

ANALYZING LOGISTICS FIRMS BUSINESS PERFORMANCE

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Abstract: The aim of this study is to determine logistics firms identify the most important evaluation criterion for achieving customer satisfaction using the causal relationships among the four dimensions of business performance in Balanced Scorecard and DEMATEL to construct the interrelations between criteria and synthetic utility of the criteria. Applying our approach to real life we find the interrelationships between business performances standpoint of logistics executives from Istanbul, Turkey. We would able to compare the results obtained from the respondents and come through with a conclusion.

Keywords: Balanced Scorecard, Business performance, DEMATEL, Logistics.

INTRODUCTION

We try to examine logistics firms' performance in a general meaning. Each firm has own measurement criteria and those try to compare results in it. Generally, the performance of the logistic, which is usually managed as a series of simple business functions, is measured by taking the ratio of revenue over the total operational cost. What happens if we compare those companies in our view such as balanced scorecard model (BSC) which is introduced by Kaplan and Norton (1992) [1] and using multi criteria decision making approaches? Logistics firms can be classified into many fields according to process of supply chain. It needs to be gathered common forms to compare, that's why we prefer to use balanced scorecard which provides an internal and external view of the business that managers with the means they need to navigate future competitive success. It included more non-financial measures derived specifically from the organization's strategy [2]. There are lots of reasons such as to reduce overall costs, to increase their revenue growth, enhance their shareholder value to understand why logistics firms analyze their performance. These seem to be obvious reasons why companies should want to be competent in performance analyze. Therefore, any appropriate working model would help executives to manage their business in an effective way

We define logistics as a business management of the flow of information and physical items between the point of origin and the point of consumption in order to meet requirements of customers or corporations. Logistics performance measurement describes the feedback or information on activities with respect to meeting customer expectations and strategic objectives [3].

The balanced scorecard approach, though, is designed to support a variety of organizational performance measurement structures. Being said,

the original BSC, proposed by Kaplan and Norton [1], was a performance measurement system consisting of four business perspectives: financial, customer, internal business processes, and innovation and learning. It is a useful performance measurement tool because it was not only easy to implement across different departments but also provided a well-defined framework through integrating the tangible and intangible perspectives and delivering the firm's objectives, and therefore giving the business a competitive advantage.

The Decision Making Trial and Evaluation Laboratory (DEMATEL) is used to structure relationship map of BSC criteria. A network relationship map of the performance of the BSC is prepared to measure the mutual importance of each criterion.

While we are setting a performance analyzing and relationship model, we prefer to use BSC and DEMATEL hybrid model to demonstrate the effectiveness. Therefore, the balanced scorecard approach, which has been widely adopted as a performance indicator, is applied to analyze the performance of logistics firms. We would able to find interrelations between criteria and synthetic utility of the criteria. Based on the structural model, by the research on theory and method of BSC, this paper attempts to establish a scientific and reasonable logistics performance analyzes system for the development of logistics executives.

BACKGROUND

Some recent researches related to the combination of the BSC and other methodologies are reviewed here. Four performance metrics are used to fit the template of four perspectives of the BSC, i.e., return on assets (ROA), number of access lines per employee, percentage of digital access lines and percentage of business access lines for the financial, internal process, innovation and learning, and customer perspective, respectively [6].

BSC

BSC brought a new dimension than the traditional performance management which focuses only on financial indicators. The traditional models can only measure what happened in the past, but unable to assess the organization forward-looking investment. In the industrial era, focusing on financial indicators is still an effective management approach [4]. BSC provided a series of performance measurement indicators that could be utilized to guide strategic direction and objectives [5].

The strongest point of BSC is its ability to illustrate the cause and effect relations between strategies and processes through the four perspectives of: "Financial"; "Customer"; "Internal business process"; and "Learning and growth". Based on this reasoning, to achieve its financial benefits, an organization has to take its customers' needs and expectations into account, initially. To do this, organizations should take on a process approach when developing and implementing a quality management system. The contents of four perspectives of BSC are described as follows:

(1) Financial perspective. A company's past operating performance containing setting up a financial goal and the implementation of executing strategy achievements can be shown in this perspective as organizations gain growth, return and risk control from operating strategies can all be checked in this perspective. The appraisal indices usually include a return on investment operating income, operating costs, net profit rate, cash flows, etc.

(2) Customer perspective. In order to focus on the customer market segmentation, organizations should use their intrinsic advantages and resources to show their differences in comparison with their competitors since the main measurements contain customer continuation, customer satisfaction, customer acquirement, share ratio, and customer profitability.

