Investigating the Effect of Functional and Flexible Information Systems on Supply Chain Operation: Iran Automotive Industry

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Received: 16/Nov/2016 Revised: 01/Jan/2017 Accepted: 30/Aug/2017

Abstract

This research studies the relationship between supply chain and information system strategies, their effects on supply chain operation and functionality of an enterprise. Our research encompasses other ones because it uses a harmonic structure between information systems and supply chain strategies in order to improve supply chain functionality. The previous research focused on effects of information systems on modification of the relationship between supply chain strategies and supply chain function. We decide to evaluate direct effects of information systems on supply chain strategies. In this research, we show that information systems strategy to improve the relationship between supply chain and supply chain strategies will be. Therefore, it can be said that creating Alignment between informational system strategy and supply chain strategies finally result in improvement of supply chain functionality and company's operation.

Keywords: Functional Informational Systems; Flexible Informational Systems; Supply Chain Performance.

1. Introduction

In global competitions of this era, different products must be accessible to customers according to their demands. Demand of customer for high quality and fast servicing increased the pressures that didn't exist before. As a result, companies cannot do everything individually anymore. According to this, activities such as supply and demand programming, providing material, production and programming products, product maintenance services, inventory control, distribution, delivery and customer service, which were done in company level, moved to supply chain now [1]. Generally, supply chain is a chain which includes all the activities related to product flow and material conversion, from providing material to final delivery [2]. There are two other flows in product flow one of which is information flow and the other one is financial and credit source flow. While supply chain operation plays a great role in improving company's functionality and its final success, we always try to find a way for increasing supply chain functionality [3-7]. Many tools are used in researches and actions for this among which information technology and information systems were the most effectives. There raise two questions here:

1. Does using information system improve supply chain functionality?
2. What kind of relationship must exist among information systems and supply chain in order to increase effectiveness?

One of the aspects of successful management in supply chain lies in measuring and monitoring information of functional parameters and its key function. Therefore, it is important for the company to choose those systems which are in line with supply chain that is choose information systems that facilitate processes of supply chain and provide information about parameters which identify special aims of supply chain strategies. If this correlation don't exist between supply chain and information system strategies, this relationship will not only be ineffective but also results in losing organizational capital [8]. Therefore, suitable relationship between supply chain and information systems needs a basis for analyzing how information processing needs to different supply chains can be supported via information system programs. This research shows the conceptual space between alignment of different information system strategies and supply chain strategies providing theoretical and experimental basis for analyzing the benefits of information system programs for supply chain [9, 10]. We evaluate the moderated relationships between strategies of supply chain (special types of strategic aims and purposes that supply chain can have) and information system strategies (information of information system share for supply chain) and their effects on supply chain function (flexibility of supply chain, integration and answering customers) and companies functionality (how a company reaches its financial aims). With theorization about supply chain and information system literature in a

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framework via information process theory, we provide the hypothesis of our suggestion with positive effects of two strategies of information systems – functional and flexible – on relationships between lean and agile supply chain strategies. Our research question includes the following cases which can be answered during research:

1. Can supply chain strategies improve supply chain functionality?
2. Can functional information systems improve lean supply chain strategies?
3. Can flexible information systems improve agile supply chain system?
4. Can improvement of supply chain improve company's functionality at the end?

In this section, we stated _the general research and provided primary descriptions for the main elements of research and the necessity and importance of this research. Section 2, provides a review of literature associated with precise description of research elements and the background of research. Section 3, includes two parts: in the first part conceptual research model and research hypotheses will be stated and part two describes the research method. Section 4, analyzes the conducted case study in an automotive industry. Section 5, gives the conclusion and further research suggestions.

2. Review of Literature

In this section, reviews on the related works are categorized into supply chain and information systems and also the back ground is detailed.

2.1 Supply Chain

Supply chain includes all the related activities to flow and conversion of products from raw material step to delivery to final user and information flows of them. A remarkable notion in supply chain is supply chain strategy. Supply chain strategy reflects the "nature" of it and shows its specific aims and purposes [11]. Category of supply chain strategies show that it can focus on costs and weaknesses functionalities, flexibility and quick answer or a mixture of them. Different strategies of supply chain include noble, fast, flexible or a mixture of them that we describe only lean and agile in brief:

Lean supply chain: it is based on decrease of costs and flexibility, focusing on improvement of processes. Concentration of this supply chain is on decreasing waste products and increasing additional value and it aims at fulfillment of customers' needs and maintaining benefits.

