
A framework for evaluation criteria of supply chain performance in automotive industry: the case of the Iranian automotive supply chain

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Abstract: The main purpose of this research is to present a framework for performance assessment indexes in the supply chain of Iran's automotive industry. This practical research has been conducted in a survey-based manner in the two supply chains including Iran Khodro and Saipa corporations. Cronbach's alpha method has been used so as to estimate the reliability. Also, three methods including content analysis, structure analysis, and construct analysis have been utilised so as to examine the justifiability of the framework presented. Confirmatory factor analysis and correlation test have been used to respond the research questions. During the research conducted, it was found that the framework introduced is of a suitable justifiability in the supply chain of automotive industry. Based on the results obtained from the presented model, it can be deduced that in the present paper, the most emphasise has been placed on non-financial performance (NFP) (customer, growth and innovation, and internal processes) of supply chain. Also, it can be found that there is a hierarchy relationship between performance criteria so as to reach a desirable financial performance. In this way, it would be possible to reach a better financial performance by improving the components of growth and innovation as well as customers and internal processes.

Keywords: supply chain; supply chain management; performance; automotive industry; Iran.

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1 Introduction

Some factors such as complexity of business world, economic changes, and intensity of competition, new technologies and speed of change in customer needs have caused the existing organisations to take advantage of some things such as rapid flow of information, collective decision-making, and further coordination to commercial partners and comprehensive look. Existence of such changes can be seen in a topic namely 'supply chain' whose main purpose has been stated to be 'reaching the maximum value' (Chopra and Meindl, 2007). Furthermore, in today's economy, competition is no longer about a company competing against another one. Instead, these are supply chains that compete with each other (Hult et al., 2007). Reaching the maximum value for the final customer can be considered as the main goal of supply chain (Chopra and Meindl, 2007). In order to reach this main purpose, a set of market-based (such as to increase productivity and reduce the inventory, making benefit for all members, etc.) and financial (such as rate of returns from investment, profit margin, etc.) purposes comes to be considered (Li et al., 2006). So, it can be noted that supply chain performance management is counted as a suitable source for gaining competitive advantage (Li et al., 2006). Now that twenty years have passed from the appearance of the concept of supply chain management, supply chains, however, have not necessarily become better than their past. Based on his research on the success of performance of supply chain, Hamilton believes that 45% of the samples under study have reached solutions which have failed (*InformationWeek*, 2003).

Scope of investigation and assessment of performance of supply chain includes measurement of personal or one-dimensional performance, models for performance measurement, and their interactions with many of other variables such as competitive strategies and organisational structure as well as production methods (Langfield-Smith, 1997; Chenhall and Morris, 1995; Abernethy and Lillis, 1995). Performance measurement is the process of quantifying efficiency and effectiveness of processes (Neely et al., 2005). Performance measurement can be considered as feedbacks received from the activities related to customer satisfaction and decisions as well as strategic purposes (Bhagwat and Sharma, 2007). Performance measurement provides decision-makers with the information required in order to plan, control, and conduct the organisation's activities. It also makes managers able to educate their staff and suppliers on important dimensions of performance through performance measurement, and to direct improving activities by identifying deviations from standards. With the help of measurement of supply chain effectiveness, suitable performance measurement can help to improve supply chain management more (Beamont, 1996; Shah and Singh, 2001). Supply chain performance measurement may help to reach achievements such as promotion of members' motivation, improvement of collaboration, more rapidly solving

management issues, provision of up-to-date information and required feedback (Bullinger et al., 2002; Gunasekaran et al., 2004; Holmberg, 2000; Morash, 2001; Otto and Kotzab, 2003; Tan et al., 2002). So, it can be noted that performance assessment of supply chain is an act carried out to identify improvement areas within the system and to determine if activities will be keeping on or if it is required to start new engineering actions (Bond, 1999). Generally, one may consider performance assessment of supply chain as an act carried out to improve the effectiveness of supply chain and understand mild and continuous flow of resources within it (Fox et al., 2000; Wong and Wong, 2007). But what is of much importance is that choosing suitable indexes and approach for assessing the performance of supply chain should have three key features including to be 'Informing, Steering and Controlling' (Statdtler and Kilger, 2005).

The present paper is about to present a framework for performance assessment indexes in the supply chain of automotive industry. Several researches and a lot of models for performance of supply chain have been studied, but there has not been any certain model or framework to be observed as representing all the factors existing in supply chain. So, the researchers have presented a framework for performance assessment indexes in the supply chain of automotive industry by deeply studying the research literature, and doing content analysis as well as a field study in the automotive industry, and making some interviews with academic and industry-involved experts. Introducing this framework and stating the operational indexes for each of these factors are counted as innovative aspects of the present work. So, existence of a comprehensive look at the performance assessment indexes in supply chain and introduction of operational indexes in the framework presented for this industry may be considered as innovative aspect of the research.