(3) Internal process perspective. This perspective refers to the internal organizations' operating process which should be followed, the operating strategy plans presented, as well as the attempts made to accomplish the customers' and shareholders' expectations. The total process is commenced by understanding customer requirements, it is followed by after-sales services as well as the innovation and operating processes, and finally, it ends in customer requirement achievements.

(4) Learning and growth perspective. In order to have a sustainable operation and development, organizations should rely on continual innovation and growth. Further, Kaplan and Norton [7] pointed out that "companies should regard some principles such as employees abilities enhancing, information systems performance, encouragement, authority

consistence, etc." In other words, this perspective contains three main basic appraisal criteria which are employee satisfaction, employee continuation, and productivity of employees. On the other hand, organizations should establish performance appraisal indices based on these three criteria.

EMATEL

Decision Making Trial and Evaluation Laboratory (DEMATEL) was utilized in the research and solving a group of complicated and intertwined problems. DEMATEL approach can recognize the interactions among alternative systems and evaluation criteria, because it can calculate the impacts among criteria successfully. On the other hand, DEMATEL has the potential to separate a set of composite factors into a dispatcher group and receiver group effectively, and also, conversion into an outstanding structural model. By this method of utilization, we can easily extract the mutual relationships of interdependencies among various criteria and the strength of interdependence [8] which can be arranged briefly by the following steps:

Step1. Determine the relations among the factors defined. By brainstorming or doing a literature review, system element understating and the relations between elements will be judged by professionals subjectively using a questionnaire design: A professional questionnaire is formed by comparing criteria of each element pair which is shown by numbers from 0 to 4, each standing for a level from "no influence" to "very high influence".

Step2. Set up a direct-relation matrix by the influential degree between one element and another comparison, an $n \times n$ matrix could be generated. The direct-relation matrix is shown with Z, and figures inside the matrix show the influential extent between the elements.

Step3. Compute normalized direct-relation matrix.

$$S = \frac{1}{\text{Max}_{n \leq i \leq 1} (\sum_{j=1}^n z_{ij})} \quad (1)$$

Later the elements of direct-relation matrix (Z) by S are multiplied, which leads to standardized direct-relation matrix (X) as Eq. (2):

$$X = S \times Z \quad (2)$$

Step 4. Compute total-relation (direct/indirect) matrix. We used T to show a total-relation matrix and I as a unit matrix, where X as a total relation matrix will be used, also $X = [x_{ij}]_{n \times n}$, $\lim_{k \rightarrow \infty} (X^2 + \dots + X^k)$ means that it is an indirect matrix.

When $0 \leq X_{ij} < 1$, then $\lim_{k \rightarrow \infty} X^k = 0$,

$$(3)$$

$$T = \lim_{k \rightarrow \infty} (X + X^2 + \dots + X^k) = \lim_{k \rightarrow \infty} X(1 + X + X^2 + \dots + X^{k-1}) \quad (4)$$

$$T = X(1 - X)^{-1} \quad (5)$$

$$T = [t_{ij}], \quad i, j \in \{1, 2, \dots, n\}$$

Step5. Draws causal diagram and result analysis drawing. The total amount of each row is shown by D_i and the total amount of each column is shown by R_j .

$$D_i = \sum_{j=1}^n t_{ij} \quad (i = 1, 2, \dots, n) \quad (6)$$

$$R_j = \sum_{i=1}^n t_{ij} \quad (j = 1, 2, \dots, n) \quad (7)$$

The causal diagram uses $(D + R, D - R)$ as ordered pairs. The horizontal axis $(D + R)$ shows the influential degrees of relations between elements where vertical axis $(D - R)$ shows the influential relation degrees between one element and the others. Therefore, the sophisticated causality elements themselves could be observed as a simple and clear structure by the causal diagram, and the structure could be referred to as a guide of counsel or a strategy against problems made up by decision makers or managers.

According to the analysis of the previous literature review, the efficiency evaluation model of the logistics proposed by this study is shown in Fig. 1. The analytical process is divided and carried out in four stages: (1) in the first step we determined the efficiency measurements of supply chain with review literature and expert ideals; (2) in the second step we divided these measurements into the four perspectives of the BSC approach; (3) The DEMATEL method was applied to determine causal relationships and mutual influence among perspectives; (4) an empirical analysis of synthetic performance evaluation of the logistics was made. The analytical methods, BSC, DEMATEL employed by this research are introduced in brief as follows:

Since BSC is based on causal relationships, DEMATEL was used to determine these relationships in the next stage. These relationships organize a network structure. Therefore, the model was created to determine the business performance of the logistics. The logistics was then ranked with this DEMATEL method using the BSC approach.