Agile supply chain: its aim is to create answering ability with effective costs to unpredictable changes in market in terms of type and volume. One of the most important benefits of fast supply chain is customers' satisfaction, delivery speed, introducing new product, and decreasing delivery time [12].

2.2 Information Systems

An information system is a combination of integrated elements which support decision makings and organization controls via gathering, processing, saving and distributing informational data. This system helps to provide coordination in organizational operations and helps managers and employers in organizations to analyze and simulate organizational problems [13].

Information Systems Strategies

These strategies of a company develop the nature of information system strategies in share of functional programs of it and reveal itself in company status toward information systems [14]. Two strategies of functional and flexible strategies of information systems will be evaluated now:

Function Informational Systems

This strategy tends to functionality support inside and between organizations. In supply chain, information systems include automatic workflow, electronic exchange systems and connection process systems for functionality to monitor and control between and inside organizational processes. These systems facilitate operational functionality in supply chain via recording transactions, providing information about easy accessibility to them, structuring inside and between companies works according to standard activities and using standard protocols for simplifying information communication between them [15]. One of the most important types of it is organizational resource programming, data electronic exchange and automation.

Flexible information systems.It points at a type of information systems which focus on capability of company in order to market accessing and support in terms of rapid strategic decision making. Supply chain includes information system strategies that determine the share of programs that support market information systems and strategic decision making systems. The most important flexible information systems are communication with customer management and market analysis [16].

2.3 Research Background

Bendoly and Jacobs [17] considered logistic integration improvement as a factor for having operational benefits including decreasing costs, delaying dangers, improving selling, distribution of customer services and service levels and customer content. Bendoly and Schoenherr [16] evaluated creation of administrative structure by using information technology in integration of supply chain and customers and suppliers. This structure aims at using information technology in order to create a relationship for better understanding of customers' needs. Our research encompasses other ones because it uses a harmonic structure between information systems and supply chain strategies in order to improve supply chain functionality. The previous researches Okyere [18]

focused on effects of information systems on modification of the relationship between supply chain strategies and supply chain function.

We decide to evaluate direct effects of information systems on supply chain strategies.

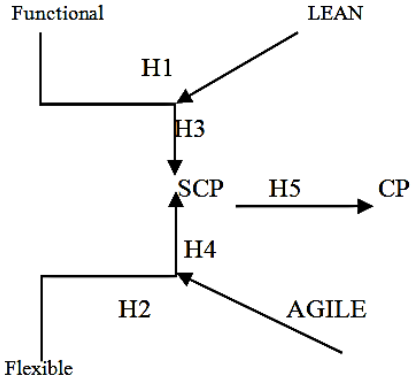
3. Research Model

In this section, the research specifications are given and the hypotheses and research questions are explained. The variables are extracted from supply chain and information systems.

3.1 Conceptual Research Model

We state that:

1. Functional information systems can improve the operation of supply chain lean strategy or empower it.
2. Flexible information systems can improve the functionality of agile supply chain strategy or empower it.
3. Improving the functionality of lean and agile strategies can improve supply chain functionality at the end.
4. Improved function of supply chain can improve total function of company.



3.2 Research Main Hypotheses

H1: Functional information system has significant effect on lean supply chain strategy.

H2: Flexibility has significant effect on agile supply chain.

H3: Lean strategy has significant effect on supply chain function.

H4: Agile strategy has significant effect on supply chain function.

H5: There is significant relationship between supply chain function and company function.

3.3 Research Method

We have three steps for this research:

1. Providing questionnaire and primary studies
2. Data collection in high level
3. Data analysis

Step one: We need questionnaires which can evaluate research hypotheses precisely. Therefore, questionnaires must be valid. Validity deals with the fact that how much measuring tools provide equal results in equal situation.

After evaluation of questionnaire,

the averages of hit ratio: 98%,
agreement between judges: 95%,
Cohen's kappa coefficient: 95%.

This shows excellent level of judgment agreement [19]. The questionnaire is as follows:

It has 6 parts:

Part one: lean supply chain functionality and operation questions

Standard product production amount	LS1
Decrease of trashes and wastes	LS2
Investment management via sending list of demands	LS3
Frequent inspection of products	LS4
Management with product quality according to needs	LS5

Part two: agile supply chain effect evaluation

Effective answer to design needs	AS1
Rapid answer to orders of customers	AS2
Ability to controlling changes in product design	AS3
Maintaining more than market need capacity for rapid answering	AS4
Making products custom-made via adding special models	AS5

Part three: effects of functional information decisions

Improving operational efficiency between suppliers and company	EIS1
Investment management between suppliers and company	EIS 2
Raw material planning management	EIS 3
Production management between suppliers and company	EIS 4
Coordination between functional (production and information) for supplier and production line	EIS 5

