	3.17
Cultural match	2.94

The results in this table indicate that the most important indicator is IT infrastructure with the 4.85 mean score followed by managerial skills (4.69), educated employee (4.68), and social media usage for brand building (4.17). The three least important indicators are cultural match (2.94), relationship with other stakeholders (3.17), and order entry methods (3.18). According to the presented results for this perspective, cultural match is less than "somewhat important", although the other indicators are more than the equivalent score (3.00) of this term. In this perspective, to the best of the researcher's knowledge, this is the first time for the consideration of the social media as a performance indicator in the BSC approach, especially for the logistics industry. The results of the online survey also confirmed that it is an important performance indicator in the logistics sector. Furthermore, several mean scores in this perspective are very close to each other and this can demonstrate the coherent structure of the perspective in terms of the representation of the cluster by the included indicators.

The third perspective is the internal process that has the maximum number of the indicators in the survey by including 16 indicators. The importance of these performance indicators in this perspective is displayed in Table 4-6.

Table 4-6: Internal process perspective results

Internal Process Perspective	**Mean Values**
On-time delivery	4.93
Circumstance of delivery	4.81
Transport capacity	4.69
Warehouse capacity	4.65
Research and development capability	3.39
Geographical location	3.38
Ethical responsibility	3.32
Responsiveness to changes	3.32
Flexibility to changes	3.32
Purchase order cycle time	3.29
Accuracy of forecasting	3.26
Value-added activities	3.25
Quality system certifications	3.18
Effectiveness of delivery invoice methods	3.17
Quality of delivery documentation	3.17
Environmental awareness/understanding	3.14

The table shows that the most important indicator in this perspective is on-time delivery with the 4.93 mean score followed by circumstance of delivery (4.81), transport capacity (4.69), and warehouse capacity (4.65). The three least important indicators appeared from the ranking are environmental awareness/understanding (3.14), quality of delivery documentation (3.17), and effectiveness of delivery invoice methods (3.17). The results present that all of the indicators in this perspective score more than 3.00, which represents the term of "somewhat important". Although the environmental awareness/understanding indicator received the lowest mean score, it cannot be interpreted as an unimportant factor for the competitiveness of the companies in the industry. The scores only indicate the relative importance of the indicators in the perspectives and the results show that operational-based indicators, such as on-time delivery, transport capacity, and circumstance of delivery were emphasised more than the other indicators representing different purposes, such as environmental awareness/understanding.

The last perspective is the stakeholders perspective containing eight stakeholders in the logistics industry. The indicators in this perspective were adopted from the stakeholder theory, as discussed in Section 2.8. The ranking of the stakeholders in this perspective is indicated in Table 4-7.

Table 4-7: Stakeholders perspective results

Stakeholders Perspective	**Mean Values**
Customer satisfaction	4.96
Employee satisfaction	4.61
Government satisfaction	4.22
Supplier satisfaction	3.40
Investor (financier) satisfaction	3.33
Community satisfaction	3.17
Environmental Group satisfaction	3.11
Non-government organization satisfaction	2.72

The results in this table show that the most important indicator is customer satisfaction with a very high mean score (4.96) followed by employee satisfaction (4.61), and government satisfaction (4.22), respectively. The three least important indicators are non-government organization satisfaction (2.72), environmental group satisfaction (3.11), and community satisfaction (3.17). The outcome of this table is consistent with the internal process perspective in terms of the environmental and operational scopes. Indeed, it can be seen from this table that more emphasis was given by the respondents to primary-related stakeholders in the operations, such as customers, employees, and the government than non-government organizations, and environmental groups. Also, it is worth noting that the customer satisfaction indicator has the highest mean value in the whole survey.

In addition to the ranking of the indicators, the results were also analysed statistically. Accordingly, in the next section, the statistical analysis of the online survey in terms of the reliability will be presented.

4.2.4.3 Statistical Analysis of the Online Survey

After obtaining the results from the respondents, reliability analyses were conducted by the researcher. In this regard, the reliability scores for each perspective were calculated.

In similar studies, which include surveys to highlight the important indicators, reliability was rarely analysed by the authors. In order to demonstrate the reliability of the perspectives, a reliability test was performed by using SPSS software. The Cronbach's alpha scores given by the software were 0.798, 0.672, 0.923, and 0.777 for each of the four perspectives, which are financial, learning and growth, internal process, and stakeholders, respectively. The representation of the Cronbach's alpha scores for each perspective is shown in Table 4-8.

Table 4-8: Cronbach's alpha scores of the perspectives

Perspectives	Cronbach's Alpha Scores
Financial Perspective	0.798
Learning and Growth Perspective	0.672
Internal Process Perspective	0.923
Stakeholders Perspective	0.777

Regarding the acceptable limits of the Cronbach's alpha scores, Huo *et al*. (2008) remarked based on Cohen's (1977) book that the commonly agreed limit in the studies is above 0.70. In this research, except for the learning and growth perspective, all alpha scores were found above 0.70. For the learning and growth perspective, the Cronbach's alpha score was also considered acceptable based upon three reasons. First, the closeness of the score to the limit point (0.70). Second, a new performance indicator (social media usage for brand building) was included as a first time in the BSC concept and, therefore, the Cronbach's alpha score could be under the general acceptable limit. Third, by analysing some studies which consider it acceptable for alpha scores of above 0.60 (e.g. Snieneh, 2009; Hair *et al*., 2010), 0.672 score was deduced as an acceptable value for this research.

After conducting the reliability tests and obtaining the results, the model of this research was established. In the next section, constitution of the conceptual model based on the survey results will be explained in detail.

4.3 Constituting the Conceptual Model

After the achieved results for the perspectives in the survey, in order to reduce the number of indicators to a manageable level, a cut-off value was set for each of the perspectives because, as Kaplan and Norton suggested, a BSC model should include a total of 14-16 performance factors (Hubbard, 2009) or should include between 15-25 measures placed under four perspectives of a BSC (Papalexandris *et al*., 2005). Besides, to reduce the indicators is also beneficial for the sake of the ANP method since it requires many pairwise comparisons in the network structure.

In the literature, different approaches were used to determine the cut-off values by the authors. For instance, Meijer *et al*. (2004) arbitrarily chose a cut-off score for the questionnaire used in their research. Likewise, Lee *et al*. (2009) arbitrarily set a threshold in the questionnaire conducted with the experts defined in their study in order to reduce the number of the indicators. On the other hand, in several studies, the Likert scale mid-point was considered as either a cut-off score (e.g. Stank *et al*., 1999) or a threshold value (e.g. Liu *et al*., 2010a). However, in this research, the cut-off values were set by considering the approach presented in Gasiea's (2010) study and all the experts were also agreed on the implementation of this technique to this research. In conclusion, the cut-off values of this research were determined by calculating the average of the highest and lowest mean scores in each perspective and these cut-off scores were defined separately for each perspective. The indicators that remained above these scores in each perspective were included in the conceptual model of this research, as shown in Table 4-9. As an example, the cut-off value for the financial perspective was estimated as follows:

(4.85 + 3.18) / 2 = 4.015

Thus, four performance indicators, namely cost, profitability, sales growth, and equity ratio were included in the conceptual model of this study. For the learning and growth perspective, the cut-off value was calculated as follows:

(4.85 + 2.94) / 2 = 3.895

Hence, four performance indicators, namely IT infrastructure, educated employee, managerial skills, and social media usage for brand building were involved in the model. For the internal process perspective, the cut-off score was computed as follows:

(4.93 + 3.14) / 2 = 4.035

By considering this score, four performance indicators, namely on-time delivery, circumstance of delivery, transport capacity, and warehouse capacity were included in the research model. For the stakeholders perspective, the cut-off value was determined as follows:

(4.96 + 2.72) / 2 = 3.84

With the help of this score, three performance indicators, namely customer satisfaction, employee satisfaction, and government satisfaction were incorporated in the model. Hence, this is the only perspective containing three indicators different than the other perspectives which consist of four indicators.

As a result, at the end of the survey, 15 performance indicators were included in the proposed model of this research after determining a cut-off value for each perspective. As previously emphasised, 15 indicators were considered sufficient for the proposed model since the number of

indicators is between the suggested 14-16 interval. Hence, the list of 15 performance indicators included in the stakeholder-based BSC model of this study is shown in Table 4-9.

Table 4-9: The list of performance indicators in the conceptual model

Financial Perspective	Learning and Growth Perspective	Internal Process Perspective	Stakeholders Perspective
Cost	IT Infrastructure	On-time Delivery	Customer Satisfaction
Profitability	Educated Employee	Circumstance of Delivery	Employee Satisfaction
Sales Growth	Managerial Skills	Transport Capacity	Government Satisfaction
Equity Ratio	Social Media Usage for Brand Building	Warehouse Capacity	

4.4. Supporting of the Performance Indicators in the Model from the Literature

Financial Perspective

Financial perspective is one of the perspectives existing in the generic BSC concept and seeks an answer of *"To succeed financially, how should we appear to our shareholders?"* (Kaplan and Norton, 1996b, p. 76). In other words, the main question to be answered by implementing the financial perspective is: *"How do we look to shareholders?"* (Kaplan and Norton, 1992, p. 72).

Financial perspective has been mostly concerned by 3PL management and investors as an important perspective because it represents the economic outcomes of organisations (Rajesh *et al*., 2012). In this perspective, different financial indicators (e.g. costs, revenue growth, cash flows) have been considered by authors in previous studies. It is important to note that it is common for the financial indicators to be collected quarterly, semi-annually or annually depending on the natural periodicity and data availability (Papalexandris *et al*., 2005).

Cost

Cost is one of the significant performance indicators evaluated by various authors under the financial perspective of the BSC concept (e.g. Chia *et al*., 2009; Shaik and Abdul-Kader, 2013). The importance of the cost indicator was emphasised in many studies in the literature. For instance, Gunasekaran and Kobu (2007) reviewed the literature on performance indicators in logistics and SCM between 1995 and 2004, and their results showed that cost still played a major role in the supply chain environment. Besides, diverse cost types (e.g. transportation cost, warranty cost, inventory cost, etc.) have been used in the literature by researchers and, according to Vijayvargiya and Dey (2010), managing transportation costs has been challenging in a company's logistics budget owing to radical changes in the transportation sector.

Profitability

Profitability is one of the major traditional performance indicators (Wang *et al*., 2012) and measures an organisation's capability to yield profits and sufficient return on invested capital (Leem *et al*., 2007). In the literature, there are several examples including profitability in the financial perspective of the BSC concept (e.g. Yu *et al*., 2007; Tjader *et al*., 2014). Moreover, profitability can be measured by some sub-measures, such as return on equity, economic value added, return on assets (Yu *et al*., 2007; Ali *et al.*, 2011).

Sales growth

To survive is a financial goal for organisations and growth in sales (or sales growth) is one of the measures to achieve this goal (Rajesh *et al*., 2012). Since sales growth is related to average annual growth rate in sales during the previous two years (Clarkson and Simunic, 1994), the unit of the sales growth indicator was highlighted in several BSC-related studies as percentage (%) (e.g. Thakkar *et al*., 2007; Yu *et al*., 2007).

Equity Ratio

This is a financial ratio showing the proportion of the stakeholder's equity used to finance a company's assets. Although it is an important financial performance indicator, inclusion of equity ratio as a performance indicator in the BSC is very limited in the literature. Yet, Gaiardelli *et al*.'s (2007b) study can be given as an example for the usage of equity ratio in the BSC concept. In their study, the BSC concept was adopted at the business level for the after-sales division of a manufacturing case company and the equity ratio on industrial operations was used in their study as a financial performance indicator.

Learning and Growth Perspective

Learning and growth is a perspective used in the generic BSC concept and seeks to answer: *"To achieve our vision, how will we sustain our ability to change and improve?"* (Kaplan and Norton, 1996b, p. 76). In other words, the perspective is focusing on improvement and creating value by answering *"can we continue to improve and create value?"* (Kaplan and Norton, 1992, p. 72).

The learning and growth perspective stresses constant innovation of organisations and helps them to continue their competitive margins and future growth trends (Hu *et al*., 2010). The literature has discussed that there are two categories for performance indicators, leading and lagging indicators, and according to Papalexandris *et al*. (2005), the learning and growth perspective includes leading indicators. As a result, this is the perspective in the BSC concept of containing strategic objectives focusing on know-how transfer, the adoption of new technologies, and the general capability of a firm in terms of responding effectively to a rapidly changing environment (Grigoroudis *et al*., 2012).

IT Infrastructure

Information technology is a performance indicator being assessed with different wordings under the learning and growth perspective by various researchers (e.g. Hu *et al*., 2010; Shaik and Abdul-Kader, 2012). Owing to the data-intensive nature of BSC implementations, organisations participating in a BSC project, should also prepare to practice IT solutions which can range from complex solutions to simple applications (Papalexandris *et al*., 2005).

Technology plays a significant role as a facilitating element in SCM (Hsiao, 2010). Improved technology is one of the external forces changing the transportation industry and IT capability is a performance indicator which allows meeting the needs of the systems (Shaik and Abdul-Kader, 2013). Also, IT capability can play a differentiating factor in the logistics industry because it is the foundation of the system network structure in an organisation. Having an advanced IT infrastructure is also beneficial for 3PL provider users for productive cooperation. In a similar vein, Vaidyanathan (2005) noted that 3PL providers with an advanced IT will lead to a decrease in logistics costs and to integrate all facets of the supply chain with enhanced productivity and growth.

Educated Employee

Educated employee, or training and capabilities of employees, has been commonly discussed in a large number of studies with different wordings. In these studies, the necessity of employee development for the growth of organisations was mainly emphasised by authors. The rationale behind this is based on the idea that organisations must have well trained and educated employees (Leem *et al*., 2007). Besides, good employee morale and education training will result in high customer satisfaction (Tsai *et al*., 2009). Therefore, the educated employee is a basis for achieving organisational objectives.

In the literature, some measures were used to represent the educated employee indicator and these include: number of the trained personnel (Thakkar *et al*., 2007), the number of the training hours per employee per year (Gaiardelli *et al*., 2007b) or percentage of employees trained (Grigoroudis *et al*., 2012). According to Hu *et al*. (2010), staff learning should be included as a performance indicator in the learning and growth perspective. In light of these, since the educated employee is a good performance indicator for development and growth of an organisation, it can be assessed in the learning and growth perspective of the BSC concept.

Managerial Skills

Managerial skills have been considered in the literature as a qualitative performance indicator with different names, such as management capability or managers' ability. Therefore, managerial skills are related to these terms as well as associating with some purports, such as knowledge and experience of managers, management support, and management expertise.

The importance of managerial skills was mentioned as a performance indicator in various BSC studies (e.g. Shaik and Abdul-Kader, 2012; Rajesh *et al*., 2012). Also, Tjader *et al*. (2014) noted that management expertise is one of the intangible assets that is critical for the success of a company and is a part of the learning and growth since management expertise and know-how assist innovation and learning activities. Moreover, it was pointed out in Tseng *et al*.'s (2009) study that management support is essential for the competitiveness of companies. Due to these remarks, the 'managerial skills' was assessed as a qualitative performance indicator in the learning and growth perspective of the proposed model.

Social Media Usage for Brand building

Social media is an Internet-based environment with many users and it contains various social networking sites, such as Facebook, Twitter, and LinkedIn. Moreover, social networking sites give a unique opportunity to build brand and, via the media, people are introduced to diverse brand communications (Jothi *et al*., 2011). Since branding at a corporate level essentially advances and manages the relationship between the corporation and its stakeholders apart from the general public (Fan, 2005), the brand building effect of social media usage is mainly emphasised and handled in this section.

The brand concept has been expanded over the years after its first definition, and now the concept can cover a variety of entities (Muzellec *et al*., 2012) including cooperations (Balmer, 2001), and services (Clifton *et al*., 2009). There are different models studied in the branding concept. For instance, in the literature on branding models, it is worth noting that the terms 'service branding' and 'corporate branding' are used interchangeably (De Chernatony *et al*., 2006). Generally speaking, in the corporate branding concept, besides the importance of an attractive logo or a powerful advertising campaign (Inskip, 2004; Khan and Ede, 2009), the role of employees is also accepted as significant, especially in service industries, in terms of building and communicating the brand (Gylling and Lindberg-Repo, 2006; Khan and Ede, 2009).

Although it was stressed that implementing the social media is significant in company activities, global corporations have a lack of understanding of the impacts of social media on their brands (Booth and Matic, 2011). In other words, business-to-business marketers have limited understanding of the social media usage as a marketing tool unlike their business-to-consumer counterparts (Swani *et al*., 2014). In addition, from the academic perspective, since research concerning social media and social networking sites is still at an embryonic stage, there is a paucity of systematic research on the usage of social networking sites by companies, especially business-to-business companies, because most of the interest was directed towards the business-to-consumer context in the literature (Michaelidou *et al*., 2011). However, more considerations concerning the use of the social media is essential because it can cause numerous advantages for companies. For instance, when companies listen to their customers' voices on media regardless of negative or positive conversations, an awareness of the content can enable practitioners to turn a dissatisfied

customer into a brand advocate (Booth and Matic, 2011). Moreover, social media is a tool used for forming buyer behaviour and it can be considered part of sustainable business development (Gunasekaran and Spalanzani, 2012). Besides, social media has a positive influence on sales for companies (Stephen and Galak, 2012) and has been becoming an important internet marketing tool that can be used to support the branding activities by developing relationships between business-to-business companies (Michaelidou *et al*., 2011).

On the other hand, usage of the social media is not free from negative consequences. As an example, a negative event can rapidly go viral and cause humiliation or a bad impression for companies (Baack *et al*., 2013). These consequences may affect company competitiveness negatively. Nevertheless, by comparing the pros and cons of the usage of social media, it can be seen that positive effects are prevailing over negatives.

Furthermore, regarding the implementation of the social media in logistics area, the results of Lieb and Lieb's (2012) study conducted in the 3PL industry highlighted that the use of social media by 3PL companies will become an important component for branding, recruiting, and communication strategies of these companies. Thus, the authors noted that the social media can be used as a significant differentiating indicator in a 3PL industry. In a similar vein, as revealed from the relevant literature, since social media has an undeniable influence on several marketing strategies, such as brand building (Küçükaltan and Herand, 2014), advertising (Baack *et al*., 2013), and communication (Hill, 2013), it is significant to consider social media usage in the business-to-business context, especially for logistics companies in terms of the brand building activities. As a result, even though the social media importance was discussed with reference to the BSC approach and as Nair (2011) highlighted that the social media can be considered a part of the learning activity, to the best of the researcher's knowledge, social media usage has not yet been assessed empirically in the BSC concept. More particularly, this research is the first in the literature for the logistics industry to examine social media usage for brand building empirically under the learning and growth perspective of the BSC concept.

Internal Process Perspective

Internal process perspective is another perspective existing in the generic BSC concept and seeks to answer: *"To satisfy our shareholders and customers, what business processes must we excel at?"* (Kaplan and Norton, 1996b, p. 76). In other words, the perspective focuses on creating and delivering customer value (Grigoroudis *et al*., 2012) by answering *"what must we excel at?"* (Kaplan and Norton, 1992, p. 72).

The perspective refers to the identified significant processes regarding competitiveness (Poveda-Bautista *et al*., 2012) and it shows areas in which operations must excel to achieve the aim (Rajesh *et al*., 2012). In this regard, in order to determine the indicators for this perspective, there is a need

to focus on the key indicators affecting the competitiveness of logistics enterprises (Hu *et al*., 2010).

On-time delivery

Time has become an important performance indicator in today's intense competition (Kaplan and Norton, 1996a), especially for the companies in a service industry such as logistics. In order to satisfy their customers, logistics companies should deliver goods on time to foreordained addresses. Likewise, the importance of the on-time delivery was also discussed in Kaplan and Norton's (1996a) book where on-time delivery was emphasised as a useful performance indicator for customer satisfaction and retention.

On-time delivery is one of the key logistics performance indicators and has been incorporated in the internal process perspective of the BSC concept by various authors (e.g. Youngblood and Collins, 2003; Chia *et al*., 2009). On-time delivery rate is a commonly used measure in the literature as an on-time delivery indicator. The calculation of the on-time delivery rate was illustrated by Rajesh *et al*. (2012) as the division of orders delivered on-time by total orders shipped.

Circumstance of delivery

Circumstance of delivery has been used in many studies, especially in BSC-related research, as a performance indicator and different names have been used for this indicator, such as defect rate of the delivery, transportation damages, or delivery quality. For instance, Gaiardelli *et al*. (2007b) examined the transportation damages on delivery as a service quality aspect. Similarly, Brewer and Speh (2000) included the damage rates as an element of a service measures category.

Quality has shifted from a strategic advantage to a competitive necessity for organisations and defect-free delivery has become a basis for companies to remain competitive (Kaplan and Norton, 1996a). According to Kaplan and Norton (1996a), since service companies cannot return a product or a quality failure as manufacturers, they can offer service guarantees to satisfy their customers. Therefore, the circumstance of delivery covers some terms, such as warranty, damages, and loss.

Transport Capacity

Transport capacity is related to transport planning and load management of vehicles to minimise damages occurring during the journey of products while maximizing vehicle utilisation (Shaik and Abdul-Kader, 2012). Also, transport capacity is a part of capacity planning activities, and in the literature, some measures (e.g. number of vehicles) were used to represent the transport capacity. Since number of vehicles is an element affecting capacity planning, it was examined within the transport capacity concept under the capacity planning category by Pettit and Beresford (2009).

Some studies exemplified the usage of transport capacity in the internal process perspective of the BSC concept. For instance, in Rajesh *et al*.'s (2012) study, it was illustrated that capacity utilisation and vehicle planning can be examined in the internal process perspective. As a more concrete example, Shaik and Abdul-Kader (2014) included the transport capacity as a performance indicator under the internal process perspective of their BSC-based model.

Warehouse Capacity

Although capacity is a broad term used by authors in the literature, the term can be extended by including storage (or warehouse) capacity (e.g. Yang *et al*., 2000; Yang *et al.*, 2010). Warehouse capacity is one of the available resources that organisations have in their operations (Mason *et al*., 2003).

On the other hand, determining the number and capacities of facilities, distribution centres, or plants is one of the key issues in the supply chain context (Jolayemi and Olorunniwo, 2004). The reviewed literature in this thesis revealed a lack of research on adopting the warehouse capacity into the BSC concept, especially for logistics companies. However, both by having the same rationale of using the transport capacity in the internal process perspective and by considering the warehouse capacity as a part of the internal process of organisations, it can be concluded that the inclusion of the warehouse capacity can be examined in the internal process perspective of a BSC concept.

Stakeholders Perspective

Stakeholders perspective, which allows stakeholder orientation, enables decision makers and policy makers to provide value to stakeholders (Shaik and Abdul-Kader, 2014). As previously mentioned, although the BSC concept is based on the stakeholder theory (Hsu *et al*., 2011), the generic BSC model does not incorporate various stakeholders. Moreover, it was emphasised in the literature that focusing mainly on customers is a major shortcoming of the generic BSC concept.

Implementing the stakeholders in the BSC in a different perspective has received very limited attention in previous studies in the logistics field. Nevertheless, several studies incorporated a stakeholder perspective either in the logistics domain (e.g. Shaik and Abdul-Kader, 2012; Shaik and Abdul-Kader, 2013) or in different areas (e.g. Tsai *et al*., 2009; Hsu *et al*., 2011). Since numerous stakeholders are involved in logistics activities (Hu *et al*., 2010), organisations must adapt to changing stakeholder needs (Rajesh *et al*., 2012). However, although different approaches have been previously used in the literature for performance measurement of logistics service providers, these approaches fail to consider the needs of company stakeholders in the identification of performance indicators for logistics companies (Lam and Dai, 2015). Consequently, in order to consider different stakeholders more comprehensively in this research, the 'stakeholders' perspective was adopted and used instead of the 'customer' perspective of the original BSC

concept. The rationale regarding the integration of the stakeholder perspective can be found in Section 2.8 in detail.

Customer Satisfaction

Customer satisfaction enables discovery of the existing gaps between customer expectations and company performance (Gaiardelli *et al*., 2007b). Customer satisfaction is a non-tangible and key logistics performance indicator (Chia *et al*., 2009). Moreover, it can be vital to 3PL companies' competitiveness because satisfying customer demands is the objective of many organisations (Wang *et al*., 2012).

Customer satisfaction was emphasised in numerous BSC-related studies (e.g. Anand *et al*., 2005; Tong *et al*., 2010; Wang *et al*., 2012; Tjader *et al*., 2014). Generally, in order to evaluate the customer satisfaction, the customer satisfaction index or ratio has been used as a measure of the customer satisfaction indicator (e.g. Thakkar *et al*., 2007; Gaiardelli *et al*., 2007b, Wang *et al*., 2012).

Employee Satisfaction

Employee satisfaction represents the satisfaction level of employees in an organisation (Shaik and Abdul-Kader, 2013). It is also an intangible indicator that is critical for the success of a company (Tjader *et al*., 2014).

The employee satisfaction indicator is measured by the employee satisfaction index and the percentage unit is used for this index (Grigoroudis *et al*., 2012). Similar to this thesis, employee satisfaction was considered in the stakeholder perspective in different BSC-related studies (e.g. Hsu *et al*., 2011; Shaik and Abdul-Kader, 2012; Shaik and Abdul-Kader, 2014).

Government Satisfaction

Government satisfaction can be defined as meeting the requirements of government policies and regulations (Shaik and Abdul-Kader, 2012). The transportation industry has been affected by some external forces, which cause some changes, and government regulation and policy is one of these forces (Shaik and Abdul-Kader, 2013).

The government was indicated as one of the stakeholders that affect a firm's performance in several studies (e.g. Hubbard, 2009; Tsai *et al*., 2009). Although the inclusion of the government as a stakeholder has received very limited interest in previous BSC-related studies, a handful of research can be exemplified (e.g. Hu *et al*., 2010; Shaik and Abdul-Kader, 2012; Shaik and Abdul-Kader, 2013). Yet, it is hard to identify the measures for the government satisfaction indicator. Nevertheless, in order to define the government interaction, several measures were used in Thakkar *et al*.'s (2007) study, such as the number of proposals sent to the government, the number of meetings organised with government officials, and the time taken by the government to accept any new proposal.

4.5 Chapter Summary

In this chapter, logistics performance indicators were investigated to develop the decision model of this thesis. Yet, there are many performance indicators in different dimensions in the logistics field. In order to deal with this complexity, two stages including an intensive systematic literature review and experienced professionals' views were used to verify the final list of indicators. Moreover, as mentioned earlier, there was also a need to consider different stakeholders rather than only customers in the BSC structure. Therefore, in the proposed model, the 'customer' perspective of the generic BSC model was replaced with the 'stakeholders' perspective by including various stakeholders. After these stages, 43 performance indicators, which were decided as being sufficient to address the whole logistics operations, were identified as significant logistics performance indicators and then grouped under the four perspectives of the proposed BSC-based model. Thus, since managers have difficulties identifying key performance indicators, the presented list of indicators can be used as a response to this problem, especially for showing the pool of indicators in the logistics field.

Subsequently, an online survey was conducted to highlight the most important indicators. By considering the answers obtained from 72 participants working in the Turkish logistics industry, the indicators were ranked in descending order of their mean ratings in each perspective and a cut-off value was calculated for the perspectives separately. Then, 15 indicators that remained above the calculated cut-off values were included in the decision model of this research.

In addition to these, reliability scores of the perspectives were tested by the SPSS software. The results of the reliability scores showed that the perspectives are reliable. Finally, the 15 proposed indicators were also supported from the previous studies in the literature, especially with the help of the BSC-related studies. Discussions concerning the identification of the performance indicators, calculation of the cut-off values, and constitution of the conceptual model can be found in Chapter 7.

CHAPTER 5 : TESTING OF THE CONCEPTUAL MODEL WITH THE ANP METHOD: A CASE STUDY IN THE TURKISH LOGISTICS INDUSTRY

5.1 Chapter Overview

This chapter presents the experimental application of the ANP method in the Turkish logistics industry based on the proposed BSC-based model. In order to fulfil this experimental task, the researcher implemented an intensive five-month analysis in the Turkish logistics sector.

Two main methods are discussed during the analysis of this part of the research. As a first method, the ANP method was performed to determine both the global weights and the relative importance of the performance indicators for the logistics industry. As a second method, the semi-structured interview technique was used to collect some data and information from the companies listed in the Fortune Turkey's top 500 regarding the 15 presented indicators used in the model.

As a summary, the chapter is organised as follows. Firstly, the rationale behind choosing the Turkish logistics industry and the main features of the industry are explained. Afterwards, the ANP process is applied to the performance indicators to determine their priorities. Then, semi structured interviews and the ranking of the companies are implemented based on the ANP results of the performance indicators. Eventually, the chapter is concluded by the prioritisation of both the indicators and the three case companies. Hence, the results of this experimental application prove the applicability of both the ANP method and the model in the logistics industry. Thus, the whole chapter provides managerial insights on how to be more competitive in the logistics industry.

5.2 Case Background

5.2.1 Logistics Industry in Turkey

The geopolitical location of Turkey makes the country strategically important in World trade because Turkey is surrounded by three seas, namely the Black Sea, the Aegean Sea, and the Mediterranean Sea. Moreover, as can be seen from Figure 5-1, it is located on the interconnection between the continents of Asia and Europe as well as connecting Balkan and the Middle East countries. Recently, Turkey has been placed on the international transport corridors and takes part in crucial international projects apart from its role in the Trans European Transport System (Aktas *et al*., 2011). Due to the strategic geopolitical location of Turkey, it has been considered as a logistics base by various authorities (MÜSİAD[5], 2013). Likewise, Aktas *et al*. (2011) pointed out that Turkey holds a significant potential of becoming a critical logistics zone as a result of its geopolitical position.

[5] Müstakil Sanayici ve İşadamları Derneği (Independent Industrialists' and Businessmen's Association)

Figure 5-1: Geographical location of Turkey

Source: Google Maps (2015**)**

Turkey was considered as an emerging market economy by the World Bank (2009, cited in Aktas *et al*., 2011, p. 834). Although there are various industries in Turkey, the logistics industry has a non-negligible contribution to the country's economy, one of the 10 large emerging markets in the World (Acar, 2012; UTİKAD, 2011). Besides, logistics is one of the growing industries in the World and has a significant competitive effect on the foreign trade of a country (Turkishtime, 2013). Along the same lines, the logistics industry has a significant role in the foreign trade of Turkey (Acar, 2012). Additionally, the Turkish logistics industry has the largest fleet of trucks in Europe (Büyüközkan *et al*., 2008; MÜSİAD, 2013; Turkishtime, 2013). Hence, all these features raise the importance of the Turkish logistics industry compared to other logistics industries.

The Turkish logistics industry was primarily developed between 1980 and 1990 based on its infrastructure (MÜSİAD, 2013) and, since then, the importance of the Turkish logistics industry has been carrying on its increasing trend. In addition to warehouse and bonded warehouse operations, the industry contains operations on both major single transportation modes (e.g. road, sea, air, rail) and different transportation types such as intermodal transportation, Ro-Ro transportation, and pipeline transportation.

Road transportation is a prominent operational mode in the Turkish logistics industry. The first reason behind this is that most of the investments supported by the government are substantially made on highways in the transportation sector (MÜSİAD, 2013) and, therefore, the infrastructure of highways is more developed than other transportation modes. Secondly, according to TOBB[6]'s (2012) data, 95% of the goods and 91.5% of passengers were transported by using the road operations within domestic freight in 2010. Thirdly, remarkable growth occurring in the export-import figures of the country also affects the Turkish logistics industry (Büyüközkan *et al*., 2008; MÜSİAD, 2013).

[6] Türkiye Odalar ve Borsalar Birliği (The Union of Chambers and Commodity Exchanges of Turkey)

In addition, there are hundreds of players from small to large firms in the Turkish logistics industry. Additionally, in the industry, there exist both international and multinational companies. Although the major part of the industry is shared among 200 companies (Büyüközkan *et al*., 2008), the number of the leading companies in the sector is not larger than 20 and the companies that operate in all logistics activities are even less (Büyüközkan *et al*., 2008). Therefore, in order to indicate remarkable results for the whole industry and to produce comparable results for the other logistics industries, the potential sample of this study remained less than 20.

So far, in this section, the significance of the geopolitical location of Turkey, the importance of the Turkish logistics industry in the country, and the features of the industry have been explained in detail. Yet, in order to see the relative importance of the Turkish logistics industry with other logistics industries in the World, we may need a more general view based on the benchmark of the countries in terms of their logistics infrastructure. In this regard, the World Bank organisation assesses and compares the logistics infrastructures of the countries. The more explanation concerning the World Bank rankings is given in the following sub-section.

