A decision support model for identification and prioritization of key performance indicators in the logistics industry

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Abstract

Performance measurement of logistics companies is based upon various performance indicators. Yet, in the logistics industry, there are several vaguenesses, such as deciding on key indicators and determining interrelationships between performance indicators. In order to resolve these vaguenesses, this paper first presents the stakeholder-informed Balanced Scorecard (BSC) model, by incorporating financial (e.g. cost) and non-financial (e.g. social media) performance indicators, with a comprehensive approach as a response to the major shortcomings of the generic BSC regarding the negligence of different stakeholders. Subsequently, since the indicators are not independent of each other, a robust multi-criteria decision making technique, the Analytic Network Process (ANP) method is implemented to analyze the interrelationships. The integration of these two techniques provides a novel way to evaluate logistics performance indicators from logisticians' perspective. This is a matter that has not been addressed in the logistics industry to date, and as such remains a gap that needs to be investigated. Therefore, the proposed model identifies key performance indicators as well as various stakeholders in the logistics industry, and analyzes the interrelationships among the indicators by using the ANP. Consequently, the results show that educated employee (15.61%) is the most important indicator for the competitiveness of logistics companies.

Keywords: logistics performance indicators, balanced scorecard, ANP, multi-criteria decision making, stakeholders, social media.

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1. Introduction

Performance indicators are fundamental managerial tools for decision-making in organizations (Gunasekaran, Irani, Choy, Filippi, & Papadopoulos, 2015). In the past, financial indicators were largely considered in performance measurement systems (Yang, Chuang, & Huang, 2009); however, current performance measurement is based on both financial and non-financial indicators (Poveda-Bautista, Baptista, & García-Melón, 2012) due to its multidimensional structure (Gutierrez, Scavarda, Fiorencio, & Martins, 2015). Despite including financial and non-financial indicators in a system which assists companies to carry out their decision-making processes in a more conscious manner (Gunasekaran & Gallear, 2012), it brings to the fore one of the most widespread issues, which is having too many indicators in performance measurement (Shaw, Grant, & Mangan, 2010; Keebler & Plank, 2009).

Performance measurement is implemented in different areas, one of which is the logistics aspect of a supply chain. Logistics is a part of the supply chain management (Lambert & Cooper, 2000; Wu, Dong, Chang, & Liao, 2015) and diverse activities existing in logistics operations are mainly provided by logistics companies as they play crucial roles in a supply chain. Recently, logistics has become substantially more important (Gunasekaran & Ngai, 2012) as a result of globalization as well as advanced technologies (Wu et al., 2015). Increasingly, fierce competition forces logistics companies to assess their performance with a comprehensive measurement model to become more competitive in the industry. To have a comprehensive model, the consideration of a broad range of indicators from different perspectives may be required for organizations (Bhagwat & Sharma, 2009). However, logistics companies have poor capabilities for efficiently adapting performance indicators (Forslund, 2012), and, deciding on which indicators are the most important for their competitiveness becomes another issue to be addressed (Liu, McKinnon, Grant, & Feng, 2010a). These lead practitioners to seek answers to several questions, including, what indicators they should use and when they should use them (Gopal & Thakkar, 2012). Therefore, there is a need in the logistics industry to establish a framework for applying a strategic performance measurement system to third-party logistics (3PL) providers (Rajesh, Pugazhendhi, Ganesh, Ducq, & Koh, 2012) by examining a good balance of indicators with a holistic approach (Gutierrez et al., 2015). However, the performance measurement and indicators with respect to 3PL companies have received only limited interest from both researchers and practitioners (Rajesh et al., 2012). Similarly, there are few studies focusing on both logistics performance evaluation from multiple perspectives (Wang, Zhang, & Zeng, 2012) and logistics performance measurement in particular (Keebler & Plank, 2009).

Accordingly, in order to identify the key indicators in logistics performance measurement, the Balanced Scorecard (BSC) concept, which is a widely accepted approach (Rajesh et al., 2012), was found to be suitable for the present study due to its outstanding features, such as incorporating financial and non-financial indicators from different perspectives (Jothimani & Sarmah, 2014; Poveda-Bautista et al., 2012; Chia, Goh, & Hum, 2009) and allowing cause-and-effect relationships (Kaplan & Norton, 1996). Thus, the present study extends the existing knowledge on the applicability of the BSC in the logistics industry by presenting a comprehensive balanced set of logistics performance indicators from different perspectives.

Moreover, identification of key indicators is not the only challenge for performance measurement systems in companies. In complex real-life scenarios, interdependencies may also occur among indicators (Tzeng, Chiang, & Li, 2007), owing to the fact that they are not always completely independent of each other (Tsai, Chou, & Hsu, 2009; Wu & Lee, 2007). Yet, this has been barely considered by researchers working in the field of performance measurement (Grosswiele, Röglinger, & Friedl, 2013) and organizations (Thakkar, Deshmukh, Gupta, & Shankar, 2007). Since modelling the hierarchical structure as well as determining and prioritizing dependencies among diverse indicators constitute a challenging and still unresolved issue in the domain of the supply chain (Akyuz & Erkan, 2010), it is essential for logistics companies to investigate relationships between their various capabilities (Wong & Karia, 2010). Thus, logistics managers need to further try to answer several questions, such as how to prioritize the indicators and how to construct a hierarchical relationship to identify the influences among indicators (Qureshi, Kumar, & Kumar, 2008). In such cases, multi criteria decision making (MCDM) methods offer practical solutions, but, designing a framework of performance measurement in accordance with the complexity of MCDM has also been a difficult issue in terms of fulfilling the needs of the field (Shaik & Abdul-Kader, 2014). Despite this, within these methods, the Analytic Network Process (ANP) appears to be promising, since it provides a more accurate and realistic performance score (Yurdakul, 2003). Thus, the present research deploys the ANP method to capture the interdependencies among the performance indicators and to prioritize them by addressing this issue.

Consequently, to deal with the previously mentioned challenges, there is a need to develop a model for identifying the key logistics performance indicators and determining their interrelationships. Therefore, the aim of the present study is to provide a comprehensive decision model that identifies the key performance indicators for the logistics industry and assesses the interrelationships among these indicators from the perspective of logisticians by using an MCDM process. In order to achieve this aim, the main research question of this research is established as: *How can a decision model be formed by incorporating key logistics performance indicators and can help the prioritization of these indicators by considering all interrelationships?*

Although there are a number of studies focusing on the BSC concept in the logistics industry, implementing the MCDM approach with the BSC concept has received very limited attention in the logistics area. Specifically, despite the existence of some studies on the BSC-ANP integration, none of these have focused on the aforementioned integration for logistics companies. Besides, in order to deal with the major deficiency of the conventional BSC concept, the present study has replaced the 'customer' perspective with the 'stakeholders' perspective. In this way, a novel approach has been pursued to propose a comprehensive decision model that consists of four perspectives (financial, internal process, stakeholders, learning and growth) for the evaluation of logistics performance indicators by considering various stakeholders. The implementation of this approach was proven on the example of the Turkish logistics industry.

The remainder of the paper is organized as follows. In Section 2, the literature pertaining to the BSC, the ANP, and their implementations in the logistics industry are reviewed. In Section 3, the research methods employed to meet the aim of this study are explained. Section 4 presents the stakeholder-informed BSC decision model of this study, followed by the ANP application of the developed model in the Turkish logistics industry in Section 5. The implications for theory and management are listed in Section 6, followed by the conclusions, which are explained in Section 7.