2 Research literature

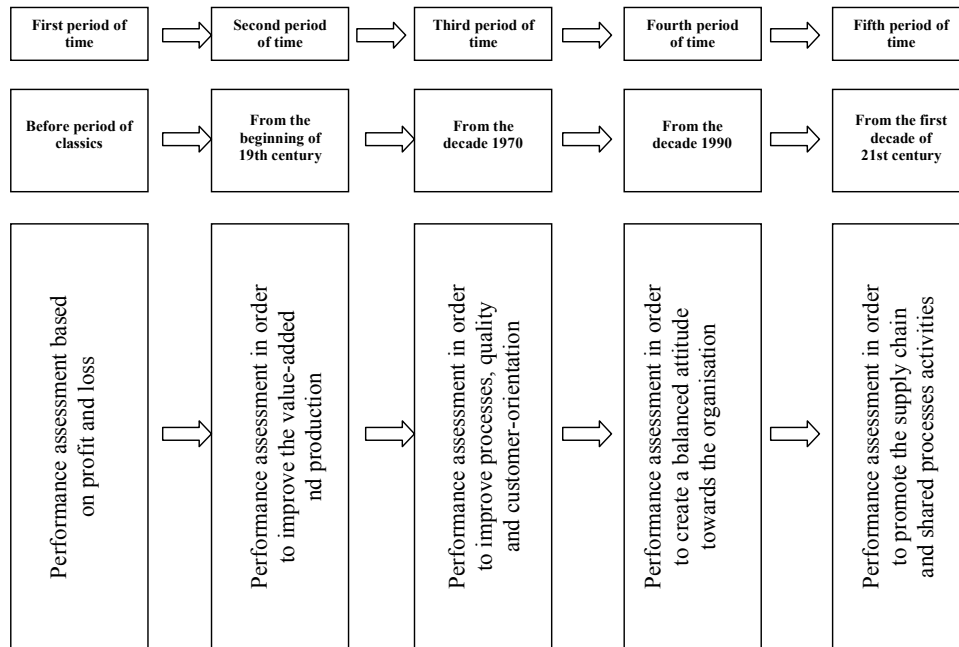
2.1 Supply chain performance

Supply chain includes all the stages which, directly or indirectly, participate in realisation of customer needs (Chopra and Meindl, 2007). It involves a range extended from final customers to initial suppliers. There are three main information, physical, and monetary streams flowing through this chain (Nurmilaakso, 2007). Logistic and purchase system are often transformed into advanced system of supply chain management. Successful corporations heavily invest on softwares which manage information flows in supply chain. From the years 1999 to 2002, vendors have sold more than 15 billion dollars of softwares related to supply chain management while this amount does not include set-up and maintenance costs (Kanakamedala et al., 2003). Now that twenty years have passed from the appearance of the concept of supply chain management, nonetheless, supply changes have not necessarily become better than their past. As time passes, performance measurement has increasingly attracted more attention worldwide. What is important is that in the past, performance assessment of supply chain was mainly based on

cost/efficiency, profit-based nature, and short-term time periods with individual indexes whereas given that industries become competitive, modern approaches have come to be considered in order to assess the performance of supply chain. These include value-based and customer-based natures, long-term time periods as well as use of a set of collective indexes for performance assessment (McCormack et al., 2008).

Performance measurement over the time may be seen in five time phases, as shown in Figure 1. Scope of investigation and assessment of performance of supply chain includes measurement of personal or one-dimensional performance, models for performance measurement, and their interactions with many of other variables such as competitive strategies and organisational structure as well as production methods (Langfield-Smith, 1997; Chenhall and Morris, 1995; Abernethy and Lillis, 1995). Performance measurement is the process of quantifying efficiency and effectiveness of processes (Neely et al., 2005). Performance measurement can be considered as feedbacks received from the activities related to customer satisfaction and decisions as well as strategic purposes (Bhagwat and Sharma, 2007). Performance measurement provides decision-makers with the information required in order to plan, control, and conduct the organisation's activities. It also makes managers able to educate their staff and suppliers on important dimensions of performance through performance measurement, and to direct improving activities by identifying deviations from standards. With the help of measurement of supply chain effectiveness, suitable performance measurement may help to improve supply chain management more (Beamont, 1996; Shah and Singh, 2001). Supply chain performance measurement may help to reach achievements such as promotion of members' motivation, improvement of collaboration, more rapidly solving management issues, provision of up-to-date information and required feedback (Bullinger et al., 2002; Gunasekaran et al., 2004; Holmberg, 2000; Morash, 2001; Otto and Kotzab, 2003; Tan et al., 2002).

So, it can be noted that performance assessment of supply chain is an act carried out to identify improvement areas within the system and to determine if activities will be keeping on or if it is required to start new engineering actions (Bond, 1999). Generally, one may consider performance assessment of supply chain as an act carried out to improve the effectiveness of supply chain and understand mild and continuous flow of resources within it (Fox et al., 2000; Wong and Wong, 2007), with the purpose of producing a commodity with lesser costs, delivering products to customers in a timely manner, and raising customer satisfaction (Chopra and Meindl, 2007). Efficient management and performance of supply change are now identified as a vital factor in reaching competitive advantages of corporations much more than before (Christopher, 1998; Simchi-Levi et al., 2000). Several indexes including cost, responsibility to customer and duration of production process have been used for performance assessment in the initial studies on modelling of supply chain (Arntzen et al., 1995; Lee and Billington, 1993; Pyke and Cohen, 1994). So, it is necessary to choose an approach in order to assess the supply chain (like other approaches existing in assessment of businesses and corporations).