5.2.2 The Position of the Turkish Logistics Industry in the World Bank Logistics Performance Index (LPI)

The World Bank prepares reports relevant to the logistics performance index (LPI) of countries globally. In these reports, two logistics performance indexes are announced by the World Bank. The first is the International LPI and the latter is the Domestic LPI. These LPIs contain both qualitative and quantitative measures on a structured online survey by using a 5-point Likert scale (from lowest score to highest score). Surveys are conducted by the World Bank and its partners consisting of academic and international institutions, private companies, and individuals employed in international logistics (World Bank, 2014). According to their records, the World Bank announced the global ranking of the countries in 2007, 2010, 2012, and 2014, respectively. Each year, different numbers of countries have been indicated in the rankings.

The first index, which is the International LPI, is measured by six dimensions (the efficiency of customs and border management clearance- 'customs', the quality of trade and transport infrastructure- 'infrastructure', the ease of arranging competitively priced shipments- 'ease of arranging shipments', the competence and quality of logistics services—trucking, forwarding, and customs brokerage- 'quality of logistics services', the ability to track and trace consignments- 'tracking and tracing', the frequency with which shipments reach consignees within scheduled or expected delivery times- 'timeliness') in order to present and compare the countries' performances (World Bank, 2015a). With reference to the organisation's reports, the Turkish logistics industry has been included in the World Bank ranking since 2007. In addition to the number of the countries listed in the ranking, both the position and the LPI score of the Turkish logistics industry are shown in Table 5-1.

Table 5-1: Information about the Turkish logistics industry based on the World Bank data

	The Number of the Countries in the Ranking	Position of the Turkish Logistics Industry	LPI Score of the Turkish Logistics Industry
2007	150	34	3.15
2010	155	39	3.22
2012	155	27	3.51
2014	160	30	3.50

Source: Extracted from World Bank (2015b)

As can be seen from the table, the LPI score of the Turkish logistics industry increased in 2007, 2010, and 2012 although the score in 2014 was nearly the same as the 2012 score. Also, it can be seen that there was an increment in the number of the countries in the ranking between 2007 and 2014. In response to this, the position of the industry in the ranking decreased from 34th in 2007 to 39th in 2010. However, compared to 2010, the position of the industry increased from 39th to 27th in 2012 while 155 countries were listed in the rankings in both years. In 2014, which was the latest report when this research was conducted, the relative position of the Turkish industry was shown as 30th in the ranking out of 160 countries.

The second LPI, the Domestic LPI, which is based on the assessments of logistics professionals in their own countries, contains four major determinants ('infrastructure', 'services', 'border procedures and time', 'supply chain reliability') to measure performance (World Bank, 2015c). The domestic LPI scores of Turkey based on these four years are also indicated in the World Bank reports. In the reports of 2007, 2012, and 2014, Turkey was shown as the top performer in the region. Accordingly, besides the geographical advantage of the country and having the largest fleet in Europe, being a top performer in the region supports the country to become outstanding for this research compared to other countries.

5.3 The ANP Method Application for the Performance Indicators in the Conceptual Model

5.3.1 Defining the Experts

The ANP method is one of the MCDM techniques (Ho *et al*., 2010; Tsireme *et al*., 2012) that incorporates expert judgments to reach final results (Ravi *et al*., 2005; Saaty and Vargas, 2006; Saaty, 2008). The initial stage of the ANP methodology is to define an expert group for pairwise comparisons. The main reason for using experts' judgments is due to uncertain information (Poveda-Bautista *et al*., 2012) or in cases of when there is no quantitative data that can be applied. Since there are several qualitative indicators in the model and the data in logistics companies are complex and uncertain (Gong and Yan, 2015), using experts' judgments is a suitable approach for this research.

In the ANP technique, the opinions and knowledge of experts are crucial for evaluations of the relationships. In this research, since the experts will evaluate both the indicators and the selected

logistics companies, their experience and knowledge are more important for the success of this research. Therefore, during the selection of the experts, their experience and knowledge on the ANP processes, the BSC approach, and the logistics sector were considered as the main factors since the scope of this research covers these subjects. Additionally, in order to choose experienced experts, having at least 10 years of experience was also considered important as pointed out in Kayakutlu and Buyukozkan's (2011) study. Furthermore, their voluntary participation was decided as another essential factor for the selection of the experts.

Throughout the selection and identification of the experts, the researcher first contacted six people in order to establish an expert group. Then, three of these experts stated that they were too busy to take part in the long processes and information elicitation associated with the ANP method. Finally, three experts agreed to participate in this research. As a result, three experts, who have experience and knowledge in the logistics field, were selected to analyse interdependencies and feedback among the 15 performance indicators as part of the ANP method and were invited to participate in the research. Thus, the expert group for the ANP part of this research consisted of these three decision-makers.

Similar to this research, three experts were included in various decision-making studies (e.g. Karpak and Topcu, 2010; Öztayşi *et al*., 2011; Poveda-Bautista *et al*., 2012). The detailed information about the experts of this research is as follows:

Expert 1: A professor, who has an engineering background, has much experience and knowledge about logistics and optimisation over 20 years at different universities in Turkey. Moreover, the expert had worked as a consultant to a logistics company in Turkey for around 15 years. In addition to many subjects, the expert has taught the BSC and the MCDM subjects at a university. Furthermore, the expert has more than 20 publications in the academic field.

Expert 2: The expert has much experience and knowledge regarding logistics and marketing subjects with over 20 years at different universities in Turkey. Apart from the expert's administrative duties in the logistics field at a university, the expert is a member of several leading logistics associations as well as taking part in many projects in UTİKAD, Turkey. Moreover, the expert worked as a consultant to a logistics company in Turkey. Also, the expert undertook some research related to the BSC and the MCDM methods during his career. Additionally, this expert has more than 50 publications in the academic area including journal articles, books, book chapters, and bulletins.

Expert 3: The expert, who has an industrial engineering background, has more than 10 years' experience in the Turkish logistics industry. Moreover, the expert has worked as a manager in a major logistics company in Turkey and had taken a part in several projects concerning both MCDM methods and the BSC approach.

In this study, similar to the ANP-based study by Karpak and Topcu (2010), which focuses on prioritising the factors affecting success for Turkish small to medium sized manufacturing enterprises, two of the three experts have had academic titles and one has worked in a company. Thus, two of the experts are academics while the latter is a practitioner working as a manager in the industry.

5.3.2 Constituting the Final Influence Matrix

After defining the experts, the next stage is to build the influence matrix and to constitute the final influence matrix based on the experts' decisions. The influence matrix shows the relationships between the indicators in the model. In this research, in order to determine the relationships among the performance indicators, a 15x15 matrix was formed and sent to the three experts. The experts evaluated the relationships among the indicators based on their experience and knowledge in the logistics field. During the evaluations, each expert attained "1", if the metric in the row influenced the metric in the column. If there was not any influence and relationship among the indicators, the experts inserted "0" in the corresponding cell. After obtaining the completed influence matrices from each expert, the majority rule of the experts' preference (Beynon, 2006) was taken into account to aggregate experts' answers in order to generate the final influence matrix (Gasiea *et al*., 2010), as shown in Appendix B.

Based on the "1" values, the outcome of the final influence matrix shows that there are interrelationships among the indicators in the matrix. In other words, each indicator is related to at least one indicator in the network. Hence, this situation led us to solve the problem with the ANP method because the relationships within and between the clusters are considered in a network structure via the ANP method rather than only the hierarchical relations (Saaty, 2008), as proposed in the AHP method structure.

Furthermore, it is worthy of note that alternatives were not included in the ANP process of this research as was the case in the study by Hsu *et al*. (2011) since the aim of this research is not to select the best alternative. In contrast, the aim is to propose a decision model in order to help decision-makers in logistics companies to decide which performance factors affect their companies' competitiveness more. Hereby, the proposed model is intended to be applicable to the whole industry rather than simply being helpful for the selected alternatives or a customer. Nevertheless, the evaluation of the alternative companies was not excluded completely in this research. Similar to the studies of Celik *et al*. (2009) and Yang *et al*. (2009), after the determination of the indicators' weights, the relative importance (or weights) of the alternatives were determined later, even though the alternatives were not included directly in the ANP network structure. Thus, the alternative companies in this study, which are three companies in the Turkish logistics industry, were assessed with the help of the experts after the determination of the indicators' weights through the ANP. More details regarding the case companies and ratings of these companies will be given in Section 5.5.

5.3.3 The ANP Questionnaire Practice

Considering the interrelationships among the indicators and the perspectives (or clusters), as shown in Figure 5-2, based on the final influence matrix, pairwise comparisons for the relevant indicators were formed in a questionnaire and conducted with the experts. During the pairwise comparisons of the performance indicators in the questionnaire, each expert assigned a score from the 1-9 scale. Then, in order to aggregate the experts' judgments for each comparison, the geometric mean method was used as Saaty suggested in his studies. Thus, the geometric means of the comparisons were calculated for each cell to assign a value from the fundamental scale into the relative cell in a comparison matrix (Saaty, 1980; Poveda-Bautista *et al*., 2012) and these obtained values constituted the basis of the unweighted, weighted, and limit matrices.

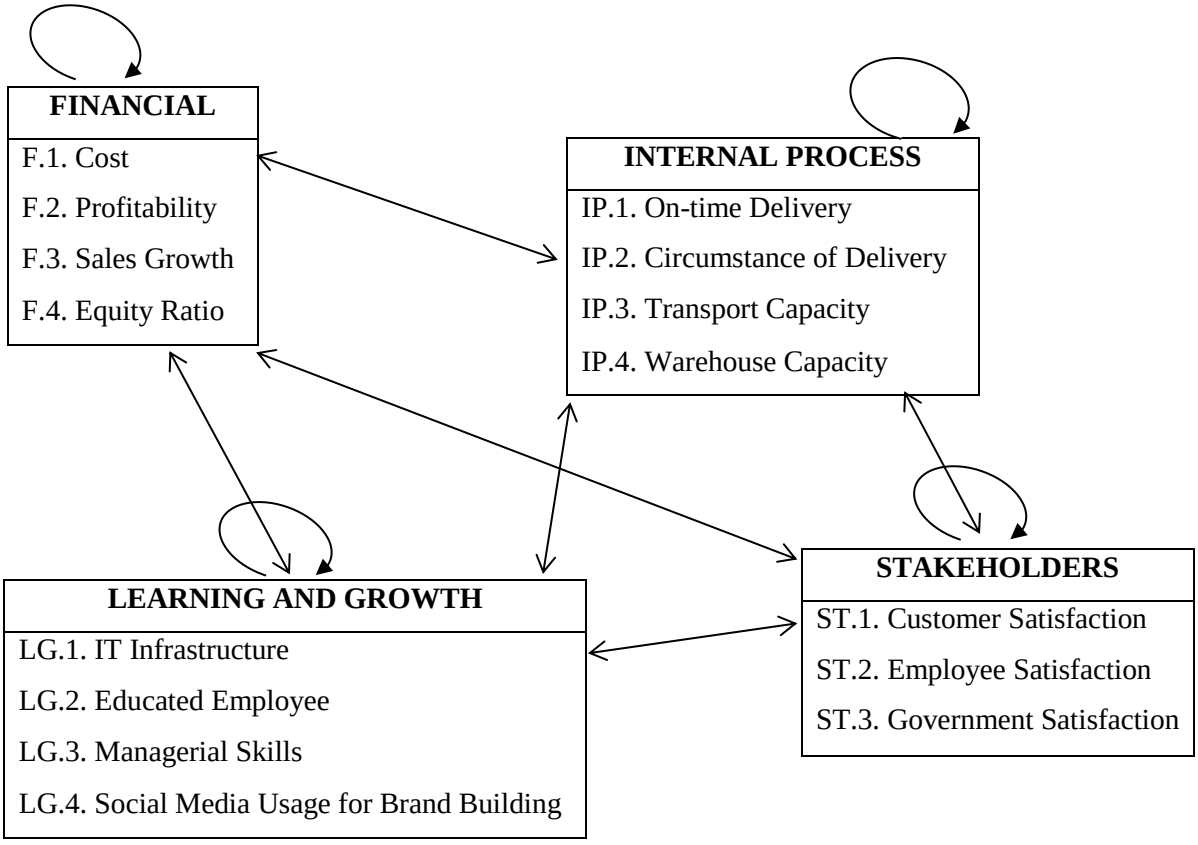


Figure 5-2: Interrelationships among the perspectives

In the ANP structure, there are numbers of pairwise comparisons for the parent elements. For example, for the equity ratio (F4) indicator as a parent element, there are two comparison matrices. One of these matrices comes from the Financial (F) cluster while the other comes from the Internal Process (IP) cluster. Also, for this indicator, there are four pairwise comparisons because the estimation of the number of the pairwise comparison is based on a formula of n (n-1)/2 where n denotes the number of elements. Thus, from this formula, the number of the elements in the Financial (F) cluster is three whereas there are two elements in the Internal Process (IP) cluster. The calculation of the number of the pairwise comparison can be generated as follows with respect to the equity ratio (F4) indicator:

$[n_1 (n_1\text{-}1)/2] + [n_2 (n_2\text{-}1)/2]$ = Total number of pairwise comparisons

$[3 (3\text{-}1)/2] + [2(2\text{-}1)/2] = 4$ comparisons

In brief, the representation of the number of the matrices, number of the elements, and number of the pairwise comparisons with respect to the equity ratio (F4) indicator are illustrated in Table 5-2. More comprehensively, Table 5-3 presents the same information for all indicators and perspectives in the model.

Table 5-2: Number of pairwise matrices and comparisons with respect to the equity ratio

Number of matrices	Number of elements	Number of pairwise comparisons
2	3, 2	4

According to Table 5-2, there are two matrices when the equity ratio (F4) indicator is a parent element because both the Financial (F) cluster and the Internal Process (IP) cluster have at least two scores of "1" in the final influence matrix. The 'number of the elements' column shows the numbers of the elements in the same cluster having a score of "1". Then, these numbers constitute the inputs of the formula mentioned above. The formula is applied to all cluster matrices and then they are aggregated in order to produce the number of comparisons.

Table 5-3: Number of pairwise matrices and comparisons for all performance indicators

Performance Indicators	Number of Matrices	Number of Elements	Number of Pairwise Comparisons
Cost	4	3,4,3,2	13
Profitability	4	3,4,4,2	16
Sales Growth	4	2,4,4,2	14
Equity Ratio	2	3, 2	4
IT Infrastructure	2	3,3	6
Educated Employee	1	2	1
Managerial Skills	1	2	1
Social Media Usage for Brand Building	3	2,2,3	5
On-time Delivery	3	3,3,2	7
Circumstance of Delivery	2	2,3	4
Transport Capacity	1	4	6
Warehouse Capacity	1	4	6
Customer Satisfaction	2	4,4	12
Employee Satisfaction	2	3,4	9
Government Satisfaction	-	-	-
FINANCIAL PERSPECTIVE	1	4	6

INTERNAL PROCESS PERSPECTIVE	1	4	6
LEARNING AND GROWTH PERSPECTIVE	1	4	6
STAKEHOLDERS PERSPECTIVE	1	4	6

The pairwise comparison numbers are the questions to be answered by each expert in the questionnaire. An example question for a pairwise comparison is formed for the ANP questionnaire of this research, by considering Saaty and Vargas (2006), as follows: *"Among the presented indicators with respect to the equity ratio, which one has more influence?"*

Moreover, the question can also be structured either as follows: *"which of these two elements is more dominant with respect to the equity ratio?"* or by considering Saaty's (2009) study, can be formed as: *"how many times is the transport capacity more dominant than the warehouse capacity with respect to the equity ratio criterion?"* However, as Saaty (2009) also highlighted, the influence term was used in the pairwise comparisons of this research. Therefore, the first question including the 'influence' term was asked to the experts and all comparisons in the questionnaire were made in the same way.

It is significant to note that the pairwise comparisons require intensive efforts and plenty of time to be completed by experts. In order to reduce these difficulties, two steps were applied at the preparation stage of the questionnaire. Firstly, the comparison matrices were organised in a Microsoft Word format questionnaire (both in English and Turkish) and sent by e-mail to each of the experts. Secondly, in order to clarify the ANP process before starting the comparisons and to receive their possible questions related to the process, a meeting was held with each expert at their offices. Thus, some explanations were given based on the printed questionnaire. Moreover, three example comparisons were provided on the questionnaire. By doing so, the experts became more familiar with the presented scale and the questions before they started the comparisons. The ANP questionnaire of this research is given in Appendix C.

After asking the questions to the experts, the next stage is to collect the questionnaires and to compute the geometric mean value from the obtained scores given by the experts for each comparison. In other words, the geometric mean method was used to determine the judgment for each comparison. Meanwhile, while entering the calculated geometric mean values to each cell of the pairwise comparisons, the inconsistency ratios of the matrices were also measured. During the measurement of the inconsistencies, as Saaty (2009) suggested, the inconsistency of a matrix should be less than or equal to 0.10. By considering this limit, all CRs were checked in all matrices in the network and only one inconsistency was found in one matrix, as shown in Figure 5-3. In order to improve the inconsistency ratio, the process, pointed out by Saaty (2004), was followed:

1. The most inconsistent judgment was found in the matrix,

2. In order to improve the inconsistency, the range of values for that judgment was determined,

3. The possibility of assigning a more plausible value was asked to the experts to reach the consistency between the acceptable limits.

More specifically, the inconsistent matrix had a value of CR= 0.13205 and the SuperDecisions[7] was used to determine the range of values for each pairwise comparison in order to assign more plausible values. For instance, the entry of 3.9790, which refers to the comparison of the transport capacity and warehouse capacity with respect to the on-time delivery, was identified to be changed. For this comparison, since the most consistent value for this entry is 1.3173, lowering this value to 1.3173 will bring the CR of the matrix to lower than the 10% limit. In this regard, the experts checked their scores regarding this comparison, and after these processes, the new geometric mean value for this entry was changed from 3.9790 to 3. As a result, the new CR value became 0.0728, which is within the acceptable limit. Meanwhile, it is worthy of note that the ranking of the indicators for this matrix remained the same after this alteration.

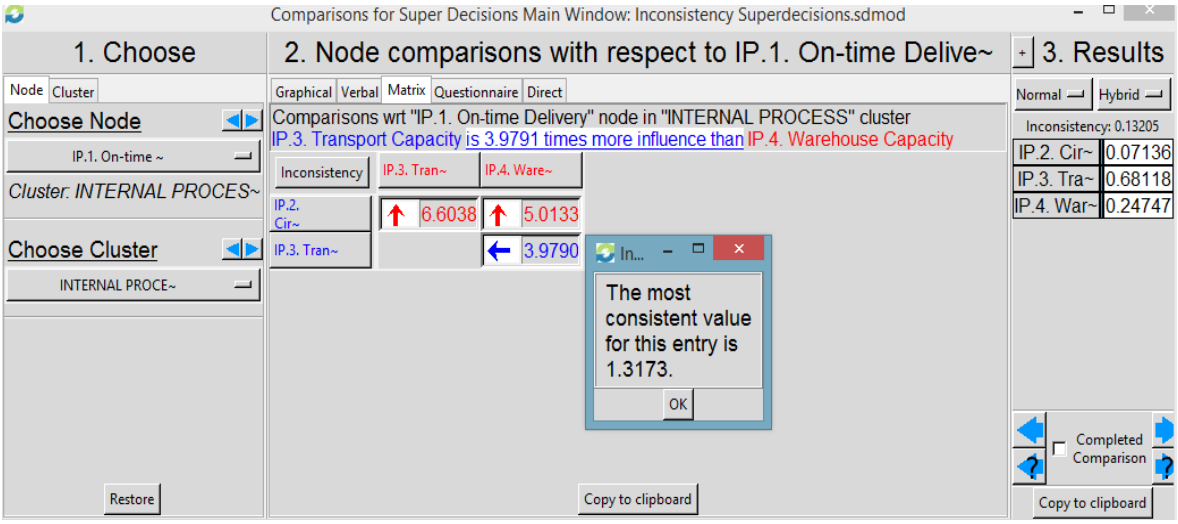


Figure 5-3: The inconsistent matrix

At the end of these processes, inconsistencies of all matrices were checked again by using the SuperDecisions. Thus, the aforementioned condition of the CRs for all comparison matrices was fulfilled and the comparisons were found consistent in the entire questionnaire. An example of both a pairwise comparison matrix in terms of the financial cluster and a representation of the inconsistency ratio with respect to the equity ratio (F4) indicator are shown in Figure 5-4 by using the SuperDecisions software.

[7] http://www.superdecisions.com/

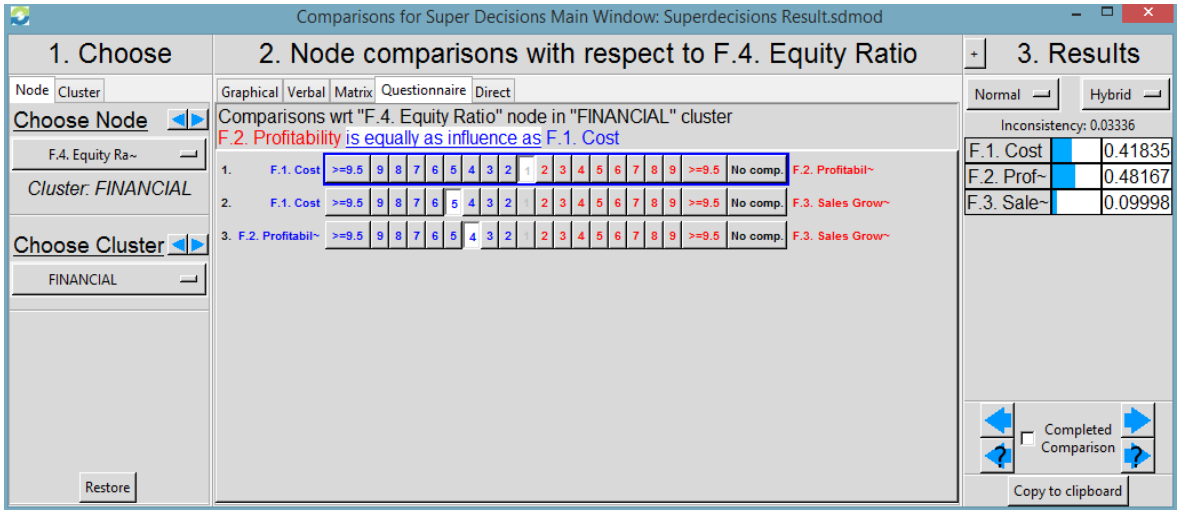


Figure 5-4: A pairwise comparison matrix and the inconsistency with respect to the equity ratio

In Figure 5-4, the pairwise comparisons with respect to the equity ratio indicator within the financial perspective are shown by using the 1-9 scale of the ANP method. Moreover, the inconsistency score of the matrix, which is less than 0.10 as indicated on the right side of the screen, shows that the matrix is consistent. All comparison matrices in the model for each indicator and perspective by including the geometric mean values and the CR scores are given in Appendix D.

After the pairwise and inconsistency assessments, the next phase is the calculation of the relative importance of the performance indicators in the clusters. For each comparison matrix, eigenvectors of the indicators were obtained through SuperDecisions as demonstrated on the right side of Figure 5-4 in a bar chart. Based on the obtained eigenvectors in this figure, profitability has a higher influence than other indicators in the financial cluster with respect to the equity ratio indicator, followed by cost, and sales growth. Thus, this shows that the relative priorities of indicators for each comparison matrix can be reached by the computation of eigenvectors. The other sections on this figure, namely graphical, verbal, matrix, and direct gives more information concerning the pairwise comparisons.

Furthermore, the calculated eigenvectors obtained from the pairwise comparison matrices are entered as part of relevant columns in a supermatrix. The eigenvectors show the degree of influence or dominancy of an element on the left of the matrix on another element at the top of the matrix. In order to reach the final results in terms of the global weights of the indicators, the SuperDecisions was used to constitute the unweighted, weighted, and limit supermatrices including all necessary computations regarding the network model of the research.

The first supermatrix of a network system is the unweighted supermatrix which includes all the local priorities achieved from the pairwise comparisons throughout the network. The unweighted supermatrix of this research is shown in Appendix E and all local priorities in the network can be seen from this supermatrix.

Following the computations in the unweighted supermatrix, the cluster weights are determined by using the cluster matrix. Yet, in the literature, some authors do not consider computing the cluster matrix before constituting the weighted and limit matrices since they assume equal weights for the clusters whereas some authors take cluster matrix into considerations during the constitution of the weighted and limit matrices. As Saaty (2005) suggested using the cluster matrix, in this research, the cluster matrix was computed in order to reach accurate results. Nevertheless, the possible outcome with the assumption of the equal weights for all clusters will also be shown as a different scenario in Section 6.6.

With the help of the included cluster matrix, all influences among the clusters (perspectives) of the proposed model were identified in the cluster matrix and the relative dominancy degrees of the clusters (perspectives) on each other were computed by using the SuperDecisions. The weights of each cluster (perspective) are shown in Table 5-4.

Table 5-4: Cluster matrix

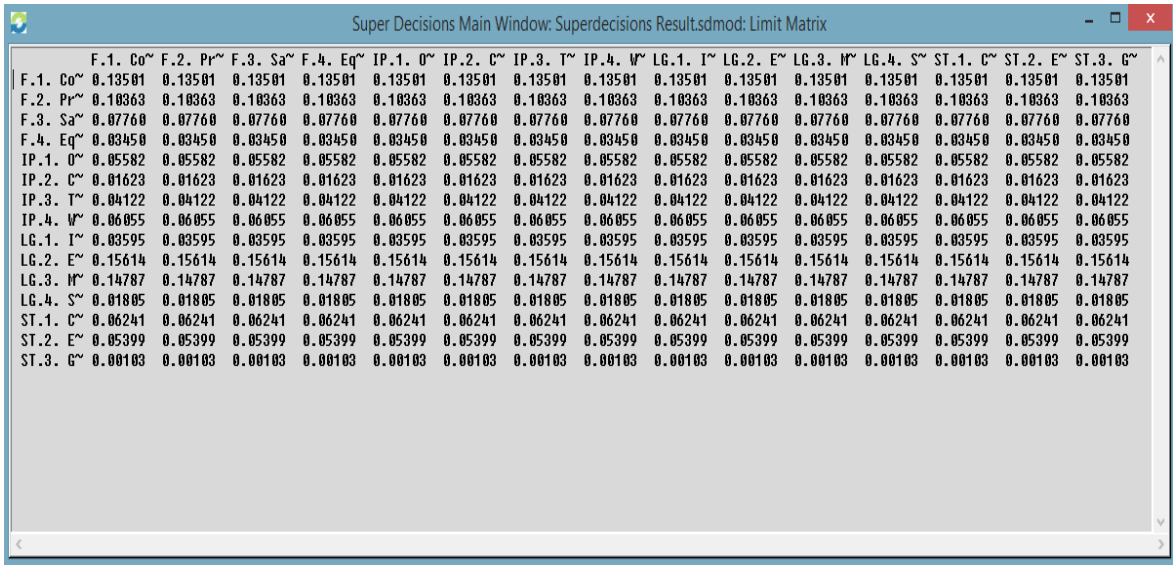
	FINANCIAL	**INTERNAL PROCESS**	**LEARNING AND GROWTH**	**STAKEHOLDERS**
FINANCIAL	0.615861	0.093853	0.129440	0.162864
INTERNAL PROCESS	0.203365	0.610182	0.222126	0.134040
LEARNING AND GROWTH	0.069160	0.183058	0.534322	0.086705
STAKEHOLDERS	0.111613	0.112907	0.114112	0.616391

In the cluster matrix, different weights were attained to these four clusters during the pairwise comparisons among the clusters. As a result of these comparisons, their influences on each other were calculated.

After obtaining both the unweighted and the cluster matrices, the weighted supermatrix was derived by multiplying all the entries in a block of the component in the unweighted supermatrix by the corresponding component weight estimated in the cluster matrix. After the repetition of these weighting processes for all columns in the network, the sums of the columns in the supermatrix were made unity (renormalized if the sum of a column is not “1”) and, thus, the supermatrix became column stochastic. The weighted supermatrix is shown in Appendix F.

After the constitution of the weighted supermatrix, the limit supermatrix was acquired by raising the weighted supermatrix to the power until it converged (as explained in Section 3.8.3). Thus, all the transitivities of influences in all possible paths that exist in the supermatrix were captured in the limit supermatrix. The result of the limit matrix gave the final weights and priorities of the

performance indicators. The limit matrix of this research by using the SuperDecisions is shown in Figure 5-5 and also shown in Appendix G in the Word format.



	F.1. Co~	F.2. Pr~	F.3. Sa~	F.4. Eq~	IP.1. O~	IP.2. C~	IP.3. T~	IP.4. W~	LG.1. I~	LG.2. E~	LG.3. M~	LG.4. S~	ST.1. C~	ST.2. E~	ST.3. G~
F.1. Co~	0.13501	0.13501	0.13501	0.13501	0.13501	0.13501	0.13501	0.13501	0.13501	0.13501	0.13501	0.13501	0.13501	0.13501	0.13501
F.2. Pr~	0.10363	0.10363	0.10363	0.10363	0.10363	0.10363	0.10363	0.10363	0.10363	0.10363	0.10363	0.10363	0.10363	0.10363	0.10363
F.3. Sa~	0.07760	0.07760	0.07760	0.07760	0.07760	0.07760	0.07760	0.07760	0.07760	0.07760	0.07760	0.07760	0.07760	0.07760	0.07760
F.4. Eq~	0.03450	0.03450	0.03450	0.03450	0.03450	0.03450	0.03450	0.03450	0.03450	0.03450	0.03450	0.03450	0.03450	0.03450	0.03450
IP.1. O~	0.05582	0.05582	0.05582	0.05582	0.05582	0.05582	0.05582	0.05582	0.05582	0.05582	0.05582	0.05582	0.05582	0.05582	0.05582
IP.2. C~	0.01623	0.01623	0.01623	0.01623	0.01623	0.01623	0.01623	0.01623	0.01623	0.01623	0.01623	0.01623	0.01623	0.01623	0.01623
IP.3. T~	0.04122	0.04122	0.04122	0.04122	0.04122	0.04122	0.04122	0.04122	0.04122	0.04122	0.04122	0.04122	0.04122	0.04122	0.04122
IP.4. W~	0.06055	0.06055	0.06055	0.06055	0.06055	0.06055	0.06055	0.06055	0.06055	0.06055	0.06055	0.06055	0.06055	0.06055	0.06055
LG.1. I~	0.03595	0.03595	0.03595	0.03595	0.03595	0.03595	0.03595	0.03595	0.03595	0.03595	0.03595	0.03595	0.03595	0.03595	0.03595
LG.2. E~	0.15614	0.15614	0.15614	0.15614	0.15614	0.15614	0.15614	0.15614	0.15614	0.15614	0.15614	0.15614	0.15614	0.15614	0.15614
LG.3. M~	0.14787	0.14787	0.14787	0.14787	0.14787	0.14787	0.14787	0.14787	0.14787	0.14787	0.14787	0.14787	0.14787	0.14787	0.14787
LG.4. S~	0.01805	0.01805	0.01805	0.01805	0.01805	0.01805	0.01805	0.01805	0.01805	0.01805	0.01805	0.01805	0.01805	0.01805	0.01805
ST.1. C~	0.06241	0.06241	0.06241	0.06241	0.06241	0.06241	0.06241	0.06241	0.06241	0.06241	0.06241	0.06241	0.06241	0.06241	0.06241
ST.2. E~	0.05399	0.05399	0.05399	0.05399	0.05399	0.05399	0.05399	0.05399	0.05399	0.05399	0.05399	0.05399	0.05399	0.05399	0.05399
ST.3. G~	0.00103	0.00103	0.00103	0.00103	0.00103	0.00103	0.00103	0.00103	0.00103	0.00103	0.00103	0.00103	0.00103	0.00103	0.00103

Figure 5-5: The limit matrix shown by SuperDecisions

5.3.4 The Results of the Performance Indicators

After the computations of the three supermatrices, the priorities and the global weights of the performance indicators were obtained through the limit matrix. Thus, the global weights of the performance indicators in the model were presented through the limit matrix.

As seen in Figure 5-5, each indicator has the same global weight across all the rows. The performance indicators in the model are shown in the limit matrix of SuperDecisions based on their written orders within the perspectives. Therefore, in order to rank the indicators in descending order by considering their global weights indicated in the limit matrix, the given orders were rearranged from the highest to the lowest value as shown in Figure 5-6.