2. Emergence of the need to use the BSC-ANP combination in logistics performance measurement

Performance measurement holds a complex value-creating system together, and formulates a strategy implementation which is monitored (Choy, Chow, Tan, Chan, Mok, & Wang, 2008; Handfield & Nichols, 1999). It is an interdisciplinary field which is also applicable to logistics. Logistics performance measurement has been researched by various authors and identified as a key aspect to be focused on. Yet, there is a small amount of research relating to how logistics companies manage performance management processes (Forslund, 2012). Moreover, only few papers have so far dealt with logistics performance evaluation from multiple perspectives (Wang *et al*., 2012), although it is a complex task for organizations to manage these processes in a balanced approach. In order to overcome this complexity, different performance measurement models (e.g. Balanced Scorecard, Performance Prism, Performance Pyramid, Results and Determinants Framework, Performance Measurement Matrix) have been proposed. Of these models, the models developed after the mid-1980s provide a more balanced structure in terms of incorporating both financial and non-financial indicators (Garengo, Biazzo, & Bititci, 2005).

The BSC, which was initially introduced by Kaplan and Norton in 1992 as a performance measurement model (Kladogeni & Hatzigeorgiou, 2011; Kaplan & Norton, 2001), dominates the performance measurement area (Neely, 2005) and allows incorporating cause-and-effect relationships with a balanced structure (Kaplan & Norton, 1996). Similarly, Shaw et al. (2010) noted that the BSC is the most extensively accepted model by organizations, and it provides a high-level strategic view for organizational performance. However, the implementation of the BSC remains limited for studies conducted in a logistics context.

One example of these studies is Chia & Hoon's (2000) study, where they first emphasized that the performance of an organization is usually measured by financial indicators, although, for a balanced measurement it is also necessary to use non-financial indicators. For that purpose, they applied a case-based approach to show the adaptation of the BSC in two leading logistics companies in Singapore, by interviewing the CEOs and senior-managers of the companies as well as conducting a questionnaire with them. At the end of the study, they pointed out that senior-managers may not be fully aware of an organization’s vision and strategies, and therefore, the BSC approach allowed them to make observations in a more balanced way rather than focusing solely on the financial measures. Likewise, Rajesh et al. (2012) implemented a three-stage method, namely the expert opinion method, the modified Q-sort method, and the Delphi analysis, to develop a BSC-based framework in a 3PL context. In their paper they identified five critical functions/departments, and the perspectives of the BSC approach were considered for each function/department to develop a generic model. On the other hand, McLachlin, Larson, & Khan (2009) emphasized the adaptability of the BSC approach to the humanitarian logistics context, and also pointed out that the limited usage of the performance measures was expanded in the business logistics context with the help of the BSC approach.

The BSC concept has also been investigated in a reverse logistics context. Shaik & Abdul-Kader (2012) proposed a BSC-based model, where performance measures were prioritized by the Analytic Hierarchy Process (AHP) method. Particularly, they utilized both the BSC and the performance prism approaches with the adaptation of the ‘stakeholder’ perspective into their BSC-based model. Likewise, in a further study by Shaik & Abdul-Kader (2013), the BSC and the performance prism approaches were combined, and both the metrics and the perspectives were prioritized using the same method, although the performance metrics used in the framework were fewer, and some of them were different when compared to their previous study. In yet another study, Shaik & Abdul-Kader (2014) linked the six perspectives of the model (financial, process, stakeholder, innovation and growth, environmental, social) to the dimensions of strategies, processes, and capabilities to form their performance measurement framework, and they used the DEMATEL technique to identify the strength of the relationships between the indicators and the perspectives.

Although it is a dominating model, the BSC also has some limitations, as indicated in the literature, as follows. First, despite the BSC being based on the stakeholder theory (Hubbard, 2009), the generic BSC does not reflect the interests of all stakeholders (Striteska & Spickova, 2012). This deficiency needs to be addressed, due to the existence of many stakeholders (e.g. employees, government, customers, investors), in the logistics and transportation system which connects different channel members (Shaik & Abdul-Kader, 2013). Second, the relationships between the perspectives and making a decision on how many and which of the perspectives to have in the framework, remain a multi-objective and multi-criteria evaluation problem (Shaik & Abdul-Kader, 2014; Wagner, 2002).

To overcome the first limitation, we replaced the 'customer' perspective of the original BSC model with the 'stakeholders' perspective having been informed by the previous works with a similar approach (e.g. Shaik & Abdul-Kader, 2014; Hsu, Hu, Chiou, & Chen, 2011). Moreover, whilst incorporating the 'stakeholders' perspective, we pursued some steps for the identification of various stakeholders, such as examining proposed stakeholder models in different papers, scrutinizing feasible criticisms on Freeman's (1984) stakeholder concept, reviewing relevant studies concerning the stakeholder concept with commonly used stakeholders, and considering the Turkish governmental structure since different types of organizations (e.g. trade unions, foundations, associations) were identified as part of non-government organizations in Turkey. This way, by considering not only the customers, but also other stakeholders in the logistics field, the research addresses the issue from a more comprehensive aspect. With regard to the second limitation, we applied the ANP method as an MCDM technique to capture the interdependencies between and within the perspectives as the method was suggested by Yeap, Ignatius, & Ramayah (2014) when there are interdependencies among criteria. As a consequence, by applying the ANP, we are able to take advantage of using a network structure that is more appropriate to represent the reality (Yang et al., 2009).

The ANP can be used either as a single method or as a part of mixed methods, in a conventional form or with fuzzy datasets (e.g. Leung, Lam, & Cao, 2006; Thakkar et al., 2007; Yurdakul, 2003). Using the ANP as a single technique and in the conventional form is more effective, since with fuzzy logic, it is difficult to scale this to larger problems (Wang, Xu, & Li, 2009) and it is difficult to produce valid answers in decision-making (Saaty, 2006).

Although there are different MCDM techniques studied by previous researchers, each of them has different limitations. As Velasquez & Hester (2013) indicated the features of these techniques, some techniques (e.g. DEA) are not suitable for this research since there is no input/output relationship between the indicators in the model whereas several methods (e.g. TOPSIS, AHP) are not appropriate due to the existing interrelationships and correlations among the indicators. Furthermore, in Saaty & Vargas's (2006) study, a comparison of different group decision-making methods, summarized by Couger (1995), was presented and according to the comparison, the ANP appears as the most outstanding technique in terms of the 16 selected criteria, which are: *leadership effectiveness, learning, scope, development of alternatives, breadth, depth, faithfulness of judgments, breadth and depth of analysis (what-if), cardinal separation of alternatives, prioritizing group members, consideration of other actors and stakeholders, scientific and mathematical generality, applicability to intangibles, psychophysical applicability, applicability to conflict resolution,* and *validity of the outcome (prediction).* Additionally, it was pointed out by Kayakutlu & Buyukozkan (2011) that the ANP represents a unique way to offer more accurate results by considering interdependent relationships.

Although there are many applications of the ANP in performance measurement and evaluation, there are few studies focusing on the logistics and supply chain management domain. According to Meade & Sarkis (1998), applications of the analytical models for the logistics strategy analysis are very rare, and more specifically, the ANP application remained very limited. Therefore, they employed the ANP method in their research to evaluate three logistics systems for an enterprise. Another research was proposed by Zang, Luo, Zhang, Li, & Zhang (2013) who utilized the ANP method to prioritize and select the best municipal solid waste logistics systems. In a more particular study conducted by Kayakutlu & Buyukozkan (2011), 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 analyze the interrelationships among the factors. Therefore, they chose the ANP method to capture the interdependencies.