Figure 1 Overall view of the evolution of performance measurement

Approaches effective to be applied to assessment indexes of supply chain should have the following features:

- connection between indexes and business strategy
- balanced and comprehensive indexes
- indexes based on superior internal and external patterns
- aggressive but available
- able to be seen, monitored and assessed at all levels of the organisation
- a tool for continuous improvement
- implementing the indexes according to the official and regular operational plan (Cohen and Roussel, 2005).

Considering the issues discussed, it would be possible to introduce several models for performance assessment of supply chain, as shown in Table 1.

Table 1 Several types of models and methods for performance assessment of supply chain

<i>Researcher</i>	<i>Aspects/indexes</i>	<i>Model/framework</i>
Supply-Chain Council (2006)	Reliability, flexibility, cost, asset	SCOR
Grimaldi and Rafele (2007), Rafele (2004) and Leeuw (2008)	Tangible components, methods for realisation, informative actions	LOGISTIQUAL
Lapide (2000) and Ashayeri and Lemmes (2006)	Study and assessment of projects done among members of the chain	Economic value added
Logistics Resources International Inc. Atlanta, GA (Jana et al., 2007)	Financial performance, logistic productivity, logistic qualitative criteria, logistic time criteria	Logistic assessment model
Azapagic and Clift (1999) and Hagelaar and Van der Vorst (2002)	Focus on environmental responsibilities of supply chain	Life cycle analyses
Romero and Rehman (2003)	Establishing clear criteria for determining the rate of achieving intended targets	Multi criteria analyses
Gunasekaran et al. (2001)	Financial and non-financial criteria	Finance/non-finance
Dixon et al. (1990) and Bowersox et al. (2002) and Hines (2004)	Identifying key areas in the chain, and determining some criteria for the identified areas Key areas such as quality indexes, cost-based indexes, flexibility, acceleration and speed indexes, services offered to customer, reliability, management of assets, productivity	Performance measurement questionnaire
Azzone et al. (1991)	Aspects: research and development, production and operation, marketing	Time-based competition method
Chan and Qi (2003)	Soft (intangible): effectiveness, reliability, availability, flexibility Hard (tangible): cost, time, capacity, productivity, efficiency, outputs	Soft and hard factors
Chan et al. (2003)	Qualitative factors: customer satisfaction, flexibility, integration of material and information flows, risk management, supplier's performance Quantitative factors: cost-creating factors, responsiveness factors, productivity factors	Qualitative and quantitative factors
Otto and Kotzab (2003)	Approaches: systems' dynamic nature, operation research,	Six-approach model
Hult et al. (2006)	Dimensions: speed, quality, cost, flexibility	Competitive priorities model
Gunasekaran et al. (2004)	Dimensions: the criteria existing in processes of planning, sourcing, production, offer and delivery, after sale services, and customer satisfaction	The model based on supply chain processes

Note: *Strategic measurement analysis and reporting technique (SMART)

Table 1 Several types of models and methods for performance assessment of supply chain (continued)

<i>Researcher</i>	<i>Aspects/indexes</i>	<i>Model/framework</i>
Gunasekaran et al. (2001)	Levels: strategic, technical, operational	Three-level model
Chopra and Meindl (2007) and Zokaei and Hines (2007)	Efficiency: indexes related to production cost and delivering product to customer (process-based) Responsiveness (effectiveness): investigating customer satisfaction and changes (customer-orientation)	Efficiency/ responsiveness model
Macpherson and Wilson (2003)	• Communication abilities (commitment, participation, etc.) • Process-related abilities (pattern-following, technologic, flexibility, etc.) • Abilities related to commodities and services for new and/or existing products (quality, speed, cost, etc.)	The model based on supply chain abilities
Macpherson and Wilson (2003)	Technical criteria: the chain's production- and logistics-related abilities, etc. Administrative criteria: excellent rate of supporting management, presence of required executive experts, financial supports, etc.	Technical-administrative model
National Research Council (2010)	General indexes of chain: Specific indexes of chain: delivery, flexibility and responsiveness, logistics, management of assets	National Research Council
Sambasivan et al. (2009)	• Web-based service indexes • Data reliability indexes • Cost and time indexes • Electronic responsiveness indexes • Proforma-issuing and payments indexes • Electronic document management indexes	The model for assessment of electronics supply chain
Varma (2006) and Epstein and Wisner (2001) and Hervani et al. (2005)	Indexes such as faster delivery, renewability, rate of saving in and maintenance of energies, business green actions, balance between cost and pollution, etc.	The model for assessment of the green chain
Kaplan and Norton (1992)	Financial, customer, internal processes, innovation and learning	Balanced score card
Lapide (2000)	Investigation of behaviour of cost-creating variables	Activity-based costing
Zhu (2003)	Input and output criteria in supply chain	DEA
Camp (1995) and Silvio and Carlos (2001)	Determining some criteria and comparing them to the superior pattern (benchmarking) model	EFQM
Wang Laboratories, Inc. (Lynch and Cross, 1991) and Wu and Chen (2006) and Saad and Patel (2006)	Strategic criteria, criteria for commercial unit, operational criteria, customer satisfaction and productivity criteria	SMART*

