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Presenting a Mathematical Model for Evaluation of the (Effectiveness of) Supply Chain Management through Balanced Scorecard Approach (A Case Study of ISACO Corporation)

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ABSTRACT

The organizations are interacting with suppliers, customers and even competitors in order to achieve the customer satisfaction as well as the greater success and profitability in the new commercial environment. Supply chain management is the most important part of the company's strategy to optimize the planning and implementation of the processes to respond to the market changes and it will not be possible without the efficient and effective internal process. Certainly, to ensure effectiveness of the integrated processes, they should be periodically evaluated by some indicators. Therefore, this study has discussed the effectiveness of supply chain management using the balanced scorecard methodology, to do which a goal programming model is presented to minimize sum of deviations. In this study, first, the indices affecting the four perspectives (financial, customer, internal process and learning and growth) of balanced scorecard in ISACO Corporation are identified. Then, the weight and prioritization of the indices affecting the four perspectives of balanced scorecard are calculated, and then, the distance of performance of each one of the perspectives of balanced scorecard from the goals of the studied company has been measured. In addition, the goal programming model is presented to evaluate the effectiveness of supply chain in order to minimize sum of absolute deviations using the goal programming model.

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Introduction

The complexity of business competitive environment and the increase of customer expectations have made it more essential to be aware of the strengths and weaknesses of the organization and continuously improve the productivity. In the companies of automotive after-sales services, the communication channels between suppliers and end users (automobile consumers) are very important. It is impossible to provide high quality services and competitive prices, reduce the time to provide customer service and finally, to attract the customers' satisfaction unless through the optimal supply chain management throughout the country. Therefore, today's managers are searching to achieve a comprehensive, reliable and flexible solution to evaluate the performance of their organization so that they could obtain accurate and adequate information on their current status while ensuring that their strategies are implemented, and also develop and improve their organizations by looking at the future. An evaluation method must be able to present the general state of the organization compared to the organizational goals (in terms of distance to the target) at any moment and to specify the organization's status in relation to the surrounding environment (market, competitors and the other organizations). Moreover, it indicates the efficacy of all the activities performed in the organization (Ibn Rasul, Tarhani, and Lotfi, 2007).

To achieve high levels of success and excellence in the organization, there is a need to implement the plan of improvement and organizational change. One of the prerequisites for success in the competitive markets is the effort to improve the performance and enhance the quality of goods and services. The continuous and regular evaluation of the companies' activities is essential to improve their performance. Performance evaluation allows the organizations to clearly identify their strengths and areas of improvement, and then to develop some plans to improve the performance and enhance their products quality and thus try to develop and improve the organization.

Performance evaluation describes the feedback of the activities performed considering the strategic goals and customer expectations and this indicates that which parts need to improves performance and thus, can help improve the efficiency and quality (Bhagwat & Sharma 2007).

In today's international competitions, the customers should be provided with various products according to their request. Due to the customer demand for high quality and quick service in the existing competitive market, enterprises and manufacturers feel the need to manage and monitor the resources and related elements outside the organization, while considering the internal organization and resources. This is partly to achieve the competitive advantage/s in order to obtain a larger part of the market. The key issue in supply chain is to manage and control all these activities. Supply-chain management is a phenomenon that does this so that the customers could receive reliable and quick services along with high quality products at minimum cost (Vajdi, 2004).

Supply chain management includes integration of supply chain activities and their associated information flows by improving supply chain relationships in order to achieve reliable and permanent competitive advantage. Therefore, supply chain management is the process of integration of supply chain

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activities and their related information flows, by improving and coordinating the activities in the supply chain of the production and supply of products. The limitations in traditional methods of performance evaluation on the one hand, and the new attitudes toward the organization or enterprise on the other hand, have had a significant role in changing the attitudes toward the performance evaluation of the organizations. In the early 1990s, Robert Kaplan, the professor in the Business School of Harvard University and David Norton, the director of a research company, started a research plan to investigate the causes of success and methods of the performance evaluation. Also, in a paper, they suggested that successful companies do not only rely on financial measures to evaluate their performance, but they also evaluate their performance from three other aspects, i.e. customer, internal process and learning and growth. They also suggested that to conduct a full evaluation of the organization performance, it should be evaluated from four perspectives .Balanced scorecard model (BSC) is one of the methods, which has removed the inadequacies and shortcomings of traditional methods of performance evaluation.

To evaluate the organization performance, four basic questions must be answered in each perspective:

• How can we keep our current service levels according to our budget level, and use the existing opportunities to increase the interests and benefits of the organization? (Financial perspective)

• What services or products meet our customers' needs and expectations? (Customer perspective)

• To obtain added value and customer satisfaction after analyzing the current trends, which job and work process of ours should be improved or given priority? (Internal process perspective)

• How should we train and improve our organization to achieve our goals? (Learning and growth perspective)

The four BSC perspectives are discussed in table 1.