Furthermore, in order to present a robust analysis, the ANP was integrated with the BSC approach by researchers in various contexts, including the universities (e.g. Atafar, Shahrabi, & Esfahani, 2013), the advertising industry (e.g. Poveda-Bautista, García-Melón, & Baptista, 2013), the fashion industry (e.g. De Felice & Petrillo, 2013), and the manufacturing industry (e.g. Lee, Chen, & Tong, 2008). In addition, the use of the BSC-ANP combination was highlighted and proposed by some authors for further studies. For instance, Poveda-Bautista et al. (2012) assessed 17 competitiveness indicators and three companies in the plastic industry of Venezuela, using the combination of the BSC-ANP, and also recommended to use this combination for future studies. From this point of view, the ANP method was followed in this current research to evaluate the logistics performance indicators under the four perspectives in the model.

Additionally, using the BSC-ANP integration in the present research has the potential to provide a robust approach to reflect the real life examples, since the integration helps to overcome some traditional shortcomings of the BSC implementation, such as dependencies of the indicators, and the use of subjective or objective indicators (Leung et al., 2006). Since the ANP provides a suitable way of considering interactions among the BSC indicators, as well as prioritizing them, the combined BSC-ANP approach helps decision makers in diverse ways, such as establishing relationships among and within the various dimensions, measuring the strengths of the interactions, and deriving priorities for the dimensions (Tjader, May, Shang, Vargas, & Gao, 2014).

As a result, we used the following search terms to identify relevant studies for integrating the BSC and ANP approaches: “Balanced scorecard-Analytic Network Process-logistics”, “BSC-ANP-logistics”, "Balanced scorecard-ANP-logistics", and "BSC-Analytic Network Process-logistics", in five databases; namely, ABI/Inform, ScienceDirect, Scopus, Emerald, and Sage. The searches were conducted mainly in the abstract, title, and keywords of the articles indexed in these databases. Consequently, one peer-reviewed journal article was found after these searches. In the article, Ravi, Shankar, & Tiwari (2005) analyzed reverse logistics operations for end-of-life computers and applied a case study based upon a small PC manufacturing company to demonstrate the applicability of the BSC-ANP combination. They also denoted that the BSC-ANP integration provides more realistic and accurate results for selecting the relevant indicators and for determining the interdependent relationships among these indicators. Thus, the literature review demonstrates that the integration of these two powerful approaches can fill the research gap and can address the aforementioned challenges in the logistics field by considering the entire logistics industry, without focusing on any specific operation, such as reverse logistics, or any other sector (e.g. manufacturing).

3. Methodology

There is not one preferred method in business studies, and the choice of method, which confirms the rules and procedures in order to solve problems, depends on the research problem, the research design, and the aim of the research (Ghauri & Grønhaug, 2005). Drawing on the previously mentioned research problems, the current study seeks to identify the key logistics performance indicators and to prioritize them by considering the existing interrelationships. Accordingly, in order to accomplish this purpose, the methodology of this study is designed as shown in Fig.1, where the procedures were followed as guidelines throughout the research to address the aforementioned research problems. The main research methods used in the study are introduced in the following sub-sections.

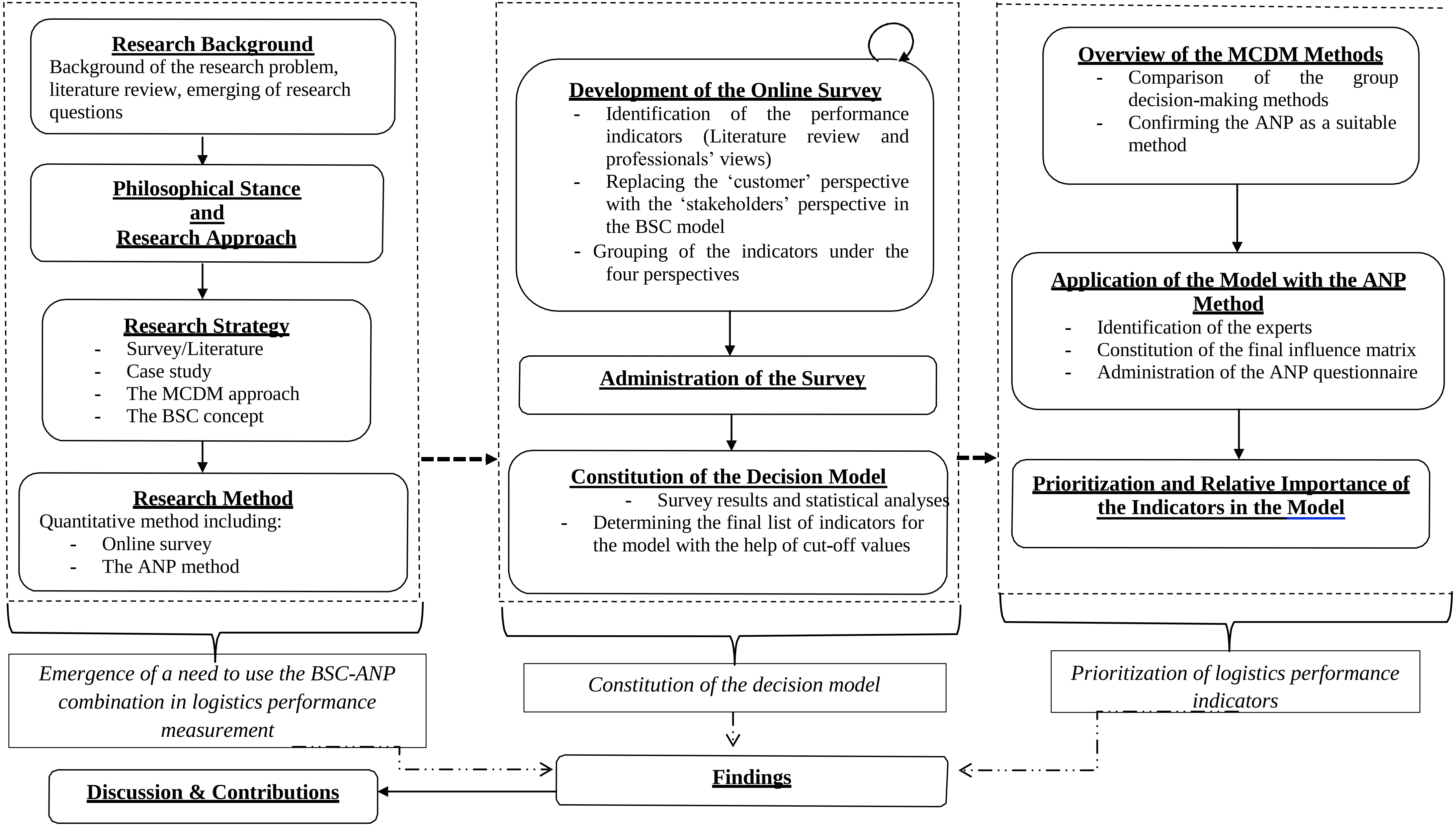

Fig.1. The research design

3.1. Online survey

The most frequently used technique for an empirical research in social sciences is the survey method (Bortz & Döring, 2002, cited in Grant, Teller, & Teller 2005, p. 140), especially in the logistics and supply chain management field (Grant et al., 2005). There are different survey tools and one of them is questionnaires, which are used to transform the data obtained from large groups of people into information (Hair, Bush, & Ortinau, 2003).