Part four: ability of effective information systems evaluation

Introducing new products and services of market	FIS1
Monitoring situations and market changes	FIS 2
Answering market changes	FIS 3
Changing product design	FIS 4
Ability in communication with customers	FIS 5

Part five: determination of supply chain function

Ability to investigation non-standard order	SCP1
Ability to answer special demands of customers	SCP2
Ability to produce goods with different features	SCP3
Ability to setting speed in answering changes in customer's demands	SCP4
Ability to accelerate introducing improved products	SCP5
Ability to introduce new products	SCP6
Quick answer to customers	SCP7
Common activities of company and business partners	SCP8
Improving integration level via informational system	SCP9
Shortening time of order - delivery	SCP10

Part six: company function

Market share	CP1
Investment return	CP2
Stock growth	CP3
Benefit and profit differences	CP4
General competitive situation of company	CP5

Range 1 (weak) to 5 (excellent) is used in the questionnaire.

Step two: Analyzing unit is in central company. Senior executive managers are chosen from selling/ production/ supply chain sections. This research evaluates

companies with advanced information systems. Our case study is Iran Best Automotive Industry.

Step three: after answering questionnaires via senior managements, the answers will be evaluated with modeling structural equation analysis software. Then t-value will evaluate the strength and meaningfulness of research hypotheses to show meaningful hypotheses.

4. Statistical Analysis

Data analysis is a multiple step process which use gathering tools in sample to summarize, code, categorize, etc. and finally processing data to analyze them. Data will be processed conceptually and experimentally here and different statistical techniques play an important role here.

This section analyses data collected via questionnaires using statistical suitable techniques and results will be provided by descriptive statistical techniques. Statistical indexes are used including frequency, frequency percentage, and cumulative frequency percentage for information analysis. Hypotheses are tested via modeling technique of structural equations.

4.1 Answerers' Characteristics

Statistical descriptive indexes are used for describing general features. Frequency of answerers is evaluated in terms of age, education, gender and work experience and related charts are provided.

Gender

169 people, more than 72% of the answerers were men. 65 people, more than 27% were women.

Age

24 people were less than 30. 72 people were 30-40 and 87 people are 41-50 and 51 people are more than 50.

Education

16 people have high school degree or less, 55 people have associate degree, 117 people have BA which has the most frequency and 46 people have MA and higher degrees.

Work Experience

26 people have less than 5 years' work experience. 55 people have 5015 years, 84 people have 16-25 years and 69 people have more than 25 years' work experience.

4.2 Descriptive Statistics of Research Variables

As described, in descriptive methods it is tried to provide tables and use descriptive statistic tools including central and dispersion indexes to describe research data to clear the subject. The following table includes descriptive statistics for all the research variables. In the first part, the most important central and dispersion indexes are provided. Among central indexes, average, median and among dispersion indexes standard derivation are used. All the variables are provided maximum and minimum and difference of these numbers provides one of the simplest dispersion indexes; that is changing ratio. SPSS software calculated the element of this table:

Table 1. Descriptive statistics of Research variables

Variable	Minimum	Maximum	Average	Variance
Functional information system	1.60	3.56	5.00	0.41
lean strategy	1.60	3.60	5.00	0.45
Agile strategy	1.60	3.57	5.00	0.56
Flexible information system	1.40	3.68	5.00	0.50
Supply chain function	1.50	3.62	5.00	0.42
Company function	1.60	3.74	5.00	0.43

Note that the reliability of the questionnaire is computed by Cronbach's alpha equal to 0.81 which is desirable.

4.3 Testing Normalness of Data Distribution

Kolmogorov-Smirnov technique is used in this research for determining normalness of data distribution. In accepting data analysis and modeling of structural equations there is no need to normalness of all data yet factors must be normal. Therefore, considering data normalness in 0.05 meaning fulness level is tested via Kolmogorov- Smirnov technique. The following hypothesis must be set for this test:

H0: data distribution of all variables are normal.

H1: data distribution of all variables are not normal.

Normalness test result of data is provided in Table 2.

As seen in Table 2, meaningfulness is higher than 0.05 in all cases. So there is no reason to deny H0. It means that data distribution is normal and parametrical tests can be done.