Table 1 : The four perspectives in a balanced scorecard(Bhagwat & Sharma 2007)

Customer perspective (value-adding	Financial perspective (shareholders'			
view)	view)			
Mission: to achieve our vision by	Mission: to succeed financially, by			
delivering	delivering value to our shareholders			
value to our customer	Mission: to achieve our vision, by			
Internal perspective (process-based	sustaining innovation and change			
view) Learning and growth	capabilities, through continuous			
perspective (future view)	improvement and preparation for			
Mission: to promote efficiency and	future challenges			
effectiveness				
in our business processes				

The meaning of balanced scorecard is reflected in its name and indicates its purpose, which is to balance the perspectives (short and long term goals, financial and non-financial measures and the viewpoint of internal and external performance). Many companies have adopted their strategic management system based on BSC, which is a way to reduce costs and create opportunities for growth and added value for products and services. (Bhagwat and Sharma 2007)

This study has intended to evaluate the effectiveness of supply chain through balanced scorecard approach, identify the indicators affecting four financial, customer, internal process and learning and growth perspectives, prioritize each indicator and calculate the performance deviation of each perspective from the objectives of the studied company and consequently, to present a mathematical model for goal programming model to minimize the sum of absolute deviations.

An overview of the research literature

In todays pressed trade world, one of the causes of the product success in the market is to have an efficient and effective supply chain. It is so important that in the new competition model, unique companies do not compete as company against company, but as supply chains against supply chain. Therefore, companies with more economical supply chain than their competitors will be successful. Therefore, information and physical management in supply chain is one of the main success factors in any supply chain. In recent years, many studies have been conducted on performance evaluation of supply chain and balanced scorecard, the main part of which is introduced in this section. According to Lambert, it is very simple to talk about supply chain management and development of theoretical models in this regard, but it is very time consuming, difficult and accurate to implement even the simplest techniques and presented models, and requires great care. Generally, performance evaluation efficiency is defined as the process of quantification of the performance effects and efficiency. Moreover, one of the most important studies conducted to create a framework to establish an empirical relationship between the supply-chain management operations and supply chain performance includes a list of critical areas for the capability to achieve the logical integration of supply chain and the study of the relationship between logical integration of capabilities and performance. Integration capability in this context includes customer integration, internal integration, technology integration planning, measurement integration, integration of communication and dependencies.

between 1994 and 1996, In the time period approximately 3615 articles have been published regarding performance evaluation. In 1996 in USA, every week two new books were presented to the market in this regard. Also in England, Intelligence Business Company, which is responsible for organizing the professional conferences, has held over 23 conferences in this field since 1994. In addition, more than 50 worldwide websites have designed to evaluate business performance (Mirza Sadeghi et al, 2002).

The questionnaires of customer satisfaction measurement are considered a basis which is developed almost in most of the areas. These questionnaires are not limited to hotels, restaurants and so on. Surveys and studies show that a development and revolution has occurred in the organizational performance evaluation. Up to the last 10 years, non-financial performance was little considered by the employees and senior executives. Recently, some organizations have highly emphasized the relationship between financial and non-financial aspects of performance. For example, since 1996, the United States has considerably emphasized non-financial performance indicators to prepare public and annual reports. Moreover, the researchers at the University Of Michigan, Stockholm School of Economics, Sweden, realized that there is a significant customer satisfaction and financial correlation between performance of companies. It means that one percent increase in customer satisfaction is associated with 7.48 dollar percent of net income.

Another study titled "Performance evaluation and application of BSC: a case study of municipalities in the United States and Canada" was published in 2004 in the third Number of International journal of public sector management. The study suggests that after facing the limitations of financial instruments and the increase of responsibility in the issues, the organizations decided to apply modern management. In 2004, a study entitled "a case study of designing a strategic management system using the third-generation of balanced scoring model" was published in International journal of public sector management No. 7. In this study conducted in Zemail airline, first the company's ineffective strategic plan in 2001 is discussed, which has been designed through traditional logical methods.

The research, conducted in 2003 by Bin and the company, indicated that over 60% of the 6300 studied companies have accepted the balanced scorecard as one of their management tools. Also, recent studies showed that more than 300 articles of the articles of 1994 are devoted to the discussion on BSC and have been published in various industries such as education, health, accounting and information technology .(Knotts et al, 2006).