Note: *Strategic measurement analysis and reporting technique (SMART)

In the present paper, a group of criteria which are of much importance in the performance of supply chain has been generally collected first, due to the lack of performance measurement system in automotive industry. Despite several methods have been already presented so as to assess the performance of supply chain, the balanced scorecard (BSC) technique has some advantages over the other ones, which include directing supply chain processes towards improvement of customer satisfaction, improving operational purposes, expanding the area of operational criteria, identifying improvement areas, Making supply chain activities to focus on strategic purposes and integrated assessment system at management levels (Bhagwat and Sharma, 2007). In this research, we are about to extract those criteria which are of much importance among in automotive industry from all the remarked criteria. Bhagwat and Sharma (2007) have also used the BSC technique for performance assessment of supply chain. Despite they have put the assessment criteria into four perspectives in the same way, the present paper cannot be considered as efficient and applicable to any specific industry, given the small number of the criteria under study and general nature of the research.

In this way, criteria for performance assessment of supply chain (along with some of performance indexes of the green chain and electronic chain) have been introduced in Table 2. We extracted main indices with the help of literature review and with studying main performance model in literature of supply chain performance. Then, all indices in different models were classified in Table 2.

3 Research procedure

3.1 Case: automotive industry of Iran

Iran's automotive industry is the second most active industry of the country, after its oil and gas industry, accounting for 10% of Iran's GDP and 4% of the workforce (700,000 persons) (Washington Post, 2013). Since the early 2000, automobile production in Iran has grown exponentially. Iran's automobile production crossed the 1 million mark in 2007/2008. Today, Iran is the 18th largest automaker in the world and one of the largest in Asia, with annual production of more than 1.6 million (Press TV, 2010). In 2009 Iran ranked fifth in car production growth standing next to China, Taiwan, Romania and India (English Fars News, 2010).

The Iranian manufacturers currently produce six different types of vehicle, including passenger cars, 4WD, trucks, buses, minibuses, and pickup trucks. The sector directly employs about 500,000 people (roughly 2.3% of the workforce), and many more in related industries. About 75% of local output is passenger cars, with pick-ups the next largest category, accounting for around 15% (Economist Intelligence Unit, 2008).

The first tier of supply chain of Iran Khodro Company includes SAPCO (main supplier), Iran Khodro Industrial group (manufacturer) and ISACO (main after Sale Company) and the first tier of supply chain of Saipa Company includes Sazeh Gostar (main supplier), Saipa Industrial group (manufacturer) and Saipa Yadak (main after Sale Company). SAPCO and Sazeh Gostar are main responsible companies for supply and procurement management in automotive industry of Iran.

Table 2 Assessment indexes for the performance of supply chain

<i>Researchers</i>	<i>Assessment index</i>	<i>Dimensions of performance</i>
Lai et al. (2002), Bhagwat and Sharma (2007), Kannan and Choon (2005) and Davis (1993)	Duration of responding to customers' demand	Customer
Cai et al. (2009), Bhagwat and Sharma (2007)	Extent and variety of products and services	
Bhagwat and Sharma (2007), Kannan and Choon (2005), Xu et al. (2009), Cai et al. (2009) and Chen et al. (2007)	Order lead time	
Deshpandé et al. (1993), Kim (2007), Bhagwat and Sharma. (2007), Hult et al. (2007) and Flynn et al. (2010)	Level of cooperation between seller and buyer	
Mabert and Venkataramanan (1998), Davis (1993), Holmberg (2000), Xu et al. (2009) and Cai et al. (2009)	Delivery lead time	
Bhagwat and Sharma (2007)	Level of the ability to immediately deliver product to customer	
Bhagwat and Sharma (2007)	Quality of product delivery documents	Financial
Mabert and Venkataramanan (1998), Bhagwat and Sharma (2007), Kannan and Choon (2005) and Cai et al. (2009)	Quality of the commodities delivered to the customer	
Bhagwat and Sharma (2007), Bechtel and Jayaram (1997) and Xu et al. (2009)	Rate of return on investment	
Varma et al. (2006)	Making a balance between created cost and pollutions	
Bhagwat and Sharma (2007)	Delivery performance	
Bhagwat and Sharma (2007)	Cost of sharing and exchange of information	
Bechtel and Jayaram (1997) and Bhagwat and Sharma (2007)	Cost of production and operation per hour	

Table 2 Assessment indexes for the performance of supply chain (continued)

<i>Researchers</i>	<i>Assessment index</i>	<i>Dimensions of performance</i>
Holmberg (2000), Bhagwat and Sharma (2007) and Xu et al. (2009)	Supplier lead time considering the type of industry	Internal process
Varma et al. (2006)	Renewability of products	
Varma et al. (2006)	Rate of saving in and maintenance of energies	
Bhagwat and Sharma (2007)	Total time of inventory turnover	
Chen et al. (2007) and Bhagwat and Sharma (2007)	Accuracy in forecast techniques	
Bhagwat and Sharma (2007) and Xu et al. (2009)	Purchase order lead time	
Bhagwat and Sharma (2007)	Efficiency of order-recording methods	
Sambasivan et al. (2009)	Web-based responsiveness and services	
Sambasivan et al. (2009)	Electronic documents management	
Mabert and Venkataramanan (1998) and Kannan and Choon (2005)	Identifying and determining customers' future needs	Growth and innovation
Kim (2007), Bhagwat and Sharma (2007) and Kannan and Choon (2005)	Supplier's innovation for reducing the costs	
Bhagwat and Sharma (2007), Kannan and Choon (2005), Graham et al. (1994) and Maloni and Benton (1997)	Supplier's collaboration for solving the technical problems	
Bhagwat and Sharma (2007)	Supplier's ability to respond to qualitative problems	