The categorization of the questionnaires varies based on the ways they are administrated. Each type of questionnaire has different strengths and weaknesses. For instance, the self-administered postal or mail surveys have some disadvantages, such as a low return, high non-response rates, lack of external validity and a lack of control over how the questionnaires are completed, and how respondents are stimulated to give their answers (Atteslander & Bender 1993, cited in Grant et al., 2005, p.140). To deal with these shortcomings, logistics researchers considered new opportunities provided by the Internet or web-based questionnaires (Grant et al., 2005). Thus, the online survey was chosen in the first stage of the methodology of the present study, so as to reveal the most predominant indicators used in the logistics industry.

3.2. The ANP method

The Analytic Network Process (ANP) proposed by Saaty (1996) (Liou & Chuang, 2010; Saaty & Vargas, 2006) is one of the MCDM techniques (Öztayşi, Kaya, & Kahraman, 2011). ANP is an extension of the Analytic Hierarchy Process (AHP) (Saaty, 2013; Lin, Tsai, Shiang, Kuo, & Tsai, 2009), and it incorporates a supermatrix approach (Saaty & Vargas, 2006). Therefore, the ANP is also termed 'Supermatrix' in the literature (Yurdakul, 2003). While the AHP allows for a strict hierarchical structure (Kayakutlu & Buyukozkan, 2011), the ANP method goes beyond this one-way structure by allowing feedback (Saaty, 2013; Poveda-Bautista et al., 2012) and revealing dependencies both within and among the clusters (Saaty, 1999; Ravi et al., 2005). Furthermore, the ANP is a comprehensive decision making tool that can accommodate both financial and non-financial indicators in a model (Ravi et al., 2005).

ANP enables the aggregation of different individual opinions obtained from several experts as a result of the group decision making approach. This is an advantage for the ANP since group decision making may prevent the possibility of a bias being introduced by a single decision maker (Horenbeek & Pintelon, 2014). The ANP has been extensively practiced as a decision making tool for different purposes in the literature (Hsu et al., 2011). In this current study, the ANP method was used to evaluate and prioritize the logistics performance indicators in three major stages, as follows:

Stage 1: Building the network

A network system includes components and elements with their interactions (Saaty & Vargas, 2006). The first phase of network model formation is the determination of the components (clusters), elements (or criteria), and sub-criteria (if there are any) in the network model in regard to the aim and objectives of a study. After the clusters and the elements are identified for the network model, the elements are classified in the corresponding clusters in a network system. Then, the interactions within and among the clusters are identified by a group of experts, so that the transmitted influences can be captured. The relationships of the elements within a cluster are shown with a looped arc on the top of the cluster (inner dependence), whereas the interrelationships between the elements in different clusters are depicted with arcs (outer dependence) (Saaty, 2008).

Stage 2: Pairwise comparisons and consistency

It is initially essential to form an influence matrix in order to determine the possible influences as well as the strengths of these influences among the elements in the network. The influence matrices obtained from each decision maker are used to form the final influence matrix, in which zero values represent no relationship, whilst non-zero values show the relationships among the elements. With regard to the non-zero values in the final influence matrix, pairwise comparisons are generated and the level of dominance is aimed to be measured during the pairwise comparisons (Saaty, 2009). For each comparison, decision makers assign relative scores from Saaty's 1-9 scale by comparing two components or elements. This scale translates the human judgments into numerical values and, in this scale, a score of 1 shows 'equal importance' while a score of 9 represents the 'extreme importance' or a superior dominance of a row component over the column component (Hsu et al., 2011). In the comparison scores, the assigned value is represented by a_{ij}, while inverse dominance level is indicated by a_{ji} where the column component has dominance over the row component. This feature demonstrates that there are reciprocal relationships, and these are supported by the ANP technique.

Moreover, during the pairwise comparisons of the ANP technique, the geometric mean method is used to aggregate individual scores attained by each decision maker (or expert), since this is the only way to describe reciprocal relations in decision making (Saaty & Vargas, 2006; Saaty, 2009). Furthermore, conducting consistency tests for each comparison matrix is also crucial. In the ANP studies, the overall inconsistency is measured by the consistency ratio (C.R.) which is the score for a comparison matrix, and should be less than or equal to 10% (Saaty, 2008; Saaty, 2009). Further details can be found in Saaty's (2009) published book.

Stage 3: Constructing supermatrices

The supermatrix approach resembles the Markov chain process (Saaty, 1996) and in the supermatrix, only the elements having non-zero influence are pairwise compared (Saaty & Vargas, 2006). As a result of the comparisons, the calculated priority vectors are entered as part of the relevant columns in the supermatrix system (Saaty, 2009). Generally, there are three supermatrices in an ANP network, which are unweighted, weighted, and limit supermatrices.

Different priorities acquired from various pairwise comparisons form the unweighted supermatrix, which is used to produce the weighted supermatrix with the help of the cluster matrix (Saaty, 2005). By raising the weighted supermatrix to the power 2^{k+1} until it converges, where k is an arbitrarily large number (Meade & Sarkis, 1999), the limit matrix is constituted (Saaty, 2005). The main reason for raising the weighted supermatrix to these powers is to capture the transmission of impacts across all possible paths of the supermatrix (Saaty & Vargas, 2006). At the end of these stages, the final weights of both the elements and the clusters are obtained as well as their prioritizations.

3.3. Ethics in the research process

On the first page of the online survey, the respondents were provided with the relevant information regarding the research, such as the purpose, the need for their voluntarily participation, the confidentiality of their answers, and the contact details of the researchers. Additionally, in the expert interview processes, as will be explained in the next section, the interviewees were also informed that the collected data would be used only for academic purposes and their identities would remain anonymous.

4. The development of the stakeholder-informed BSC decision model

4.1. Identification of the performance indicators prior to the online survey

In the present research, the key performance indicators that have an impact on the logistics industry, and in turn the competitiveness of logistics companies, were constructed after a comprehensive literature review and interviews with academics and practitioners in the field. The conventional BSC structure was adjusted to incorporate the stakeholder perspective, together with the financial, internal process, and learning and growth. For the identification of the relevant performance indicators from the literature, the authors followed the phases explained below.

Firstly, the keywords shown in Table 1 were searched for mainly within the abstracts, titles, and keywords, similar to that in Küçükaltan & Herand's (2014) study, using the five previously mentioned databases. By doing this, previous peer-reviewed studies regarding performance indicators in logistics were reviewed.

Table 1
Keywords used in the five 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*"

At the end of the literature review, the initial list of performance indicators was formed, and afterwards, with the guidance of five logistics professionals' assessments, as will be explained later, several processes were followed by the authors. For instance, a number of studies (e.g. Gunasekaran & Kobu, 2007; Chow, Heaver, & Henriksson, 1994) that either reviewed the literature regarding the performance factors or that focused on the incorporation of performance criteria used in the logistics field, were examined in order to be guided on the direction of a right approach to be followed. Furthermore, studies related to stakeholder theory concept (e.g. Freeman, 1984; Mishra & Dwivedi, 2012; Donaldson & Preston, 1995; Freeman, 1994) were scrutinized to adapt various stakeholders comprehensively in the stakeholder-informed BSC survey. In addition, various articles from the fields of logistics and supply chain were analyzed to determine the common and significant logistics performance indicators. Lastly, a number of related studies, in line with the scope of this research, were investigated by the cross-referencing method, as previously used in different studies (e.g. Colicchia, Marchet, Melacini, M., & Perotti, 2013; Marasco, 2008).