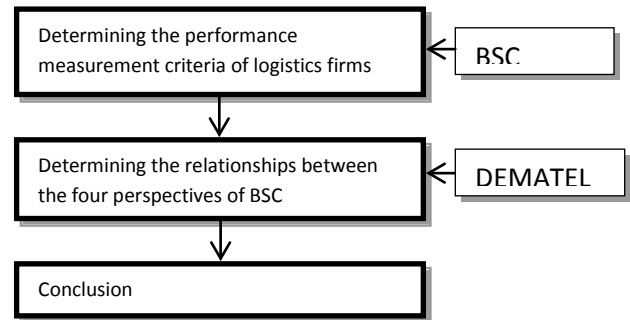


FIGURE I. Analyzing logistics firms business performance.

LOGISTICS FIRMS BUSINESS PERFORMANCE METRICS

On the basis of the above mentioned considerations, the study aimed at developing a network based on the well- BSC framework suitable for logistics firms' business performance. The reason to choose this context was that the logistics firms in Istanbul has received a great deal of attention in the past decade due to issues. A questionnaire is designed using questionnaire format, and the four perspectives of the BSC and the selected performance indicators are included. The questionnaire is distributed to senior managers of the logistics departments in Istanbul, and the feedbacks are analyzed through a constructed DEMATEL approach to obtain the relative importance of the four perspectives and the relative importance of the key performance indicators under each perspective. The results can provide some suggestions to logistics departments in developing future strategies, development objectives and performance evaluation.

Metrics

Contributions from industry and academia, as well as the results of an extensive literature review, were used to establish twenty criteria for an analyze logistics firms business performance. The performance measures required a set of criteria, which include information regarding the financial aspect (A1), customer aspect (A2), internal operations aspect (A3) and learning and growth aspect (A4).

TABLE I.
PROPOSED BSC MEASURES

Financial perspective (A1)	
A11	Profit
A12	Staff cost
A13	Overhead cost
A14	Transportation cost
A15	Inventory cost
Customer perspective (B1)	
B11	Customer satisfaction rate
B12	Market share
B13	Customer loyalty
Internal process perspective (C1)	
C11	Effective problem-solving percentage

C12	Service cycle processing time
C13	Environmental safety incident index
Learning and growth perspective (D1)	
D11	Training number and hours of personnel
D12	Employee retention: percentage of key staff turnover
D13	Number of promotions from within

completely to the researchers and 11 questionnaires were accepted and analyzed, and a 55% satisfactory response rate was yielded. Relationships among BSC perspectives are determined by employing the DEMATEL technique. Firstly, senior managers define elements and determine relations and indices of each of the BSC perspectives are determined. The total influence matrix T and the NRM of the relationship between the perspectives found are shown in Table 3 and Fig. 4. The total influence matrix T for the criteria is shown in Table 4. It can be seen that all aspects are interdependent.

The BSC shows how the overall business performance of a logistics firm is translated into the performance metrics drivers that have identified as critical success metrics (criteria).

DEMATEL technique for building a network relationship map

Among the 20 questionnaires distributed to respondents, only 11 questionnaires were returned

TABLE II.
TOTAL-INFLUENCE MATRIX T : FOUR PERSPECTIVES

BSC perspectives	A1	B1	C1	D1	D_i	R_i	D_i+R_i	D_i-R_i
A1	0.515	0.480	0.550	0.485	2.030	1.989	4.019	0.041
B1	0.490	0.472	0.527	0.465	1.954	1.923	3.877	0.031
C1	0.528	0.526	0.566	0.500	2.120	2.138	4.258	-0.018
D1	0.456	0.445	0.495	0.496	1.892	1.946	3.838	-0.054

Some criteria have positive values of D_i-R_i and thus greatly influence the other criteria. These criteria are called dispatchers; others have negative values of D_i-R_i and thus are greatly influenced by the other criteria. These are called receivers. The value of D_i+R_i indicates the degree of relationship of each criterion with the other criteria. Criteria having higher values of D_i+R_i have stronger relationships with the other criteria, while those having lower values of D_i+R_i have a weaker relationship with the others. A significantly positive value of D_i-R_i represents the fact that the criterion affects other criteria much more than those other criteria affect it, implying it should be a

priority for improvement. DEMATEL provides some insights that allow enterprises to improve their performance based on the criterion that most significantly influences the performance of other criteria [9].