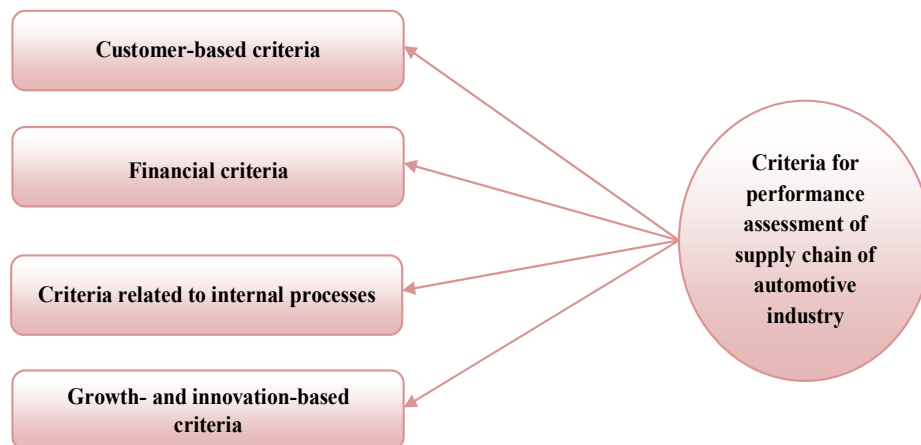
As of 2001, there were 13 public and privately owned automakers in Iran, of which two – Iran Khodro and Saipa – made up 98% of the total domestic production. The main reason behind selection of these two companies are that these two accredited companies own most of Iran's automobile market share, and the history of their activity is more than that of the other companies in this industry (Nikabadi and Zamanloo, 2013). Iran Khodro is one of the largest car manufacturers in Asia. It has established joint-ventures with foreign partners on four continents.

In 2007, Iran's car exports stood at around \$500 million. Iran's car exports reached \$1 billion by March 2009. Production raised to 1.13 million units by 2012 (\$200 million in exports expected by 2010) and 60,000 units exported by 2013 (Companies and Markets, 2008).

3.2 Conceptual model of the research

Considering the carried out literature review, the conceptual model of the research can be drawn as in Figure 2 (this model is based on Table 2).

Figure 2 Conceptual model of the research (see online version for colours)



3.3 Research variables

According to Figure 2, main variables of the research include dimensions of performance assessment of the supply chain, and subsidiary variables consist of a set of indexes created for each of the factors existing in Table 2.

3.4 Research questions

Considering the conceptual model presented research questions can be expressed as follows:

- 1 What are the main *customer-based indexes* in performance assessment of the supply chain of automotive industry?
- 2 What are *financial indexes* in performance assessment of the supply chain of automotive industry?
- 3 What are the main *internal-processes-based indexes* in performance assessment of the supply chain of automotive industry?
- 4 What are the main *growth- and innovation-based indexes* in performance assessment of the supply chain of automotive industry?

3.5 Research methodology

In terms of type of results, the present paper is of practical type, and in terms of variable, it includes qualitative variables categorised as descriptive type and carried out in a survey-based manner. The tool used in this research is a series of questionnaires based on five-point Likert scale as well as some interviews with experts to analyse the findings. Locative scope of the research includes the group of manufacturer, supplier, and after-sale services corporations in Iran's automotive industry.

Methodology of the research may be explained in two overall parts.

3.5.1 First part

Given the purpose and main questions of the research, researchers are looking to present a framework for performance assessment indexes in the supply chain of Iran's automotive industry. For this purpose, we have used library studies, and content analysis method as well as pilot study in order to extract, fix and adjust the indexes, and to validate and verify the presented model. The following methods have been also used so as to present the introduced framework as well as to make the required corrections and adjustments for identifying the final variables of the research:

- 1 the research literature and frequency rate of introduction of indexes
- 2 four university professors' opinions, whose fields of research are logistic management, supply chain, and performance assessment
- 3 the viewpoints of three experts, who have had graduate studies, each having more than five years of experience in the automotive industry
- 4 viewpoints of three PhD students in operations and production management, whose research or executive background is related to supply chain management, logistic management, and performance management.

After the above proceedings, the introduced framework was fixed and adjusted. And at the end, with the help of the following proceedings, the final variables of the model were presented in order to follow the next steps, as shown in Table 3.