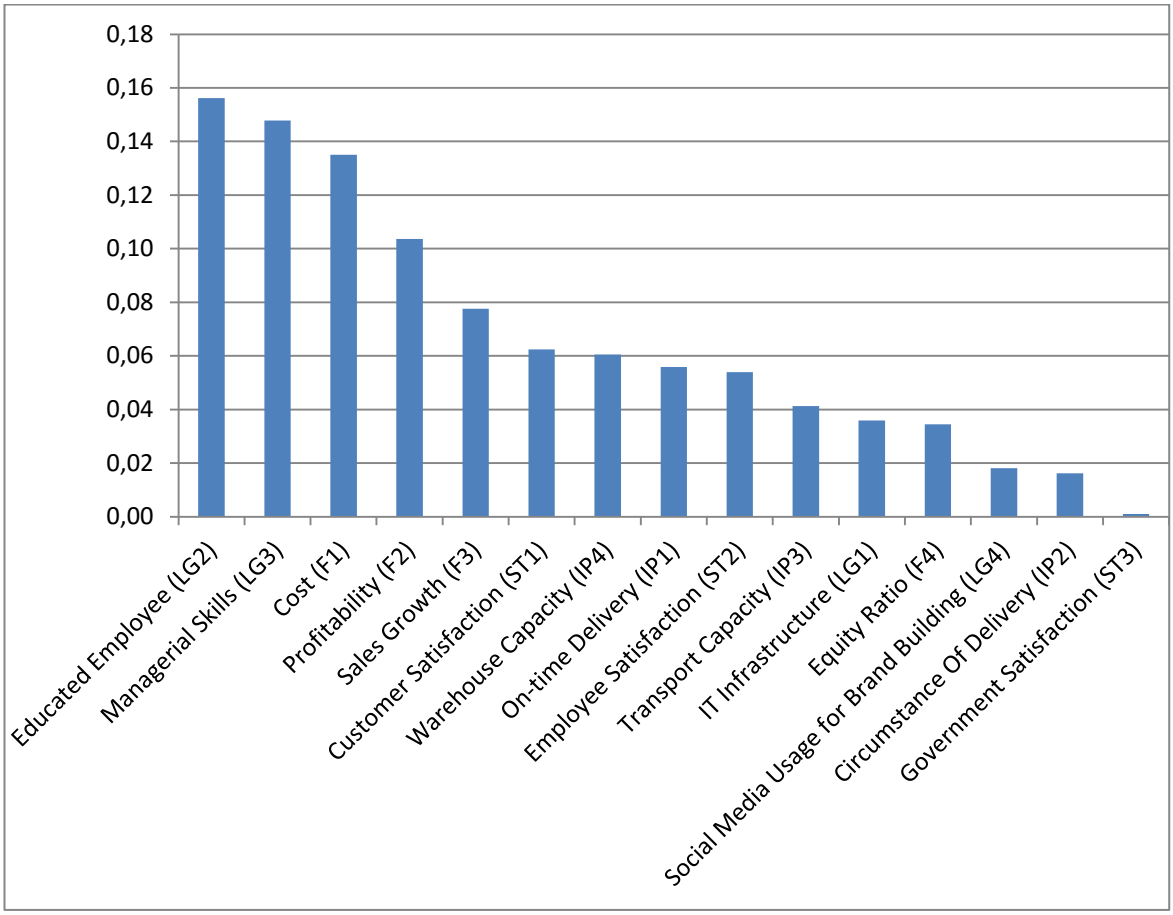


Figure 5-6: Descending importance of the indicators based on their global weights

Figure 5-6 summarises the weights of the performance indicators provided by the three experts when the four perspectives have different relative weights after constituting the cluster matrix. Moreover, this figure indicates the relative priority of the performance indicators in the logistics industry.

These global results, according to the three experts, show that the most important indicator is educated employee with 15.61% of the weight, closely followed by managerial skills (14.78%), cost (13.50%), and profitability (10.36 %). On the other hand, the three least important indicators in the model are social media usage for brand building (1.80%), circumstance of delivery (1.62%), and government satisfaction (0.10%). The global weights of the remaining indicators in the ranking are 7.76% for sales growth, 6.24% for customer satisfaction, 6.05% for warehouse capacity, 5.58% for on-time delivery, 5.39% for employee satisfaction, 4.12% for transport capacity, 3.59% for IT infrastructure, and 3.45% for equity ratio, respectively.

Hence, the results illustrate that educated employee is the most influential indicator for competitiveness of logistics companies in the industry and, therefore, it should be primarily considered by decision-makers in logistics companies. Additionally, decision-makers in logistics companies should also consider these weights and orders of the indicators in order to become more competitive in the logistics industry. In Section 5.5.4, these global weights of the performance indicators will be used in the calculation of the ranking of the case companies.

5.4 Semi-Structured Interviews to Collect Information from Case Logistics Companies

In order to demonstrate the applicability of the model and the method, the case study approach was implemented in this research. At this stage, the researcher attempted to obtain data and information from the companies regarding the performance indicators used in the model. There are various techniques to obtain information from companies and one of these techniques is the interview. As explained in Section 3.9, the semi-structured interview method is an interview technique used to collect data by asking open-ended questions. In this research, the semi-structured interview method was used to collect some information from the case companies regarding the performance indicators in the model.

The case logistics companies in this study were initially extracted from the Fortune Turkey lists. More information about the selection process of the case companies can be found in Section 5.5.1 and Section 5.5.2. The researcher attempted to reach the relevant managers or directors working in these companies by using both his personal contacts and by sending an e-mail to their addresses. Some managers from seven logistics companies replied and scheduled an appointment.

The interview survey, as shown in Appendix H, covers four perspectives of the proposed model. In each perspective, different questions about the performance indicators were asked to the relevant manager or responsible person in the companies. All questions in the interview survey are based on the information revealed from the literature. Furthermore, it was also considered by the researcher that to obtain accurate and more detailed information about the indicators, it might be necessary to determine some sub-indicators under each indicator. Therefore, the researcher examined the relevant literature for each indicator and its contents pointed out by previous researchers.

As a result, under these four perspectives, 15 open-ended questions in terms of each indicator were asked to the relevant people working in the companies and the respondent was encouraged to talk in order to gain more information concerning the indicators. Each interview was conducted separately and the duration of the interviews varied between 45 and 60 minutes. Also, the researcher was careful to be objective during the interviews. Meanwhile, for some questions, especially under the financial and learning and growth perspectives, different managers were interviewed by the researcher since the performance indicators in the model require some information from different departments (e.g. human resource, finance, IT). Eventually, all questions in the survey were asked to the relevant managers in the companies during the interviews, but some managers in different companies did not want to share their information for this research due to confidentiality reasons. Finally, at the end of the face-to-face interviews with these seven companies, all information regarding the 15 indicators were obtained from four companies. The remaining companies were excluded from this research because all information about the indicators should be obtained equally from each company due to an objective comparison

of the companies. Therefore, four companies were considered in the case study analysis of this research.

5.5 Analysis for the Selected Case Companies

5.5.1 Logistics Companies Listed in the Fortune Turkey

In this research, the research sample was taken from the Fortune Turkey lists where the major companies are listed for different sectors. Every year, the Fortune Turkey magazine announces the top 500 companies from different sectors in Turkey. The companies are ranked in these lists based on their sales turnover. Additionally, in the announced lists, not only sales information of the companies, but also different data (e.g. earnings before interest and tax, total assets, shareholders' equity, export, number of employees, sector, location, etc.) are presented. Therefore, since there is a variety of data exhibited in these lists, different units (e.g. percentage, Turkish Lira, person) are shown to represent the information regarding the companies.

There are several years to focus upon for the analysis of these lists. Yet, when the data collection of this research was conducted, the latest list about the best 500 companies regarding their 2012 data was announced in 2013 (sixth year) by the magazine. For this reason, the prior lists starting from 2012 were considered suitable for the scope of this study. Moreover, in order to present the latest and most realistic analysis, two consecutive years of the Fortune lists, 2012 and 2011, were taken into account in this part of the study. There are three main reasons to choose these years. Firstly, these were the last two years when the data collection was started and these two years presented the latest information concerning the major companies in the industry. Secondly, one of the indicators (sales growth) requires a comparison with the previous year and, therefore, two consecutive years were needed for the analyses. Lastly, being in the lists of two consecutive years shows the continuity of companies.

In addition, there are a large number of categories in the Fortune Turkey lists. As Çakır and Perçin (2013) similarly analysed the logistics companies listed in the category of 'warehousing, transportation and logistics services' defined by the Fortune Turkey, the same category was used as the focus in this research since this is the most related category in the magazine including logistics companies. In the light of this information, the companies placed in the 'warehousing, transportation and logistics services' category of the Fortune Turkey 2012 are shown in Table 5-5.

Table 5-5: The 'warehousing, transportation and logistics services' category in the Fortune Turkey 2012 list

1	Devlet Hava Meydanları İşletmesi Genel Müdürlüğü
2	Netlog Lojistik Hizmetleri A.Ş.
3	Ekol Lojistik A.Ş.
4	Kühne+Nagel Nakliyat Ltd. Şti.
5	Horoz Lojistik Kargo Hizmetleri ve Ticaret A.Ş.
6	Borusan Lojistik Dağıtım Depolama Taşm. ve Tic. A.Ş.
7	Omsan Lojistik A.Ş.
8	Fasdat Gıda Dağıtım Sanayi ve Ticaret A.Ş.
9	Mersin Uluslararası Liman İşletmeciliği A.Ş.
10	Taha Kargo Dış Tic. Ltd. Şti.
11	Mars Lojistik Uluslararası Taşıma Depo. Dağ. Ve Tic. A.Ş.
12	Balnak Nakliyat ve Lojistik Hizmetleri Tic. A.Ş.
13	Turistik Hava Taşımacılık A.Ş.
14	Reysaş Taşımacılık ve Lojistik Tic. A.Ş.
15	Alişan Uluslararası Taşımacılık ve Tic. A.Ş.
16	Sürat Kargo Lojistik ve Dağıtım Hizmetleri A.Ş.
17	TLS Lojistik A.Ş.

Source: Fortune: Türkiye (2013)

According to Table 5-5, there are 17 companies in this category but the companies compatible with the definition of '3PL provider' that provide some services in different operations are even less in this list. Similarly, a list of the previous year announced by the Fortune Turkey magazine, which is 2011, is presented in Table 5-6.

Table 5-6: The 'warehousing, transportation and logistics services' category in the Fortune Turkey 2011 list

1	Devlet Hava Meydanları İşletmesi Genel Müdürlüğü
2	Netlog Lojistik Hizmetleri A.Ş.
3	Omsan Lojistik A.Ş.
4	Horoz Lojistik Kargo Hizmetleri ve Ticaret A.Ş.
5	Ekol Lojistik A.Ş.
6	Borusan Lojistik Dağıtım Depolama Taşm. ve Tic. A.Ş.
7	Fasdat Gıda Dağıtım Sanayi ve Ticaret A.Ş.
8	Turistik Hava Taşımacılık A.Ş.
9	Mersin Uluslararası Liman İşletmeciliği A.Ş.
10	Mars Lojistik Uluslararası Taşıma Depo. Dağ. Ve Tic. A.Ş.
11	Reysaş Taşımacılık ve Lojistik Tic. A.Ş.
12	Taha Kargo Dış Tic. Ltd. Şti.
13	Alişan Uluslararası Taşımacılık ve Tic. A.Ş.
14	Sürat Kargo Lojistik ve Dağıtım Hizmetleri A.Ş.

Source: Fortune: Türkiye (2012)

As seen in Table 5-6, there are 14 companies in this category, although some of them cannot be interpreted as 3PL providers (e.g. Devlet Hava Meydanları İşletmesi Genel Müdürlüğü). An intersection of these two lists shows the same companies as presented in the 2011 list. By this way, the sample of this research was detected based on these 14 companies. However, some of these companies operate predominantly in air transportation (e.g. Turistik Hava Taşımacılık A.Ş.). Also, the main operational scope of several companies is different than other logistics companies in terms

of providing various logistics activities (e.g. Mersin Uluslararası Liman İşletmeciliği A.Ş.). Therefore, both based on these reasons and by considering Çakır and Perçin's (2013) proposed list, the final list of the companies for this research was formed. The logistics companies in the final list are in line with the research scope of this study and they are depicted in Table 5-7.

Table 5-7: The final list of the companies

1	Netlog Lojistik Hizmetleri A.Ş.
2	Omsan Lojistik A.Ş.
3	Horoz Lojistik Kargo Hizmetleri ve Ticaret A.Ş.
4	Ekol Lojistik A.Ş.
5	Borusan Lojistik Dağıtım Depolama Taşm. ve Tic. A.Ş.
6	Mars Lojistik Uluslararası Taşıma Depo. Dağ. Ve Tic. A.Ş.
7	Reysaş Taşımacılık ve Lojistik Tic. A.Ş.
8	Taha Kargo Dış Tic. Ltd. Şti.
9	Alişan Uluslararası Taşımacılık ve Tic. A.Ş.
10	Sürat Kargo Lojistik ve Dağıtım Hizmetleri A.Ş.

5.5.2 Selecting Case Logistics Companies Listed in the Fortune Turkey

In the literature, there are several ANP-related studies considering case companies in the network system. In these studies, different criteria were considered by the authors while including the companies in the ANP network structure. For instance, Kayakutlu and Buyukozkan (2011) chose two logistics companies, which both play an important role in Europe and have similar volumes of logistics operations with different backgrounds and strategies. Cheng and Lee (2010) involved an asset-based and a non asset-based 3PL provider in the ANP network. In another study, Poveda-Bautista *et al*. (2012) noted that it is necessary to select companies from the same industrial segment and with similar characteristics for valid comparisons or prioritisations. Also, while deciding the companies to compare in the value chain for the industry, some criteria such as to employ at least 50 workers, to be leaders and competitors in the same field, and to use similar methods in their manufacturing and marketing processes, were considered by their expert group. Moreover, Daim *et al*. (2013) noted that quality, cost, capacity and delivery capability can be addressed as elimination criteria of the unsuitable candidates. In addition to this, the final list of the 3PL providers was decided by considering the trade criterion on an American Stock Exchange. In Yang *et al*.'s (2009) study, three companies in the wafer fabricating industry in Taiwan were analysed. During their case analysis, they list the similarities of the case companies, such as having more than three factories, having at least one 12-inch factory, and playing significant roles in their sectors.

In a similar vein, based on these ANP-related studies in the literature, some criteria, such as to operate in the same industry, to be one of the major companies in the sector, to employ at least 300 workers, not to take part in mergers with another company, to be listed in the Fortune Turkey's top 500 companies in two consecutive years since some indicators (e.g. sales growth) in the model may include some comparisons with a previous year, to have at least three companies within the

corporate group of a company, to have similar distribution operations and to have a similar operational share in terms of the main transportation mode were considered by the experts and the researcher as the main criteria during the selection of the case companies. The rationale behind these criteria is to choose comparable companies from the same segment in order to reach more realistic results.

Consequently, based on the final list shown in Table 5-7, the author conducted interviews with seven companies from this list although only four of these companies gave relevant information about the indicators. Then, by considering the aforementioned criteria, three case companies were used to illustrate both the applicability of the proposed model and the practicality of the ANP application. For confidentiality reasons, the case companies are named in this research as Company A, Company B, and Company C.

5.5.3 Rating of the Case Companies

After obtaining the final weights of the indicators, as shown in Section 5.3.4, and selecting the three case companies to be evaluated using the proposed BSC-ANP decision model, a case study approach regarding the ratings of these companies was conducted. During the case study, various data were collected from the interviews with the high-level managers of these companies. Yet, due to the privacy conditions and/or non-existing data in a company, some information concerning relevant indicator(s) was not available. In such cases, the rating system was used to convert non-numerical investigations into ranking series, as Daim *et al*. (2013) proposed. Also, for some indicators, in which non-numeric data were obtained from the interviews, experts' evaluations were used to designate a rate for the companies with regards to these indicators. For example, managers did not want to share their cost information explicitly due to privacy reasons and, therefore, the cost structure of the companies based on their operational (or functional) costs was investigated instead of examining their costs. Thus, only in the case study part of this research, the cost structure of the companies will be referred to as the cost indicator.

In order to help the experts with their interpretations regarding the ratings of the companies, several statements were examined for the verbal identification of the ratings. Finally, as the experts agreed on these identifications, a 5-point rating was used in this part of the research. The verbal expressions of the rating scales were taken verbatim from Saaty and Vargas's (2006, p.19) book. Also, the same verbal ratings were found in the help section of the SuperDecisions software. Thus, the 5-point scale used in the rating process of the companies is as follows:

1-Poor, 2-Below Average, 3-Average, 4-Above Average, 5-Excellent

The rating process was based on two phases. In the first phase, each expert assigned a rating score from the 5-point scale for each case company based on their knowledge and experience in the industry. In the second phase, the mean value of the three experts' judgments was assigned as a

final rating for indicators. The illustration of the rating scores for the three case companies with respect to their cost structures is shown in Table 5-8.

Table 5-8: Rating scores of each company with respect to their cost structures

Companies	**Company A**			**Company B**			**Company C**		
Experts	**EXP.1**	**EXP.2**	**EXP.3**	**EXP.1**	**EXP.2**	**EXP.3**	**EXP.1**	**EXP.2**	**EXP.3**
Ratings	5	4	4	5	4	4	4	4	4

According to Table 5-8, the mean score of Company A regarding the indicator is 4.33 while the score is 4.33 for Company B, and 4 for Company C. The same process was followed for all rating required indicators.

After all data were obtained from both the case companies and the experts related to the indicators in the model, different units, such as Turkish Lira for profitability, rating scores for several indicators (cost structure, circumstance of delivery, transport capacity, IT infrastructure, educated employee, managerial skills, social media usage for brand building, government satisfaction), percentages for some indicators (sales growth, equity ratio, on-time delivery, customer satisfaction, employee satisfaction), and m^2 for warehouse capacity were obtained from the analyses. In this case, there was a need to reach the same type of unit. Thus, similar to the study of Daim *et al*. (2013) for converting different types of numbers into one type of score, the normalization approach was applied in this study. During the normalization computations, the mean scores of each company in terms of each indicator were divided by the sum of these mean scores. To be more precise on the same example, the sum of the mean scores for the cost structure is 12.67 (4.33+4.33+4) and the relative normalization scores of the companies are 0.34, 0.34, and 0.32, respectively. Along the same lines, the same computations were applied to all 15 indicators in the model. After all, the normalised scores of the companies for each indicator were obtained. In the next section, it will be demonstrated that these scores were used to constitute the final ranking of the companies by considering the weights of the indicators shown in Section 5.3.4.

5.5.4 The Results of the Case Companies

After establishment of the normalised values for the companies in terms of each indicator, the normalised scores of each company was multiplied by the relative indicator weight obtained in the limit matrix. As a result of these multiplications, the total scores of the companies both in terms of each indicator and as a sum of all indicators are shown in Table 5-9.

Table 5-9: Total scores of the companies

	Indicator Weights	COMPANY A	COMPANY B	COMPANY C
Cost Structure	0.13501	0.0462	0.0462	0.0426
Profitability (F2)	0.10363	0.0389	0.0115	0.0532
Sales Growth (F3)	0.0776	0.0121	0.0347	0.0309
Equity Ratio (F4)	0.0345	0.0151	0.0094	0.0099
On-time Delivery (IP1)	0.05582	0.0197	0.0187	0.0173
Circumstance Of Delivery (IP2)	0.01623	0.0051	0.0070	0.0042
Transport Capacity (IP3)	0.04122	0.0130	0.0130	0.0153
Warehouse Capacity (IP4)	0.06055	0.0110	0.0220	0.0275
IT Infrastructure (LG1)	0.03595	0.0117	0.0136	0.0107
Educated Employee (LG2)	0.15614	0.0604	0.0554	0.0403
Managerial Skills (LG3)	0.14787	0.0522	0.0565	0.0391
Social Media for Brand Building (LG4)	0.01805	0.0074	0.0074	0.0033
Customer Satisfaction (ST1)	0.06241	0.0201	0.0216	0.0208
Employee Satisfaction (ST2)	0.05399	0.0193	0.0180	0.0167
Government Satisfaction (ST3)	0.00103	0.0003	0.0004	0.0002
TOTAL		**0.3324**	**0.3354**	**0.3322**

As can be seen in the table[8], Company B (33.54%) is the first company in this case study, followed by Company A (33.24%), and Company C (33.22%), respectively. The companies were numerically ranked in this research and, therefore, by considering these numeric values, we can say one is better than the others. Yet, in real life, the closeness of the total scores shows that the companies are competitive with each other. For this reason, in terms of these 15 indicators, we can conclude that the case companies are not explicitly better than on another.

Concerning the results obtained in Table 5-9, relative global scores of the three logistics companies by focusing on each indicator were also analysed as shown in Figure 5-7. Thus, each company can see their relative position in terms of each indicator compared to their competitors in the industry.

[8] Although it does not change the final ranking of the companies, the scores presented here may be slightly different than the actual calculated scores due to the decimals.

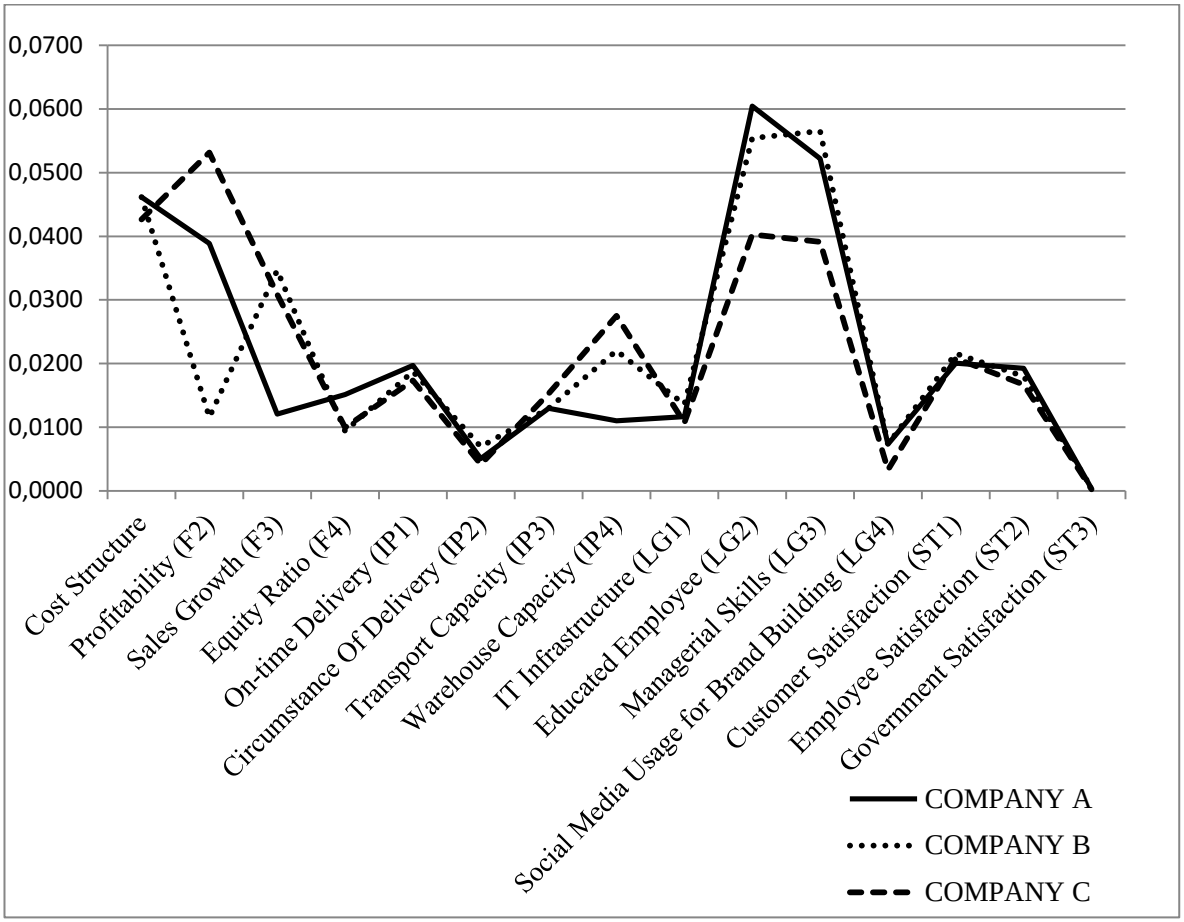


Figure 5-7: Analysis of the companies in terms of each indicator

Figure 5-7 shows the relative position of the companies based on the obtained information through interviews and the aggregated judgments of the three experts. The figure also summarises the priorities of the companies in terms of each indicator. With the help of this figure, the decision-makers in these companies can consider their operations and can easily decide on which performance indicators they need to focus upon more/less in order to be more competitive in the industry. For instance, if Company C gives much weight to social media usage for brand building and managerial skills criteria, *ceteris paribus*, it can become the second or even the first company depending on how much emphasis they put on these indicators in their operational usages.

5.6 Feedback Survey

Finally, at the end of the study, a feedback survey was conducted on the expert group. Before conducting the survey, a feedback survey of Poveda-Bautista *et al*. (2012), which was based on Smith-Perera *et al*.'s (2010) study, was slightly modified by the researcher in terms of the way of asking questions. Then, the final version of the feedback survey was performed with the experts. As shown in Table 5-10, a 5-point scale was used in the survey.

Table 5-10: Feedback survey applied to the experts

In this study, the results obtained with the ANP method with respect to what you expected are:				
1. Very unsatisfactory	2. Unsatisfactory	3. Somehow satisfactory	4. Satisfactory	5. Very satisfactory
In your opinion, the decision-making process used was:				
1. Very inefficient	2. Inefficient	3. Somehow efficient	4. Efficient	5. Very efficient
The process in this study was:				
1. Very difficult	2. Difficult	3. Normal	4. Easy	5. Very easy
Would you use this methodology in the future studies:				
1. Never	2. Maybe	3. Possibly	4. Most probably	5. Certainly

Source: Modified from Poveda-Bautista *et al*. (2012)

During the calculation of the survey results, the mean values of the three experts' scores for each question were computed in order to reach the final scores. The survey outcome shows that the results obtained with the ANP method were between satisfactory and very satisfactory with a score of 4.33. Moreover, the decision making process used in this research was between efficient and very efficient with a score of 4.66 while the difficulty score of the process was 3. Lastly, according to the experts, the probability of using this methodology for future studies was a point of 4.33. In addition to these calculations, the scores of this survey were compared with Poveda-Bautista *et al*.'s (2012) study and the comparison can be found in Section 7.2.

As a result, these scores also support that the results provided by the ANP method are more than satisfactory and the decision making process was between efficient and very efficient. Moreover, the difficulty level of the process was accepted as normal by the experts. All these outcomes enabled the experts to decide to use this methodology in their future studies.

5.7 Chapter Summary

In order to investigate the impact of the proposed performance indicators on competitiveness of logistics companies, a case study approach by including the ANP method and the semi-structured interview technique were used in this chapter. Initially, the ANP method procedures were followed by a systematic approach starting from the definition of the three experts, constitution of the final influence matrix to the ANP questionnaire administration. At the end of these procedures, the global weights and the priorities of the performance indicators were obtained through the ANP method software, the SuperDecisions. Thus, another research problem, which is the complexity of determining the interrelationships among the performance indicators, was addressed at this stage of the chapter.

In pursuit of the achievement of the global weights of the indicators in the model, in order to demonstrate the applicability of the model and the ANP outcome, the semi-structured interview technique was conducted with seven logistics companies listed in the Fortune Turkey's top 500 companies. After applying appropriate selection criteria for these companies, three of them were found to be more comparable. Then, based on the obtained information from these three case companies, for the indicators that require subjective judgment, the experts' ratings were used while for the indicators allowing numerical calculations, the normalization approach was used directly by the researcher. Afterwards, since indicators were collected in different units, all indicators were normalised. Finally, in order to rank the companies by considering the impacts of all indicators, the global weights collected from the ANP method were multiplied by these normalised scores and summed across all indicators.

In addition, a feedback survey including four questions regarding the results and the decision making process was conducted after obtaining the results. Thus, apart from the analysis for the indicators and the companies, the chapter also gives some insights about the presented process and the significance of the results.

CHAPTER 6 : SENSITIVITY ANALYSIS

6.1 Chapter Overview

Sensitivity analysis shows how possible alterations affect the ranking of the alternatives and tests the outcomes of the model to see how they are robust to the changes. In other words, possible "what-if" scenarios are conducted in the sensitivity analyses to check the robustness of the model and the outcomes against the changes.

In this research, the alternatives consisted of the three logistics companies and the alterations were made by providing different weights to the indicators used in the model when the perspective weights were already unequal. Thus, initially in this chapter, the analysis of the 15 indicators is presented in figures and tables separately. In the figures[9], the global scores of the three companies are placed on the y axis concerning different weights of the relative indicators (between 0-1 scores) which are exhibited on the x axis. In the tables, the alterations of the global scores of the case companies are shown based on the three scores assigned for the indicators. Meanwhile, it is worth noting that when an indicator is 0 in the table presentations, the global weights of the remaining indicators are changed in order to make the sum 1.

In the last section of this chapter, another alteration is also computed by considering equal weights for the four perspectives of the research model. Thus, 16 "what-if" scenarios, including their outcomes, are presented in this chapter.

6.2 Sensitivity Analysis Process

In the literature, owing to the fact that sensitivity analyses are experiments of special interest, different sensitivity analyses were performed by previous authors in order to monitor the changes in different scenarios. For instance, Kirytopoulos *et al.* (2008) presented a sensitivity analysis based on their study's dominant criterion. In their study, the ranking of alternatives, which were plotted on the y axis, were tested against the changes on the criterion value (between 0-1 scores), as placed on the x axis. Likewise, in Tjader *et al.*'s (2014) ANP-BSC combination-related study, the impact of different criteria weights (between 0-1) on the alternative rankings was analysed. Thus, in light of this information, a similar approach is adopted in this research and the alteration on the global scores of case companies are monitored regarding different weights of the relative indicators.

During the sensitivity analyses of the indicators, different stages were followed. Initially, 15 indicators in the model and the three case companies were selected for the analyses, and then, two circumstances consisted of equal and unequal perspective weights were examined. In case of the unequal perspective weights, different scenarios were investigated by the researcher and these scenarios are shown in figures and tables in the following sections of this chapter.

[9] The intersection values in the figures are approximate values due to deviations in decimals.

In the figures, the global scores of companies, plotted on the y axis, were analysed regarding different weights of the corresponding indicators plotted on the x axis. In order to determine the global scores of companies, two steps were mainly used in connection with different indicator weights. In the first step, when the corresponding indicator weight is 0, the new weights of remaining indicators (by making the sum 1) in the model were calculated, and then, these new indicator weights were multiplied by the normalised company scores (see Section 5.5.3) in order to obtain scores of companies for each indicator. Finally, the sum of the scores of companies for each indicator formed the global scores of companies. In the second step, when the corresponding indicator weight is 1, the new weights of all indicators in the model were multiplied by the normalised company scores (see Section 5.5.3). Afterwards, the sum of the scores of companies for each indicator in the model formed the global scores of companies. Following these two steps, the trend line of each company was drawn on the alignment between 0-1 values on the x axis by presenting the changes of global scores of companies on the y axis. Based on the difference of the global scores of companies when the corresponding indicator has 0 and 1 values, it can be deduced that the more the change in global scores, the higher the sensitiveness for companies.

In the tables, the global scores of companies were calculated and presented based on the three cases, which are:

- when the corresponding indicator weight is 0,
- when the corresponding indicator weight is as shown in Figure 5-6 (the current situation),
- when the corresponding indicator weight is 1.

On the other hand, the second circumstance, which is the consideration of equal perspective weights, was also examined as discussed in the last section of this chapter. All in all, the representation of the sensitivity analysis practice is shown in Figure 6-1.

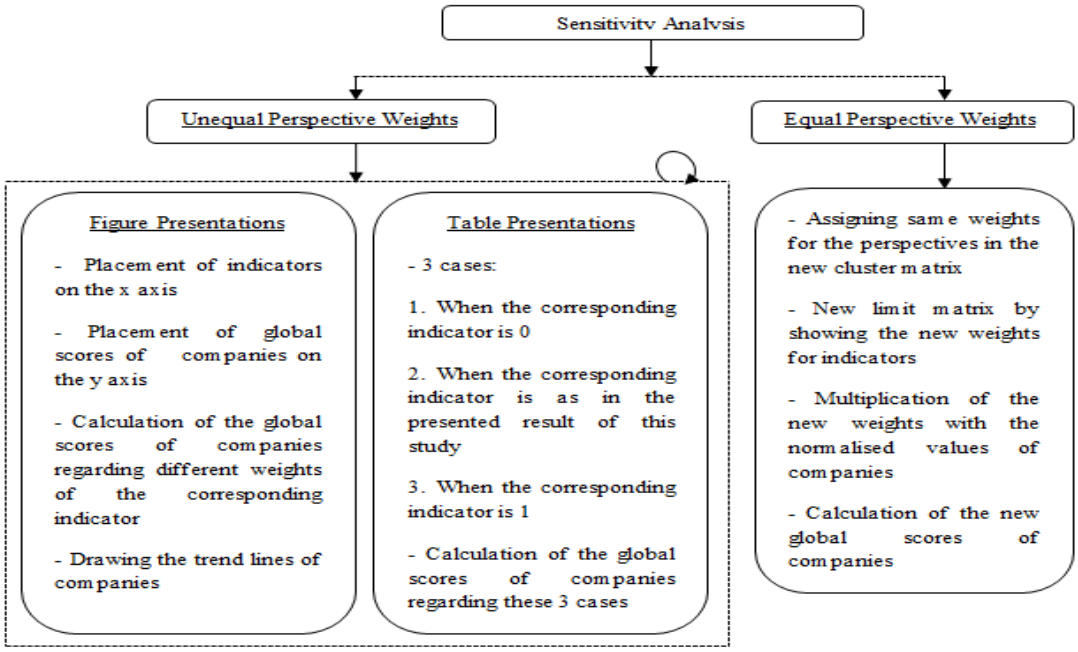


Figure 6-1: Sensitivity analysis process

6.3 Financial Perspective

The financial perspective is constituted by four performance indicators (cost, profitability, sales growth, and equity ratio) and the sum of these four indicators' weights can be interpreted as the total weight of the perspective among the other perspectives in the model. As a result, the financial perspective weight is calculated as 35.07%.