Kanji in 2002 claimed that the approach of Kaplan and Norton is strong in the conceptual model, but it is weak in terms of measurement tool and that is due to "non-clarity of the identification of the indicators and how to measure them and to correlate them". Kanji Business Excellence how Measurement System (KBEMS) includes a performance questionnaire for the company's self-assessment, improvement strategies for organizational excellence and certification issuance for highly efficient achievements. While the (BSC) and (KBEMS) models are different in application, Kaplan and Norton, and Kanji agreed that success depends on a balanced approach, an approach in which a wide range of relevant factors are used for performance evaluation and the financial measures of the organization are not merely examined (Knotts et al, 2006).

Also, another study was conducted in "2008" entitled "the human resources managers' perception of the plan and competencies of the balanced scorecard in hotels" (MCphail et al 2006). In 2009, another study was conducted in this field entitled "The design of a knowledge-based systems for strategic planning: balanced scorecard viewpoint" (Huang,2009). In addition, in 2005, another study was conducted in this field by Papa-lexandri et al entitled "The integrated method for implementing balanced scorecard" (Papalexandris et al, 2005).

Research conceptual model

Research conceptual model is presented in figure 1.





The Research Goals

The goals of this Research are:

1)Identification and prioritization of the indicators affecting the financial perspective of balanced scorecard approach to evaluate supply chain of ISACO

2)Identification and prioritization of the indicators affecting internal process perspective of balanced scorecard approach to evaluate supply chain of ISACO

3)Identification and prioritization of the indicators affecting learning perspective of balanced scorecard approach to evaluate supply chain of ISACO

4)Identification and prioritization of the indicators affecting customer perspective of balanced scorecard approach to evaluate supply chain of ISACO

5)Measurement of the indicators distance from the financial learning - the customer and internal process perspective from the goals of ISACO company

6)Presenting a mathematical model to optimize the effectiveness of the supply chain of ISACO through goal programming approach

The Research Questions

1)What are the criteria and priority of each indicator in the financial perspectives of the balanced scorecard approach to evaluate supply chain of ISACO?

2) What are the criteria and priority of each indicator in the customer perspective of the balanced scorecard approach to evaluate supply chain of ISACO?

3) What are the criteria and priority of each indicator in the learning perspective of the balanced scorecard approach to evaluate supply chain of ISACO?

4) What are the criteria and priority of each indicator in the internal process perspective of the balanced scorecard approach to evaluate supply chain of ISACO?

5) How much is the distance of each indicator in the financial perspective, learning, customer and internal process from the goals?

6)Can a mathematical model be presented through goal programming approach to optimize the effectiveness of the supply chain in ISACO Company?

The Hypothesis of Research

1)The most important indicator affecting the financial perspective of balanced scorecard approach to evaluate the supply chain is integrated.

2)The most important indicator affecting the customer perspective of balanced scorecard approach is to increase customer satisfaction.

3)The most important indicator affecting the internal process perspective of the balanced scorecard approach in supply processes is the improvement of parts supply cycle.

4) The most important indicator affecting the learning perspective of balanced scorecard approach is management information assets, management of networks and information infrastructures.

5)Financial indicators show the greatest distance from goals.

6)Mathematical model with goal programming approach is an appropriate model for evaluating the effectiveness of supplychain using the balanced scorecard.

The research methodology

This study is an applied research with modeling process in terms of goal and a descriptive-survey method in terms of data collection. The questionnaires have been used in this study in order to collect data.

Data Analysis

Identification of the indicators affecting the four perspectives of balanced scorecard

This study has identified the indicators affecting the four perspectives of balanced scorecard. The indicators affecting the financial perspective are given in table 2.

Table 2: The indicators affecting the financial perspec	tive
Increased Income (Revenue growt	h)
Increase in net income (combined incom	ie)
Increase market share	re
Optimum use of assets & cost structure improvement	nt
Achieving Competitive Advantage in the market for parts and service	es

The Zero hypothesis and opposite hypothesis for Friedman test of the financial perspective are expressed as follows: $H_0:\beta_1=\beta_2=\beta_3=\beta_4=\beta_5$

(Hypothesis. 1)

$\mathbf{H}_1: \boldsymbol{\beta}_i \neq \boldsymbol{\beta}_1$ i, j=1,2,3,4,5

H₀ means that the impact of all five indicators in the financial perspective on supply chain is the same and they are not different.

Friedman tests results, including statistical specifications and

statistic $\mathbb{I}(\chi)$ are presented in table (3).

Table 3: The output of Friedman test of the financial perspective

Statistical indicators	The calculated values
N	20
Chi-square	14.299
df	4
Asymp. Sig.	0.006

As shown in table 3, the value of the statistic x^2 has been measured (14.299) using Friedman test. From the table x^2 , the critical value with degree of freedom (K-1=5) at confidence level of "0.95" is extracted (9.48). Since the test statistic value obtained from table 3 is greater than this value, Zero hypothesis will be rejected and H1 hypothesis at the confidence level of 0.95 will be confirmed. In other words, the five indices of the financial perspective to evaluate the effectiveness of supply chain have different importance.