It can be seen in the Table II. that C1 (Internal process) is the first in the index of strength of influence given and received (4.258 in total sum (D_i+R_i)); A1 (Financial) is next; and B1 (Customer) is the third. In other words, the Internal process (C1) is the most important influencing factor. On the other hand, the Learning and growth component (D1) affects the other factors the least (3.838 in total sum (D_i+R_i)).

TABLE III.
TOTAL-INFLUENCE MATRIX T : FOURTEEN CRITERIA

Criteria	A11	A12	A13	A14	A15	B11	B12	B13	C11	C12	C13	D11	D12	D13	D_i
A11	0.48	0.56	0.49	0.51	0.50										2.56
	0	9	8	2	3										2
A12	0.55	0.50	0.50	0.50	0.49										2.56
	8	3	8	1	8										8
A13	0.49	0.52	0.41	0.44	0.48										2.36
	5	0	3	4	8										0
A14	0.50	0.45	0.53	0.50	0.46										2.46
	2	6	9	3	7										7
A15	0.44	0.46	0.42	0.43	0.43										2.21
	8	8	1	9	4										0
B11						0.53	0.57	0.57							1.68
						9	0	1							0
B12						0.51	0.53	0.48							1.53
						9	0	6							5
B13						0.44	0.54	0.46							1.45
						0	1	9							0

C11												0,58	0.59	0.57				1.74
												0	0	7				7
C12												0,49	0.52	0.48				1.50
												3	0	8				1
C13												0,51	0.49	0.47				1.48
												2	5	4				1
D11															0.53	0.52	0.55	1.61
															9	6	4	9
D12															0.55	0.60	0.50	1.66
															5	2	8	5
D13															0.50	0.46	0.49	1.47
															8	8	9	5
R_i	2.48	2.51	2.37	2.39	2.39	1.49	1.64	1.52	1.58	1.60	1.53	1.60	1.59	1.56				-
	3	6	9	9	0	8	1	6	5	5	9	2	6	1				

TABLE IV.
 SUM OF INFLUENCES GIVEN AND RECEIVED ON CRITERIA

BSC Metrics	D_i	R_i	D_i+R_i	D_i-R_i
A1 Financial Perspective	2.030	1.989	4.019	0.041
A11 Profit	2.562	2.483	5.045	0.079
A12 Staff cost	2.568	2.516	5.084	0.052
A13 Overhead cost	2.360	2.379	4.739	-0.019
A14 Transportation cost	2.467	2.399	4.866	0.068
A15 Inventory cost	2.210	2.390	4.600	-0.180
B1 Customer Perspective	1.954	1.923	3.877	0.031
B11 Customer satisfaction rate	1.680	1.498	3.178	0.182
B12 Market share	1.535	1.641	3.176	-0.106
B13 Customer loyalty	1.450	1.526	2.976	-0.076
C1 Internal Process Perspective	2.120	2.138	4.258	-0.018
C11 Effective problem-solving percentage	1.747	1.585	3.332	0.162
C12 Service cycle processing time	1.501	1.605	3.106	-0.104
C13 Environmental safety incident index	1.481	1.539	3.020	-0.058
D1 Learning and Growth Perspective	1.892	1.946	3.838	-0.054
D11 Training number and hours of personnel	1.619	1.602		
			3.221	0.017
D12 Employee retention: percentage of key staff turnover	1.665	1.596		
			3.261	0.069
D13 Number of promotions from within	1.475	1.561	3.036	-0.086

The $D_{11}-R_{11}$ for the maximum customer satisfaction rate (B11), shows that this metric has the greatest direct impact on others ($D_{11}-R_{11} = 0.182$) in total difference; whereas inventory cost (A15) is the metric most easily influenced by other metrics ($D_{15}-R_{15} = -0.180$) in total difference. Furthermore, it can be seen in the Figure II that there exists a significant causal relationship between the four performance perspectives and that they influence each other.

Figure II presents a casual diagram of BSC metrics relationships that A1 (Financial perspective) exhibits a positive influence on the perspective, B1 (Customer Perspective), C1 (Internal Process Perspective) and D1 (Learning and Growth Perspective). B1 has a positive influence on perspectives (C1) and (D1). The perspective of C1 has a positive influence on the perspective of D1. This means that the final aim of

all perspectives is learning and growth perspective and they have a positive influence on that. The survey of analyzing logistics firms' business performance metrics indicates that influences according to results of surveys.