During the cross-referencing stage, social media usage was found to be a significant performance indicator for the logistics industry. Although having been mainly used in the business-to-consumer context, social media has also been used in the business-to-business domain by many companies (Michaelidou, Siamagka, & Christodoulides, 2011). Using social media affects marketing outcomes and leads to an increase in sales (Stephen & Galak, 2012), reputation, and profitability of the companies.

In the logistics industry, the study by Lieb & Lieb (2012) emphasized that, even though social media is vital for brand building activities in the industry, the impact of the social media tools on the regional logistics industry have currently been limited. From this point of view, the authors pointed out that social media can be used as a differentiation element by logistics companies, and will become increasingly important for logistics companies' brand building strategies. Similarly, Wu, Lirn, & Dong (2014) highlighted the scarcity of research on marketing and branding activities in the 3PL industry. Therefore, it was decided that 'social media usage for brand building' should be included in the BSC concept for the first time, especially for the logistics industry.

While gathering all these indicators, in order to reduce the number of indicators to a manageable level and to present the indicators coherently, some of the indicators were combined (e.g. 'personnel training' and 'employee training'), whilst some others were eliminated from the list, based on the following reasons:

- Several indicators (e.g. after-sales services) are more likely to be used in the supply chain scope rather than the logistics industry. The present research intends to address the significant metrics used in the logistics industry from the logisticians' perspective,
- The scope of some indicators (e.g. risk) can be interpreted as being either too broad or too narrow/specific (e.g. transportation cost) to be included,
- As similar inference was pointed out by Gunasekaran & Kobu (2007), some of the indicators either refer to the same practices, although they are expressed differently (e.g. damage-free delivery and reducing freight damages), or overlap (e.g. customer satisfaction).

Throughout these phases, starting from the initial list to the final list of the indicators, feedback was also obtained from the five professionals, including two practitioners and three scholars in the logistics field. They were contacted through e-mail, telephone, and face-to-face meetings. According to the professionals, keeping the number of indicators at a manageable level is crucial for the success of the survey, as including too many indicators can cause ambiguity for the respondents. Tjader et al. (2014) similarly suggested that it is not possible to incorporate every measure in the perspectives of the BSC concept. Therefore, at the feedback stage, first, the initial list was sent to the professionals who were asked to remove/add indicator(s) as necessary. Then, during the following processes, the same strategy was repeated until a consensus on the new list of indicators was reached. On the one hand, these rounds enabled the professionals to merge some of the indicators into one broader name, whilst on the other hand, these also helped to identify any new indicators (e.g. equity ratio) for the survey. Finally, 43 logistics performance indicators, as can be seen in Table 2, were included in the online survey.

4.2. Grouping of the performance indicators into the four perspectives and the pilot test

After the determination of the indicators, the 43 defined indicators were categorized before conducting the online survey by following a similar approach carried out in some previous studies (e.g. Rajesh et al., 2012). In this regard, all of the defined indicators were placed into the four perspectives of the BSC model, based on both the examination of numerous studies in the literature and the consensus of the professionals in the logistics field. Besides, Nair (2011) discussed the usage of social media in the BSC concept and pointed out that social media can be considered as a part of the learning activity. Hence, social media usage for brand building was placed under the ‘learning and growth’ perspective.

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 easy-to-understand for the respondents. Before conducting the survey, a pilot study phase was carried out with five professionals, who checked the clarity, content, verbal aspect, and translation of the survey, as well as the representativeness of the 43 performance indicators for the logistics industry, and then, the survey was tested by six professionals from both academia and practice. Thus, the content and face validity of the survey were checked by the professionals, and the final version of the survey to be sent to the respondents was designed.

4.3. Administration and outcome of the survey

The survey was generated through an online survey service provider and the survey link was sent to both academics and practitioners in the Turkish logistics industry by using different sources, such as the e-mail addresses of existing contacts of the authors, as is the case in Vondey's (2010) research, and via some business networking sites (e.g. LinkedIn). The target population for this study is white-collar employees working in the logistics industry, government officers, and the academics working on logistics-related research. Yet, since it was difficult to contact some particular occupational groups (e.g. government officers), some of the respondents offered support for the distribution of the survey to their personal contacts. Therefore, the snowball sampling technique was also used in the distribution of the survey. Before implementing the snowball sampling procedures, certain requisite information, such as the appropriate demographic features of the potential respondents, the aim and the significance of the research, and the features of the survey were clearly explained in detail to the avid respondents, in order to obtain valid results from a wide and relevant range of people in the industry.

Ultimately, within twenty days, 72 respondents had answered all of the questions. As it is the case in other snowball sampling studies, it was difficult to calculate the certain return rate. Also, since the main objective of the online survey was only to highlight the most significant performance indicators used in the logistics industry in order to build the decision model, both the number of the indicators and the number of respondents were deemed as sufficient. As a matter of fact, the number of respondents in this research is also higher than other studies with a similar aim, such as Gasiea, Emsley, & Mikhailov's (2010) research, where 62 responses were considered sufficient, while Chang (2013) included 34 responses for the survey.

Apart from the significance degrees of the performance indicators, certain questions regarding both their job titles and working years (as can be seen in Fig.2) were also asked to the respondents. The demographics of the respondents showed that the highest number of respondents were from the officer/specialist category (29%), followed by other management positions (27%), academician (15%), engineer (15%), government officer/policy maker (8%), and high level management or owner (6%) categories, respectively. By including a variety of participants, a range of diversified opinions from different backgrounds was covered. Thus, these categories confirm that the respondents are familiar with the indicators and are able to provide valuable information about the importance of the indicators.

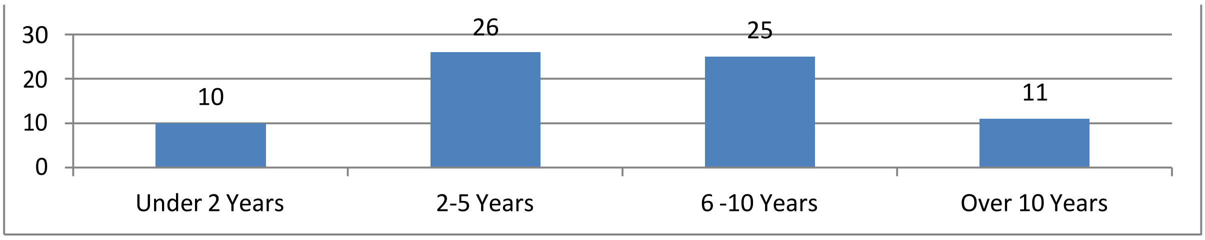

Fig.2. Working years of the respondents

On the other hand, the results concerning the working years indicate that majority of the respondents had more than two years working experience and half of the respondents had more than six years of working experience. These results confirm that experienced and knowledgeable professionals in the Turkish logistics industry completed the online survey.