The indicators affecting the customer perspective are presented in table 4.

Table 4: The indicators affecting the customer perspective

Brand Growth
Improve and maintain strong relationships with customers
Increase customer satisfaction

Zero hypothesis and opposite hypothesis for Friedman test of the financial perspective are expressed as follows:

 $H_0:\beta_1 = \beta_2 = \beta_3$ (Hypothesis. 2)

$H_1:\beta_i \neq \beta_1$ i, j=1,2,3

H₀ means that the impact of all 3 indicators in the customer perspective on supply chain is the same and they are not different.

Table 5: The output of Friedman test of the customer perspective

Statistical indicators	The calculated values
Ν	20
Chi-square	8.143
df	2
Asymp. Sig.	0.017

As shown in table 5, the value of the statistic x^2 has been measured "8.143" using Friedman test. From the table x^2 , the critical value with degree of freedom (K-1=2) at confidence level of "0.95" is extracted (5.99). Since the test statistic value obtained from table 5 is greater than this value. Zero hypothesis will be rejected and H₁ hypothesis at the confidence level of 0.95 will be confirmed. In other words, the three indices of the financial perspective to evaluate the effectiveness of supply chain have different importance.

The indicators affecting the internal process perspective are presented in table 6.

Table 6: The indicators affecting the internal process

perspective			
Agility to market changes			
Channel Development Products and Services			
Improvement Quality			
Being the market leader			
Time services and products to customers			
Development of sources			
Improve the provision of cycle			
Optimization of the structure and processes			

Zero hypothesis and opposite hypothesis for Friedman test are expressed as follows:

$$\widetilde{H_0}$$
: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = \beta_7 = \beta_8$
(Hypothesis. 3)

$H_1:\beta_i \neq \beta_1$ i, j=1,2,3,4,5,6,7,8

H₀ means that the impact of all 8 indicators in the internal process perspective on supply chain is the same and they are not different.

Table 7: The output of Friedman test of the internal process perspective

Statistical indicators	The calculated values
Ν	20
Chi-square	18.259
df	7
Asymp. Sig.	0.011

Friedman tests results, including statistical specifications and statistic $\mathbb{I}(\chi)^{\uparrow}$ are presented in table (7). The value of the statistic χ^2 has been measured "18.259" using Friedman test. From the table x^2 , the critical value with degree of freedom (K-1=7) at confidence level of "0.95" is extracted (14.0671). Since the test statistic value obtained from table 7 is greater than this value, Zero hypothesis will be rejected and H₁ hypothesis at the confidence level of (0.95) will be confirmed. In other words, the 8 indices introduced in the internal process perspective to evaluate the effectiveness of supply chain have different importance.

The indicators affecting learning and growth perspective are presented in table 8.

Table 8: The indicators affecting the learning and growth

perspective			
Continuous learning			
Develop the skills and expertise			
Support and upgrade information systems			
Network management and information infrastructure			
Increased levels of employee satisfaction			

Zero hypothesis and opposite hypothesis for Friedman test are expressed as follows:

$$\begin{array}{l} \hline H_0: \beta_1 = \beta_2 = \beta_2 = \beta_4 = \beta_5 \\ (\text{Hypothesis. 4}) \end{array}$$

$\mathbf{H}_{1}:\boldsymbol{\beta}_{i} \neq \boldsymbol{\beta}_{j} \qquad \text{i}, j=1,2,3,4,5$

 H_0 means that the impact of all 5 indicators in the learning and growth perspective on supply chain is the same and they are not different.

Table 9: The output of Friedman test of the learning and
growth perspective

Statistical indicators	The calculated values
Ν	20
Chi-square	12.058
df	4
Asymp. Sig.	0.017

Friedman tests results, including statistical specifications and statistic $\mathbb{I}(\chi)^{\uparrow}$ are presented in table (9). The value of the

statistic x^2 has been measured "12.058" using Friedman test. From the table x^2 , the critical value with degree of freedom (K-1=4) at confidence level of "0.95" is extracted (9.48). Since the test statistic value obtained from table 7 is greater than this value, Zero hypothesis will be rejected and H₁ hypothesis at the confidence level of 0.95 will be confirmed. In other words, the 5 indices introduced in the learning and growth perspective to evaluate the effectiveness of supply chain have different importance.