6.3.1 Cost (F1)

Cost was found as the third important indicator in the conceptual model, and in Figure 6-2, the changes in the global scores of the three companies based on the different cost weights from 0 to 1 scores are presented.

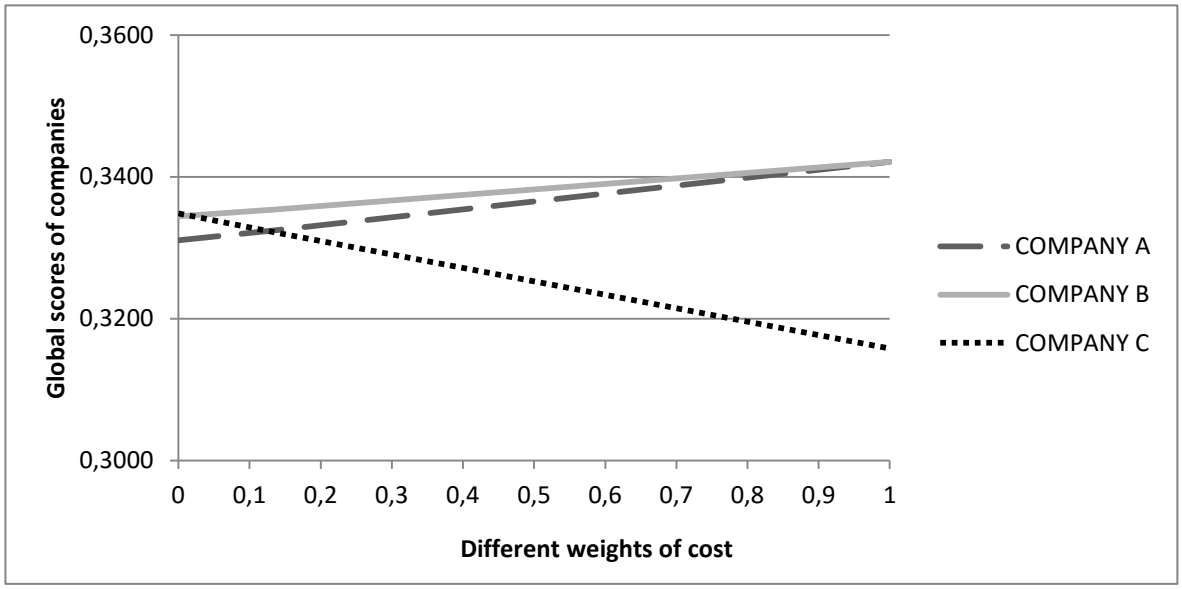


Figure 6-2: Distribution of the global scores of the case companies with respect to the cost indicator

According to Figure 6-2, although C is the first company before (0.0153, 0.3345), Company B starts to become the first company at this point while Company C becomes second between (0.0153, 0.3345) and (0.1267, 0.3324) values. After (0.1267, 0.3324), the position of Company B does not change but Company A takes the second position whilst Company C is the last company in the ranking.

Table 6-1: The global weights of the case companies based on the three scenarios in the cost indicator

	COMPANY A	COMPANY B	COMPANY C
WHEN F1=0	0.3310	0.3344	0.3348
WHEN F1=0.13501	0.3324	0.3354	0.3322
WHEN F1=1	0.3421	0.3421	0.3158

The table indicates that at the zero value of the cost indicator, Company C is a dominating alternative followed by Company B, and Company A. Yet, when the weight of the cost indicator

(the current situation) is equal to 0.13501, Company B appears as the first company in the ranking followed by Company A, and Company C. At the 1 value of the indicator, Company A and Company B have the same weights and share the first position in the ranking but Company C remains as the last company. Overall, the difference of the global scores of the companies, when the cost indicator has 0 and 1 values, exhibits that Company C is more sensitive than Company A, and Company B, respectively.

6.3.2 Profitability (F2)

Profitability was found as the fourth important indicator in the conceptual model, and in Figure 6-3, the changes in the global scores of the three companies based on the different profitability weights varying from 0 to 1 scores are shown.

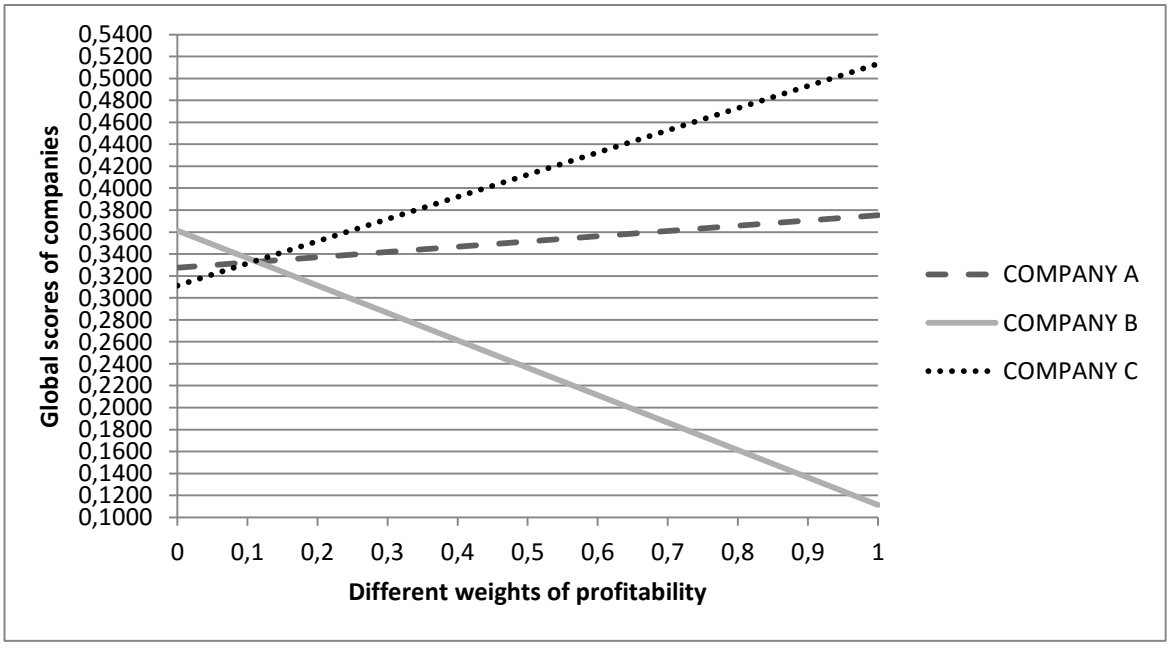


Figure 6-3: Distribution of the global scores of the case companies with respect to the profitability indicator

In Figure 6-3, Company B remains first while Company C becomes second and Company A becomes third at (0.1052, 0.3324). After that point, the first position in the ranking is taken by Company C at (0.1111, 0.3336) from Company B. The declining trend continues for Company B and it takes the third position in the ranking at the (0.1142, 0.3329) point whilst Company A becomes second at this point.

Table 6-2: The global scores of the case companies based on the three scenarios in the profitability indicator

	COMPANY A	COMPANY B	COMPANY C
WHEN F2=0	0.3275	0.3613	0.3113
WHEN F2=0.10363	0.3324	0.3354	0.3322
WHEN F2=1	0.3754	0.1115	0.5132

As shown in Table 6-2, both at the zero weight of profitability and in the current situation (when the profitability weight is 0.10363), Company B is the ideal among the case companies. However, when this indicator is the only indicator in the model, Company C has the biggest global weight compared to other case companies. As a result, the difference of the global scores of the companies, when the profitability indicator has 0 and 1 values, presents that Company B is more sensitive than Company C, and Company A, respectively.

6.3.3 Sales Growth (F3)

Sales growth was found as the fifth important indicator in the conceptual model, and in Figure 6-4, the changes in the global scores of the three companies based on the different sales growth weights between 0 and 1 scores are illustrated.

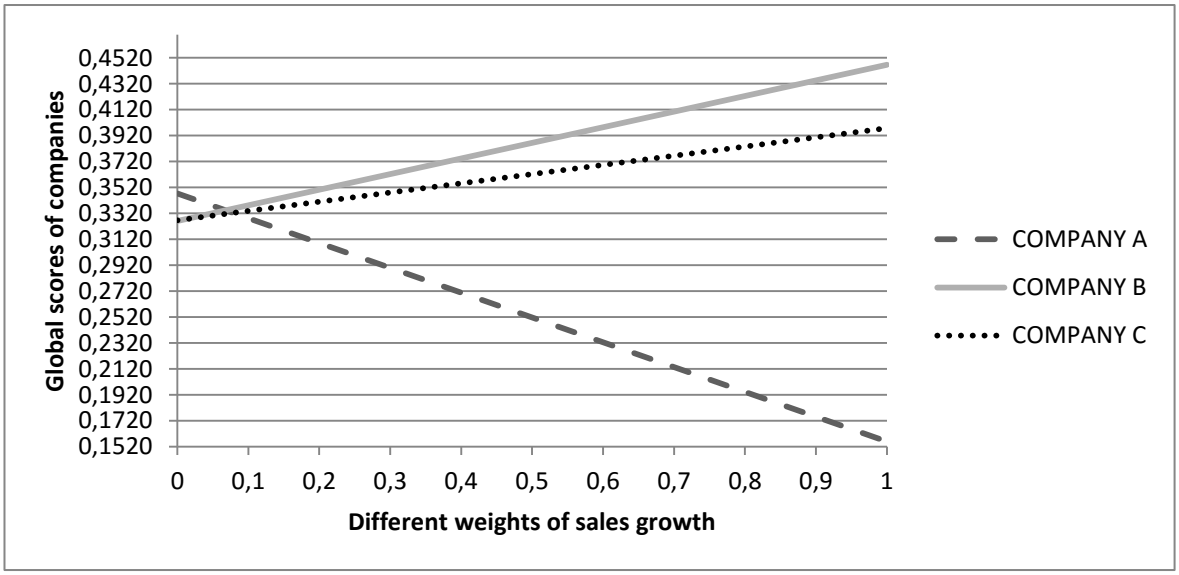


Figure 6-4: Distribution of the global scores of the case companies with respect to the sales growth indicator

In Figure 6-4, there are three milestones causing changes in the ranking of the companies. The first milestone is when the sales growth weight is at (0.0143, 0.3277). Before this point, Company A is the first, Company C is the second, and Company B is the last company in the ranking. After this point, the position of Company A does not change while Company B takes the second position and Company C takes the third position in the ranking. The second milestone is when the sales growth is at the (0.0685, 0.3342) point which causes a change of the positions between Company B and Company A while Company C remains the last one. The third milestone occurs when the sales growth reaches the (0.0786, 0.3323) point. After this last milestone in this figure, Company B becomes first, Company C becomes second, and Company A takes the third position in the ranking.

Table 6-3: The global scores of the case companies based on the three scenarios in the sales growth indicator

	COMPANY A	COMPANY B	COMPANY C
WHEN F3=0	0.3473	0.3260	0.3267
WHEN F3=0.0776	0.3324	0.3354	0.3322
WHEN F3=1	0.1557	0.4465	0.3977

As seen in Table 6-3, Company A is the ideal company when the sales growth has no value. When the indicator has a weight of 0.0776 (the current situation), Company B has the highest score followed by Company A and Company C, respectively. When the sales growth has a score of 1, Company B becomes the first company whereas Company C is the second, and Company A is the third company in the ranking. To conclude, the difference of the global scores of the companies, when the sales growth indicator has 0 and 1 values, shows that Company A is more sensitive than Company B, and Company C, respectively.

6.3.4 Equity Ratio (F4)

Equity ratio was found as the twelfth important indicator in the conceptual model, and in Figure 6-5, the changes in the global scores of the three companies based on the different equity ratio weights from 0 to 1 scores are presented.

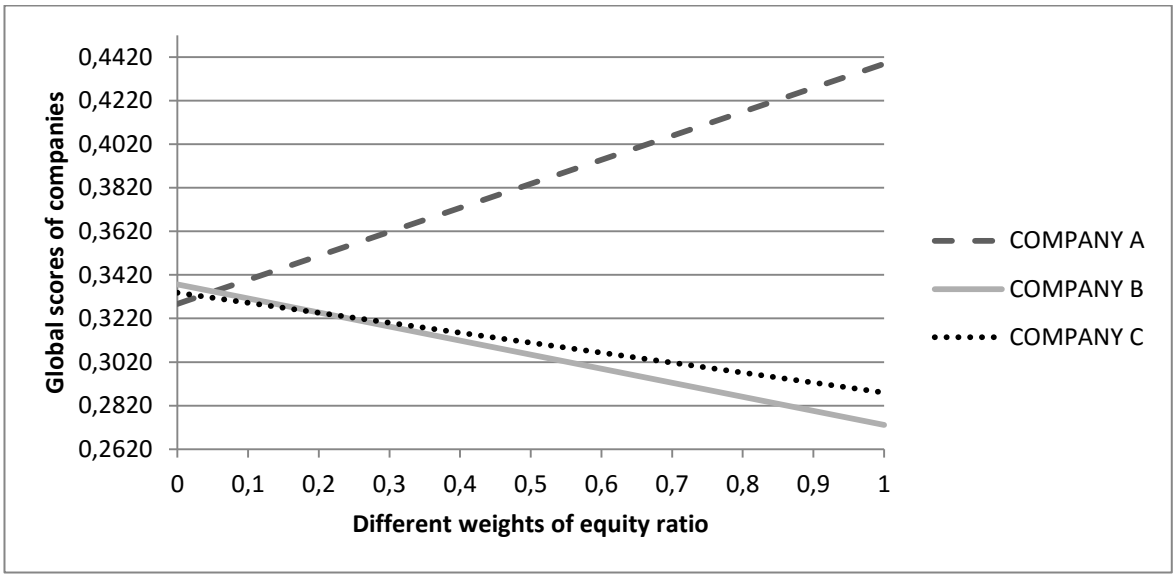


Figure 6-5: Distribution of the global scores of the case companies with respect to the equity ratio indicator

Figure 6-5 depicts the changes of the global weights of equity ratio indicator and shows the relative results for the three case companies based on these changes. Similar to the sales growth indicator, three landmarks cause the ranking alteration. The first point of these landmarks is at (0.0335, 0.3323) and the second is at (0.0517, 0.3342). At the first landmark, the second position in the ranking is taken by Company A from Company C while Company B remains first. After that point, Company A continues the inclining trend, and at the second landmark, Company A becomes first

whilst the ranking of Company B drops to the second position. At the third landmark, which is (0.2, 0.3248), the second position is juxtaposed between Company C and Company B whereas Company A remains first in the ranking.

Table 6-4: The global scores of the case companies based on the three scenarios in the equity ratio indicator

	COMPANY A	COMPANY B	COMPANY C
WHEN F4=0	0.3286	0.3376	0.3338
WHEN F4=0.0345	0.3324	0.3354	0.3322
WHEN F4=1	0.4388	0.2732	0.2880

According to Table 6-4, both in the zero point of the equity ratio indicator and in the current situation (when the equity ratio is 0.0345), Company B remains as ideal among the case companies while Company A has a higher value than Company C in the current situation, although Company A is the last company at the zero point. At the point of 1, Company A has the greatest score among the three case companies followed by Company C and Company B. In conclusion, the difference of the global scores of the companies, when the equity ratio indicator has 0 and 1 values, illustrates that Company A is more sensitive than Company B, and Company C, respectively.

6.4 Internal Process Perspective

The internal process perspective is constituted by four performance indicators (on-time delivery, circumstance of delivery, transport capacity, warehouse capacity) and the sum of these four indicators' weights can be interpreted as the total weight of the perspective among the other perspectives in the model. As a result, the internal process perspective weight is calculated as 17.38%.

6.4.1 On-time Delivery (IP1)

On-time delivery was found as the eighth important indicator in the conceptual model, and in Figure 6-6, the changes in the global scores of the three companies based on the different on-time delivery weights varying from 0 to 1 scores are shown.

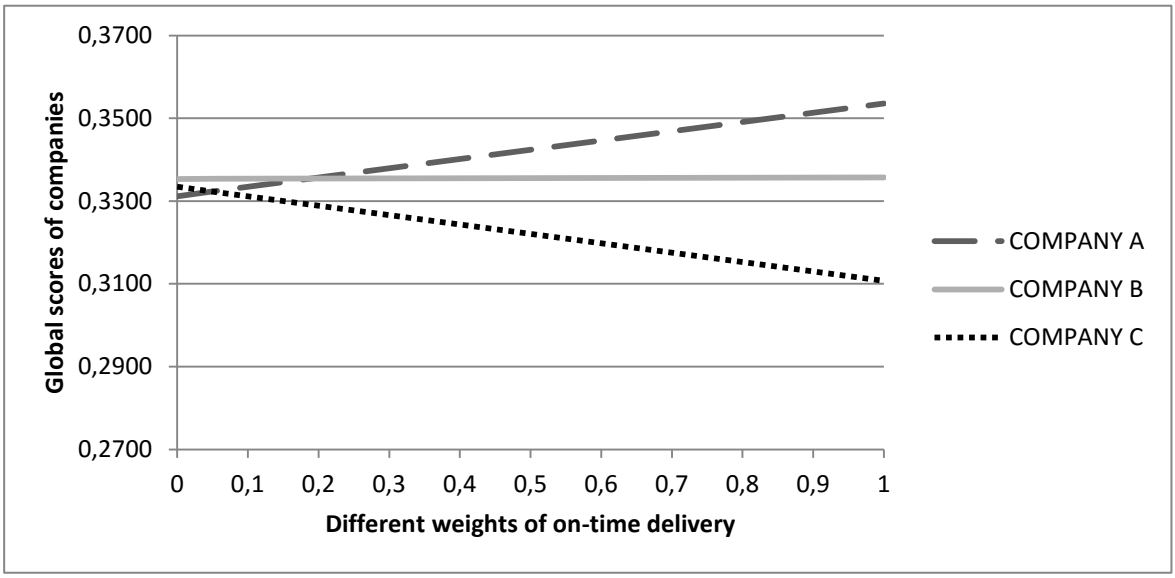


Figure 6-6: Distribution of the global scores of the case companies with respect to the on-time delivery indicator

Figure 6-6 shows that Company B is the ideal company until (0.1944, 0.3355) while the second position in the ranking is taken by Company A at the (0.0523, 0.3324) point from Company C which becomes the last after that point. Subsequent to (0.1944, 0.3355), Company B becomes second and Company A starts dominating, although Company A is the last company in the ranking before (0.0523, 0.3324).

Table 6-5: The global scores of the case companies based on the three scenarios in the on-time delivery indicator

	COMPANY A	**COMPANY B**	**COMPANY C**
When IP1=0	0.3312	0.3354	0.3335
When IP1=0.05582	0.3324	0.3354	0.3322
When IP1=1	0.3536	0.3357	0.3107

Table 6-5 illustrates that when on-time delivery has no weight, Company B is the first organisation closely followed by Company C, then Company A, respectively. In the current situation, the position and the weight of Company B does not change whereas Company A has a higher weight than Company C. When the on-time delivery is the only indicator in the model, Company A is first, Company B is second, and Company C is the third company in the ranking. All in all, the difference of the global scores of the companies, when the on-time delivery indicator has 0 and 1 values, presents that Company C is more sensitive than Company A, and Company B, respectively.

6.4.2 Circumstance of Delivery (IP2)

Circumstance of delivery was found as the fourteenth important indicator in the conceptual model, and in Figure 6-7, the changes in the global scores of the three companies based on the different circumstance of delivery weights from 0 to 1 scores are indicated.

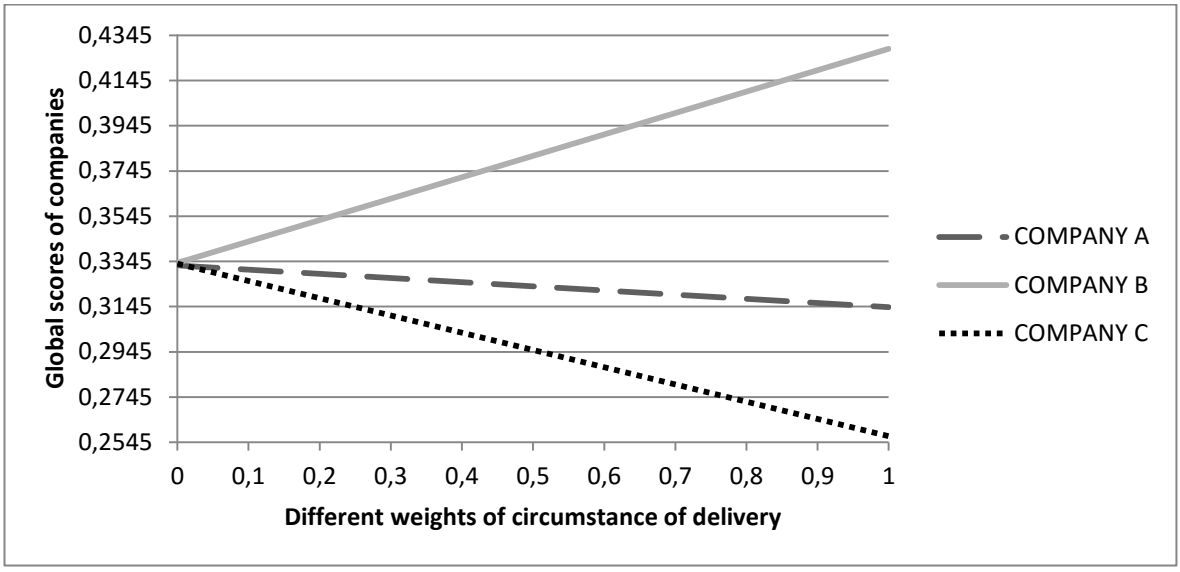


Figure 6-7: Distribution of the global scores of the case companies with respect to the circumstance of delivery indicator

In this figure, it can be seen that the ranking of Company B does not depend on the different weights of the indicator because the company comes first in the ranking for all weight variations of the indicator. Conversely, Company A increases its position from the third to the second at (0.0121, 0.3326) while the position of Company C decreases from the second to the third at this point.

Table 6-6: The global scores of the case companies based on the three scenarios in the circumstance of delivery indicator

	COMPANY A	**COMPANY B**	**COMPANY C**
When IP2=0	0.3328	0.3339	0.3335
When IP2=0.01623	0.3324	0.3354	0.3322
When IP2=1	0.3143	0.4286	0.2571

The table shows that when circumstance of delivery indicator has different values between 0 and 1, Company B remains first among the three companies whilst in the current situation and when circumstance of delivery is the only criterion, Company A becomes second and Company C takes the third position in the ranking. Overall, the difference of the global scores of the companies, when the circumstance of delivery indicator has 0 and 1 values, exhibits that Company B is more sensitive than Company C, and Company A, respectively.

6.4.3 Transport Capacity (IP3)

Transport capacity was found as the tenth important indicator in the conceptual model, and in Figure 6-8, the changes in the global scores of the three companies based on the different transport capacity weights between 0 and 1 scores are presented.

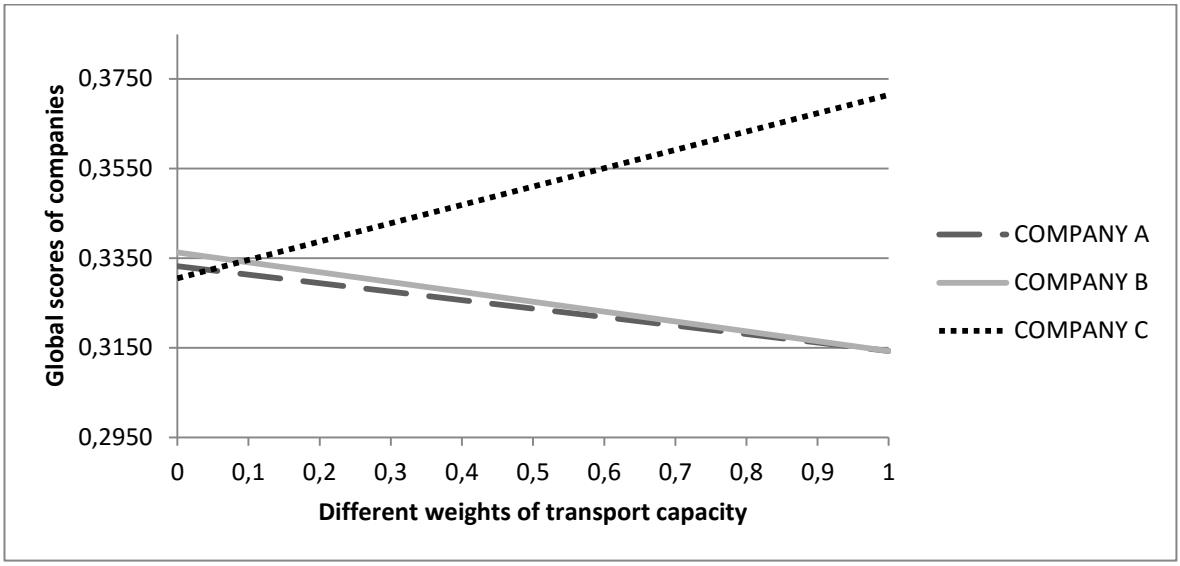


Figure 6-8: Distribution of the global scores of the case companies with respect to the transport capacity indicator

Figure 6-8 exhibits both the alteration of the weights of the transport capacity and the changes of the companies' scores depending on these alterations. In this figure, Company C has an increasing trend and it primarily enhances its position from the third to the second at (0.0457, 0.3324) by surpassing Company A while Company B remains as the first company. Then, Company C takes the first position at (0.0921, 0.3343) where Company B becomes second in the ranking. The position of Company A drops to the third position at (0.0457, 0.3324) but it shares the same score with Company B at point 1.

Table 6-7: The global scores of the case companies based on the three scenarios in the transport capacity indicator

	COMPANY A	**COMPANY B**	**COMPANY C**
When IP3=0	0.3332	0.3363	0.3305
When IP3=0.04122	0.3324	0.3354	0.3322
When IP3=1	0.3143	0.3143	0.3714

Table 6-7 presents that when the transport capacity has values of 0 and 0.04122, the ranking of the companies, which is in B-A-C order, does not change but when the transport capacity is the only indicator in the model, Company C is first while Company A and Company B have the same weights. Consequently, the difference of the global scores of the companies, when the transport capacity indicator has 0 and 1 values, shows that Company C is more sensitive than Company B, and Company A, respectively.

6.4.4 Warehouse Capacity (IP4)

Warehouse capacity was found as the seventh important indicator in the conceptual model, and in Figure 6-9, the changes in the global scores of the three companies based on the different warehouse capacity weights varying from 0 to 1 scores are illustrated.

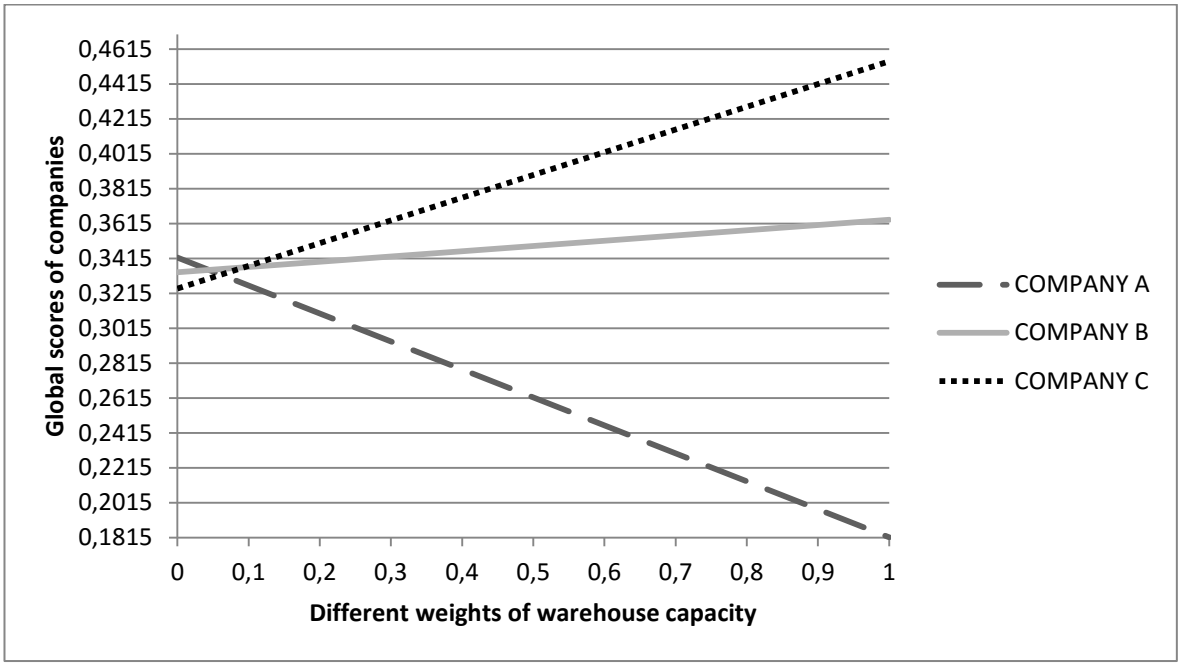


Figure 6-9: Distribution of the global scores of the case companies with respect to the warehouse capacity indicator

In Figure 6-9, Company A starts as the first organisation in the ranking while its position is taken by Company B at (0.0447, 0.3349). Afterwards, Company A becomes third at (0.0614, 0.3323), where Company C takes the second position. At (0.093, 0.3364), Company C carries on enhancing its position and becomes first in the ranking, followed by Company B then Company A.

Table 6-8: The global scores of the case companies based on the three scenarios in the warehouse capacity indicator

	COMPANY A	**COMPANY B**	**COMPANY C**
When IP4=0	0.3421	0.3336	0.3243
When IP4=0.06055	0.3324	0.3354	0.3322
When IP4=1	0.1818	0.3636	0.4545

The table exhibits that when warehouse capacity indicator does not exist in the model, Company A would become first whereas Company B becomes second and Company C takes the third position in the ranking. In the current situation, when the warehouse capacity has 0.06055, the first position in the ranking is taken by Company B and the other two positions are taken by Company A and Company C, respectively. When the warehouse capacity is the only indicator, Company C takes the first position, while Company B becomes second and Company A is the last company in the ranking. All in all, the difference of the global scores of the companies, when the warehouse capacity indicator has 0 and 1 values, indicates that Company A is more sensitive than Company C, and Company B, respectively.

6.5 Learning and Growth Perspective

The learning and growth perspective is constituted of four performance indicators (IT infrastructure, educated employee, managerial skills, and social media usage for brand building) and the sum of these four indicators' weights can be interpreted as the total weight of the perspective among the other perspectives in the model. As a result, the learning and growth perspective weight is calculated as 35.81%.

6.5.1 IT Infrastructure (LG1)

IT infrastructure was found as the eleventh important indicator in the conceptual model, and in Figure 6-10, the changes in the global scores of the three companies based on the different IT infrastructure weights from 0 to 1 scores are depicted.