Table 3 Performance assessment indexes of supply chain

<i>Assessment index</i>	<i>Code</i>	<i>Dimension of performance</i>
Duration of responding to customers' demand	CP1	customer
Extend and variety of products and services	CP2	
Order lead time	CP3	
Level of cooperation between seller and buyer	CP4	
Delivery lead time	CP5	
Quality of the commodities delivered to the customer	CP6	
Rate of return on investment	FP7	Financial
Delivery performance	FP8	
Cost of sharing and exchange of information	FP9	
Cost of production and operation per hour	FP10	
Supplier lead time considering the type of industry	PP11	Internal process
Total time of inventory turnover	PP12	
Accuracy in forecast techniques	PP13	
Purchase order lead time	PP14	
Identifying and determining customers' future needs	GP15	Growth and innovation
Supplier's innovation for reducing the costs	GP16	
Supplier's collaboration for solving the technical problems	GP17	
Supplier's ability to respond to qualitative problems	GP18	

3.5.2 *Second part*

In order to respond to all the questions, we took advantage of descriptive method and confirmatory factor analysis of the first and second phases. In this research, purpose of using confirmatory factor analysis is to reduce the components of the dimensions existing in the research so as to identify components having more degree of importance. Those indexes having a factor loading less than 0.5 will be deleted. But before doing the confirmatory factor analysis, KMO sampling adequacy test should be carried out to make sure about adequacy of the sampling. Value of this index should be larger than 0.6 (Momeni, 2012).

3.6 *Statistical population*

Given that the unit analysed in this research is the supply chain of automotive industry, statistical population of the research includes the automotive industry's group of experts. Experts and specialists forming the statistical population of the research will be chosen from those having three years of experience in field of management of the group of organisations under study as well as one feature of the followings:

- a having a university degree (BSc or higher) in industrial engineering, management, and economy
- b having reports, researches, or scientific articles in fields of performance management, supply chain management, logistics, and performance assessment of supply chain
- c their executive activities in their organisation are related to strategy, design and planning of supply chain and/or performance management and logistics management.

The statistical population existing in this part has been chosen from the corporations which are active in supply chain of Iran's two large corporations, Iran Khodro and Saipa. The main reason behind this selection is that these two accredited companies own most of Iran's automobile market share, and the history of their activity is more than that of the other companies active in this industry (Hanafisadeh and Nikabadi, 2011). So, sampling has been done among the experts whose field of expertise is related to the research subject in the two companies. Since the subject of the research is among those of novel and newly-discussed types in the industry and that there are only a limited number of desirable and related persons to respond the research questions, we have chosen the sample experts in a judgment-based and purposeful manner.

3.7 Validity and reliability of the research

In this research, literature review was firstly used to investigate the content validity in order to assess the adequacy and accuracy of the indexes of the research model, and then some modifications, adjustments, and corrections were applied to the indexes, based on the frequency rate cited in the research literature. Finally, the latest corrections and adjustments were made by four university professors whose research background is supply chain and performance management, three industry experts with experiences of more than five years, and three PhD students having research background in field of supply chain, logistics, and performance management. Also, construct analysis has been used so as to evaluate the reliability of the framework presented in this research. In addition to construct and content validity analyses, we will take advantage of discriminant validity analysis in model-finding of the structural equations. Bagozzi et al. (1991) consider the discriminant validity as the rate of differentiation of one dimension and its indexes from the other ones and their indexes. Fornell and Larcker (1981) believe that to verify this validity, the correlation between indexes of two dimensions or two parts of the model should be less than 'square root of the average variance' for the considered dimension. Cronbach's alpha method has been also used to investigate the reliability in this research. If the Cronbach's alpha is larger than 0.7, the test is of an acceptable reliability (Christmann and Van Aelst, 2006).

3.8 Method of data gathering and data analysis

Library and field studies have been the method for data gathering in the present paper. Also questionnaire and interview with experts are the tools used in this work. Tools of descriptive and inferential statistics, especially the first- and second-order factor analyses have been used so as to analyse the data and respond to the research questions. Statistical

analyses have been carried out with the help of the softwares SPSS (version 21) and LISREL (version 8.54).

4 Research findings

Among the 220 questionnaires, only 206 of them were suitable for doing statistical analysis (response rate: 94%). Of these, suppliers (SAPCO and SAZEHGOSTAR), manufacturers (Irankhodro and Saipa), and after-sale (ISACO and SAIPAYADAK) companies active in supply chain of automotive industry owned 70, 104, and 32 questionnaires, respectively. Around 75% of respondents had a work experience more than seven years in the automotive industry.

Table 4 Verification or rejection status for each of criteria in several dimensions of the performance of supply chain