Prioritization of the indices affecting the four BSC perspectives

At this stage of the research, the indices affecting the four BSC perspectives will be prioritized and weighted through the special vector technique. Since the paired comparisons have been performed by a group of experts, the geometric mean is used. The consistency rate of paired comparison matrices obtained from the geometric mean of the experts' opinion is calculated less than "0.1". Thus, the experts' opinions are consistent and reliable. Since respondents were the experts in the field of research, the responses' weight has been considered equal and at the same level of priority. The results of the prioritization of the indicators affecting the financial perspective in supply chain evaluation based on the special vector technique are shown in tables (10 and 11).

Table 10: Paired comparison matrix of the indicators affecting the financial perspective

financial	Increase	Increas	Increas	Optimu	Achieving	weight
perspective	d	e in net	e	m use of	Competitiv	S
	Income	income	market	assets	e	
			share		Advantage	
Increased Income	1	0.89	0.86	1.98	1.08	0.213
Increase in net income	1.12	1	1.51	1.65	1.33	0.253
Increase market share	1.16	0.66	1	1.56	1.35	0.215
Optimum use of assets	0.50	0.60	0.64	1	0.47	0.121
Achieving Competitiv e Advantage	0.92	0.75	0.74	2.12	1	0.198

Table 11: Weight of the indicators affecting the financial perspective of the balanced scorecard approach

-		
priority	weights	indices
3	0.213	Increased Income
1	0.253	Increase in net income
2	0.215	Increase market share
5	0.121	Optimum use of assets
4	0.198	Achieving Competitive Advantage

According to the results of the prioritization and the results shown in tables (10 and 11), the index of "increase of net profit" is the most important indicator of the financial perspective and thus, the first research hypothesis will be confirmed. The results of the prioritization of the indicators affecting the customer perspective in supply chain evaluation based on the special vector technique are shown in tables (12 and 13).

Table 12: Paired comparison matrix of the indicators affecting the customer perspective

uncering the customer perspective					
Customer perspective	Brand Growth	Improve and maintain strong relationships with customers	Increase customer satisfaction	weights	
Brand Growth	1	0.69	0.64	0.250	
Improve and maintain strong relationships with customers	1.44	1	0.96	0.365	
Increase customer satisfaction	1.56	1.04	1	0.385	

Table 13: Weight of the indicators affecting the customer perspective of the balanced scorecard approach

priority	weights	indices
3	0.250	Brand Growth
2	0.365	Improve and maintain strong relationships with customers
1	0.385	Increase customer satisfaction

The results of the prioritization of the customer perspective are shown in tables (12 and 13), and the index of "increase of customer satisfaction" is the most important indicator of the customer perspective and thus, the second hypothesis of research will be confirmed.

The results of the prioritization of the indicators affecting the internal process perspective are shown in tables (14, 15).

 Table 15: Weight of the indicators affecting the internal process perspective of the balanced scorecard approach

00000	perspectiv	·
nriority	weights	i

priority	weights	indices
4	0.135	Agility to market changes
6	0.085	Channel Development Products and Services
2	0.170	Improvement Quality
1	0.184	Being the market leader
3	0.141	Time services and products to customers
7	0.083	Development of sources
5	0.102	Improve the provision
5	0.102	Optimization of the structure and processes

According to the results of the prioritization and the results shown in tables (14 and 15), the third hypothesis of research will not be confirmed and will be rejected.

In addition, in the internal process perspective, the index of leadership of the market (to become a leader agency in the market) and reliability are the first priority and the most effective index.

The results of the prioritization of the indicators affecting the learning and growth perspective in supply chain evaluation based on the special vector technique are shown in tables (16 and 17).

Table 17: Weight of the indicators affecting learning and growth perspective of the balanced scorecard approach

priority	weights	indices
3	0.166	Continuous learning
2	0.222	Develop the skills and expertise
4	0.164	Support and upgrade information systems
3	0.166	Network management and information infrastructure
1	0.282	Increased levels of employee satisfaction

According to the results of the prioritization and the results shown in tables (16 and 17), the fourth hypothesis of research will not be confirmed and will be rejected. In growth and learning perspective, the indicator of "the increase of the employees' satisfaction levels" is the most effective and the first priority indicator.

Prioritization of the indices affecting the four BSC perspectives

At this stage of the study, the performance distance of the financial perspective, customer, internal process and learning and growth perspective has been measured and the goal and performance of each one of the indicators affecting the four perspectives of balanced scorecard has been studied.

Therefore, the performance deviation from the goals of the indices affecting the four perspectives of balanced scorecard (financial perspective, customer perspective, internal process perspective, and learning and growth perspective) is calculated by indicators of the mean absolute deviation MAD 4 and the mean squared error MSE 5 according to Bias and the results are presented in table (18).