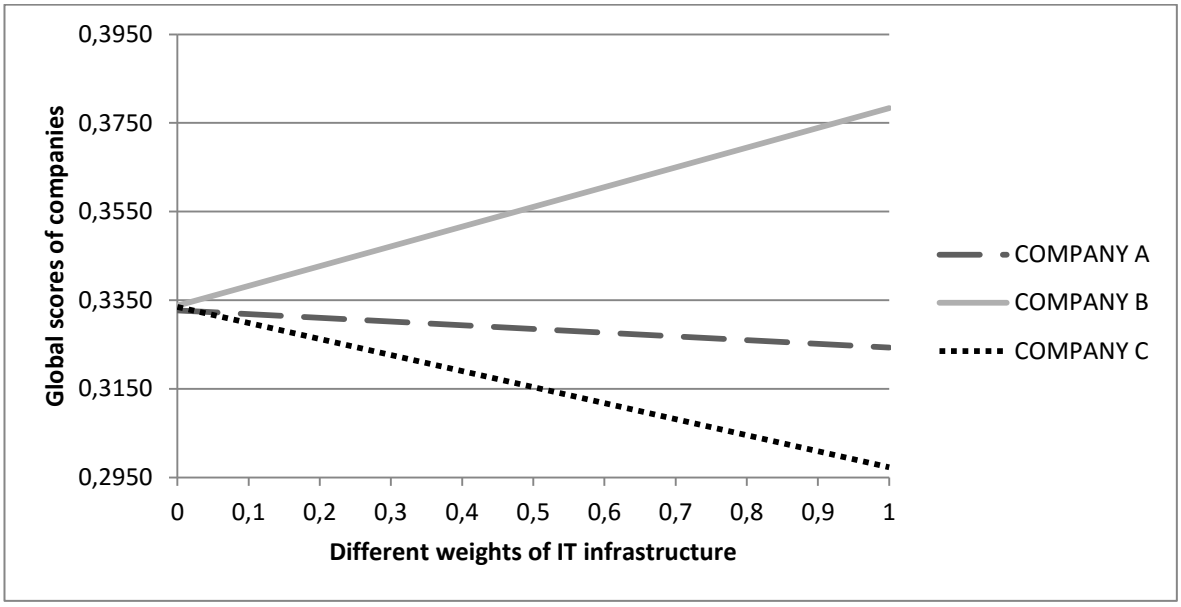


Figure 6-10: Distribution of the global scores of the case companies with respect to the IT infrastructure indicator

According to Figure 6-10, Company B is the first company in the all weights of the indicator and Company A becomes second at (0.0286, 0.3325) while Company C drops to the third position in the ranking.

Table 6-9: The global scores of the case companies based on the three scenarios in the IT infrastructure indicator

	COMPANY A	COMPANY B	COMPANY C
When LG1=0	0.3327	0.3338	0.3335
When LG1=0.03595	0.3324	0.3354	0.3322
When LG1=1	0.3243	0.3784	0.2973

As similarly interpreted in Figure 6-10, Table 6-9 indicates that Company B is the first organisation in the ranking when IT infrastructure has three different weights which are 0, 0.03595, and 1. The

positions of Company A and Company C change in the current case and when IT infrastructure is the only indicator in the model. While Company C is the second organisation when the indicator is not included in the model, it becomes third in the ranking both in the current case and in the last case where the weight of the indicator has a score of 1. To conclude, the difference of the global scores of the companies, when the IT infrastructure indicator has 0 and 1 values, exhibits that Company B is more sensitive than Company C, and Company A, respectively.

6.5.2 Educated Employee (LG2)

Educated employee was found as the most important indicator in the conceptual model, and in Figure 6-11, the changes in the global scores of the three companies based on the different educated employee weights varying from 0 to 1 scores are presented.

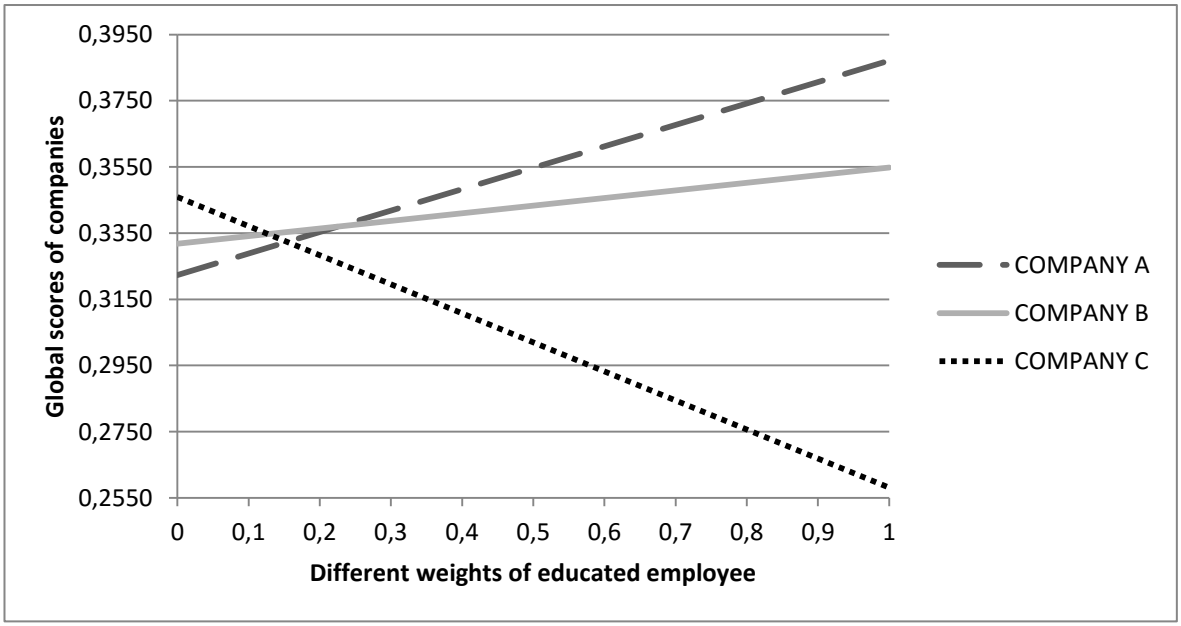


Figure 6-11: Distribution of the global scores of the case companies with respect to the educated employee indicator

In Figure 6-11, Company C starts as the first company but this position is replaced by the second organisation, Company B, at (0.1282, 0.3347). Company A, which was the last company in the ranking before (0.1563, 0.3323), takes second position after that point while Company C becomes third. Then, at (0.2317, 0.3371), Company A becomes first in the ranking by surpassing Company B.

Table 6-10: The global scores of the case companies based on the three scenarios in the educated employee indicator

	COMPANY A	COMPANY B	COMPANY C
When LG2=0	0.3223	0.3318	0.3459
When LG2=0.15614	0.3324	0.3354	0.3322
When LG2=1	0.3871	0.3548	0.2581

According to Table 6-10, every case has different rankings. When educated employee is excluded from the model, Company C becomes first in the ranking whereas Company B is second and Company A is third. In the current case, Company B is the first organisation whilst Company A becomes second and Company C becomes third in the ranking. When the educated employee is the only indicator in the model, Company A takes the first position whereas the positions of Company B and Company C are second and third, respectively. Overall, the difference of the global scores of the companies, when the educated employee indicator has 0 and 1 values, illustrates that Company C is more sensitive than Company A, and Company B, respectively.

6.5.3 Managerial Skills (LG3)

Managerial skills was found as the second important indicator in the conceptual model, and in Figure 6-12, the changes in the global scores of the three companies based on the different managerial skills weights from 0 to 1 scores are shown.

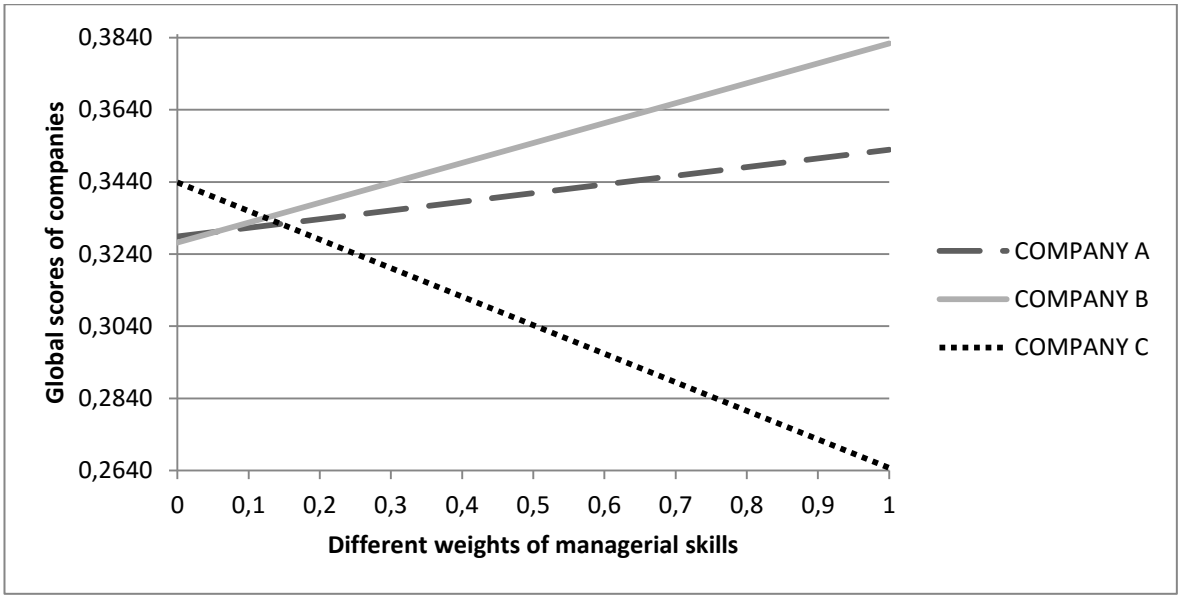


Figure 6-12: Distribution of the global scores of the case companies with respect to the managerial skills indicator

Figure 6-12 presents the changes in weights of managerial skills indicator and the relative alterations of the companies` ranking based on these changes. In this figure, there are three landmarks. The first landmark is at (0.0548, 0.3302) which is the point that Company B becomes second while Company A becomes third in the ranking. The point of (0.1246, 0.3341) is the second landmark where Company B takes the first position by surpassing Company C. Finally, at (0.1456, 0.3324), which is the third landmark, the position of Company C drops to third whereas Company A becomes second, and Company B remains as the first company.

Table 6-11: The global scores of the case companies based on the three scenarios in the managerial skills indicator

	COMPANY A	COMPANY B	COMPANY C
When LG3=0	0.3289	0.3272	0.3439
When LG3=0.14787	0.3324	0.3354	0.3322
When LG3=1	0.3529	0.3824	0.2647

The table indicates that when managerial skills has no weight, Company C is the dominating organisation in the ranking whilst Company A takes second and Company B takes the third position. Both in the current situation and when the managerial skills is the only indicator in the model, Company B becomes first, Company A becomes second, and Company C is the last in the ranking. As a result, the difference of the global scores of the companies, when the managerial skills indicator has 0 and 1 values, presents that Company C is more sensitive than Company B, and Company A, respectively.

6.5.4 Social Media Usage for Brand Building (LG4)

Social media usage for brand building was found as the thirteenth important indicator in the conceptual model, and in Figure 6-13, the changes in the global scores of the three companies based on the different social media usage for brand building weights varying from 0 to 1 scores are illustrated.

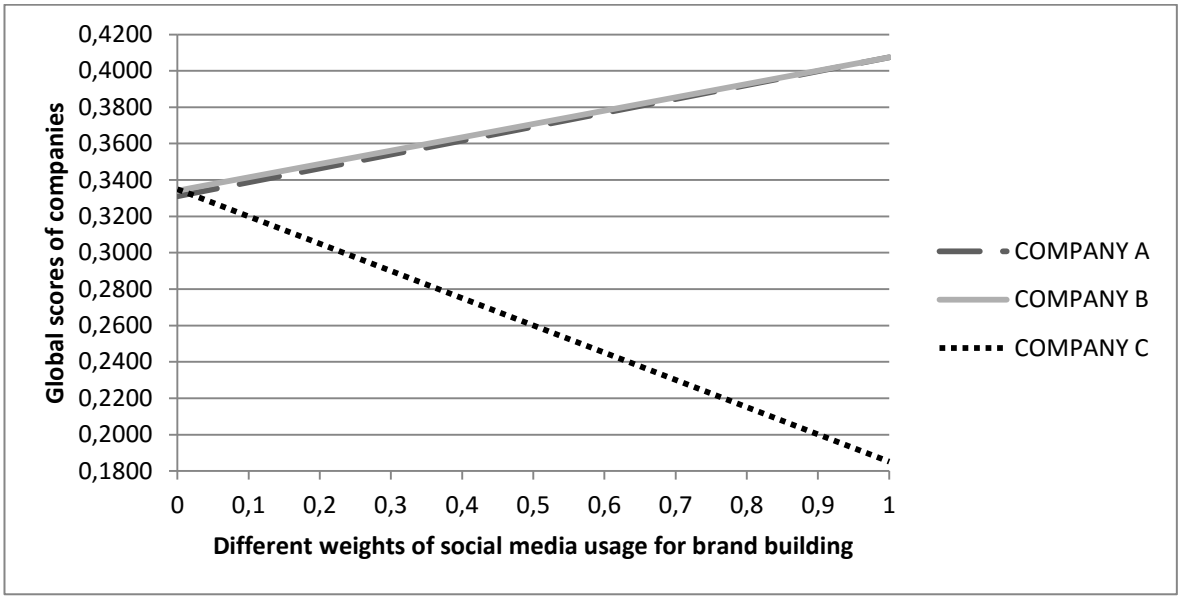


Figure 6-13: Distribution of the global scores of the case companies with respect to the social media usage for brand building indicator

According to this figure, Company C starts as the first company while the first position is taken by Company B, which is second in the beginning, at (0.0036, 0.3344). The fall of Company C continues and it becomes third at (0.0169, 0.3324) whereas Company A becomes second and

Company B remains as the first. After the (0.0169, 0.3324) point, there is a convergence between Company B and Company A resulting in having the same weight at the point of 1.

Table 6-12: The global scores of the case companies based on the three scenarios in the social media usage for brand building indicator

	COMPANY A	COMPANY B	COMPANY C
When LG4=0	0.3311	0.3341	0.3349
When LG4=0.01805	0.3324	0.3354	0.3322
When LG4=1	0.4074	0.4074	0.1852

According to Table 6-12, when social media usage for brand building indicator has no weight, the ranking of the companies appear in C-B-A order. In the current situation, the order is changed to B-A-C. When the indicator has a weight of 1, Company B and Company A share the first position in the ranking while Company C is the third company. All in all, the difference of the global scores of the companies, when the social media usage for brand building indicator has 0 and 1 values, presents that Company C is more sensitive than Company A, and Company B, respectively.

6.6 Stakeholders Perspective

This perspective is constituted by three performance indicators (customer satisfaction, employee satisfaction, and government satisfaction) and the sum of these three indicators' weights can be interpreted as the total weight of the perspective among the other perspectives in the model. As a result, the 'stakeholders' perspective weight is calculated as 11.74%.

6.6.1 Customer Satisfaction (ST1)

Customer satisfaction was found as the sixth important indicator in the conceptual model, and in Figure 6-14, the changes in the global scores of the three companies based on the different customer satisfaction weights between 0 and 1 scores are exhibited.

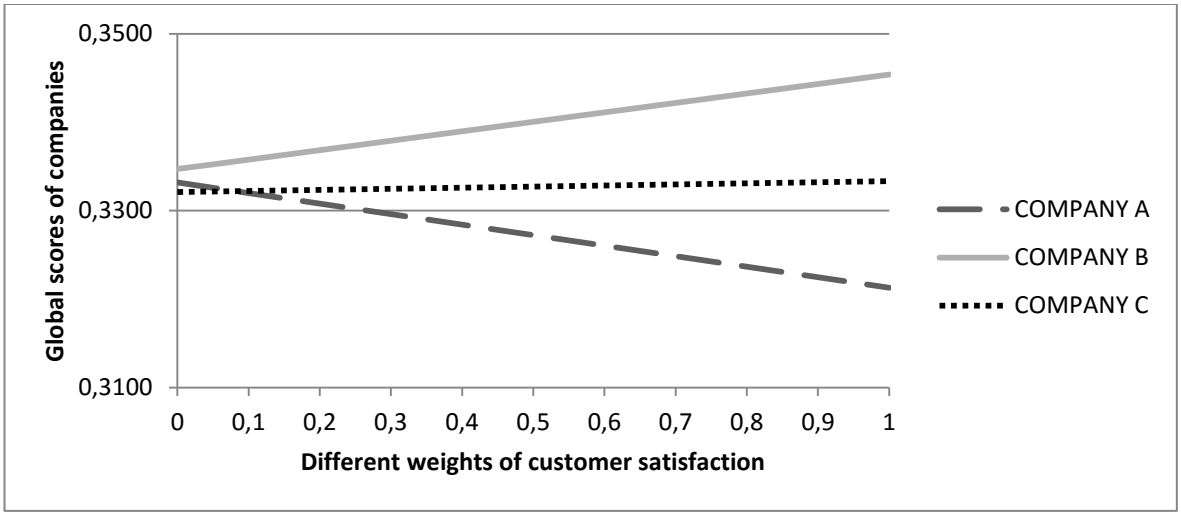


Figure 6-14: Distribution of the global scores of the case companies with respect to the customer satisfaction indicator

In Figure 6-14, it is seen that the position of Company B is not affected by different weights of the indicator and it remains as the first organisation during all weights. Yet, the positions of Company C and Company A change at the (0.0917, 0.3322) point and, after this point, Company C becomes second, although it is the third company at the point of 0.

Table 6-13: The global scores of the case companies based on the three scenarios in the customer satisfaction indicator

	COMPANY A	COMPANY B	COMPANY C
When ST1=0	0.3332	0.3347	0.3321
When ST1=0.06241	0.3324	0.3354	0.3322
When ST1=1	0.3213	0.3454	0.3333

In Table 6-13, it can be seen that when the customer satisfaction indicator has a value of either 0 or 0.06241, the ranking of the companies is arranged as Company B, Company A, and Company C, respectively. When there is no other indicator in the model, the position of Company B does not change but Company A and Company C replace their positions in the ranking. Overall, the difference of the global scores of the companies, when the customer satisfaction indicator has 0 and 1 values, shows that Company A is more sensitive than Company B, and Company C, respectively.

6.6.2 Employee Satisfaction (ST2)

Employee satisfaction was found as the ninth important indicator in the conceptual model, and in Figure 6-15, the changes in the global scores of the three companies based on the different employee satisfaction weights varying from 0 to 1 scores are depicted.

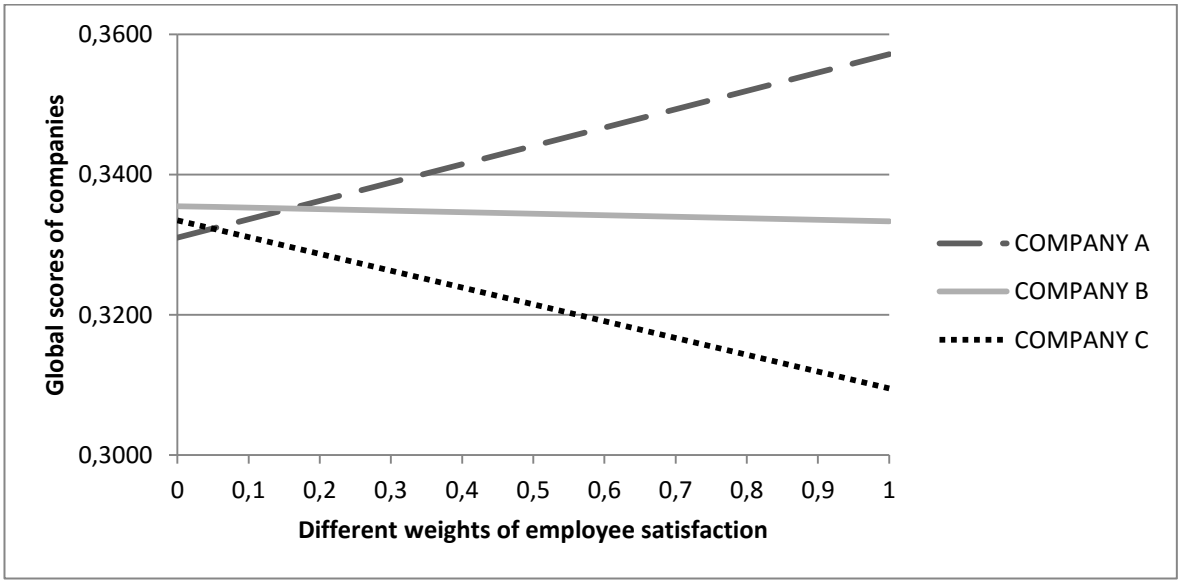


Figure 6-15: Distribution of the global scores of the case companies with respect to the employee satisfaction indicator

At the beginning of this figure, Company B is the first company while Company C is second, and Company A is third. At (0.05, 0.3323), Company B remains first but Company A becomes second.

At the (0.1607, 0.3352) point, Company A and Company B replace their positions whereas Company C is the last organisation in the ranking.

Table 6-14: The global scores of the case companies based on the three scenarios in the employee satisfaction indicator

	COMPANY A	COMPANY B	COMPANY C
When ST2=0	0.3310	0.3355	0.3335
When ST2=0.05399	0.3324	0.3354	0.3322
When ST2=1	0.3571	0.3333	0.3095

According to the table, each case has different company rankings. In the first case, when the employee satisfaction has a value of 0, Company B is the dominating firm in the ranking, Company C is second, and Company A is the last company. In the second case, which shows the current situation, Company B remains as the first but Company A becomes second followed by Company C. In the third case, when the indicator has a score of 1, Company C remains last but Company A appears as the first organisation in the ranking while Company B takes the second position. To conclude, the difference of the global scores of the companies, when the employee satisfaction indicator has 0 and 1 values, illustrates that Company A is more sensitive than Company C, and Company B, respectively.

6.6.3 Government Satisfaction (ST3)

Government satisfaction was found as the fifteenth important indicator in the conceptual model, and in Figure 6-16, the changes in the global scores of the three companies based on the different government satisfaction weights from 0 to 1 scores are presented.

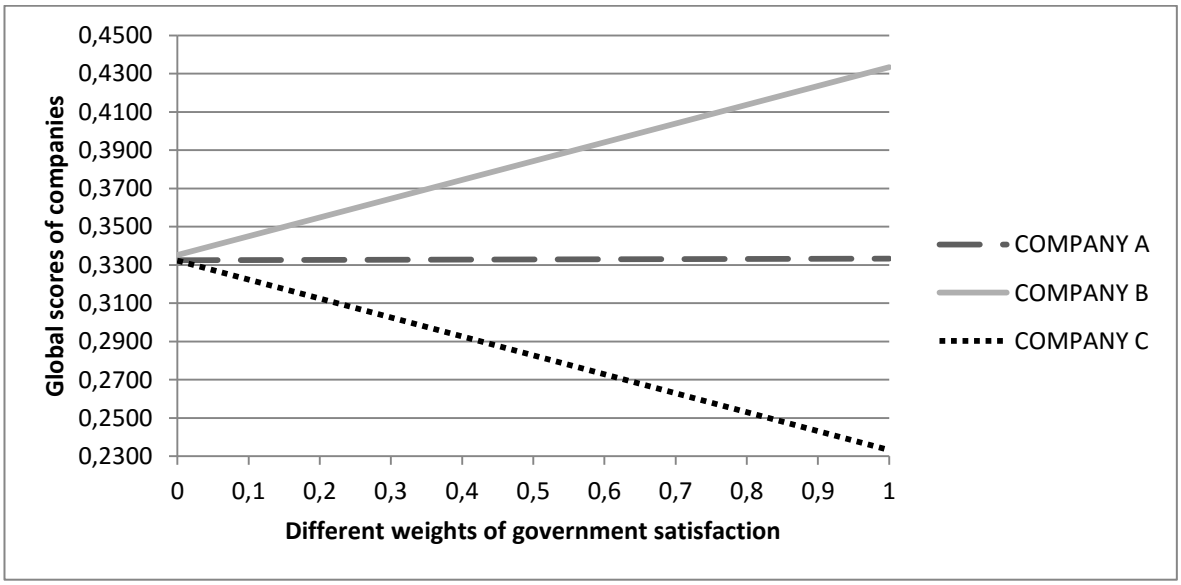


Figure 6-16: Distribution of the global scores of the case companies with respect to the government satisfaction indicator

In Figure 6-16, it can be seen that the ranking of the companies does not depend on the alteration of the indicator. Thus, in all weights of the indicator, Company B is the first organisation, Company A is the second, and Company C is the third in the ranking.

Table 6-15: The global score of the case companies based on the three scenarios in the government satisfaction indicator

	COMPANY A	COMPANY B	COMPANY C
When ST3=0	0.3324	0.3353	0.3323
When ST3=0.00103	0.3324	0.3354	0.3322
When ST3=1	0.3333	0.4333	0.2333

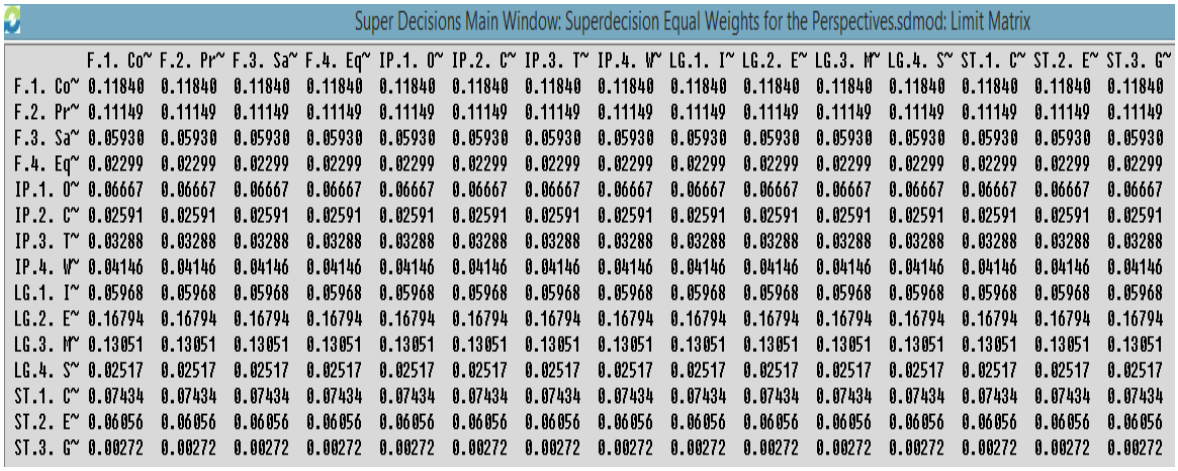
Table 6-15 presents the three scenarios where the ranking of the companies is the same in all of them. According to the results, the order of these companies is as follows: Company B, Company A, and Company C. All in all, the difference of the global scores of the companies, when the government satisfaction indicator has 0 and 1 values, indicates that Company C is more sensitive than Company B, and Company A, respectively.

6.7 Equal Weights for the Perspectives

This section shows an additional scenario apart from the possible outcomes of the 15 indicators as presented in the previous sections. As mentioned in Section 5.3.3, this section indicates a sensitivity analysis when equal weights are considered for the four perspectives of the proposed model.

Although it was not stated explicitly, the rationale of the BSC concept is based on the idea that the four dimensions of the BSC model need to be assessed equally since the main aim of the BSC approach is to give importance not only to the financial measures, but also to the non-financial indicators in a more balanced view (Kaplan and Norton, 1996a). Therefore, in order to see alternative results without considering the cluster matrix, equal weights were given to the four perspectives of the proposed BSC-based model.

In this analysis, since the performance of the companies does not change, the calculated normalization values of each company regarding the indicators (see Section 5.5.3) were kept the same. However, the global weights of the 15 indicators are changed due to the disregarding of the cluster matrix, which enables different weights for the perspectives as a result of the interrelationships, in this experiment. After determining the equal weights for the perspectives, the new limit supermatrix was generated through the SuperDecisions software by including the new global weights of the indicators as presented in Figure 6-17.



Super Decisions Main Window: Superdecision Equal Weights for the Perspectives.sdmod: Limit Matrix

	F.1. Co~	F.2. Pr~	F.3. Sa~	F.4. Eq~	IP.1. O~	IP.2. C~	IP.3. T~	IP.4. W~	LG.1. I~	LG.2. E~	LG.3. M~	LG.4. S~	ST.1. C~	ST.2. E~	ST.3. G~
F.1. Co~	0.11840	0.11840	0.11840	0.11840	0.11840	0.11840	0.11840	0.11840	0.11840	0.11840	0.11840	0.11840	0.11840	0.11840	0.11840
F.2. Pr~	0.11149	0.11149	0.11149	0.11149	0.11149	0.11149	0.11149	0.11149	0.11149	0.11149	0.11149	0.11149	0.11149	0.11149	0.11149
F.3. Sa~	0.05930	0.05930	0.05930	0.05930	0.05930	0.05930	0.05930	0.05930	0.05930	0.05930	0.05930	0.05930	0.05930	0.05930	0.05930
F.4. Eq~	0.02299	0.02299	0.02299	0.02299	0.02299	0.02299	0.02299	0.02299	0.02299	0.02299	0.02299	0.02299	0.02299	0.02299	0.02299
IP.1. O~	0.06667	0.06667	0.06667	0.06667	0.06667	0.06667	0.06667	0.06667	0.06667	0.06667	0.06667	0.06667	0.06667	0.06667	0.06667
IP.2. C~	0.02591	0.02591	0.02591	0.02591	0.02591	0.02591	0.02591	0.02591	0.02591	0.02591	0.02591	0.02591	0.02591	0.02591	0.02591
IP.3. T~	0.03288	0.03288	0.03288	0.03288	0.03288	0.03288	0.03288	0.03288	0.03288	0.03288	0.03288	0.03288	0.03288	0.03288	0.03288
IP.4. W~	0.04146	0.04146	0.04146	0.04146	0.04146	0.04146	0.04146	0.04146	0.04146	0.04146	0.04146	0.04146	0.04146	0.04146	0.04146
LG.1. I~	0.05968	0.05968	0.05968	0.05968	0.05968	0.05968	0.05968	0.05968	0.05968	0.05968	0.05968	0.05968	0.05968	0.05968	0.05968
LG.2. E~	0.16794	0.16794	0.16794	0.16794	0.16794	0.16794	0.16794	0.16794	0.16794	0.16794	0.16794	0.16794	0.16794	0.16794	0.16794
LG.3. M~	0.13051	0.13051	0.13051	0.13051	0.13051	0.13051	0.13051	0.13051	0.13051	0.13051	0.13051	0.13051	0.13051	0.13051	0.13051
LG.4. S~	0.02517	0.02517	0.02517	0.02517	0.02517	0.02517	0.02517	0.02517	0.02517	0.02517	0.02517	0.02517	0.02517	0.02517	0.02517
ST.1. C~	0.07434	0.07434	0.07434	0.07434	0.07434	0.07434	0.07434	0.07434	0.07434	0.07434	0.07434	0.07434	0.07434	0.07434	0.07434
ST.2. E~	0.06056	0.06056	0.06056	0.06056	0.06056	0.06056	0.06056	0.06056	0.06056	0.06056	0.06056	0.06056	0.06056	0.06056	0.06056
ST.3. G~	0.00272	0.00272	0.00272	0.00272	0.00272	0.00272	0.00272	0.00272	0.00272	0.00272	0.00272	0.00272	0.00272	0.00272	0.00272

Figure 6-17: The limit matrix with equal perspective weights

In Figure 6-17, the representation of the weights of the indicators was illustrated in the text format as given by SuperDecisions. Also, the Word format of this limit matrix is given in Appendix I. Additionally, in order to observe the changes in priorities of the indicators in the rankings, the researcher compared the results of the different perspective weights with equal perspective weights. The comparison of the results of all indicators is summarised in Table 6-16.

Table 6-16: Comparison of the results between different perspective weights and equal perspective weights

Priorities of Indicators / Indicators	Different Perspective Weights	Equal Perspective Weights
Cost	3	3
Profitability	4	4
Sales Growth	5	9
Equity Ratio	12	14
On-time Delivery	8	6
Circumstance of Delivery	14	12
Transport Capacity	10	11
Warehouse Capacity	7	10
IT Infrastructure	11	8
Educated Employee	1	1
Managerial Skills	2	2
Social Media Usage for Brand Building	13	13
Customer Satisfaction	6	5
Employee Satisfaction	9	7
Government Satisfaction	15	15

According to the table, the first four performance indicators (educated employee, managerial skills, cost, and profitability), social media usage for brand building, and government satisfaction remained in the same position in both cases while positions of the remaining indicators changed.

Based on the limit supermatrix shown in Figure 6-17, the relative priority of the 15 performance indicators in the logistics industry can be also arranged in a descending order as depicted in Figure 6-18.