Table 2. Data distribution normalness test

Variable	Freedom degree	Amount of K.S	status
Functional information system	234	0.08	normal
Lean strategy	234	0.08	normal
Agile strategy	234	0.08	normal
Flexible information system	234	0.08	normal
Supply chain operation	234	0.07	normal
Company operation	234	0.09	normal

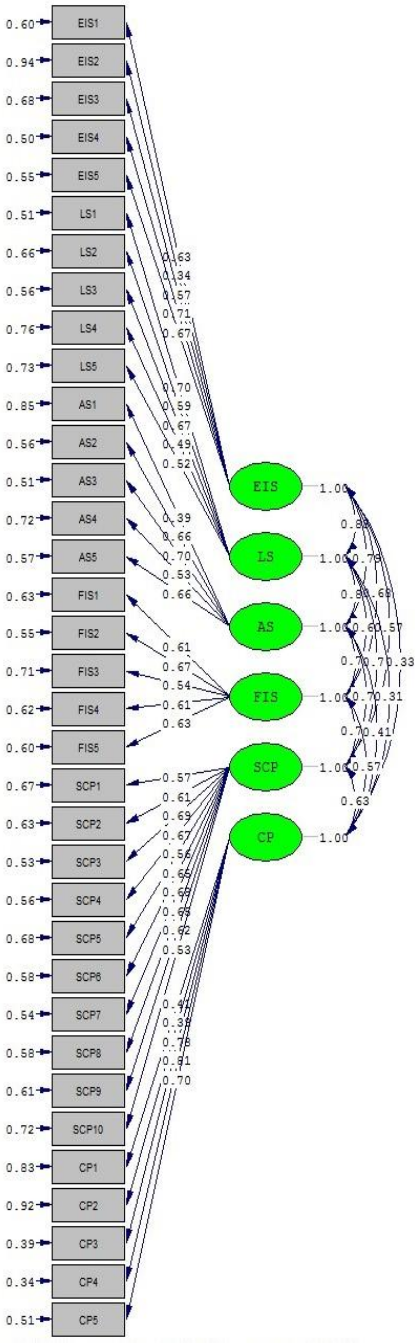
4.4 Factorial Acceptance Analysis of Research Questionnaire

This research uses questionnaire for gathering data. Therefore, factorial acceptance analysis evaluated general structure of research in terms of validity. For factorial acceptance analysis and modeling structural equations, t statistic and standard load factor are measured. The following regulation is true generally:

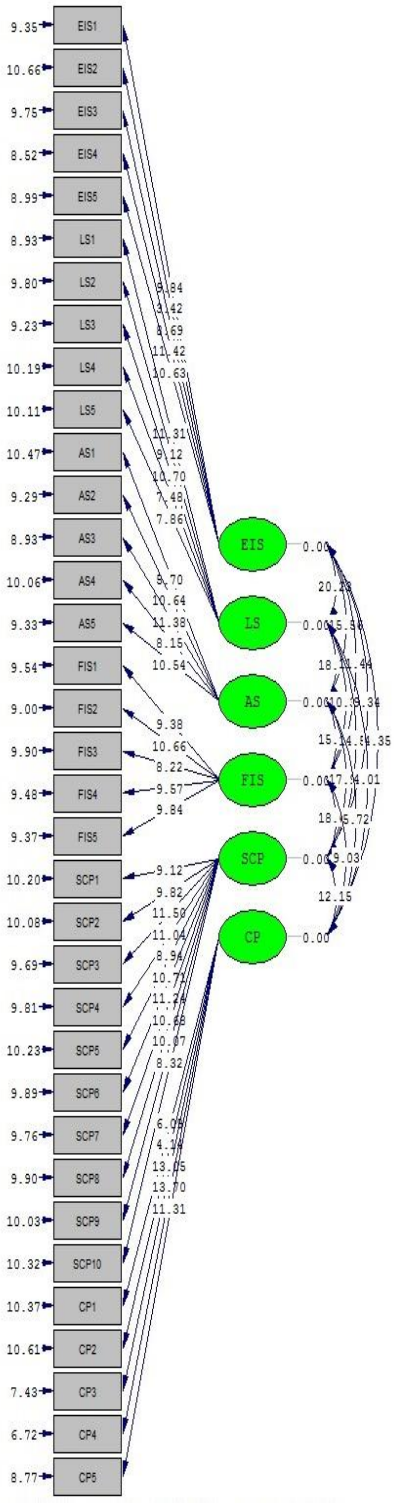
The relationship power between factor (hidden variable) and obvious one is shown via load factor. Load factor is a number between 0 and 1. If it is less than 0.3, the relationship will be considered as weak and will be taken for granted. Load factors between 0.3 and 0.6 are acceptable and if it is more than 0.6 it can be considered as favorable. After determining correlation between variables, meaningfulness test must be done. In order to evaluate meaningfulness of relationships t test and t value

is used. Because meaningfulness is studied in 0.5 error level, if loads of t-value is less than 1.96, the relationship is not meaningful and it will be shown with red color in LISREL software.