 Table 18: Performance deviation of four balanced scorecard

 annroaches

	uppi ouches						
Bias	MSE	MAD	perspective				
0.08	0.01	0.08	financial				
0.05	0	0.05	Customer				
0.06	0	0.04	Internal process				
0.09	0.01	0.09	Learning & Growth				

According to table (18), the "learning and growth" perspective is "0.01", according to the performance deviation of mean absolute deviation (MAD) and Bias "0.09" and based on the mean squared error (MSE). Thus, the "growth and learning" perspective show the greatest performance distance from goals. Therefore, the fifth hypothesis will not be confirmed and will be rejected according to the obtained results.

Goal programming model

In this section, first, each perspective of the balanced scorecard will be weighted and prioritized through the special vector technique. Geometric mean of paired comparison matrix is presented in table 19. The consistency rate of paired comparison matrices is calculated less than "0.1". Thus, the experts' opinions are consistent and reliable. Since respondents were the experts in the field of research, the responses' weight has been considered equal and at the same level of priority.

Table 19: paired comparison matrix of the four balanced scorecard approach

	scorecard approach						
weight	perspectiv	perspectiv	perspectiv	perspectiv	Balanced		
S	e Learning	e Internal	e	e financial	score		
	& Growth	process	Customer		cards		
0.271	1.5	1.19	0.88	1	erspective		
					financial		
0.331	1.70	1.76	1	1.13	erspective		
					Customer		
0.225	1.51	1	0.56	0.84	perspectiv		
					e Internal		
					process		
0.174	1	0.66	0.58	0.66	perspectiv		
					e Learning		
					& Growth		

Given that the customer perspective is the first priority with the greatest weight among the four balanced scorecard perspectives, the goal programming model has been presented to achieve the highest level of customer satisfaction through minimizing the deviations and the optimal budget allocation to the above perspective. For this purpose, the opinions of the experts in the studied company have been used to design the sub-indices of the customer perspective, which are presented in table 20:

Table 20: Sub-indices of the customer perspective

Sub-indices	indices
Price competitive parts and service	
Reduce service time	Increase customer satisfaction
Quality Parts and Service	
Flexibility	
Improve handling of customer	Improve and maintain strong
personnel	relationships with customers
Fulfill obligations	
Advertising	
The number of distribution channels	Brand Growth
and service components	
TT1 1 1 1 1 1	1

The special vector technique is used to weight the indices of customer perspective, and the results are presented in tables (20-21-22):

 Table 20: Paired comparison matrix of sub-index of the customer satisfaction

	customer satisfaction						
weights	Reduce service time	Reduce service time	Price competitive parts and service	Increase customer satisfaction			
0.469	1.64	2.01	1	Price competitive parts and service			
0.205	0.55	1	0.49	Reduce service time			
0.326	1	1.81	0.60	Quality Parts and Service			

Table 21: Paired comparison matrix of sub-index of the establishment, improvement and preservation of a strong

		relationship	with customers	
. 1.	E 10°11	T	F1 111	т

weights	Fulfill obligations	Improve handling customer personnel	of	Flexibility	Improve relationships with customers
0.278	0.42	1.95		1	Flexibility
0.171	0.37	1		0.51	Improve handling of customer personnel
0.552	1	2.70		2.38	Fulfill obligations

Table 22: Paired comparison matrix of sub-index of the brand development

weights	The nu	mber of	Advertising	Brand Growth
	distribution	channels		
	and service of	components		
0.510	1.04		1	Advertising
0.490	1		0.96	The number of
				distribution channels
				and service components

The mathematical structure of goal programming model is as follows: (Chung et al 2008)

(1)

Minimize
$$\mathbf{Z} = W_J d_J$$

Subject to :
$$a_{ij}x_j + d_1^- - d_1^+$$

For i=1, 2,..., m i=1,2,..., n

r i=1, 2,...,m j=1,2,...,n (2)
$$x_{11}, x_n \ge 0$$

$$x_{11}, x_n \ge 0 \tag{3}$$

As it can be seen in this model:

 w_j =weight of each index , d_j =Positive or negative deviation from the i_{th} goal ,

 a_{ij} =the coefficient x_j (j=1, 2, ..., n) For each goal (i = 1, 2, ..., i) , **x**11, **x**12, ..., **x**n =the decision variables

 b_1, b_2, \dots, b_n = the numbers on right side of the budgets available for each indicator

The numbers on right side (b_1, b_2, \dots, b_n) indicate the budget which can be allocated. This budget is considered 5,000,000,000 Tomans based on 1% of sales last year of the studied company and according to the decision-making and opinion of the experts and will be allocated based on weight and priority of each one of the indicators of the customer perspective. Considering that this model aims to minimize the mean of sum of deviations and optimal allocation of budget to the customer perspective in order to achieve the highest level of customer satisfaction. The allocated budget is limited and should not exceed the specified limit. Therefore, the intended deviations

should appear positive $[(\mathbf{d}]_{\mathbf{k}}^+)$ in the objective function and sub-indices of the customer perspective are considered as the technical coefficients of the variables.