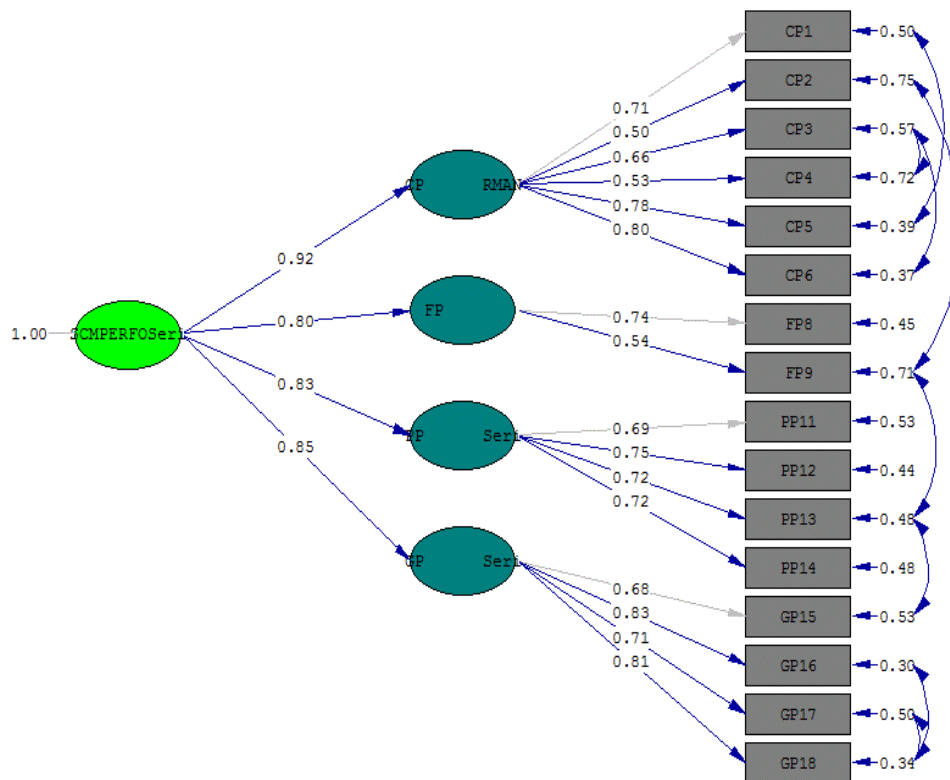
<i>Performance of supply chain</i>	<i>Index code</i>	<i>Status</i>	<i>Factor loading</i>
<i>Customer</i>			
Duration of responding to customers' demand	CP1	Verified	0.71
Extent and variety of products and services	CP2	Verified	0.50
Order lead time	CP3	Verified	0.66
Level of cooperation between seller and buyer	CP4	Verified	0.53
Delivery lead time	CP5	Verified	0.78
Quality of the commodities delivered to the customer	CP6	Verified	0.8
<i>Financial</i>			
Rate of return on investment	FP7	Rejected	-
Delivery performance	FP8	Verified	0.74
Cost of sharing and exchange of information	FP9	Verified	0.54
Cost of production and operation per hour	FP10	Rejected	-
<i>Internal processes</i>			
Supplier lead time considering the type of industry	PP11	Verified	0.69
Total time of inventory turnover	PP12	Verified	0.75
Accuracy in forecast techniques	PP13	Verified	0.72
Purchase order lead time	PP14	Verified	0.72
<i>Growth and innovation</i>			
Identifying and determining customers' future needs	GP15	Verified	0.68
Supplier's innovation for reducing the costs	GP16	Verified	0.83
Supplier's collaboration for solving the technical problems	GP17	Verified	0.71
Supplier's ability to respond to qualitative problems	GP18	Verified	0.81

4.1 Investigation of reliability and validity index, adequacy of sampling, and confirmatory factor analysis

Cronbach's alpha in a 30-person pilot group has been equal to 0.915, verifying the reliability of the questionnaire. Adequacy of sampling (KMO index) for the designed questionnaire has been calculated equal to 0.905. Table 4 shows whether each of the indexes has been verified in several dimensions of the conceptual model of the research (response to the subsidiary questions of the research).

Until this phase of the research, each of the dimensions of the research model has been analysed individually, with the help of first- and second-order factor analyses, and the key indexes for each of these factors have been identified. In this section, indexes chosen in each dimension are merged with each other so that the average of these indexes is the overall indicator of that factor.

Figure 3 Factor analysis for organisational factors in standard mode after applying the modifications (see online version for colours)



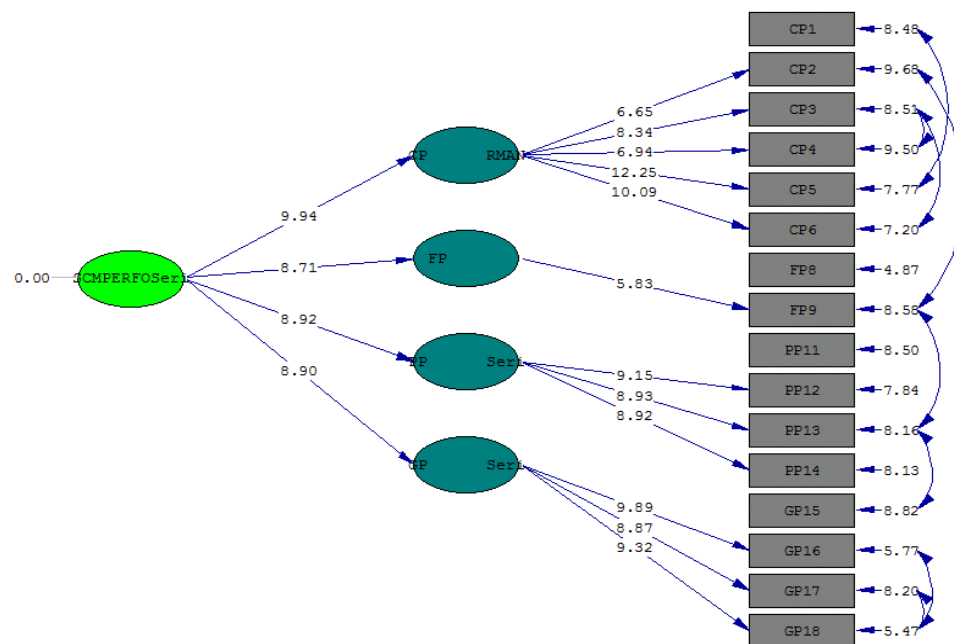
Notes: Chi-square = 146.29, df = 92, p-value = 0.00027, RMSEA = 0.054