In the main part of the survey, 43 scaled questions were formed with respect to the performance indicators, which were placed under the four perspectives. The respondents were asked to assign a score from the 5-point Likert scale (1-not important, 2-slightly important, 3-somewhat important, 4-important, 5-very important) to determine the degree of importance for each indicator. After the questionnaires were received from the respondents, the performance indicators were ranked in descending order for each perspective, based on the mean values of the indicators, as presented in Table 2.

Table 2
Results of the performance indicators in the survey

Performance Indicators	Mean Values	Cut-off Values
Financial Perspective		4.01
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	

Performance Indicators	Mean Values	Cut-off Values
Learning and Growth Perspective		3.89
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	
Internal Process Perspective		4.03
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	
Stakeholders Perspective		3.84
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	

Subsequently, in regard to the survey results, the reliability test was performed to check the overall reliability of each perspective. The calculated Cronbach's alpha scores regarding the perspectives were 0.798, 0.672, 0.923, and 0.777 for financial, learning and growth, internal process, and stakeholders, respectively.

Although the general acceptable limit is above 0.70, the alpha scores above 0.60 have also been accepted in different studies (e.g. Björklund & Forslund, 2013; Hair, Black, Babin, & Anderson, 2010). Therefore, all reliability scores for the perspectives were considered to be within the acceptable limits for this research.

4.4. Constitution of the decision model

After the results achieved in regard to the 43 indicators, the number of indicators was reduced, because as Kaplan and Norton implied, a BSC model should contain a total of 14-16 indicators with around four to six in each perspective (Hubbard, 2009). This is also essential for the ANP method which allows pairwise comparisons among the indicators in the model. Therefore, a cut-off value approach for each of the perspectives was considered appropriate. In previous studies, different approaches were used to identify the cut-off values. For instance, Lee, Kang, Hsu, & Hung (2009) arbitrarily decided a cut-off score for their questionnaire, while in several studies, the Likert scale mid-point was set as either a cut-off point (e.g. Stank, Daugherty, & Ellinger, 1999) or a threshold score (e.g. Liu, Grant, McKinnon, & Feng, 2010b). In the current study, the cut-off values were decided separately for each perspective in a more statistical-based approach by computing the average of the highest and the lowest mean scores of each perspective. The indicators that remained above the cut-off scores are shown in bold in Table 2. Consequently, 15 performance indicators, which were between the suggested intervals, were included in the final set of indicators in the developed stakeholder-informed BSC decision model of this study, as exhibited in Table 3.

Table 3
The list of performance indicators in the decision model

Financial Perspective	Learning and Growth Perspective	Internal Process Perspective	Stakeholders Perspective
Cost (F.1)	IT Infrastructure (LG.1)	On-time Delivery (IP.1)	Customer Satisfaction (ST.1)
Profitability (F.2)	Educated Employee (LG.2)	Circumstance of Delivery (IP.2)	Employee Satisfaction (ST.2)
Sales Growth (F.3)	Managerial Skills (LG.3)	Transport Capacity (IP.3)	Government Satisfaction (ST.3)
Equity Ratio (F.4)	Social Media Usage for Brand Building (LG.4)	Warehouse Capacity (IP.4)	-

5. Application of the developed model with the ANP method in the Turkish logistics industry

5.1. Case background

The position of Turkey is geopolitically important due to its location in the epicenter of transport corridors connecting Asia, Europe, the Middle East, and the Balkan countries. By having this strategic position, the country has the noteworthy potential to become a significant international logistics zone (Aktas, Agaran, Ulengin, & Onsel, 2011). The Turkish logistics industry plays a significant role in international trade since the industry has the largest fleet of trucks in Europe (Büyüközkan, Feyzioğlu, & Nebol, 2008). Additionally, according to the World Bank domestic logistics performance reports for 2007, 2012 and 2014, Turkey was illustrated as the top performer in its region (World Bank, 2015).

On the other hand, Turkey is one of the developing countries, and studies focusing on the ongoing supply chain and logistics activities of developing countries remain rather limited in the literature (Aktas & Ulengin, 2005; Ulengin & Ulengin, 2003). Furthermore, the interviews conducted with practitioners in the industry indicated that decision-makers have difficulties in deciding which indicators should be more focused upon. Therefore, in the light of the said motivations, and in order to provide a robust approach as a response to the existing research problems and to reflect the problem solutions in a strategically important case country, the Turkish logistics industry was examined in the present study.

5.2. The ANP method application

As previously mentioned, the experience and knowledge of the experts regarding a particular topic plays a critical role with respect to the assessments in the ANP structure. Experts' judgments are used when the information available is uncertain and biased (Poveda-Bautista et al., 2012) or when there is no quantitative data that can be analyzed.

Concerning the incorporation of experts' judgments, three experts were included in the decision making process of this study as the same number of experts were included in various decision-making studies (e.g. Öztayşi et al., 2011; Poveda-Bautista et al., 2012). These experts were selected to analyze interdependencies and feedback among the 15 identified performance indicators. In addition to their voluntary participation, the selection of the three experts was based on their experience and knowledge on the ANP processes, the BSC approach, and the logistics sector. For the experience in the logistics sector, as pointed out in Kayakutlu & Buyukozkan's (2011) study, having at least 10 years of experience was considered to be a significant factor for choosing the experienced experts. Therefore, the experts with more than 10 years of experience in the industry were selected for the study.

Moreover, despite two of the selected experts being from the academic field (similar to Karpak & Topcu, 2010) and serving as professors, they are also experienced in practice since they had both provided consultancy services to logistics companies in Turkey. More specifically, the first expert has much experience and knowledge about logistics and optimization whereas the expertise of the second is rather on logistics and marketing subjects. The third expert is from the industry with more than a decade experience and is employed as one of the top executives in a major logistics company in Turkey.

After the selection of the experts, the next phase was to build the final influence matrix. In this current study, alternatives were not involved in the ANP network as was the case in the study by Hsu et al. (2011), since our aim was not to select the best logistics company. On the contrary, the aim is to understand the priorities and relationships among the logistics performance indicators in order to help decision makers in logistics companies regarding which performance indicators affect their companies' competitiveness to a larger degree. For this reason, the developed model is intended to be applicable to the entire logistics industry rather than just to the included alternatives or a customer. Thus, a 15x15 influence matrix was sent to each expert in order to determine the relationships among the performance indicators in the model, and then, by applying the majority rule of the experts' choices (Beynon, 2006), the final influence matrix was generated.

5.2.1. The ANP questionnaire practice

Considering the interrelationships among the indicators and the perspectives (or clusters), as shown in Fig.3, based on the final influence matrix, an ANP pairwise comparison questionnaire with Saaty's 1-9 scale was sent to the experts. The three experts were requested to assess pairwise comparisons of the elements in the questionnaire. During the data input obtained from the expert scores, if the column element was dominant over the row element, the scale was transformed from 1 to 1/9 by keeping the same meanings of the scales for the advantage of the column element. This conforms to the ANP rules suggested by Saaty (2009).