According to the data obtained using the formulated special vector technique, goal programming model is as follows:

$$Min z = .385 d_1^+ + .365 d_2^+ + .25 d_2^+$$

Subject to:

 $.469 x_{11} + .205 x_{12} + .326 x_{13} + d_1^- - d_1^+ = 19250000$

3

 $.278 x_{21} + .171 x_{22} + .552 x_{23} + d_2^- - d_2^+ = 18250000$

$$.510 x_{21} + .490 x_{22} + d_3^- - d_3^+ = _{125000000} (5) x_{11}, x_{12}, x_{13}, x_{21}, x_{22}, x_{23}, x_{31}, x_{32} \ge C$$

According to figure 1, the final solution to the research model is zero. It means that the total deviation from the goals will be zero. The variables x_9 , x_{11} , x_{13} i.e. respectively $d_1^-.d_2^-, d_3^-$ are basic variables (the variables that are main variables in the final table) and the objective function variables i.e. $x_{10} x_{12} x_{14}$

respectively d_1^+, d_2^+, d_3^+ are zero. Total deviation from the goals being zero is the most ideal state in the goal programming. Therefore, considering the allocation of budget of 5,000,000,000 Tomans by the experts, the most optimal state for the above model is when the deviation from goal is zero. In other words, allocating a budget of 1.925 billion Tomans to the index of customer satisfaction increase (including sub-indices of competitive price, reduction of the service offering time and the quality of parts and services), and allocating a budget of 1.825 Tomans to the index of improvement and preservation of a strong relationship with customers, by considering the subindices (improvement of the employees' treatment with customers, fulfillment of the obligations to customers and flexibility) and the index of the brand development (including sub-indices of advertising, the number of channels of parts distribution and service offering) allocating a budget of 1.25 billion Tomans, the company can achieve the highest level of customer satisfaction.

Figure (1): The final solution of solving the goal programming equation

_			1 0					
	Goal Level	Decision Variable	Solution Value	Unit Cost or Profit c(j)	Total Contribution	Reduced Cost	Allowable Min. c(j)	Allowable Max. c(j)
1	61	XI	0	0	0	0	0	м
2	61	X2	0	0	0	0	0	м
3	61	X3	0	0	0	0	0	м
4	61	X4	0	0	0	0	0	м
5	61	X5	0	0	0	0	0	м
6	61	×6	0	0	0	0	0	м
7	61	X7	0	0	0	0	0	м
8	61	×8	0	0	0	0	0	м
9	61	X9	1,924,999,936.00	0	0	0	-0.38	0
10	61	×10	0	0.38	0	0.38	0	м
11	61	X11	1,824,999,936.00	0	0	0	-0.37	0
12	61	X12	0	0.37	0	0.37	0	м
13	61	X13	1,250,000,000.00	0	0	0	-0.25	0
14	61	X14	0	0.25	0	0.25	0	м
	61	Goal	Value	(Min.) =	0	[Alternate	Solution	Exists ¹¹)
	Constraint	Left Hand Side	Direction	Right Hand Side	Slack or Surplus	Allowable Min. RHS	Allowable Max. RHS	ShadowPrice Goal 1
1	C1	1,924,999,936.00		1,924,999,936.00	0	0	м	0
2	C2	1,824,999,936.00		1,824,999,936.00	0	0	M	0
3	C3	1,250,000,000.00		1,250,000,000.00	0	0	м	0

Model Sensitivity Analysis

Sensitivity analysis is of the positive aspects and strengths of programming models. Given that goal programming model always follows multiple objectives; the sensitivity analysis gets much more important in this model. Sensitivity analysis gives the model a dynamic aspect and indicates the changes of the objective function, variables and the numbers on the right side in the ranges that change the basic variables and the optimal solution. In other words, sensitivity analysis shows that to what extent each one of the variables changes (increase or decrease) without affecting the basic optimal solution.

Sensitivity analysis of the objective function priorities coefficients

Sensitivity analysis of the objective function priorities coefficients shows that how much the change of the coefficients makes no change in the optimal solution and combination of basic variables. According to the final results of the model for each program, the allowable increase and allowable decrease of its priority has been determined. According to the figure (7), if variable^X9 changes the the in range of $-.38 \le d_1^- = x_0 \le 0$ and the variable x_{12} changes in the range of $-.25 \le d_3^- = x_{13} \le 0$, the value of the objective function i.e. Z-0 will not change and the total deviation from the goals will be zero.