As similar results can be found from Table IV is that in financial perspective profit and staff cost have an impact on to overhead cost, transportation cost, and inventory cost. In customer perspective customer satisfaction rate has the most positive influence among all metrics which is (3.178, 0.182) that also makes that metric impact on market share and customer loyalty. In internal process perspective we see that effective problem solving percentage has positive influence on service cycle processing time and environmental safety incident index. Finally, learning and growth perspective has three sub perspectives which are training number and hours

of personnel, employee retention: percentage of key staff turnover, and number of promotions from within. Number of promotions from within metric has negative influence on that perspective.

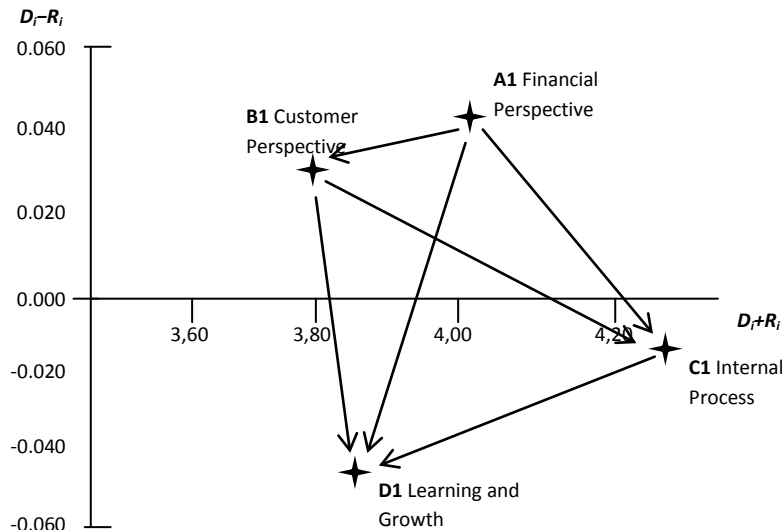


FIGURE II. Causal diagram of BSC metrics relationships

CONCLUSION

In that study a general framework is presented to analyze the overall performance of the logistics business by means of the BSC and DEMATEL model. In the first step, the efficiency measurements of the logistics were determined via doing a thorough review of the related literature and relying on the scrutiny of the expert ideals. In the second step, these measurements were divided into the four perspectives of the BSC approach; The DEMATEL method was applied to determine the causal relationships and mutual influences among the perspectives; in the next step, the proposal model for performance analyze was applied to Turkish logistics firms. By the way, a network structure obtained from the BSC, by applying the DEMATEL methods, was developed.

Numerous factors that affect logistics performance are embedded in the balanced scorecard, which can thus increase both the precision of business performance measurement and the effectiveness of the subsequent decision-making on the successful implementation of an logistics systems.

The BSC approach discussed in previous proposes four performance evaluation perspectives, but it does not explain the relative weight of the sub-factors, the degree of influence of each factor and which sub-factors will affect these factors. It is advantageous for the management of logistics firms to realize the relative weights of the factors and sub-factors for performance evaluation. Therefore, in this study, we develop a performance evaluation and interrelation model for logistics firms. Analysis of survey results is utilized to provide and prioritize the factors necessary to improve and to develop a strategy map that can be used as a reference for the logistics industry. According to the results of DEMATEL, metrics that can enhance the performance of logistics firms' are defined.

In addition, the logistics firms business performance measurement framework employed in this study provides a platform for further investigation into how different perspectives affect the performance of logistics systems, which is closely linked to firms' strategic objectives. Finally, this study presents an evaluation approach that can act as a reference for better understanding the factors that affect logistics performance.

LIMITATIONS AND FUTURE STUDIES

The presented method should enable adjustments for alignment with the paradigms on which they are based, improve business performance and permit consistent application with a well-structured method for logistics firms. This method can complement and refine the results by providing consecutive filters.

Future studies may include more firms to develop a comparative study or an entire industrial-based study.

From this insightful study, future studies could achieve the following objectives: extend the input information in the context of the proposed method; incorporate this presented DEMATEL in an industrial study; apply this proposed method to other decision-making problems; and utilize this method and these results to develop a detailed practical indicator for logistics policy-making processes.

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