4.1.1 General model of the criteria for performance assessment of supply chain in standard mode and after applying the modifications

Figure 3 indicates that the most important criteria for performance assessment of supply chain are related to those for customer and growth and innovation.

Figure 4 shows the meaningfulness of the model in the t-value mode.

Figure 4 Investigation of meaningfulness of the organisational factors in t-value mode after applying the modifications (see online version for colours)



Notes: Chi-square = 146.29, df = 92, p-value = 0.00027, RMSEA = 0.054

Table 5 shows the fitness of the model in the standard mode.

According to Table 5, it can be concluded that after applying the modifications, the model has a meaningful fitness, and construct validity is verified for the model.

Table 5 Fitness indexes for organisational factors in standard mode after applying the modifications

χ^2/df	Standard root mean square residual (SRMSR)	Goodness of fit index (GFI)	Adjusted goodness of fit index (AGFI)	Root mean square error of approximation (RMSEA)	Normed fit index (NFI)	Non- normed fit index (NNFI)	Comparative fit index (CFI)
1.59	0.051	0.92	0.88	0.054	0.96	0.98	0.98

Desirable values:

Hartwick and Barki (1994) and Segars and Grover (1993)

$\chi^2/df \leq 3$; GFI, NFI, NNFI, CFI ≥ 0.90 ; AGFI ≥ 0.80 ; RMSEA ≤ 0.08 ; SRMSR ≤ 0.10

4.1.2 Correlation between organisational factors and investigation of the discriminant validity of the model

Table 6 shows the correlation and discriminant validity for the performance indexes of supply chain. For each of the factors, square root of the average variance has been also calculated (main diagonal of the matrix). Given that for all the factors, this index is more than its correlation of that factor with the other factors, discriminant validity is also verified.

Table 6 Correlation (with the confidence level of 99%) between factors of performance dimensions of supply chain and investigation of discriminant validity

	<i>Customer</i>	<i>Financial</i>	<i>Internal process</i>	<i>Growth and innovation</i>
Customer	0.672			
Financial	0.528	0.674		
Internal process	0.605	0.59	0.722	
Growth and innovation	0.667	0.414	0.593	0.760

5 Discussion, implication and conclusions

The main purpose of this research is to present a framework for performance assessment indexes in the supply chain of the automotive industry. Several researches and a lot of models for performance of supply chain have been studied, but there has not been any certain model or framework to be observed as representing all the factors existing in supply chain of automotive industry. Existence of a comprehensive look at the performance assessment indexes in supply chain of 'automotive industry' and introduction of practical indexes in the framework presented for automotive industry may be considered as innovative aspect of the research.

The research has been conducted in the two supply chains including Iran Khodro and Saipa Corporations, the largest and most active automobile manufacturer corporation in Iran (as a case) and Researchers should be careful in generalising the findings to the another automotive supply chain.

Based on the results obtained from the presented model, it can be deduced that in the general model, the most emphasise has been placed on non-financial performance (NFP) (customer, growth and innovation, and internal processes) of supply chain. It is interesting to note that all members of the chain will be seeking to gain financial profit, but this research indicates that non-financial factors are more important than financial ones. It can be inferred that paying attention to productive manager of the performance of supply chain requires a long-term look as it is possible to receive long-term profits and reach a desirable financial performance only through improving performance indexes of growth and innovation, and customer as well as internal processes. A study carried out by Liu and Tsai (2007) showed that even knowledge-based supply chains pay the maximum attention to the performance of growth and innovation. According to the finding, it can be exactly found that there is a hierarchy relationship between performance components so as to reach a desirable financial performance. In this way, it would be possible to reach a better financial performance by improving the components of growth and innovation as

well as customers and internal processes. As a result, it is concluded that a long-term look is required to reach the financial outcomes of supply chain. In general, the most important finding in this study as the most important criteria is the non-financial criteria. According to research findings, it can be concluded that the good performance of a supply chain requires a long-term view why more time is needed to achieve non-financial criteria. The reason for this finding can be understood that the purpose of the supply chain, delivering maximum value to the end customer. Another important consideration in the automotive industry is a hierarchical relationship between supply chain performance assessment criteria.

The main limitation of this study is to consider only two supply chain in Iran (as a case) and for generalising the conceptual model presented in this paper must be surveyed in a large number of supply chains in automotive industry. Another limitation was that the survey was conducted only in the first layer of the supply chain (main suppliers, Manufacturers, and main after sale companies).

Future researchers may assess the performances in the automotive industry using the framework presented in this paper, and calculate the performance of these chains using calculation and quantitative methods.

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