Figure 7: Sensitivity analysis of the objective function of the presented model

21:22:43	Decision Variable	Goal Level	Heduced Cost	Unit Cost or Profit c(j)	Allowable Min. c[j]	Allowable Max. c(i)
1	×1	61	0	0	0	м
2	×2	61	0	0	0	м
3	X3	G1	0	0	0	м
	×4	61	0	0	0	м
5	×5	61	0	0	0	м
6	×6	61	0	0	0	м
7	X7	61	0	0	0	м
- 0	×e	61	0	0	0	м
9	×9	G1	0	0	-0.38	0
10	×10	61	0.38	0.38	0	м
11	×11	61	0	0	-0.37	0
12	×12	G1	0.37	0.37	0	м
13	×13	G1	0	0	-0.25	0
14	×14	61	0.25	0.25	0	м

*Sensitivity analysis of the numbers on the right side (the level of budget)

Since the variable values are determined based on available resources, the sensitivity analysis of these resources is of utmost importance.

As shown in figure (8), the values on the right side of each limitation can change between 0 and M (a very large figure).

12-01-2011 21:23:11	Constraint	Direction	Right Hand Side	Allowable Min. RHS	Allowable Max. BHS	Shadow Price Goal 1
1	C1	-	1,924,999,936.00	0	м	0
2	C2	=	1,824,999,936.00	0	м	0
3	C3		1,250,000,000.00	0	м	0

Figure 8: Sensitivity analysis of the values on the right side of the presented model

Conclusion

In this study, first, the indices affecting the four perspectives of financial, customer, internal process and learning and growth were identified and prioritized, and the results of the special vector technique showed that the index of "increase of net income (Consolidated profit)" from the financial perspective, the index of "increase of customer satisfaction" from the customer perspective and "leadership of the market" (becoming a leader in the market) and "reliability" from the internal process perspective and learning and growth perspective, the index of "increase of the level of employee satisfaction" are the first priority compared to the other indicators in the balanced scorecard perspectives. In the next step, the performance distance of the balanced scorecard perspectives will be measured from the goals of the studied company (ISACO) as a result of which "learning and growth perspective" shows the greatest distance from the goals.

Finally, the goal programming model is presented to minimize total deviations on the customer perspective, which has the greatest weight among the balanced scorecard perspectives and a budget was allocated as constraint (numbers on the right side) with respect to the weight of each indicator and the optimal solution was zero. On the other hand, the total deviation from goals was zero. Thus, the studied company will achieve the highest level of customer satisfaction by optimal allocation of the considered budget and the sensitivity analysis of the presented model on the objective function and the numbers on the right side will be calculated.

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	1 401	C 14 . I an cu	i comparison i	matrix of the f	nuicators	ancering the i	nici nai process p	<i>cispective</i>	
weights	Optimization of the structure and processes	Improve the provision of cycle	Development of sources	Time services and products to customers	Being the market leader	Improvement Quality	Channel Development Products and Services	Agility to market changes	Internal process perspective
0.135	1.23	1.11	2	0.78	0.82	0.94	1.46	1	Agility to market changes
0.085	0.77	0.8	0.82	0.66	0.49	0.54	1	0.68	Channel Development Products and Services
0.170	1.95	1.65	1.85	1.43	0.95	1	1.85	1.06	Improvement Quality
0.184	2	1.75	2.25	1.50	1	1.05	2.04	1.21	Being the market leader
0.141	1.5	1.46	1.78	1	0.66	0.69	1.51	1.28	Time services and products to customers
0.083	0.73	0.88	1	0.56	0.44	0.54	1.21	0.5	Development of sources
0.102	0.90	1	1.13	0.68	0.57	0.60	1.25	1.11	Improve the provision
0.102	1	1.11	1.36	0.66	0.5	0.51	1.29	1.23	Optimization of the structure and processes

Table 14 : Paired comparison matrix of the indicators affecting the internal process perspective

Table 10: Farred comparison matrix of the mulcators affecting learning and growth perspective									
veights	Increased levels of	Network management and	Support and upgrade	Develop the	Continuous		Learning & Growth		
	employee satisfaction	information infrastructure	information systems	skills and	learning		perspective		
				expertise					
0.166	0.57	0.81	0.91	1.03	1		Continuous learning		
0.222	0.64	1.85	1.55	1	0.97		Develop the skills and		
							expertise		
0.164	0.63	0.99	1	0.64	1.09		Support and upgrade		
							information systems		
0.166	0.66	1	1.01	0.54	1.23		Network management and		
							information infrastructure		
0.282	1	1.51	1.58	1.56	1.75		Increased levels of		
							employee satisfaction		

Table 16: Paired comparison matrix of the indicators affecting learning and growth perspective

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