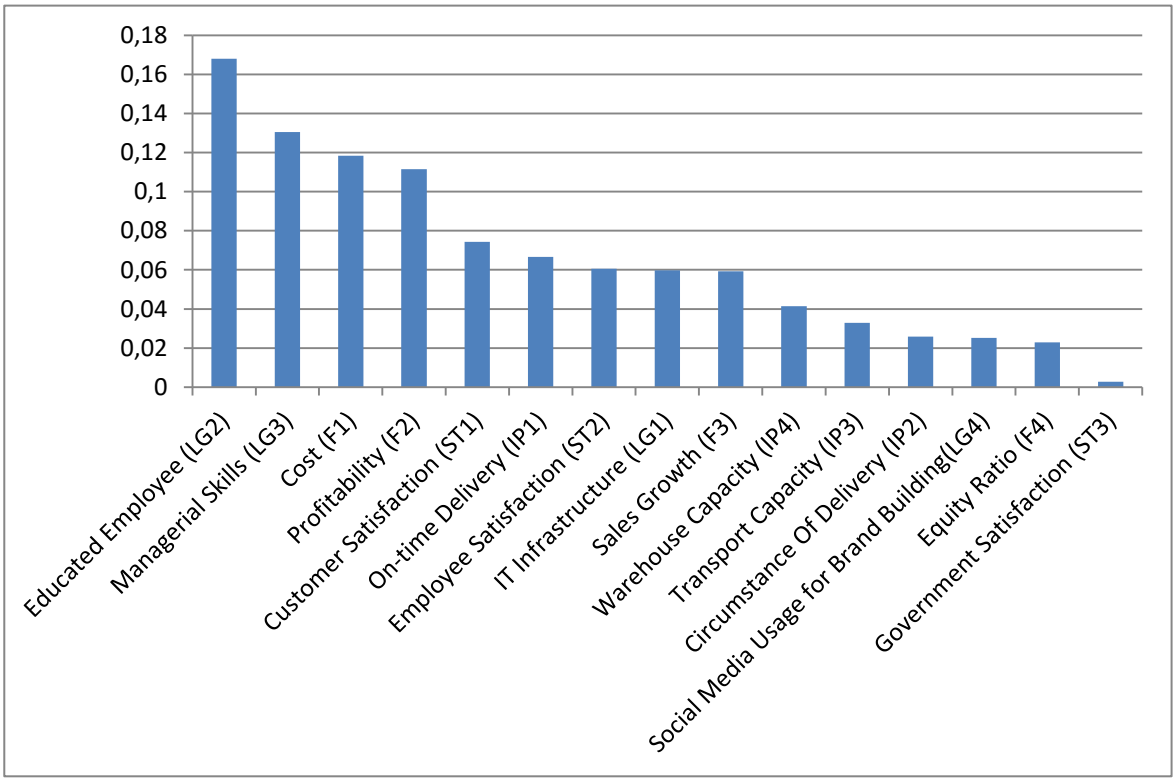


Figure 6-18: The descending order of the indicators' weights with equal perspective weights

Figure 6-18 summarises the global weights of the performance indicators obtained through the three experts' judgments when the four perspectives have equal weights. These global weights indicate that the most important indicator in the industry is educated employee with 16.79% of the weight, closely followed by managerial skills (13.05%), cost (11.84%), and profitability (11.14 %). On the other hand, the three least important indicators are social media (2.51%), equity ratio (2.29%), and government satisfaction (0.27%). Hence, based on these results, companies should focus more on the proposed important indicators in their operational processes in order to be more competitive in the industry.

In conjunction with these changes made in the limit matrix, both the relative priorities and the global scores of the companies are also changed due to the alterations of the weights of the 15 indicators. To reach the final scores for the companies, the normalised values regarding each indicator obtained in Section 5.5.3 were multiplied and summed by the corresponding indicator

weight shown in Figure 6-17. Thus, the final scores of the companies were constituted after these stages and the sum of the indicators showed the total scores of the companies. The final scores of the companies in terms of each indicator and their total scores after these alterations are shown in Table 6-17.

Table 6-17: Final scores of the companies with equal perspective weights

	COMPANY A	**COMPANY B**	**COMPANY C**
Cost Structure	0.041	0.041	0.037
Profitability (F2)	0.042	0.012	0.057
Sales Growth (F3)	0.009	0.026	0.024
Equity Ratio (F4)	0.010	0.006	0.007
On-time Delivery (IP1)	0.024	0.022	0.021
Circumstance Of Delivery (IP2)	0.008	0.011	0.007
Transport Capacity (IP3)	0.010	0.010	0.012
Warehouse Capacity (IP4)	0.008	0.015	0.019
IT Infrastructure (LG1)	0.019	0.023	0.018
Educated Employee (LG2)	0.065	0.060	0.043
Managerial Skills (LG3)	0.046	0.050	0.035
Social Media for Brand Building (LG4)	0.010	0.010	0.005
Customer Satisfaction (ST1)	0.024	0.026	0.025
Employee Satisfaction (ST2)	0.022	0.020	0.019
Government Satisfaction (ST3)	0.001	0.001	0.001
TOTAL	**0.338**	**0.334**	**0.328**

As seen from the total scores of the companies presented in the table[10], Company A (33.8 %) is the first company in the ranking followed by Company B (33.4%), and Company C (32.8 %), respectively. The closeness of these total scores can allow us to make a deduction that these companies are comparable with each other and also justifies how true the selection criteria (see Section 5.5.2) are for this research. According to the results indicated in Table 6-17, an analysis of the three logistics companies in terms of the 15 indicators can be also arranged as in Figure 6-19.

[10] Although it does not change the final ranking of the companies, the scores presented here may be slightly different than the actual calculated scores due to the decimals.

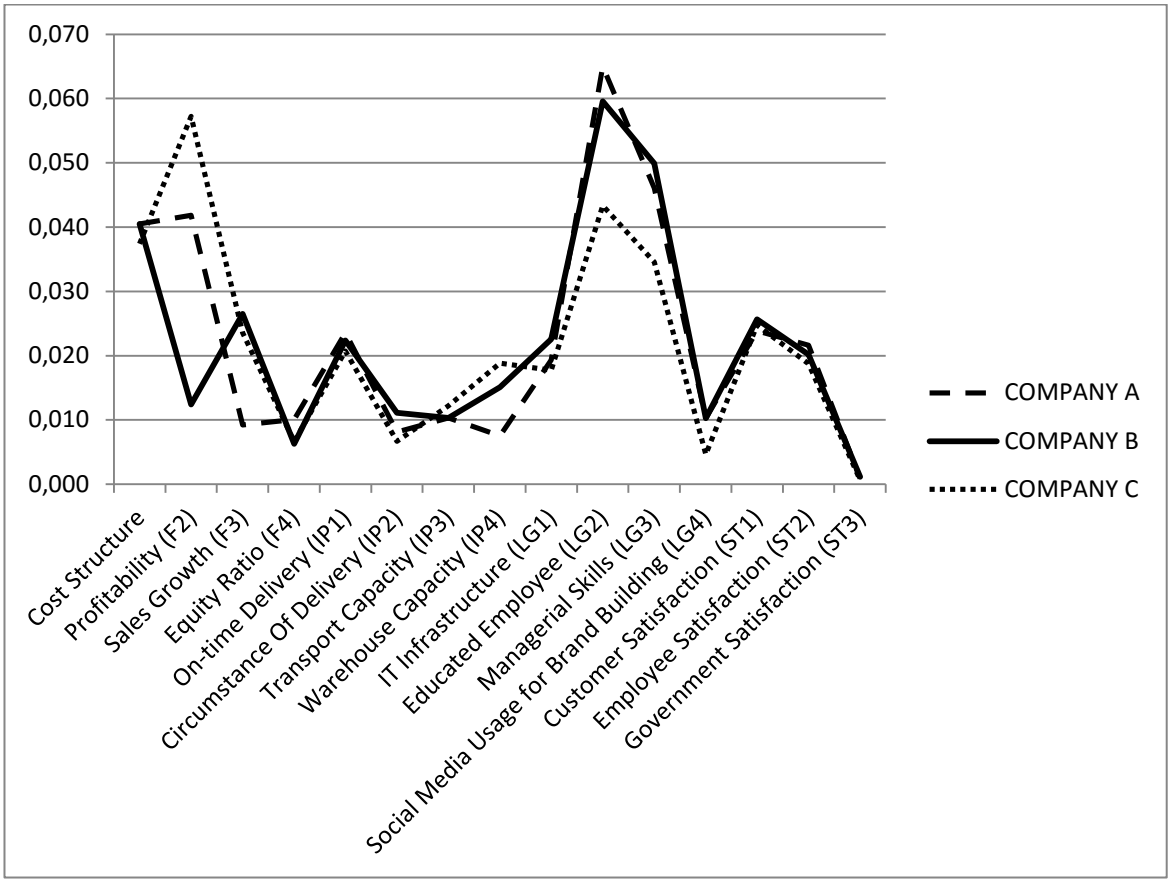


Figure 6-19: Analysis of the companies (equal perspective weights)

Figure 6-19 is exhibited as a visual guide about the rankings of the companies over the 15 indicators. The graph shows the relative position of the companies and summarises the priorities of the companies in terms of each indicator. With the help of this figure, the decision-makers in these companies can analyse their operational excellence compared to their competitors and can easily decide on which indicators they need to focus more/less in order to be more competitive in the industry.

6.8 Chapter Summary

In this chapter, firstly, weights of the perspectives in the model were calculated based on the sum of the performance indicators' weights under each perspective. According to the results, the learning and growth perspective has the highest weight with 35.81%, followed by financial perspective (35.07%), internal process (17.38%), and stakeholders perspective (11.74%). Afterwards, 16 "what-if" scenarios were conducted to check robustness of the rankings of the three case companies against the changes in indicator weights. More specifically, in order to investigate the possible rankings of the case companies, 15 scenarios were exhibited by changing the weights of the performance indicators between 0 and 1 scores while one additional scenario was organised by considering equal weights for the four perspectives of the proposed BSC-based research model.

During the sensitivity analyses of the 15 indicators, the weight of one indicator was altered whereas the weights of the remaining indicators in the model were rearranged in order to reach a score of 1,

which is the total score. In the sensitivity analyses, weights of the indicators varied from 0 to 1 interval with the increment of 0.10. In the graphs, the global scores of the case companies were plotted on the y axis regarding the different weights of the relevant performance indicators shown on the x axis.

On the other hand, the last sensitivity analysis showed the assignment of equal weights to the four perspectives of the model. In this analysis, the global weights of the 15 indicators obtained from the ANP method were changed by disregarding the consideration of the cluster matrix, which enables different perspective weights due to the interrelationships among the perspectives, in this experiment. Thus, a new limit matrix based on the new weights of the indicators was computed through SuperDecisions. As a conclusion, the relative priorities of the companies were also changed owing to the changes of the 15 indicators' weights.

In this chapter, during the sensitivity analyses, the tables, which are based on the three specific weights for each indicator, were provided below the figures, which show the alterations in the rankings within the 0-1 interval. More specifically, in these tables, the first columns represented three different weights of an indicator, which include: when an indicator has a score of 0, the normal score that was generated in the final limit matrix in Section 5.3.4 (current situation), and the score of 1 of an indicator. The remaining columns in these tables illustrated the changes in the global scores of each case company based on the weights shown in the first column.

Regarding the results of these 15 scenarios, decision makers in these case companies can understand how different weights of the indicators may affect their rankings whilst the last scenario allows decision makers to understand how equal weights of the perspectives affect both the priorities of the indicators and the ranking of the companies rather than using different weights for the four perspectives.

CHAPTER 7 : DISCUSSION AND SUMMARY OF KEY FINDINGS

7.1 Chapter Overview

This chapter is dedicated to discussions of the key findings obtained from the empirical analyses of this research; these include the online survey to identify key performance indicators in the logistics industry; the ANP method to determine the relative importance of these key indicators based on their interrelationships; and the case study to demonstrate the operationalisation of the decision model. The discussions are based on the research questions listed in Chapter 1 to check how these findings support, complement or diverge from the existing research in the literature. Hence, in this chapter, first, the main research question is analysed and, then, more detailed information is given in the five supportive sub-questions which are breakdowns to address the main research question.

7.2 Discussion of the Findings by Addressing the Research Questions

Main Research Question (RQ): How can a decision model be formed by incorporating key logistics performance indicators and can help the prioritisation of these indicators by considering all interrelationships?

It was explicitly shown in the literature review (see Chapter 2) that there are different performance measurement models to be used in decision processes. In these models, the BSC approach appeared as an outstanding model in terms of its various advantageous features, such as allowing cause-and-effect relationships, having a balanced view by including financial and non-financial indicators in its structure, and translating strategy into actions based on various perspectives. These features conformed with the purpose of this research. Although the adaptation of the BSC is still uncertain for some managers, the open nature of the BSC concept has a significant influence on its implementation. Therefore, the BSC was chosen as a suitable model to represent the research aim and objectives of this thesis. However, in order to address the existing research problems accurately, the major shortcoming of the generic BSC concept, which is the negligence of incorporating various stakeholders (Mooraj *et al.*, 1999; Hsu *et al*., 2011), allowed the researcher to integrate the stakeholder perspective into the proposed model of this thesis. Thus, following the discussions in the literature regarding this shortcoming of the BSC model, as seen in Section 2.8, a stakeholder-based BSC model including four perspectives (financial, internal process, learning and growth, and stakeholders) was formed in this research.

Afterwards, all defined performance indicators were placed under these perspectives and relevant calculations were made both to identify the key indicators and to prioritise these indicators through the ANP which allows analysis of direct and indirect relationships in a model. Thus, the proposed model was used both to investigate key logistics performance indicators, as indicated in Chapter 4, and to prioritise these indicators by considering all interrelationships with the help of the ANP method, as shown in Chapter 5. Hence, the current study contributes to the literature of

performance measurement in logistics by using both the BSC approach and the ANP method with the consideration of various stakeholders in the logistics field.

Additionally, as earlier studies in the literature (e.g. Keebler and Plank, 2009; Rajesh *et al*., 2012; Wang *et al*., 2012) revealed, performance measurement in logistics, especially for logistics companies, has received limited attention. More particularly, the literature review of this study demonstrated that there is a lack of study relating to logistics companies' competitiveness by using both the BSC concept and the ANP method and, therefore, the presented research fills that research gap in the logistics field. Moreover, it is worthy of note that although the 'indicators' term is used in this thesis, these are also known as metrics, measures, or figures (Neely *et al*., 2000; Grosswiele *et al*., 2013).

Sub-RQ1. How can all stakeholders and the BSC approach be integrated and evaluated together in the decision-making process?

As highlighted in the literature review (Chapter 2), although the BSC approach is based on the stakeholder theory (Hsu *et al*., 2011), consideration of all stakeholders is neglected in the generic BSC concept which forms the major shortcoming of the concept. In order to overcome this issue and to present a more comprehensive decision model with inclusion of various stakeholders, the 'customer' perspective of the generic BSC concept was replaced with the 'stakeholders' perspective, as similarly considered by some authors (e.g. Hsu *et al*., 2011; Shaik and Abdul-Kader, 2012; Shaik and Abdul-Kader, 2014). However, according to the presentation of these similar studies, inclusion of various stakeholders in a decision model was not determined either by a systematic approach, such as a survey (e.g. Shaik and Abdul-Kader, 2012) or even if a survey was conducted, not all stakeholders existing in the generic stakeholder model were considered by researchers (e.g. Hsu *et al*., 2011). In this regard, eight stakeholders (customer, employee, government, supplier, investor/financier, community, environmental group, and non-government organisations) were incorporated in the BSC model of this research based on the systematic analysis of the relevant literature by considering the debates in the area (see Section 2.8).

Also, for the constituted 'stakeholders' perspective, the 'satisfaction' approach was mainly emphasised for the stakeholders because, as highlighted by many authors in the literature, meeting the expectations of the stakeholders and to satisfy their needs are the dominant priorities for organisations. Moreover, during the integration of these stakeholders, 'competitors' and 'media' were not included since they either did not comply with the stakeholder approach or represent an influence rather than stake (Donaldson and Preston, 1995). As a matter of fact, Freeman (1984) noted that the stakeholders shown in the generic model of the stakeholder theory can serve as a starting point or a checklist for stakeholder groups. Similarly, Kaplan and Norton (1996a) noted that the four generic perspectives of the BSC concept should be considered as a template and all stakeholder interests can be incorporated in a BSC when they are vital for the success of a business unit's strategy.

Accordingly, based on the debates and studies in the literature, eight stakeholders were brought into the 'stakeholders' perspective under the BSC concept. Hence, a stakeholder-based BSC model was constituted for this thesis. In this way, the conflicting interests of different stakeholders were also evaluated together in this research.

Sub-RQ2. What are the most significant performance indicators in the logistics industry?

Hundreds of performance indicators, financial and non-financial, have been incorporated in the performance measurement models by researchers. Although essential, identifying and including both financial and non-financial indicators in a performance measurement system is a complex task. Besides being revealed from the literature, according to business magazines in logistics and the researcher's interviews, managers in the logistics industry point out the same complexity. Thus, in order to deal with this complexity, the objective of this research was set as to highlight the most significant performance indicators in the logistics industry regardless of whether they are financial or non-financial. Yet, there are limited studies focusing on only logistics performance indicators, especially within the BSC concept. Therefore, the performance indicators were scrutinised through both literature review and taking into account the professionals' views, as explained in Chapter 4. After these two-step processes, 43 indicators, as shown in Table 4-3, were determined as significant logistics performance indicators to cover various operations in the logistics industry and they were included in the online survey conducted in the Turkish logistics industry (See Chapter 4). These identified indicators are used in the literature as both performance enhancing factors and performance metrics. Also, various authors consider some of these indicators as outputs or inputs, as in the DEA approach. However, the scope of this study is not to categorise the indicators as output or inputs. On the contrary, these are performance indicators to help companies become more competitive.

Moreover, even though the 43 indicators were placed well under the BSC perspectives, the identification and grouping of these indicators can vary case by case. Yet, it is worth noting that the BSC does not guarantee to include every measure in its perspectives (Tjader *et al*., 2014) and the presented indicators should stand for the logistics operations as well as representing the same operational levels in the logistics industry without being too specific or too general.

There are diverse studies in the literature having a similar aim with this research in terms of reducing the number of the indicators by using certain methods (see Section 4.2.2, Table 4-2). In these studies, it can be observed that the initial number of indicators was decided between 30 and 47 while the final list of indicators after the implemented methods was usually kept around 16 and 18. Consequently, the 43 listed indicators were found to be applicable for this research. Also, with the help of these 43 indicators, diverse interests of various stakeholders can be held together as well as illustrating the essential logistics industry norms.

The online survey including these 43 indicators was conducted both to highlight the most significant indicators and to reduce the number of indicators to a manageable level by eliminating the less significant indicators (see Section 4.2.4). The results of the survey were obtained from 72 respondents who have different backgrounds in the Turkish logistics industry. Since the aim of the survey was to inspect the importance of these indicators, 72 respondents were reasonable compared to other studies with similar aims. For instance, in these studies, Liao and Chang (2009) analysed the responses of 40 executives in their TV-shopping sector-based study while Chang (2013) collected 34 executives' responses from century-old Taiwanese food businesses. In the study of Gasiea *et al*. (2010), which is a rural telecommunications infrastructure context-based research, 62 answers were obtained from experts around the world through an online survey.

After the online survey, the indicators were ranked based on their mean values derived from the 72 answers and a cut-off value approach was applied to all perspectives. For the calculation of these cut-off values, different approaches were used by several authors, such as arbitrarily choosing a cut-off score (e.g. Meijer *et al*., 2004), arbitrarily setting a threshold value (e.g. Lee *et al*., 2009) or stating the Likert scale mid-point as a threshold value (e.g. Liu *et al*., 2010a). In this research, cut-off values were determined by calculating the average of the highest and lowest mean scores of the indicators in each perspective because using a statistical calculation was considered more significant for the successful representation of the results than deciding arbitrarily or based on a mid-point. Then, the indicators which remained above these cut-off scores in each perspective were included in the proposed model of this study. As a result, 15 indicators were indicated as the most significant indicators which formed the conceptual model of this thesis (see Section 4.3). Thus, this final number of indicators was found to be consistent with the suggestion of Hubbard (2009) who emphasises that a BSC model should incorporate a total of 14-16 performance indicators. In fact, the final number of the indicators was also found similar to the aforementioned example studies as shown in Table 4-2 (see Section 4.2.2). Yet, in most of these example studies, statistical techniques were not applied to show some follow-up analyses, such as reliability or validity for dimensions. Thus, in order to prove the significance of the results for the 43 indicators and the perspectives themselves, reliability and validity tests were also conducted in this thesis (see Section 4.2.4.3).

Sub-RQ3. How can the interrelationships among the indicators be captured?

In complex real-life scenarios, performance indicators may not always be independent and they may influence other performance indicators either directly or indirectly. Previous studies examined in the literature review showed that it is difficult to understand interactions between indicators for organisations (Thakkar *et al*., 2007) and it has been barely considered by researchers (Grosswiele *et al*., 2013). Accordingly, this complex structure allowed the researcher to explore the MCDM methods, as examined in Chapter 3.

There are various MCDM techniques used by researchers and each has different strengths and weaknesses. The comparison of these techniques was summarised by Couger (1995) in terms of the

defined 16 criteria examined under six main headings, as shown in Saaty and Vargas's (2006) study. According to this comparison (see Section 3.7.2), the ANP, which enables investigation of direct as well as indirect relationships in a network structure, appeared as a promising method for the purpose of this study among the other MCDM techniques. Thus, the ANP method and a frequently used software package, the SuperDecisions, were implemented to capture the interrelationships among the performance indicators. After following the required sequences in the ANP process, the interdependencies were identified starting from the final influence matrix based on the judgments of each expert. Hence, interrelationships between both the indicators and the perspectives were captured via the ANP (see Section 5.3).

Sub-RQ4. What are the relative priorities of the performance indicators in the logistics area?

Another problem that practitioners face is not only to determine the interrelationships between the indicators, but also to prioritise them. In this research, the interrelations were determined through an influence matrix obtained from each expert and a final influence matrix was formed based on the majority rule of the experts, which was explained by Beynon (2006) and was similarly implemented by Gasiea *et al*. (2010). By doing so, the group judgment of the experts was taken into account in the process. Considering group judgments is an advantage of the MCDM techniques because it may prevent the bias of a single decision maker (Horenbeek and Pintelon, 2014) and can present real-life solutions.

In the MCDM techniques, the ANP shows the interdependencies and enables calculation of the priorities of both the perspectives and indicators in a network structure by allowing the group judgment. During the determination of the interrelationships and calculation of the relative priorities through pairwise comparisons, the SuperDecisions program, which was developed for the AHP and the ANP, was used in this research. In this way, all possible transmissions as well as the strengths of the influences existing between indicators were captured in the network system. Additionally, the software checked the inconsistencies for each pairwise comparison and gave the inconsistency results of the three experts' judgments. Regarding inconsistency, Saaty (2009) highlighted that the maximum level of inconsistency should be less than or equal to 10%. Therefore, while obtaining the final results of the indicators, the inconsistency score of each pairwise comparison matrix was considered to be less than 10% in value where the expert judgments are accepted as consistent.

Meanwhile, during the constitution of the network system, the alternative cluster was excluded in this research because the objective here is to determine the interrelationships among the indicators as well as to prioritise them rather than selecting the best option based on the ranking of the alternative cluster. Therefore, the 15x15 matrix was presented as there are 15 performance indicators in the proposed decision model. This is also consistent with some prior studies. For instance, Hsu *et al*. (2011) excluded the alternatives in their decision model since their aim was to propose a sustainability BSC framework for a semiconductor industry by using the ANP method.

Likewise, Yang *et al*. (2009) initially utilised the AHP and ANP methods to compute the global weights of the indicators in their model by excluding the alternative cluster, and then to demonstrate the applicability of the model, three companies in a wafer fabricating industry were ranked based on the scores obtained from corresponding indicators in the model. In a similar vein, in this thesis, in order to illustrate the applicability of the model and the ANP method, the three selected 3PL companies were rated for each indicator through the obtained information by using the semi-structured interview technique. Later, these companies were ranked based on the multiplication of these ratings with the relevant global weights of the indicators achieved by SuperDecisions. According to the results given by SuperDecisions in terms of the 15 performance indicator weights, the global weights of these indicators were presented in the limit matrix (see Section 5.3.4) by considering different perspective weights.

The results showed that educated employee was the most important indicator with a global weight of 15.61%, closely followed by managerial skills (14.78%), cost (13.50%), and profitability (10.36 %). As seen in Figure 5-6, after these first four indicators, there is a big drop of 2.60%, compared to the rest of the indicators' decreases. Remarkably, these four indicators account for more than a half of the total percentage with 54.25% of the global weights of which represents the majority of the indicators used in the model. Therefore, it is these four indicators that should be the main focus in the logistics industry. Moreover, the second biggest fall in the ranking, which is 1.65%, occurred between the equity ratio and the social media usage for brand building. After this fall, the last three indicators in the model were ranked as social media usage for brand building (1.80%), circumstance of delivery (1.62%), and government satisfaction (0.10%).

On the other hand, the rankings of some indicators were initially unexpected. For instance, at the beginning of the research, the on-time delivery indicator was expected to be among the first three indicators based on the obtained feedback from the practitioners in the field and this opinion also appeared in the results of the online survey. However, though unexpected initially, these results were found significant by the experts and the researcher.

A similar outcome was also discussed in Karpak and Topcu's (2010) study in which a different indicator appeared more important than that expected when they used the ANP method to prioritise the success factors for small and medium manufacturing enterprises in Turkey. Karpak and Topcu (2010, p.67) explained this outcome as "*...if there are interdependencies among the factors, the factors that are less important individually might turn out to be more important when evaluated collectively. The human mind can only capture first (maybe second) degree of influences. We need a systematic approach such as ANP to capture second, third, and higher degree of influences".* In a similar vein, Zhang and Wang (2011) noted that an insignificant factor may turn out to be more important because the ANP includes feedback and interrelationships among the factors. Therefore, since the educated employee forms the basis of competitiveness for organisations as a core necessity in the industry and has significant influences on all operations, it might turn out to be the

most important indicator in the developed model. This conduced an inference that the more knowledgeable and the further educated employee the more competitive a company can be. This outcome is also consistent with the argument of Huang and Jhong (2012) because they noted that the BSC highlights the learning and growth of the employees which positively affects internal processes, customers and the financial performance of an organisation. Also, the outcome may be explained by the fact that there is a labour-intensive nature in the logistics industry (Min and Joo, 2006). Hence, the result of this research showed that the educated employee is the most significant indicator affecting the competitiveness in logistics rather than the other mainly expected indicators (e.g. on-time delivery). Thus, since the ANP enables the capture of direct and indirect transmissions in a network system, the overall ranking of the performance indicators in the developed model was considered valuable and accurate by the experts and the researcher.

Furthermore, the outcomes were not totally different compared to other ANP-BSC studies conducted in different industries, especially in terms of the unexpected indicators. Some of the indicators were used either with the same or similar meanings in these studies. For instance, the training level of the workers was concluded as the fourth, delivery time was found as the eleventh, and profitability was shown as the seventh most important indicators out of 17 criteria in the study of Poveda-Bautista *et al*. (2012) conducted in the plastic sector in Venezuela. Likewise, training programs/hours of employees was indicated as the tenth, profit was proposed as the first, customer satisfaction was noted as the fourth, and employee satisfaction was stated as the eighth important indicator out of 25 metrics in Hsu *et al*.'s (2011) study practiced in the Taiwanese semiconductor industry. From this point of view, the priorities of the indicators analysed in this research have some similarities with other studies in the literature in terms of the ranking of these five indicators. Table 7-1 summarises the outcomes of these two different studies concerning these five indicators.

Table 7-1: Summary of some indicators included in different BSC-ANP studies in different industries

Indicators	**Poveda-Bautista *et al*. (2012)**	**Hsu *et al*. (2011)**
training level of the workers & training programs/hours of employees	4^{th} /17	10^{th} /25
delivery time	11^{th} /17	-
profitability & profit	7^{th} /17	1^{st} /25
customer satisfaction	-	4^{th} /25
employee satisfaction	-	8^{th} /25

On the other hand, the government satisfaction indicator was shown among the middle runners after using the AHP method in the BSC-based studies of Shaik and Abdul-Kader (2012, 2013); this was found, however, contradictory in this thesis. This outcome might have occurred since they used the AHP method and also focused on reverse logistics operations in which government procedures and legislations are in the foreground. Yet, by considering all logistics operations and the whole industry, the significance of the government satisfaction may be reduced due to indirect

and direct relationships between indicators used in the model. That is to say, although the government satisfaction is one of the key performance indicators in the industry, its influence on the other indicators is either less or none.

The same deductions can be also made for the other two indicators, which are circumstance of delivery and social media usage for brand building activities, appearing among the last three indicators in the results of this research. Even though these indicators were revealed among the most significant indicators after conducting the online survey, their relative priority was reduced after considering the direct and indirect relationships between the indicators. Nevertheless, their final priority found in this research cannot be interpreted as the indicators are not at all significant because the ranking only shows the relative priority of the existing indicators in the model which includes a higher degree of influences. In other words, even if they are considered as important, they do not affect the competitiveness in the logistics industry as much as they do when they are independently analysed due to their direct and indirect relationships with other performance indicators.

Additionally, Kayakutlu and Buyukozkan (2011) analysed 20 performance attributes for two 3PL companies and ranked these attributes by using the ANP method. In their study, 'fleet', which can be equivalent to the transport capacity indicator in this thesis, was found the most significant indicator for both companies. Yet, in this research, transport capacity was indicated as the tenth important indicator in the ranking. Also, they presented the 'loss of goods' performance attribute, which can be similar to the circumstance of delivery in this research. Their results showed that the 'loss of goods' was the twelfth out of 20 attributes in the ranking of Company A while it was the ninth for Company E. However, in our study, the circumstance of delivery was found to be the fourteenth significant indicator in the ranking. As a consequence, the rankings of the indicators can vary from case to case based on both the existing indicators in a decision model and experts' judgments.

After the ANP results, the feedback survey was provided to the experts and the outcome of this survey was compared to the answers of Poveda-Bautista *et al.*'s (2012) study which also incorporated three experts' judgments. The comparison of the answers is shown in Table 7-2.

Table 7-2: Comparison of the feedback scores

Questions	The results in this thesis	Poveda-Bautista *et al.* (2012)
In this study, the results obtained with the ANP method with respect to what you expected are:	4.33	4
In your opinion, the decision-making process used was:	4.66	4.5
The process in this study was:	3	2
Would you use this methodology in the future studies:	4.33	3.5

As a result of this comparison, it can be seen that better scores were given to each question by the experts in this research. Therefore, we can conclude that the experts selected in this thesis are at least as much satisfied concerning both the results provided by the ANP method and the decision-making process of this research as the experts in Poveda-Bautista *et al*.'s (2012) study.

To sum up, the ranking of the performance indicators shows the relative importance affecting the competitiveness of the companies in the logistics industry. Based on the results, logistics companies should give importance to the listed priorities. More specifically, decision-makers in logistics companies should pay more attention to the first four indicators of the proposed decision model in their operations since these indicators account for more than half of the total percentage.

Sub-RQ5. How can 3PL companies provide better services and be more competitive in the industry?

In order to be more competitive and to provide better services, 3PL companies should take the presented global weights of the indicators into account in their operations. To illustrate the applicability of these global weights for the companies, a case study approach, as seen in Chapter 5, was conducted after the ANP results. In this way, the applicability of both the proposed model and the method was demonstrated by using the real data. Hereby, it is worthy of note that this is not the only study excluding the alternatives from the ANP process. In contrast, examining the ranking of the alternatives apart from the ANP network was in line with several ANP studies (e.g. Celik *et al*., 2009; Yang *et al*., 2009).

The case study of this thesis consists of both qualitative and quantitative parts. In the qualitative part, the semi-structured interview technique was implemented by asking open-ended questions for each performance indicator used in the model. At the end of the interviews, the comparability of the case companies was considered as the main criterion for the success of the illustration of the model in order to reflect real life practices. However, in the literature, criteria for the comparability of alternatives vary from case to case and different criteria were included by various authors in their case studies (see Section 5.5.2). With the intention of establishing a reasonable selection decision, the following criteria, which are more comprehensive than the previous studies, were considered while choosing the case companies:

- to operate in the same industry,
- to be one of the major companies in the sector,
- to employ at least 300 workers,
- to be listed in the Fortune Turkey's top 500 in two consecutive years,
- to have at least three companies within the corporate group of a company,
- not to take part in mergers with another company,
- both to have similar distribution operations and to have similar operational weights in terms of the main transportation mode.

Ultimately, the experts and the researcher decided to compare three companies as it is similar to other studies which include the analyses of three companies (e.g. Yang *et al*., 2009). After the interviews, the data obtained from each company were collated. For some of the indicators (e.g. IT infrastructure, social media usage for brand building, etc.), which require subjective judgments, experts' ratings based on a 5-point Likert scale were used apart from the obtained information from the companies. Moreover, all of the obtained data and the ratings were normalised in order to unify the values for each indicator. A similar normalization technique to Daim *et al*. (2013) was implemented in this part of the study. After practicing the normalization process for all indicators, the normalised scores were multiplied by the global weights obtained from the ANP method and then summed for each company. Finally, the companies were ranked in terms of both the total weights and each indicator (see Section 5.5.4). The global weight results of the selected companies were found very close to each other and this shows that these companies are similar and comparable in terms of their operations.