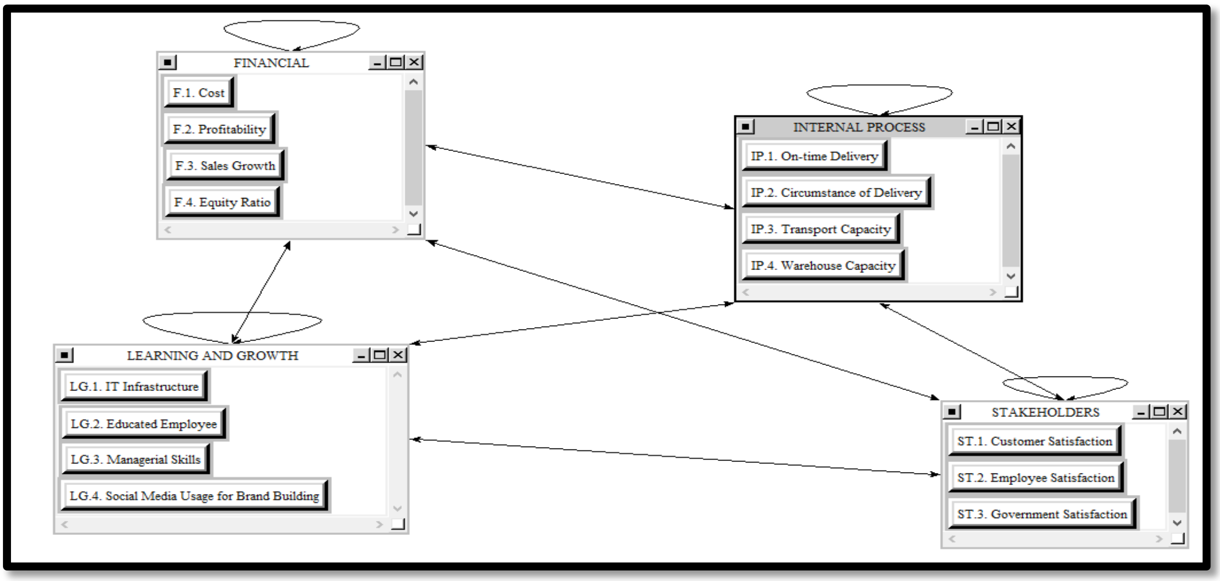

Fig.3. Interrelationships among the perspectives

During the pairwise comparisons in this study, the term 'influence' was used, as emphasized by Saaty (2009), and the experts assessed all comparisons among the indicators by using the same term. An example pairwise comparison matrix with respect to the 'profitability' indicator is illustrated in Table 4. In this table, the geometric mean values acquired from the three experts, the eigenvectors of the indicators, and the C.R. score of the whole matrix are also displayed.

Table 4
Pairwise comparison among the indicators with respect to profitability

	Cost	Sales growth	Equity ratio	Eigenvectors
Cost	1	7.612	6.082	0.768
Sales growth		1	0.585	0.091
Equity ratio			1	0.140

Note: C.R. = 0.01042

Eigenvectors obtained from pairwise comparisons were inserted as part of a profitability column in an unweighted supermatrix. Hence, the unweighted supermatrix, which is the first supermatrix of the ANP process, consisted of these local weights. In this research, as practiced in the calculation of the unweighted supermatrix, the *SuperDecisions* software (http://www.superdecisions.com/) was also used for calculating the remaining supermatrices.

The pairwise comparisons among the indicators were followed by the calculation of the relative weights among the perspectives. The interrelationships among the perspectives were identified on the basis of the final influence matrix and an example of the dominance among the perspectives with respect to the financial perspective is shown in Table 5.

Table 5
Pairwise comparisons among the clusters with respect to the financial perspective

	Financial	Internal process	Learning and growth	Stakeholders	Eigenvectors
Financial	1	4.160	6.649	5.313	0.615
Internal process		1	3.036	2.410	0.203
Learning and growth			1	0.480	0.069
Stakeholders				1	0.111

Note: C.R. = 0.03123

The cluster matrix, which shows the degree of the influences among the clusters, is used for the formation of the weighted supermatrix. The relative weights of the clusters computed through the *'SuperDecisions'* are presented in Fig.4.

Super Decisions Main Window: Superdecision

Cluster Node Labels	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

Done

Fig.4. Cluster matrix

Following the computations for the cluster matrix, the weighted supermatrix was formed by multiplying all of the entries in a block of the perspective in the unweighted supermatrix by the relative perspective weight computed in the cluster matrix. Then, after obtaining a stochastic matrix (each column sums to one), the limit supermatrix was derived by raising the weighted supermatrix until all of the rows showed the same scores. The outcome of the limit matrix provided us the final global weights and priorities of the performance indicators used in the decision model. The global weights for all performance indicators in the model are shown in Appendix A with the help of the *SuperDecisions*.

5.2.2. The results of the performance indicators

As seen in Appendix A, each indicator has the same score across all of the rows, and they were placed in the same order in the program as used in the presented model. The global rankings of the indicators derived from the limit matrix can be organized in a descending order as shown in Fig.5.

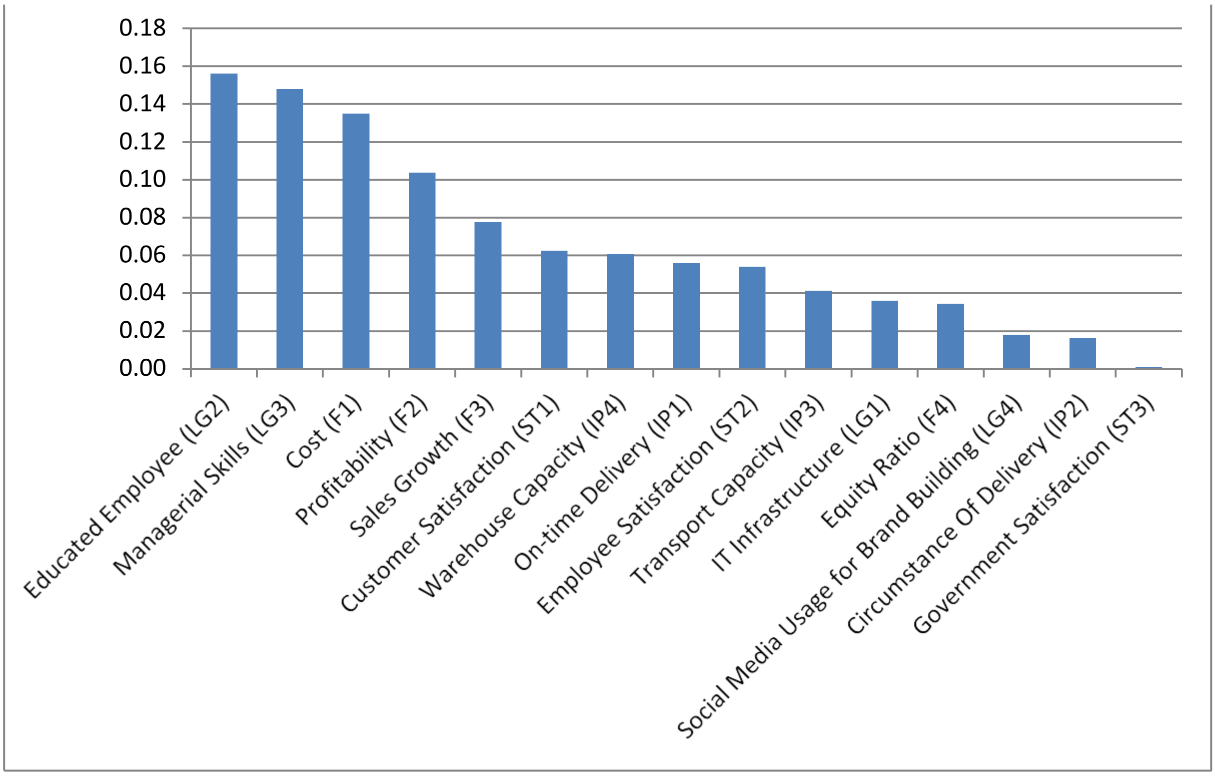

Fig.5. Ranking of the performance indicators in the logistics industry

Fig.5 presents both the relative ranking and the global weights of the performance indicators for the logistics industry based on the judgments of the expert group by using the ANP method. According to the results, the most important indicator is the educated employee (15.61%), followed by managerial skills (14.78%), cost (13.50%), and profitability (10.36 %). Remarkably, these four indicators account for more than a half of the total percentage of the 15 indicators, and therefore, it is these indicators that should be the main focus in the logistics industry for competitiveness. At the lower end of the scale, the three lowest ranked indicators in the developed model are social media usage for brand building (1.80%), circumstance of delivery (1.62%), and government satisfaction (0.10%). However, their final priority from the findings of this research should not lead to the interpretation that these indicators are not at all important, since the rankings only indicate the relative priorities of the 15 indicators selected for the decision model.