Thus, real life demonstration was indicated in the case study and with the help of this research, logistics companies can diagnose their weaknesses to improve. Specifically, the three case companies can compare their weaknesses and strengths by considering their competitors in the industry (see Section 5.5.4). From this point of view, it could be argued that these results are only valid for these selected companies. However, the used techniques and the developed model can be practiced in any company because the global weights of the indicators remain the same for the industry and this was an advantage arising from the consequence of not including the alternatives in the presented model. Therefore, the model and the methods can be applicable to all logistics companies in the industry. Nevertheless, in order to demonstrate both the applicability of the model and the applied methods, a case study approach including three companies was presented in this thesis. Consequently, as a result of the case illustration, the indicators in the model were leveraged and the developed model was verified by the case study approach including semi-structured interviews with logistics companies.

In addition to the ranking of the companies, sensitivity analyses on individual indicator weights were presented to analyse the effects of possible variations on the final outcome of the companies' rankings (see Chapter 6) as well as testing the robustness of the outcome. Conducting sensitivity analyses are useful to observe how outcome of ranking can be affected when some alterations occur in the system. Yet, it is worth noting that since the alternative cluster was not included in the network system of this research, the sensitivity analyses were not integrated in the ANP method processes and could not be performed through the SuperDecisions program. Therefore, sensitivity analyses shown in Chapter 6 were implemented separately in this thesis.

Regarding the sensitivity analyses conducted in previous studies, it was noticed that different types of sensitivity analyses were examined by various authors. In this thesis, besides investigating possible scenarios for each indicator when the perspective weights were unequal, a case of having

equal weights for the perspectives was also analysed by the researcher. The main rationale for examining the equal weights for perspectives is based on the assumptions concluded from the literature that BSC perspectives should not surpass each other because the nature of the BSC is compensating the dominance of the financial perspective. Therefore, *ceteris paribus*, the perspective weights were considered equally in a different scenario. The equal weight for the clusters approach was also supported by Öztayşi *et al*. (2011) by giving equal evaluation scores to the clusters of their decision model.

Overall, the applicability of the model and the method was demonstrated in a case study approach by including three logistics companies listed in the Fortune 500 Turkey. By doing so, managers in the logistics industry can have a certain idea when deciding on which indicators to focus more, in order to be more competitive in the industry. Moreover, with the help of this thesis, the case companies can even check the possible outcomes affecting their competitiveness in case of giving different importance to some particular indicators.

7.3 Chapter Summary

This chapter presented the comprehensive discussion of the key findings addressing the research questions of this thesis. In other words, in the chapter, it was shown that how the findings helped to enhance our understandings to address the research questions. In order to discuss the findings step-by–step, discussions were constructed based on the findings of major stages, such as the integration of the stakeholders in the BSC approach, the online survey conducted to highlight the most significant indicators and to form the conceptual model, the ANP method to determine the interrelationships among both the identified indicators and the perspectives, and the case study approach consisting of the three logistics companies listed in the Fortune Turkey's top 500 companies to demonstrate both the applicability of the model and the ANP outcomes. The discussions in this chapter highlighted the significant contributions of this research.

In conclusion, the aim of this research was to provide a comprehensive decision model that includes various performance indicators covering the whole logistics industry and assesses the interrelationships among these indicators by using a realistic MCDM approach without having any other industry-based view. Therefore, the empirical analyses conducted in this research revealed the ranking of various performance indicators in the logistics industry through the online survey as well as prioritising the selected most important 15 performance indicators through the ANP method. As a result, both the list of the 43 indicators and the results of the proposed model can serve as a guiding reference for the logistics industry and for future studies in the field.

CHAPTER 8 : CONCLUSION

8.1 Chapter Overview

This study has focused on the logistics performance indicators affecting competitiveness in the logistics industry. After a wide systematic review of the existing literature, two main research problems, consisting of the difficulties concerning identification of the key indicators among hundreds of applicable indicators and complexities of determining the interrelationships among these indicators were emphasised. To address these problems, the knowledge obtained from all the used sources during the literature review constituted the starting point of this study and made this research unique to the logistics industry, especially for logistics companies. The study originated from an extensive literature review where observations revealed that there is no study focusing on the evaluation of the logistics performance indicators by considering both the powerful approach, the BSC, and the promising MCDM technique in terms of accuracy and practicality, the ANP method.

In this chapter, a summary of the thesis starting with drawing conclusions based on the key findings is primarily provided. Then, the research contributions in terms of both academic and practical views are illustrated. Finally, the research limitations are summarised followed by a section suggesting possible directions for future studies.

8.2 Key Findings

This research was set out to identify significant logistics performance indicators that influence the competitiveness of logistics companies, to provide a comprehensive decision model that incorporates key indicators, and to examine the interrelationships between these indicators from the logisticians' perspective. To achieve the research aim and objectives, the research structure relied on three phases by including a mixed-method approach. The first two phases represent the quantitative method design while in the last phase the case study approach incorporating the semi-structured interview technique is the qualitative part of this research.

In the first phase, key logistics performance indicators were identified through a comprehensive literature review and feedback obtained from five professionals (two practitioners and three academics) by using the stakeholder-based BSC approach. After scrutinizing and analysing the existing literature, the initial list of indicators was prepared. This list formed the basis of the first round of experts' views and after around three iterations, the experts agreed on 43 performance indicators. Then, an online survey was conducted to highlight the most significant indicators. Based on the collected answers, 15 indicators were found as the most significant in the survey after defining a cut-off value for each BSC perspective, and these indicators constituted the conceptual model of this research. Hence, in this phase, the research problem concerning the identification of the key performance indicators in the logistics industry was addressed.

In the second phase, the issue in the logistics area regarding the determination of the interrelationships between indicators was addressed by a more accurate and realistic MCDM method, the ANP method. The ANP method was used in this research to prioritise the 15 indicators by considering both direct and indirect relationships in the network structure. According to the relative importance of the indicators obtained from the ANP, the educated employee appeared as the most important indicator followed by managerial skills, cost, and profitability in the ranking of these 15 indicators. On the other hand, the last three indicators were ranked in the following order: social media usage for brand building, circumstance of delivery, and government satisfaction. These results showed that logistics companies should focus primarily on the prominent indicators in order to be more competitive in the industry. Yet, this does not mean to disregard the lowest ranked indicators because the presented ranking shows the relative priority of the indicators existing in the model. Thus, this phase addressed the research problem concerning the determination of the interrelationships among the indicators in order to decide which indicator needs to be mainly focused upon by decision makers in the logistics field.

In the third phase, in order to show the applicability of the developed model and the ANP method, the case study approach was chosen since it allows investigating in depth information for the performance measurement of logistics companies. In this regard, information related to the 15 indicators was collected by applying the semi-structured interview technique in this phase. However, some data in terms of several indicators were not numeric (or unobtainable) and, therefore, subjective judgments of the experts were found essential for these types of indicators. Accordingly, experts gave rating scores for the companies regarding these indicators by considering the limited collected information with reference to these indicators and based on their own experiences and knowledge. Then, the mean value of the experts' scores was assigned as the final rating for each indicator. Thus, each indicator in the model had a score but with different units. In order to unify these units, a normalization technique was used. Hence, the selected companies had a score in terms of each indicator and these scores were multiplied by the weights of the indicators obtained through the ANP method. As a result, the sum of these multiplications provided the final scores of the selected companies in the case study phase. According to the results, Company B was the best alternative (0.3354), followed by Company A (0.3324), and Company C (0.3322). In the presented results, the closeness of the final scores of the companies verifies that the companies were comparable. From this point of view, each case company can be able to diagnose their weaknesses and strengths in comparison with their competitors based on these outcomes. This means that the results will provide significant information to the decision makers of these selected companies by giving them an opportunity to check their current conditions and their relative positions in the industry.

In conclusion, the key findings of this research are associated with the research objectives and the research questions. Based on these findings and the presented approaches, the following section will explain both the academic contributions and practical contributions of this research.

8.3 Research Contributions

In relation to the research problems pointed out earlier (see Section 1.3) this study investigated the determination of the most significant performance indicators as well as their prioritisation in the logistics industry, particularly in terms of the competitiveness of logistics companies. With the aim of addressing these problems by developing a robust and promising approach, it was crucial to select a comprehensive concept and a powerful method for this research. During the development of the proposed approach, the researcher advanced the existing knowledge in the area from different aspects, as explained in the following sub-sections.

8.3.1 Academic Contributions

In order to provide a balanced (with the inclusion of financial and non-financial, quantitative and qualitative indicators) and applicable approach, the BSC concept was found robust and comprehensive in the logistics performance measurement field (see Section 2.7.1). On the other hand, regarding the prioritisation of performance indicators, the ANP was a powerful and realistic method for this research. However, the previous BSC-related studies in the logistics area (see Section 2.6) revealed that the ANP method was not primarily considered by researchers, especially regarding the competitiveness of logistics companies. Moreover, as can be seen in Section 2.9, the BSC concept was not implemented in the earlier ANP-related studies in the logistics area. Accordingly, the conducted research in this thesis showed that there is a lack of study on competitiveness of logistics companies in terms of using the BSC approach and the ANP method. In this regard, the contribution of this research arises from the need of applying the BSC-ANP combination to assess the competitiveness in the logistics industry, especially for logistics companies. From this point of view, this study has fundamentally changed the view of identification and prioritisation of the key logistics performance indicators and has opened the door for further research in logistics through the proposed approach based on the BSC-ANP combination. Thus, the proposed approach provides a deeper understanding and greater insight of the impact of the logistics performance indicators on the competitiveness of logistics companies by addressing the stated research problems.

Additionally, the proposed approach furthers the literature in several ways. Initially, from a theoretical perspective, after selecting the BSC as a suitable and robust concept, the researcher adapted the BSC approach through several developments to meet the needs of the logistics industry within the supply chain.

- The first development was the integration of various stakeholders to a significant extent in the proposed BSC model which extends the body of knowledge of the performance measurement for logistics companies. Apart from the purpose of dealing with the shortcoming of the BSC concept by considering various stakeholders, another rationale of this development is based on the fact that previously studied approaches fail to

significantly consider the needs of stakeholders in the identification of performance indicators for logistics companies.

- The second development was the extension of previous knowledge by examining diverse performance indicators for the logistics industry in the BSC concept. The wide range of logistics performance indicators was systematically scrutinised in this research. In this way, especially, the provided list of performance indicators and their grouping into the perspectives can serve as a reference for future studies in the logistics field, more particularly for studies using the BSC structure.
- The last development was on implementing the social media usage in the BSC concept, within brand building activities in particular. The main rationale for the consideration of the social media is mainly based on the emergent nature of social media as an influential factor on the differentiation of companies, not only in the business-to-consumer context but also in the business-to-business domain. To the best of researcher's knowledge, this is the first study to implement and assess the social media effect as a performance indicator under the BSC concept, especially for the logistics industry.
- After these developments, the adapted model was tested by the ANP method for the logistics industry for the first time in the literature without having any other industry-specific point of view. In contrast to common expectations regarding the importance of some particular indicators (e.g. on-time delivery), this research shows that the educated employee is the most important performance indicator for competitiveness in the logistics industry and the four prominent indicators (educated employee, managerial skills, cost, profitability) need to be primarily considered by logistics companies since these indicators account for more than a half of the total percentage of the performance indicators in the model.
- Furthermore, this study also demonstrates that the social media is not a primarily considered performance indicator affecting the competitiveness of logistics companies, although it was evaluated as one of the significant indicators in the logistics area.
- In addition to these novelties, to the researcher's knowledge, the 'stakeholders' perspective, incorporating different stakeholders, was also assessed by the ANP method for the first time in the logistics literature, more particularly for logistics companies. Hence, the findings of this research are not only useful for logistics companies but also for existing stakeholders in the logistics industry because the ranking of the presented indicators will help stakeholders to understand the logistics industry norms, which can be used for their 3PL provider selection stages.

In conclusion, through the proposed BSC-ANP combination, key logistics performance indicators were prioritised by a balanced, more comprehensive, and more realistic approach. Furthermore, prioritisation and the relative importance of these indicators, obtained from the proposed model, can be considered as a role model in the logistics industry. Within this scope, it is worth noting that

each of these contributions advanced the field of logistics performance measurement, the BSC concept, and the ANP approach with knowledge and tools that can be used. Therefore, each stage of the research contributes differently to the existing body of knowledge.

8.3.2 Management and Practical Contributions

The proposed model and presented results of this study offer a wide range of significant management and practical contributions for businesses.

- Firstly, the main contribution from the industrial aspect is in investigating both the current situation of the logistics industry in terms of the importance of performance indicators and the current practice of logistics companies. The decision process of choosing significant performance indicators is complicated and requires much effort by decision makers. In this regard, the list of indicators and the presented model (see Chapter 4) serves as a frame of reference that will provide logistics managers with assistance to better understand key logistics indicators.
- In addition to this, the outcomes of this research will also likely help logistics managers to decide on which performance indicator to focus more in order to become more competitive by considering the interdependencies among the indicators. Thus, with the help of the presented priority of the indicators, logistics managers can examine their companies' strengths and weaknesses against the ideal proposed ranking. Within this scope, the case study in Chapter 5 highlighted the practical application of both the proposed model and the method in a strategically significant developing country, Turkey. Hence, the experimental application demonstrated the viability of the model and it can help logistics managers to deal with the determination of important indicators under favour of the applied method. This may also be very useful information for all logistics companies in the logistics sector because the result gives the overall picture of the industry. In this way, the presented results in Chapter 5 can be used by all companies operating in the Turkish logistics industry as a role model.
- Moreover, the sensitivity analyses presented in Chapter 6 showed the 'what-if' scenarios for the selected logistics companies in terms of each indicator in the model and for the case of equal weights of all perspectives. These experiments can help to demonstrate the usefulness of the model and the applicability of the ANP results in different scenarios for logistics companies. Based on the outcomes of these presented scenarios, the companies can make provisions against the possible situations when the market dynamics change in terms of the indicators' weights.
- Furthermore, in addition to the usefulness of the model for the logistics companies, the proposed model, which is based on a step-by-step approach, can also be beneficial for various stakeholders in the logistics industry due to the inclusion of the 'stakeholders' perspective in the model. Thus, different stakeholders can take their own industry norms

into account and can choose relevant indicators from the developed model. Ultimately, they can use this model as a reference within their logistics company selection processes even if they operate in different industries.

- Finally, the proposed approach regarding both the BSC concept with the inclusion of various stakeholders and the ANP technique can also be implemented in different sectors by following the phases examined in this thesis.

8.4 Research Limitations

This research has several limitations. Firstly, the research was conducted by considering mainly five databases. Also, the keywords were generally searched within abstracts, titles, and keywords with the exclusion of some sources (e.g. conference papers, dissertations, reports, etc.). Therefore, this forms the main limitation of this thesis.

Secondly, one could include a higher number of indicators into the online survey and this might result in containing different indicators in the proposed model. However, both the systematic literature review and the consensus of the practitioners minimised this possibility. Also, more respondents could have been incorporated into the online survey process. The number of respondents can seem limited due to the difficulty of reaching some groups of respondents (e.g. customs officers) in the logistics industry, invalidity of e-mail address for some respondents, having a busy schedule for some respondents, and job changes for some of the respondents. Yet, the main purpose of the survey was to highlight the most important indicators in the logistics industry and, therefore, compared to other similar purpose studies, 72 answers were considered sufficient. Besides, in order to compensate these difficulties, several respondents helped the distribution of the survey to their colleagues who are related to logistics operations or who can accurately answer such a survey.

Thirdly, during the ANP processes, the experts felt overwhelmed by the large number of pairwise comparisons they had to perform. This process is time consuming and labour intensive for the experts. However, they were relieved when the questions were organised sensibly and three example comparisons were given prior to their comparisons at the beginning of the survey. Moreover, although the ANP study was methodologically sufficient and rigorous, more experts could be included in the ANP process. Yet, finding experts in the area is not an easy task and they were not chosen randomly. The experts were selected based on their experience and knowledge concerning the BSC, the ANP, and logistics concepts as well as their willingness to participate. At the end, by considering some other ANP-related studies, three experts were similarly included in the ANP decision-making process of this research.

Fourthly, allowing the experts' subjective judgments is a drawback of the ANP method although the level of inconsistency is measured by the software program. However, in practice, we need subjective judgments to compare some elements, especially for intangible indicators. Therefore, the

researcher considered such subjectivity as an advantage rather than a drawback since there are several intangible indicators in the model and some data obtained from companies requires subjective ratings.

Fifthly, the current version of the SuperDecisions program did not allow conducting a sensitivity analysis because the proposed model did not contain an alternative cluster. Yet, the sensitivity analyses in terms of each indicator and for the equal weight of each perspective were performed by using the MS Excel Program.

Sixthly, contacting logistics companies, finding the relevant people from each department, and collecting all the necessary data in terms of each indicator were problematic. Specifically, collecting some information regarding the financial indicators was a really difficult stage. During the data collection from each company, the researcher also paid attention to the comparability of the information for each indicator. For instance, most of the companies were unwilling to share details of their costs with the researcher. In order to provide substantive information to substitute the cost indicator, the cost structures of the companies in terms of the percentages of their operations (e.g. transportation, warehousing etc.) were obtained from each case company. For the rest of the indicators in the model, relevant information was collected by the researcher. Consequently, all data collected from each company was found comparable by the experts and the researcher.

Finally, the selected case companies were mainly focusing on their road operations rather than sea, air transportation types or different operational alternatives. Therefore, the presented case study is applicable to the companies which maintain a higher percentage of road operations among other operations. For this reason, the final results of the case study may not be directly applicable to other types of logistics companies.

8.5 Suggestions for Future Studies

This study raises several suggestions and recommendations for future studies. First, more respondents for the online survey and more experts for the ANP method are needed for future studies. Consequently, the results found in this research can be compared with a study including a higher response rate.

Second, the findings obtained from this research should provide a useful basis for other studies exploring the interrelationships among the indicators. Therefore, future studies may want to replicate this study using a hybrid approach or different MCDM methods, such as DEMATEL in order to test the validity of the outcomes. Thus, the results can be compared with other research techniques and this can be another research topic in future studies.

Third, it would be beneficial to conduct further case studies either in other developing countries or in developed countries. By this way, possible differences and/or similarities in terms of indicators'

rankings can be analysed and, if possible, generalisations can be interpreted based on several factors, such as the features of the countries.

8.6 Chapter Summary

This chapter presented the key findings, research contributions, and research limitations as a summary of the thesis. Finally, the chapter was concluded with the suggestions for possible directions for future studies.

Although there have been significant developments in academic studies in terms of the performance measurement in the logistics industry, studies on the analysis of the logistics performance indicators from logisticians' perspectives have remained very limited. Therefore, it is believed that this research has provided a significant value to both academic and business fields by highlighting the key indicators in the industry as well as showing the interrelationships among these indicators. Thus, the findings of this research gives a broader view of what indicators can be used by logistics companies and brings more understanding on the priorities of the indicators that can enable competitiveness in the industry.

Additionally, the work has also provided significant findings for stakeholders in the logistics industry by presenting a reference model they can use in their decision making processes. As a result, since the research is considered compatible with the dynamic environment of the logistics industry, it contributes to ever-growing knowledge in the area.

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APPENDICES

Appendix A: Online Survey

Dear Sir/Madam,

My name is Berk KUCUKALTAN and I am currently a full time PhD student on the Management Studies Research programme at Brunel Business School, Brunel University London.

I am doing research on evaluation of competitive factors for logistics companies in Turkey. I would like to invite you to take part in my research. The aim of the survey is to investigate the appropriate competitive factors affecting the competitiveness of logistics companies in Turkey. Then, the important factors obtained from this survey, will be used to determine their impact on each other and on the competitiveness of the selected logistics companies for a case study.

The study is prepared for entirely academic purposes and will not be used for any commercial purposes. Your participation will be anonymous; none of the participants will be identifiable from the survey.

Your opinions and voluntary participations to the questionnaire in the attachment are vital to the success of my study. During your assessments by using 5-point Likert scale for the importance degree of the factors, the questionnaire is expected to take approximately 8 minutes.

For any queries, you can contact with me.

Sincerely yours,

BERK KUCUKALTAN
PhD Student
Email: Berk.Kucukaltan@brunel.ac.uk
Phone: +44(0)1895267897

Information for Participants:

This survey is intended to determine the appropriate competitive factors which affect the competitiveness of logistics companies in Turkey. During the assessment, besides considering the structure of the logistics industry in Turkey, please also take into account whether the data regarding to each factor can be measurable when they are asked to company managers. For any queries about factors, you can use the definitions listed in “Definitions of the Factors" page.

Job Titles:

Please indicate your job title in logistics field with one of these statements below.

	Please circle one of these below.
High Level Management or Owner (CEO/General Manager/President/Vice President	❍
Other Management Positions (Director/Department Manager/Chief)	❍
Officer/Specialist	❍
Academician (Professor, Associate Professor, Assistant Professor, Lecturer, Research Assistant)	❍
Engineer	❍

Government Officer/Policy Maker (Customs Officer, Foreign Trade Officer/Specialist)	❍

Working Year:

Please indicate your working year in logistics field with one of these time intervals below.

	Please circle one of these below.
Under 2 Years	❍
2-5 Years	❍
6-10 Years	❍
Over 10 Years	❍

Questionnaire:

Please assess the importance of each factor using the following identifiers.

1 Not Important
2 Slightly Important
3 Somewhat important
4 Important
5 Very Important

Example: What is the importance degree of *cost* as a competitive factor for logistics companies' competitiveness? (Please indicate a degree using 5-points scale)

Financial Perspective

	1	2	3	4	5
Cost	❍	❍	❍	❍	❍
Sales Growth	❍	❍	❍	❍	❍
Interest Coverage Ratio	❍	❍	❍	❍	❍
Equity ratio	❍	❍	❍	❍	❍
Market Share	❍	❍	❍	❍	❍
Profitability	❍	❍	❍	❍	❍
Cash Flow	❍	❍	❍	❍	❍
Return on Investments	❍	❍	❍	❍	❍
Revenue Growth	❍	❍	❍	❍	❍
Accounts Receivable Turnover	❍	❍	❍	❍	❍

Learning and Growth Perspective

	1	2	3	4	5
Educated Employee	❍	❍	❍	❍	❍
Managerial Skills	❍	❍	❍	❍	❍
Order Entry Methods	❍	❍	❍	❍	❍
Social Media Usage for Brand Building	❍	❍	❍	❍	❍
Cultural Match	❍	❍	❍	❍	❍
Willingness for Information Sharing	❍	❍	❍	❍	❍
IT Infrastructure	❍	❍	❍	❍	❍
Relationships with Other Stakeholders	❍	❍	❍	❍	❍
Past Performance	❍	❍	❍	❍	❍

Internal Process Perspective

	1	2	3	4	5
Circumstance of Delivery	❍	❍	❍	❍	❍
Effectiveness of Delivery Invoice Methods	❍	❍	❍	❍	❍
Ethical Responsibility	❍	❍	❍	❍	❍
Transport Capacity	❍	❍	❍	❍	❍
Warehouse Capacity	❍	❍	❍	❍	❍
Purchase Order Cycle Time	❍	❍	❍	❍	❍
Research and Development Capability	❍	❍	❍	❍	❍
Geographical Location	❍	❍	❍	❍	❍
Quality of Delivery Documentation	❍	❍	❍	❍	❍
Quality System Certifications	❍	❍	❍	❍	❍
Responsiveness to Changes	❍	❍	❍	❍	❍
On-Time Delivery	❍	❍	❍	❍	❍
Value-Added Activities	❍	❍	❍	❍	❍
Accuracy of Forecasting	❍	❍	❍	❍	❍
Environmental Awareness/Understanding	❍	❍	❍	❍	❍
Flexibility to Changes	❍	❍	❍	❍	❍

Stakeholders Perspective

	1	2	3	4	5
Customer Satisfaction	❍	❍	❍	❍	❍
Community Satisfaction	❍	❍	❍	❍	❍
Employee Satisfaction	❍	❍	❍	❍	❍
Supplier Satisfaction	❍	❍	❍	❍	❍
Environmental Group Satisfaction	❍	❍	❍	❍	❍
Government Satisfaction	❍	❍	❍	❍	❍
Investor (Financier) Satisfaction	❍	❍	❍	❍	❍
Non Government Organization Satisfaction	❍	❍	❍	❍	❍

Definitions of the Factors

Financial Perspective

Cost: Companies aim to achieve cost reductions and to control cost structures in terms of fixed (e.g. warehouse costs) and variable costs (e.g. transportation costs) in their operations (Hallikas et al., 2004; Hesse and Rodrigue, 2004; Daim et al., 2013).

Sales Growth: Annual growth rate in sales between two years (Clarkson and Simunic, 1994; Agrawal and Chadha, 2005).

Interest Coverage Ratio: It shows the potential slack and ability of a company about payment of interest expenses (Bromiley, 1991).

Equity ratio: This ratio (also known as the proprietary ratio) shows the percentage of the total assets which are financed by shareholders equity funds (Ramsden, 1988).

Market Share: This is the percentage of the shared market that a company wants to penetrate (Vaidya and Hudnurkar, 2013; Kaplan and Norton, 1996a; Deyoung and Nolle, 1996)

Profitability: It shows how well a business perform in their operations in terms of some financial ratios such as EBIT, ROA and so on (Fraser and Orniston, 2004; Ali et al., 2011; Flamholtz and Kannan-Narasimhan, 2005).

Cash Flow: It is the movement of money into and out of the business. Cash flow includes net income of an entity and non-cash deductions such as amortization, deferred taxes, depreciation and minority interests (Ittelson, 2009; Abrahamsen et al., 2004; Canadian Institute of Chartered Accountants, 1993).

Return on Investments: If operating surplus in terms of expected/achieved benefits is related to assets-funds relationship, it shows the return of investments (Vaidya and Hudnurkar, 2013; Walsh, 2008).

Revenue Growth: This is related to show the expansion speed of a business compared to previous year(s). It is a general term for the amount of assets received or responsibilities liquidated as consideration for the sale of goods, the presentation of services, liquidation of liabilities, use of resources or exchange of assets in a transaction that increases/decreases the net assets (Leland, 1948; Wüstemann and Kierzek, 2005).

Accounts Receivable Turnover: It is relevant with the effectiveness of an entity's credit policy and shows the frequency of accounts receivables to be converted into the cash during a year (Canadian Institute of Chartered Accountants, 1993).

Learning and Growth Perspective

Educated Employee: Besides the education level of employees, it is also related to development of employees in terms of their trainings and capabilities about problem solving (Tsai et al., 2009; Kumar and Motwani, 1995; Umble et al., 2003; Guisinger and Ghorashi, 2004).

Managerial Skills: It is related to operation ability, knowledge and experience regarding the management besides supporting the trainings of employees (Sohn et al., 2007; Razzaque and Sirat, 2001).

Order Entry Methods: These are the methods to convert the customer details into relevant information (Vaidya and Hudnurkar, 2013).

Social Media Usage for Brand Building: The usage of social media tools or social networking sites (e.g. Facebook, Twitter, LinkedIn,Youtube etc.) for brand building within marketing activities (Lieb C. and Lieb K., 2012; Michaelidou et al., 2011).

Cultural Match: This is relevant with the organizational change regarding the business strategy and, besides, is also the situation of when the international norms are convergent with domestic standards such as laws, procedures, beliefs and obligations (Checkel, 1999; Cortell and Davis, 2000).

Willingness for Information Sharing: This is relevant with cooperation and voluntarily sharing the information with others (Jarvenpaa and Staples, 2000; Fawcett et al., 2007).

IT Infrastructure: It is related to tracing and tracking the delivery information, data integrity within the operations, hardware and software systems which have been used in the company and conduct with customers via website or another system (Lai et al., 2008; Brah and Lim, 2006).

Relationships with Other Stakeholders: This is relevant with creating values and having any relationships based on communications with stakeholders (Duncan and Moriarty, 1998; Freeman et al., 2004).

Past Performance: It is relevant with corporate reputation and it is an indicator for future performance (Sharpe, 1966; Wartick, 2002).

Internal Process Perspective

Circumtance of Delivery: It is related to the performance of delivery without any damages and losses during the transportation or warehouse activities until the last delivery point (Garcia et al. 2012; Zacharia and Mentzer, 2007).

Effectiveness of Delivery Invoice Methods: These methods are based on the comparison of the invoice, which generally include delivery time, date and information of the received goods, with prior agreements in order to determine the effectiveness of the delivery (Vaidya and Hudnurkar, 2013).

Ethical Responsibility: It is an attitude which businesses should behave fair and reasonable as these are expected by society (Eltantawy et al., 2009).

Transport Capacity: This is related to the delivery of the goods during the transportation besides the transportation capacity in terms of number of vehicles and load management of vehicles (Shaik and Abdul-Kader, 2012; Vaidya and Hudnurkar, 2013; Pettit and Beresford, 2009).

Warehouse Capacity: This is an indicator of non-financial available resources that companies have and it is relevant with some factors (e.g. number of warehouses, capacities of storages) during the movements in logistics (Yang et al., 2000; Senthil et al., 2014; Mason et al., 2003; Jolayemi and Olorunniwo, 2004; Caplice and Sheffi, 1994).

Purchase Order Cycle Time: This is the time interval between the creation of a purchase order and the receipt of the delivered goods (Vaidya and Hudnurkar, 2013).

Research and Development Capability: It is relevant with different projects within innovation, new and/or substantially improved products or process that create knowledge (Papalexandris et al., 2005; Tang, 2006; Bigliardi and Dormio, 2010).

Geographical Location: Geographic area related to distribution of 3PL providers' facilities (e.g. warehouses, depots, offices etc.) within their operations and the facilities' distances to the 3PL providers' customers (Göl and Çatay, 2007; Vastag et al., 1994; Braglia and Petroni, 2000).

Quality of Delivery Documentation: This is related if the delivery records and information are updated regularly and properly (Vaidya and Hudnurkar, 2013).

Quality System Certifications: This is relevant with whether the company has quality-related certifications (e.g. ISO 9001, ISO 14000) in their processes (Lee et al., 2009; Aramyan et al., 2007; Aba and Badar, 2013).

Responsiveness to Changes: This shows the ability of a business to response quickly to the changes (Vaidya and Hudnurkar, 2013).

On-Time Delivery: It is the ratio of on-time delivered goods which has been reached to the customers' point (Hsu et al., 2013; Vaidya and Hudnurkar, 2013).

Value-Added Activities: This is relevant with the value-added activities (e.g. labelling, assembly, packaging) that companies provide in their service operations (Lambert and Cooper, 2000; McMullan,1996; van Laarhoven et al., 2000; Krauth et al., 2005).

Accuracy of Forecasting: This criterion shows the difference between the real value and the value after forecasting (Vaidya and Hudnurkar, 2013).

Environmental Awareness/Understanding: Environmental protection including the prevention of emissions and adapting the environmental goals into the business strategies (Chen et al. 2012; Tsai et al., 2009).

Flexibility to Changes: This shows the ability of a business to fulfill the changes if the conditions are changed in the market (Vaidya and Hudnurkar, 2013).

Stakeholders Perspective

Customer Satisfaction: It is a ratio which shows customers' level of satisfaction regarding the provided service during a particular time interval (Garcia et al. 2012; Hsu et al., 2013).

Community Satisfaction: Community satisfaction is based on some criteria such as social supports, living space, income, relationships with other people and service opportunities in terms of medical and education (White, 1985).

Employee Satisfaction: It is a ratio which shows employees' level of satisfaction during a particular time interval (Shaik and Abdul-Kader, 2012; Leung et al., 2006).

Supplier Satisfaction: This is relevant with some factors trust, commitment, quality of the buyer-seller relationship and so on. Also, it is relevant with supplier's feeling of fairness concerning buyer's incentives and supplier's contributions within an industrial relationship between buyer and seller as relates to the supplier's need fulfilment (e.g. the possibility of increased earnings, the actualisation of cross-selling) (Essig and Amann, 2009).

Environmental Group Satisfaction: This is relevant with the satisfaction of an environment group which focus on environmental concerns such as pollutions and misuses (Bullard, 2000; Cashore, 2002).

Government Satisfaction: This is related to fulfilment of the requirements of the government policies, tariffs and regulations (Shaik and Abdul-Kader, 2012; Joshi et al., 2013).

Investor (Financier) Satisfaction: This is relevant with the satisfaction of an owner or investor who is being affected by credit rates and investing some or all the capital of an investor with the expectation of financial return or cash flow for his/her portfolio (Sarig and Warga, 1989; Dodd, 2007).

Non-Government Organization Satisfaction (NGO): This is relevant with the satisfaction of a non-government organization which works for development of social connections and delivering social welfare (Townsend et al., 2002; Chenhall et al., 2010). Their members may also be from the variety of the groups such as associations, unions, foundations, professional organizations and so on (Vakil, 1997; Yousuf et al., 2010; Simmons, 1998).

Appendix B: The Final Influence Matrix

			Performance Indicators														
			F.1	F.2	F.3	F.4	IP.1	IP.2	IP.3	IP.4	LG.1	LG.2	LG.3	LG.4	ST.1	ST.2	ST.3
Perspectives/Performance Indicators	**Financial (F)**	Cost (F.1.)		1	1	1	1	0	1	1	1	1	0	1	1	1	0
		Profitability (F.2.)	1		1	1	0	0	1	1	0	1	0	0	0	1	0
		Sales Growth (F.3.)	1	1		1	0	0	1	1	1	0	0	1	0	1	0
		Equity Ratio (F.4.)	1	1	0		0	0	1	1	1	0	0	0	0	0	0
	Internal Process (IP)	On-time Delivery (IP.1.)	1	1	1	0		1	0	0	0	0	0	0	1	0	0
		Circumstance of Delivery (IP.2.)	1	1	1	0	1		0	0	0	0	0	0	1	1	0
		Transport Capacity (IP.3.)	1	1	1	1	1	1		0	0	0	0	1	1	0	0
		Warehouse Capacity (IP.4.)	1	1	1	1	1	0	1		0	0	0	1	1	0	1
	Learning& Growth (LG)	IT Infrastructure (LG.1.)	1	1	1	0	1	1	0	0		0	1	1	1	1	0
		Educated Employee (LG.2.)	1	1	1	0	1	1	0	0	1		1	1	1	1	0
		Managerial Skills (LG.3.)	1	1	1	0	1	1	0	0	1	1		1	1	1	1
		Social Media Usage for Brand Building (LG.4.)	0	1	1	0	0	0	0	0	1	0	0		1	1	0
	Stakeholders (ST)	Customer Satisfaction (ST.1.)	1	1	1	0	0	0	0	0	0	0	0	0		1	0
		Employee Satisfaction (ST.2.)	1	1	1	0	1	1	0	0	0	0	0	1	1		0
		Government Satisfaction (ST.3.)	0	0	0	0	1	0	0	0	0	0	0	0	0	0	

Appendix C: Pairwise Comparison Questions

F.1. Cost

Among the presented indicators with respect to the 'Cost', which one has more influence?

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

Profitability	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Sales Growth
Profitability	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Equity ratio
Sales Growth	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Equity ratio

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

On-Time Delivery	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Circumstance of Delivery
On-Time Delivery	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Transport Capacity
On-Time Delivery	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Warehouse Capacity
Circumstance of Delivery	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Transport Capacity
Circumstance of Delivery	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Warehouse Capacity
Transport Capacity	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Warehouse Capacity

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

IT Infrastructure	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Educated Employee
IT Infrastructure	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Managerial Skills
Educated Employee	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Managerial Skills

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

Customer Satisfaction	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Employee Satisfaction

F.2. Profitability

Among the presented indicators with respect to the 'Profitability', which one has more influence?

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

Cost	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Sales Growth
Cost	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Equity ratio
Sales Growth	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Equity ratio

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

On-Time Delivery	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Circumstance of Delivery
On-Time Delivery	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Transport Capacity
On-Time Delivery	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Warehouse Capacity
Circumstance of Delivery	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Transport Capacity
Circumstance of Delivery	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Warehouse Capacity
Transport Capacity	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Warehouse Capacity

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

IT Infrastructure	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Educated Employee
IT Infrastructure	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Managerial Skills
IT Infrastructure	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Social Media Usage for Brand Building
Educated Employee	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Managerial Skills
Educated Employee	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Social Media Usage for Brand Building
Managerial Skills	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Social Media Usage for Brand Building

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

Customer Satisfaction	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Employee Satisfaction

F.3. Sales Growth

Among the presented indicators with respect to the 'Sales Growth', which one has more influence?

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

Cost	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Profitability

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

On-Time Delivery	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Circumstance of Delivery
On-Time Delivery	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Transport Capacity
On-Time Delivery	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Warehouse Capacity
Circumstance of Delivery	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Transport Capacity
Circumstance of Delivery	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Warehouse Capacity
Transport Capacity	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Warehouse Capacity

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

IT Infrastructure	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Educated Employee
IT Infrastructure	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Managerial Skills
IT Infrastructure	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Social Media Usage for Brand Building
Educated Employee	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Managerial Skills
Educated Employee	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Social Media Usage for Brand Building

Managerial Skills	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Social Media Usage for Brand Building

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

Customer Satisfaction	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Employee Satisfaction

F.4. Equity ratio

Among the presented indicators with respect to the 'Equity Ratio', which one has more influence?

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

Cost	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Profitability
Cost	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Sales Growth
Profitability	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Sales Growth

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

Transport Capacity	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Warehouse Capacity

IP.1. On-Time Delivery

Among the presented indicators with respect to the 'On-Time Delivery', which one has more influence?

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

Circumstance of Delivery	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Transport Capacity
Circumstance of Delivery	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Warehouse Capacity
Transport Capacity	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Warehouse Capacity

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

IT Infrastructure	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Educated Employee
IT Infrastructure	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Managerial Skills
Educated Employee	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Managerial Skills

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

Employee Satisfaction	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Government Satisfaction

IP.2. Circumstance of Delivery

Among the presented indicators with respect to the 'Circumstance of Delivery', which one has more influence?

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

On-Time Delivery	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Transport Capacity

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

IT Infrastructure	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Educated Employee
IT Infrastructure	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Managerial Skills
Educated Employee	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Managerial Skills

IP.3. Transport Capacity

Among the presented indicators with respect to the 'Transport Capacity', which one has more influence?

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

Cost	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Profitability
Cost	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Sales Growth
Cost	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Equity ratio
Profitability	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Sales Growth
Profitability	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Equity ratio
Sales Growth	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Equity ratio

IP.4. Warehouse Capacity

Among the presented indicators with respect to the 'Warehouse Capacity', which one has more influence?

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

Cost	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Profitability
Cost	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Sales Growth
Cost	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Equity ratio
Profitability	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Sales Growth
Profitability	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Equity ratio
Sales Growth	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Equity ratio

LG.1. IT Infrastructure

Among the presented indicators with respect to the 'IT Infrastructure', which one has more influence?

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

Cost	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Sales Growth
Cost	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Equity ratio
Sales Growth	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Equity ratio

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

Educated Employee	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Managerial Skills
Educated Employee	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Social Media Usage for Brand Building
Managerial Skills	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Social Media Usage for Brand Building

LG.2. Educated Employee

Among the presented indicators with respect to the 'Educated Employee', which one has more influence?

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

Cost	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Profitability

LG.3. Managerial Skills

Among the presented indicators with respect to the 'Managerial Skills', which one has more influence?

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

IT Infrastructure	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Educated Employee

LG.4. Social Media Usage for Brand Building

Among the presented indicators with respect to the 'Social Media Usage for Brand Building', which one has more influence?

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

Cost	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Sales Growth

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

Transport Capacity	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Warehouse Capacity

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

IT Infrastructure	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Educated Employee
IT Infrastructure	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Managerial Skills
Educated Employee	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Managerial Skills

ST.1. Customer Satisfaction

Among the presented indicators with respect to the 'Customer Satisfaction', which one has more influence?

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

On-Time Delivery	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Circumstance of Delivery
On-Time Delivery	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Transport Capacity
On-Time Delivery	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Warehouse Capacity
Circumstance of Delivery	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Transport Capacity
Circumstance of Delivery	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Warehouse Capacity
Transport Capacity	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Warehouse Capacity

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

IT Infrastructure	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Educated Employee
IT Infrastructure	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Managerial Skills
IT Infrastructure	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Social Media Usage for Brand Building

Educated Employee	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Managerial Skills
Educated Employee	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Social Media Usage for Brand Building
Managerial Skills	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Social Media Usage for Brand Building

ST.2. Employee Satisfaction

Among the presented indicators with respect to the 'Employee Satisfaction', which one has more influence?

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

Cost	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Profitability
Cost	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Sales Growth
Profitability	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Sales Growth

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

IT Infrastructure	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Educated Employee
IT Infrastructure	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Managerial Skills
IT Infrastructure	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Social Media Usage for Brand Building
Educated Employee	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Managerial Skills
Educated Employee	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Social Media Usage for Brand Building
Managerial Skills	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Social Media Usage for Brand Building

ST.3. Government Satisfaction

NO MATRIX

FINANCIAL PERSPECTIVE

Among the presented perspectives with respect to the 'Financial Perspective', which one has more influence?

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

FINANCIAL PERSPECTIVE	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	INTERNAL PROCESS PERSPECTIVE
FINANCIAL PERSPECTIVE	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	LEARNING AND GROWTH PERSPECTIVE
FINANCIAL PERSPECTIVE	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	STAKEHOLDERS PERSPECTIVE
INTERNAL PROCESS PERSPECTIVE	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	LEARNING AND GROWTH PERSPECTIVE
INTERNAL PROCESS PERSPECTIVE	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	STAKEHOLDERS PERSPECTIVE
LEARNING AND GROWTH PERSPECTIVE	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	STAKEHOLDERS PERSPECTIVE

INTERNAL PROCESS PERSPECTIVE

Among the presented perspectives with respect to the 'Internal Process Perspective', which one has more influence?

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

FINANCIAL PERSPECTIVE	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	INTERNAL PROCESS PERSPECTIVE
FINANCIAL PERSPECTIVE	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	LEARNING AND GROWTH PERSPECTIVE
FINANCIAL PERSPECTIVE	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	STAKEHOLDERS PERSPECTIVE
INTERNAL PROCESS PERSPECTIVE	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	LEARNING AND GROWTH PERSPECTIVE
INTERNAL PROCESS PERSPECTIVE	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	STAKEHOLDERS PERSPECTIVE

LEARNING AND GROWTH PERSPECTIVE	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	STAKEHOLDERS PERSPECTIVE

LEARNING AND GROWTH PERSPECTIVE

Among the presented perspectives with respect to the 'Learning and Growth Perspective', which one has more influence?

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

FINANCIAL PERSPECTIVE	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	INTERNAL PROCESS PERSPECTIVE
FINANCIAL PERSPECTIVE	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	LEARNING AND GROWTH PERSPECTIVE
FINANCIAL PERSPECTIVE	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	STAKEHOLDERS PERSPECTIVE
INTERNAL PROCESS PERSPECTIVE	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	LEARNING AND GROWTH PERSPECTIVE
INTERNAL PROCESS PERSPECTIVE	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	STAKEHOLDERS PERSPECTIVE
LEARNING AND GROWTH PERSPECTIVE	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	STAKEHOLDERS PERSPECTIVE

STAKEHOLDERS PERSPECTIVE

Among the presented perspectives with respect to the 'Stakeholders Perspective', which one has more influence?

1= Equal Importance 3= Moderate Importance 5=Strong Importance

7= Very Strong Importance 9= Extreme Importance

FINANCIAL PERSPECTIVE	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	INTERNAL PROCESS PERSPECTIVE
FINANCIAL PERSPECTIVE	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	LEARNING AND GROWTH PERSPECTIVE
FINANCIAL PERSPECTIVE	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	STAKEHOLDERS PERSPECTIVE

INTERNAL PROCESS PERSPECTIVE	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	LEARNING AND GROWTH PERSPECTIVE
INTERNAL PROCESS PERSPECTIVE	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	STAKEHOLDERS PERSPECTIVE
LEARNING AND GROWTH PERSPECTIVE	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	STAKEHOLDERS PERSPECTIVE

Appendix D: Pairwise Comparisons with respect to Each Indicator and Perspective

Cost (F1)	F2	F3	F4	Priority
F2	1	1.2892	3.9148	0.50945
F3		1	1.9129	0.33875
F4			1	0.15180
				CR=0.02286

Cost (F1)	IP1	IP2	IP3	IP4	Priority
IP1	1	8.6535	7.9581	7.3186	0.71398
IP2		1	0.5555	0.4673	0.06268
IP3			1	2.4101	0.13281
IP4				1	0.09053
					CR=0.06294

Cost (F1)	LG1	LG2	LG3	Priority
LG1	1	2.1544	1.8171	0.49221
LG2		1	2	0.30466
LG3			1	0.20313
				CR=0.0802

Cost (F1)	ST1	ST2	Priority
ST1	1	6.9520	0.87425
ST2		1	0.12575
			CR=0.00000

Profitability (F2)	F1	F3	F4	Priority
F1	1	7.6116	6.0822	0.76874
F3		1	0.5848	0.09101
F4			1	0.14025
				CR=0.01042

Profitability (F2)	IP1	IP2	IP3	IP4	Priority
IP1	1	7.3186	6.3163	6.9520	0.69174
IP2		1	0.5227	0.6933	0.07728
IP3			1	1	0.12125
IP4				1	0.10973
					CR=0.01032

Profitability (F2)	**LG1**	**LG2**	**LG3**	**LG4**	**Priority**
LG1	1	1.3867	1.1696	2.8844	0.31779
LG2		1	1.1186	5.1299	0.30308
LG3			1	5.7387	0.30737
LG4				1	0.07176
					CR=0.03938

Profitability (F2)	**ST1**	**ST2**	**Priority**
ST1	1	2.8844	0.74257
ST2		1	0.25743
			CR=0.00000

Sales Growth (F3)	**F1**	**F2**	**Priority**
F1	1	5.8087	0.85313
F2		1	0.14687
			CR=0.00000

Sales Growth (F3)	**IP1**	**IP2**	**IP3**	**IP4**	**Priority**
IP1	1	8.3203	5.6462	5.6462	0.67362
IP2		1	0.5	0.5	0.06953
IP3			1	1	0.12843
IP4				1	0.12843
					CR=0.00438

Sales Growth (F3)	**LG1**	**LG2**	**LG3**	**LG4**	**Priority**
LG1	1	0.8355	0.7756	1.4422	0.25143
LG2		1	1.0527	0.4367	0.20390
LG3			1	0.4367	0.20443
LG4				1	0.34024
					CR=0.09739

Sales Growth (F3)	**ST1**	**ST2**	**Priority**
ST1	1	5.7387	0.85161
ST2		1	0.14839
			CR=0.00000

Equity Ratio (F4)	**F1**	**F2**	**F3**	**Priority**
F1	1	0.7211	5.0396	0.41835
F2		1	4	0.48167
F3			1	0.09998
				CR=0.03336

Equity Ratio (F4)	**IP3**	**IP4**	**Priority**
IP3	1	0.6299	0.38649
IP4		1	0.61351
			CR=0.00000

On-time Delivery (IP1)	**IP2**	**IP3**	**IP4**	**Priority**
IP2	1	0.1514	0.1994	0.07408
IP3		1	3	0.64364
IP4			1	0.28228
				CR=0.07283

On-time Delivery (IP1)	**LG1**	**LG2**	**LG3**	**Priority**
LG1	1	1.7099	2	0.47415
LG2		1	1.8171	0.32115
LG3			1	0.20470
				CR=0.02078

On-time Delivery (IP1)	**ST2**	**ST3**	**Priority**
ST2	1	5.1299	0.83687
ST3		1	0.16313
			CR=0.00000

Circumstance of Delivery (IP2)	**IP1**	**IP3**	**Priority**
IP1	1	1.1006	0.52396
IP3		1	0.47604
			CR=0.00000

Circumstance of Delivery (IP2)	**LG1**	**LG2**	**LG3**	**Priority**
LG1	1	0.3293	0.5	0.16373
LG2		1	1.8171	0.52786
LG3			1	0.30842
				CR=0.00345

Transport Capacity (IP3)	**F1**	**F2**	**F3**	**F4**	**Priority**
F1	1	0.8220	0.5	0.6632	0.17116
F2		1	0.4054	0.9085	0.19602
F3			1	1.1856	0.37319
F4				1	0.25962
					CR=0.01405

Warehouse Capacity (IP4)	**F1**	**F2**	**F3**	**F4**	**Priority**
F1	1	0.5503	0.1721	0.7756	0.10676
F2		1	0.4149	0.6933	0.17609
F3			1	3.4199	0.53853
F4				1	0.17862
					CR=0.02769

IT Infrastructure (LG1)	**F1**	**F3**	**F4**	**Priority**
F1	1	2.5198	4.9324	0.60301
F3		1	3.8258	0.29920
F4			1	0.09778
				CR=0.04818

IT Infrastructure (LG1)	**LG2**	**LG3**	**LG4**	**Priority**
LG2	1	2.2012	0.6057	0.32834
LG3		1	0.3218	0.15716
LG4			1	0.51450
				CR=0.00262

Educated Employee (LG2)	**F1**	**F2**	**Priority**
F1	1	0.1907	0.16022
F2		1	0.83978
			CR=0.00000

Managerial Skills (LG3)	**LG1**	**LG2**	**Priority**
LG1	1	0.1438	0.12575
LG2		1	0.87425
			CR=0.00000

Social Media Usage for Brand Building (LG4)	**F1**	**F3**	**Priority**
F1	1	1.6868	0.62782
F3		1	0.37218
			CR=0.00000

Social Media Usage for Brand Building (LG4)	**IP3**	**IP4**	**Priority**
IP3	1	1	0.50000
IP4		1	0.50000
			CR=0.00000

Social Media Usage for Brand Building (LG4)	**LG1**	**LG2**	**LG3**	**Priority**
LG1	1	0.6299	0.5723	0.22352
LG2		1	0.4367	0.27796
LG3			1	0.49852
				CR=0.05760

Customer Satisfaction (ST1)	**IP1**	**IP2**	**IP3**	**IP4**	**Priority**
IP1	1	4.9324	6.6038	6.9520	0.63206
IP2		1	5.5178	4.8202	0.24174
IP3			1	1.2599	0.06637
IP4				1	0.05983
					CR=0.08916

Customer Satisfaction (ST1)	**LG1**	**LG2**	**LG3**	**LG4**	**Priority**
LG1	1	0.6694	0.6694	1.8171	0.21435
LG2		1	1.2599	3.6342	0.36462
LG3			1	3.3019	0.31672
LG4				1	0.10431
					CR=0.00458

Employee Satisfaction (ST2)	**F1**	**F2**	**F3**	**Priority**
F1	1	0.1787	0.3293	0.10734
F2		1	1.1006	0.50569
F3			1	0.38698
				CR=0.02840

Employee Satisfaction (ST2)	**LG1**	**LG2**	**LG3**	**LG4**	**Priority**
LG1	1	0.1598	0.1984	2.6207	0.09283
LG2		1	0.3968	5.5934	0.33785
LG3			1	6.2573	0.51429
LG4				1	0.05503
					CR=0.08786

Financial (F)	**F**	**IP**	**LG**	**ST**	**Priority**
F	1	4.1601	6.6494	5.3132	0.61586
IP		1	3.0365	2.4101	0.20336
LG			1	0.4807	0.06916
ST				1	0.11161
					CR=0.03123

Internal Process (IP)	**F**	**IP**	**LG**	**ST**	**Priority**
F	1	0.1666	0.4367	1	0.09385
IP		1	5.2414	3.4760	0.61018
LG			1	2.1544	0.18306
ST				1	0.11291
					CR=0.05189

Learning and Growth (LG)	**F**	**IP**	**LG**	**ST**	**Priority**
F	1	0.3466	0.2099	2	0.12944
IP		1	0.3028	1.5874	0.22213
LG			1	3.2710	0.53432
ST				1	0.11411
					CR=0.08423

Stakeholders (ST)	**F**	**IP**	**LG**	**ST**	**Priority**
F	1	0.8434	2.2894	0.3057	0.16286
IP		1	1.2599	0.1771	0.13404
LG			1	0.1438	0.08671
ST				1	0.61639
					CR=0.02623

Appendix E: The Unweighted Supermatrix

	F.1	F.2	F.3	F.4	IP.1	IP.2	IP.3	IP.4	LG.1	LG.2	LG.3	LG.4	ST.1	ST.2	ST.3
F.1	0.00000	0.76873	0.85313	0.41835	1.00000	0.00000	0.17116	0.10676	0.60301	0.16022	0.00000	0.62782	1.00000	0.10734	0.00000
F.2	0.50945	0.00000	0.14687	0.48167	0.00000	0.00000	0.19602	0.17609	0.00000	0.83978	0.00000	0.00000	0.00000	0.50569	0.00000
F.3	0.33875	0.09101	0.00000	0.09998	0.00000	0.00000	0.37319	0.53853	0.29921	0.00000	0.00000	0.37218	0.00000	0.38698	0.00000
F.4	0.15180	0.14025	0.00000	0.00000	0.00000	0.00000	0.25962	0.17862	0.09778	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
IP.1	0.71398	0.69174	0.67362	0.00000	0.00000	0.52395	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.63206	0.00000	0.00000
IP.2	0.06269	0.07728	0.06953	0.00000	0.07408	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.24174	1.000.00	0.00000
IP.3	0.13281	0.12125	0.12843	0.38649	0.64364	0.47605	0.00000	0.00000	0.00000	0.00000	0.00000	0.50000	0.06637	0.00000	0.00000
IP.4	0.09053	0.10973	0.12843	0.61351	0.28228	0.00000	1.000.00	0.00000	0.00000	0.00000	0.00000	0.50000	0.05983	0.00000	1.000.00
LG.1	0.49221	0.31779	0.25143	0.00000	0.47415	0.16373	0.00000	0.00000	0.00000	0.00000	0.12575	0.22352	0.21435	0.09283	0.00000
LG.2	0.30466	0.30308	0.20391	0.00000	0.32115	0.52785	0.00000	0.00000	0.32834	0.00000	0.87425	0.27796	0.36462	0.33785	0.00000
LG.3	0.20313	0.30737	0.20443	0.00000	0.20469	0.30842	0.00000	0.00000	0.15716	1.00000	0.00000	0.49852	0.31672	0.51429	1.00000
LG.4	0.00000	0.07176	0.34024	0.00000	0.00000	0.00000	0.00000	0.00000	0.51450	0.00000	0.00000	0.00000	0.10431	0.05503	0.00000
ST.1	0.87425	0.74257	0.85160	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	1.00000	0.00000
ST.2	0.12575	0.25743	0.14840	0.00000	0.83687	1.00000	0.00000	0.00000	0.00000	0.00000	0.00000	1.000.00	1.000.00	0.00000	0.00000
ST.3	0.00000	0.00000	0.00000	0.00000	0.16313	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Appendix F: The Weighted Supermatrix

	F.1	F.2	F.3	F.4	IP.1	IP.2	IP.3	IP.4	LG.1	LG.2	LG.3	LG.4	ST.1	ST.2	ST.3
F.1	0.00000	0.47343	0.52541	0.31450	0.09385	0.00000	0.02282	0.10676	0.11759	0.03124	0.00000	0.08127	0.16286	0.01748	0.00000
F.2	0.31375	0.00000	0.09045	0.36210	0.00000	0.00000	0.02613	0.17609	0.00000	0.16377	0.00000	0.00000	0.00000	0.08236	0.00000
F.3	0.20862	0.05605	0.00000	0.07516	0.00000	0.00000	0.04975	0.53853	0.05835	0.00000	0.00000	0.04818	0.00000	0.06302	0.00000
F.4	0.09349	0.08637	0.00000	0.00000	0.00000	0.00000	0.03461	0.17862	0.01907	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
IP.1	0.14520	0.14068	0.13699	0.00000	0.00000	0.35282	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.08472	0.00000	0.00000
IP.2	0.01275	0.01572	0.01414	0.00000	0.04520	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.03240	0.13404	0.00000
IP.3	0.02701	0.02466	0.02612	0.09594	0.39274	0.32056	0.00000	0.00000	0.00000	0.00000	0.00000	0.11106	0.00890	0.00000	0.00000
IP.4	0.01841	0.02232	0.02612	0.15230	0.17224	0.00000	0.86669	0.00000	0.00000	0.00000	0.00000	0.11106	0.00802	0.00000	0.60722
LG.1	0.03404	0.02198	0.01739	0.00000	0.08680	0.03308	0.00000	0.00000	0.00000	0.00000	0.12575	0.11943	0.01859	0.00805	0.00000
LG.2	0.02107	0.02096	0.01410	0.00000	0.05879	0.10664	0.00000	0.00000	0.26431	0.00000	0.87425	0.14852	0.03161	0.02929	0.00000
LG.3	0.01405	0.02126	0.01414	0.00000	0.03747	0.06231	0.00000	0.00000	0.12651	0.80499	0.00000	0.26637	0.02746	0.04459	0.39278
LG.4	0.00000	0.00496	0.02353	0.00000	0.00000	0.00000	0.00000	0.00000	0.41417	0.00000	0.00000	0.00000	0.00904	0.00477	0.00000
ST.1	0.09758	0.08288	0.09505	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.61639	0.00000
ST.2	0.01404	0.02873	0.01656	0.00000	0.09449	0.12460	0.00000	0.00000	0.00000	0.00000	0.00000	0.11411	0.61639	0.00000	0.00000
ST.3	0.00000	0.00000	0.00000	0.00000	0.01842	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Appendix G: The Limit Supermatrix

	F.1	F.2	F.3	F.4	IP.1	IP.2	IP.3	IP.4	LG.1	LG.2	LG.3	LG.4	ST.1	ST.2	ST.3
F.1	0.13501	0.13501	0.13501	0.13501	0.13501	0.13501	0.13501	0.13501	0.13501	0.13501	0.13501	0.13501	0.13501	0.13501	0.13501
F.2	0.10363	0.10363	0.10363	0.10363	0.10363	0.10363	0.10363	0.10363	0.10363	0.10363	0.10363	0.10363	0.10363	0.10363	0.10363
F.3	0.07760	0.07760	0.07760	0.07760	0.07760	0.07760	0.07760	0.07760	0.07760	0.07760	0.07760	0.07760	0.07760	0.07760	0.07760
F.4	0.03450	0.03450	0.03450	0.03450	0.03450	0.03450	0.03450	0.03450	0.03450	0.03450	0.03450	0.03450	0.03450	0.03450	0.03450
IP.1	0.05582	0.05582	0.05582	0.05582	0.05582	0.05582	0.05582	0.05582	0.05582	0.05582	0.05582	0.05582	0.05582	0.05582	0.05582
IP.2	0.01623	0.01623	0.01623	0.01623	0.01623	0.01623	0.01623	0.01623	0.01623	0.01623	0.01623	0.01623	0.01623	0.01623	0.01623
IP.3	0.04122	0.04122	0.04122	0.04122	0.04122	0.04122	0.04122	0.04122	0.04122	0.04122	0.04122	0.04122	0.04122	0.04122	0.04122
IP.4	0.06055	0.06055	0.06055	0.06055	0.06055	0.06055	0.06055	0.06055	0.06055	0.06055	0.06055	0.06055	0.06055	0.06055	0.06055
LG.1	0.03595	0.03595	0.03595	0.03595	0.03595	0.03595	0.03595	0.03595	0.03595	0.03595	0.03595	0.03595	0.03595	0.03595	0.03595
LG.2	0.15614	0.15614	0.15614	0.15614	0.15614	0.15614	0.15614	0.15614	0.15614	0.15614	0.15614	0.15614	0.15614	0.15614	0.15614
LG.3	0.14787	0.14787	0.14787	0.14787	0.14787	0.14787	0.14787	0.14787	0.14787	0.14787	0.14787	0.14787	0.14787	0.14787	0.14787
LG.4	0.01805	0.01805	0.01805	0.01805	0.01805	0.01805	0.01805	0.01805	0.01805	0.01805	0.01805	0.01805	0.01805	0.01805	0.01805
ST.1	0.06241	0.06241	0.06241	0.06241	0.06241	0.06241	0.06241	0.06241	0.06241	0.06241	0.06241	0.06241	0.06241	0.06241	0.06241
ST.2	0.05399	0.05399	0.05399	0.05399	0.05399	0.05399	0.05399	0.05399	0.05399	0.05399	0.05399	0.05399	0.05399	0.05399	0.05399
ST.3	0.00103	0.00103	0.00103	0.00103	0.00103	0.00103	0.00103	0.00103	0.00103	0.00103	0.00103	0.00103	0.00103	0.00103	0.00103

Appendix H: The Semi-Structured Interview Survey

Interview Questions

1. Financial Perspective

1.1. What are the most important cost items regarding to the overall cost structure of your company?

1.2. What is the profitability rate of your company compared to last year(s) and which measures do you consider under profitability?

1.3. What is the sales growth rate of your company compared to last year(s)?

1.4. What is the equity ratio rate of your company compared to last year(s)?

2. Internal Process Perspective

2.1. Can you briefly explain about your company's on-time delivery performance?

2.2. Can you briefly explain about your company's delivery circumstances (e.g. the rate of loss and/or damages) and how do you deal with the delivery problems?

2.3. Can you briefly explain about your company's transport capacity (e.g. number of vehicles in the fleet, annual amount of carried goods etc.)?

2.4. Can you briefly explain about your company's warehouse capacity (e.g. number of warehouses, general capacity of warehouses etc.)?

3. Stakeholder Perspective

3.1. What is the overall customer satisfaction rate/index of your company and how often do you conduct this survey?

3.2. What is the overall employee satisfaction rate of your company and how often do you conduct this survey?

3.3. Can you briefly explain about your relation with the government and what kind of strategies do you follow in order to fulfil the expectation of the government?

4. Learning and Growth Perspective

4.1. Can you briefly explain about IT infrastructure of your company within internal and external operations?

4.2. Can you briefly explain what kind of activities do you organize to educate your employees/personnel and what is the education level of your employees/personnel?

4.3. Can you briefly explain about the operation and management ability of your company managers?

4.4. If you use social media, which social media activities do you do for brand building and what kind of social media tools do you use (e.g. Facebook, Twitter, LinkedIn etc.)?

Appendix I: The Limit Supermatrix with Equal Cluster Weights

	F.1	F.2	F.3	F.4	IP.1	IP.2	IP.3	IP.4	LG.1	LG.2	LG.3	LG.4	ST.1	ST.2	ST.3
F.1	0.11840	0.11840	0.11840	0.11840	0.11840	0.11840	0.11840	0.11840	0.11840	0.11840	0.11840	0.11840	0.11840	0.11840	0.11840
F.2	0.11149	0.11149	0.11149	0.11149	0.11149	0.11149	0.11149	0.11149	0.11149	0.11149	0.11149	0.11149	0.11149	0.11149	0.11149
F.3	0.05930	0.05930	0.05930	0.05930	0.05930	0.05930	0.05930	0.05930	0.05930	0.05930	0.05930	0.05930	0.05930	0.05930	0.05930
F.4	0.02299	0.02299	0.02299	0.02299	0.02299	0.02299	0.02299	0.02299	0.02299	0.02299	0.02299	0.02299	0.02299	0.02299	0.02299
IP.1	0.06667	0.06667	0.06667	0.06667	0.06667	0.06667	0.06667	0.06667	0.06667	0.06667	0.06667	0.06667	0.06667	0.06667	0.06667
IP.2	0.02591	0.02591	0.02591	0.02591	0.02591	0.02591	0.02591	0.02591	0.02591	0.02591	0.02591	0.02591	0.02591	0.02591	0.02591
IP.3	0.03288	0.03288	0.03288	0.03288	0.03288	0.03288	0.03288	0.03288	0.03288	0.03288	0.03288	0.03288	0.03288	0.03288	0.03288
IP.4	0.04146	0.04146	0.04146	0.04146	0.04146	0.04146	0.04146	0.04146	0.04146	0.04146	0.04146	0.04146	0.04146	0.04146	0.04146
LG.1	0.05968	0.05968	0.05968	0.05968	0.05968	0.05968	0.05968	0.05968	0.05968	0.05968	0.05968	0.05968	0.05968	0.05968	0.05968
LG.2	0.16794	0.16794	0.16794	0.16794	0.16794	0.16794	0.16794	0.16794	0.16794	0.16794	0.16794	0.16794	0.16794	0.16794	0.16794
LG.3	0.13051	0.13051	0.13051	0.13051	0.13051	0.13051	0.13051	0.13051	0.13051	0.13051	0.13051	0.13051	0.13051	0.13051	0.13051
LG.4	0.02517	0.02517	0.02517	0.02517	0.02517	0.02517	0.02517	0.02517	0.02517	0.02517	0.02517	0.02517	0.02517	0.02517	0.02517
ST.1	0.07434	0.07434	0.07434	0.07434	0.07434	0.07434	0.07434	0.07434	0.07434	0.07434	0.07434	0.07434	0.07434	0.07434	0.07434
ST.2	0.06056	0.06056	0.06056	0.06056	0.06056	0.06056	0.06056	0.06056	0.06056	0.06056	0.06056	0.06056	0.06056	0.06056	0.06056
ST.3	0.00272	0.00272	0.00272	0.00272	0.00272	0.00272	0.00272	0.00272	0.00272	0.00272	0.00272	0.00272	0.00272	0.00272	0.00272