This result reinforced that the more knowledgeable and educated the employees are, the higher competitiveness will the logistics companies have in the industry. This outcome is also consistent with the argument of Huang & Jhong (2012), where 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 organization. Additionally, the outcome may be also explained by the fact that there is a labor-intensive nature in the logistics industry (Min & Joo, 2006).

Consequently, although the rankings of some of the indicators (e.g. on-time delivery) are initially unforeseen, the result was found to be significant by the experts after the discussions, because the ANP enables the capture of both the direct and the indirect interactions by considering second, third, and higher degrees of influences. Since the human mind usually captures up to the second degree of influences, this feature of the ANP technique proves that the technique can provide realistic and accurate results.

6. Implications for management

Compared with the previous studies in the literature, this study has provided the following insights that impact on the management literature. First, although the BSC concept was revealed in the literature as a prevalent concept, and the ANP method was pointed out to be a powerful as well as a realistic computer-supported approach, especially in terms of capturing higher degree of influences than the human mind does, no study appeared to have integrated the BSC and the ANP in the logistics area regarding the competitiveness of logistics companies. In other words, it is observed that prioritization of the performance indicators involved in a BSC model has not to date been assessed for logistics companies by using the ANP method, especially from the logisticians' perspective. From this point of view, this study has fundamentally changed the view of identification and prioritization of the key logistics performance indicators and has opened the door for further studies in logistics area. Moreover, the realistic and accurate result presented in this study, based on the said integration, will help practitioners and researchers in the logistics field to decide on which indicators they should focus more in order to achieve a higher degree of competitiveness in the industry. Thus, with the help of the presented priority of the indicators, logistics managers can compare the priorities of their own company with the ideal proposed ranking.

Additionally, the proposed approach also adds to the literature in several ways. First, previous studies in the logistics area (e.g. Shaik & Abdul-Kader, 2014; Shaik & Abdul-Kader, 2012) pointed out that the stakeholder perspective was inadequately incorporated in the BSC concept. To the best of our knowledge, besides extending the body of knowledge in terms of including various stakeholders to a significant extent in the stakeholder perspective of the BSC concept, the stakeholder perspective was assessed by the ANP method for the first time for logistics companies. Thus, in this study, the 'stakeholders' perspective was evaluated comprehensively in order to understand the impact of the relevant stakeholders on both the BSC concept and the logistics companies. The presented results can therefore be used as a reference by various stakeholders to comprehend the logistics industry norms, which can be practical for their logistics service provider selection processes. That is to say, the outcome of this study is not only useful for logistics companies but also for different stakeholders in the logistics area.

Second, the literature reveals difficulties in identifying performance indicators used solely for the logistics context rather than for the whole supply chain area, especially in the BSC concept. Hence, the presented list of indicators as well as the developed model extends the previous knowledge regarding the examination of logistics performance indicators, particularly in the BSC concept, and can be used as a template to present the performance indicators practiced extensively in the logistics industry.

Finally, to the extent of our knowledge, no other study has so far applied social media as a logistics performance indicator in the BSC approach. Therefore, social media usage has been assessed in the BSC perspectives for the first time in the logistics literature and the relative priority of social media usage was presented in the outcome of this study. In this regard, this study demonstrates that the social media is not a primarily considered performance indicator affecting the competitiveness of logistics companies, although it was appraised as one of the significant indicators in the logistics area.

7. Conclusions

Logistics companies are inundated with performance indicators to measure their performances. This has, however, caused decision makers to face the challenges of identifying, and then prioritizing, those measures that are the most appropriate for their strategic, tactical, and operational needs. To address these needs and to ensure the impact of each of these indicators, a comprehensive evaluation model for logistics performance indicators by considering the interrelationships was proposed through a two-stage procedure in this study:

- Firstly, significant performance indicators were identified through a comprehensive literature review and the views of industry professionals. Meanwhile, the major deficiency of the BSC concept was addressed through the inclusion of the 'stakeholders' perspective by replacing the 'customer' perspective of the generic BSC concept in order to consider the various stakeholders in the proposed model more comprehensively. Following this, an online survey was conducted in the Turkish logistics industry in order to constitute the decision model with inclusion of the most significant performance indicators. As a result, 15 indicators, which had been identified as the most important in the logistics industry, were included in the decision model.
- Secondly, the 15 indicators in the proposed model were prioritized by using the ANP method as a response to the prioritization complexity of the performance indicators. Consequently, the present study includes extensive analysis of the logistics performance indicators and the prioritization of these indicators by using the BSC-ANP combination. Accordingly, the proposed model is able to meet the current needs of the field in terms of the identification of both the key indicators and their dependencies.

The developed model and the outcomes are not only useful for the academic field, but also for practitioners. Since selecting significant performance indicators is a complicated and tiresome activity for decision makers, the list of indicators and the presented model serves as a frame of reference that will provide logistics managers with assistance to better understand key logistics indicators. In regard to the results, this study helps decision makers in the logistics area to diagnose their operational prioritization in order to be more competitive in the industry. That is to say, both the model and the method provide managerial insights into evaluating operations based on the performance indicators and companies' relative positions within the industry.

Moreover, in contrast to common expectations regarding the importance of some particular metrics (e.g. on-time delivery), this research indicates that the educated employee is the most important performance indicator for the competitiveness in the logistics industry. In addition, this study shows that the four prominent indicators (educated employee, managerial skills, cost, profitability) determined after the ANP, account for more than half of the total percentage of the 15 indicators which represents the majority of the indicators used in the decision model, and as such, these four indicators should be the preliminary focus for managers in the logistics industry.

However, there are several limitations of this study. First, the study was conducted mainly based on five databases and the keywords were searched predominantly within abstracts, titles, and keywords. Second, in the phase of listing the 43 indicators, although the indicators were systematically and diligently selected, a higher number of indicators could have been incorporated into the online survey with different points of view, since this phase was completed on the basis of subjective evaluation. Third, more people could be included, both in the online survey phase and for the expert group phase. Therefore, the extension of the model in terms of different perspectives or indicators is a potential for future studies, as is the consideration of the involvement of more people at the two study phases. Additionally, for future studies, different MCDM techniques or hybrid approaches can be used. This way, the outcomes of the present study can be compared and the robustness of both the model and the method can be tested. Moreover, the case study approach concerning logistics companies should be used in further studies to demonstrate the applicability of the model.

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Appendix A: 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