Factorial acceptance analysis is shown in figure ١. Standard load factor accepts power of relationship measurement between each factor with its obvious variable is more than 0.3 in all cases. Therefore, this questionnaire is acceptable. After measuring standard load factor, meaningfulness must be tested. According to the results in figure ٢, t load factor of each aspect in 0.05 confident levels is more than 1.96. Therefore, the correlations are meaningful.



Chi-Square=1203.54, df=545, P-value=0.06412, RMSEA=0.024
Fig. 1. Standard load factor of questionnaire



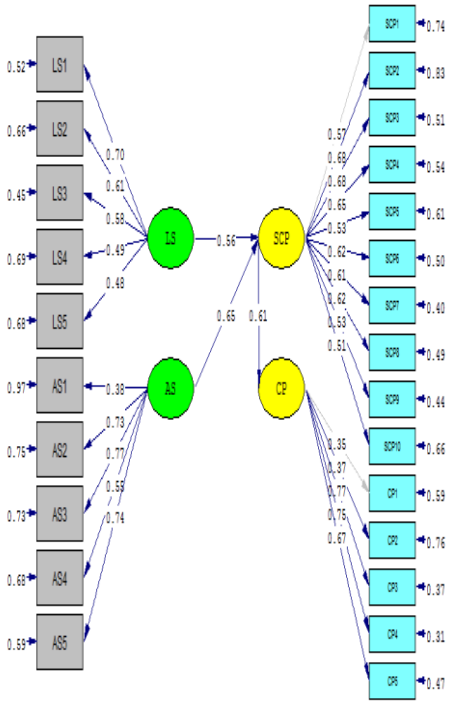
Chi-Square=1203.54, df=545, P-value=0.06412, RMSEA=0.024
Fig. 2. t-value of questionnaire

4.5 Final Model of Relationships between Variables and Evaluation of Research Hypotheses

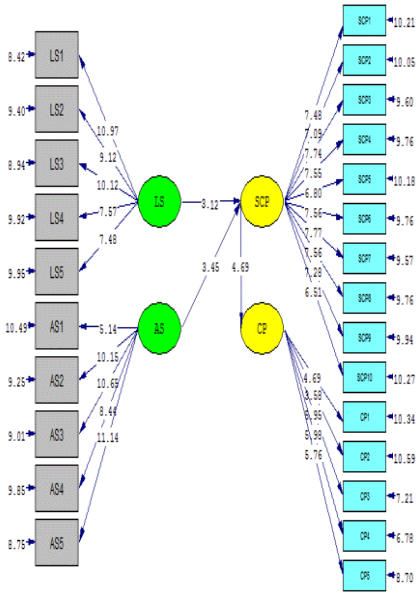
Final structural equation model for measuring the relationship between main factors of research is used. Because each factor includes some hidden variables, the average answer of each variable is measured and that variable is used in the final model as an obvious one.

Final model is provided in figure 4. This model is drawn using LISREL software. The results from data meaningfulness measurement are shown in figure 5.

The impact of the strategy of lean and agile on supply chain performance without information systems are shown in Figures 3 and 4, respectively.



Chi-Square=726.85, df=271, P-value=0.00000, RMSEA=0.035
Fig. 3. Results of accepting final model of relationship between research variable



Chi-Square=726.85, df=271, P-value=0.00000, RMSEA=0.035
Fig. 4. Results of accepting final model of relationship between t-value

In order to fit structural research model a number of goodness of fix indexes are used. One of the general indexes for measuring free parameters in calculating fitness indexes is Chi do index which is calculated via dividing *Chi* do to freedom degree. If it is between 1 to 5, the amount is favorable. $\frac{\chi^2}{df} = \frac{726.85}{271} = 2.68$

In order to determine fitness of model some of goodness fit indexes are used which are shown in Table 3. Because RMSEA is less than 0.1, model fitness is good. Other goodness of fit indexes is also acceptable.

Table 3. *Goodness* of Fit *Index*

Fitness index	SRMR	RMSEA	GFI	AGFI	NFI	NNFI	IFI
Acceptable amounts	<0.1	<0.1	>0.9	>0.9	>0.9	>0.9	0-1
Calculated amounts	0.035	0.020	0.92	0.95	0.96	0.94	0.98

Lean supply chain strategy has correlation with function of supply chain performance.

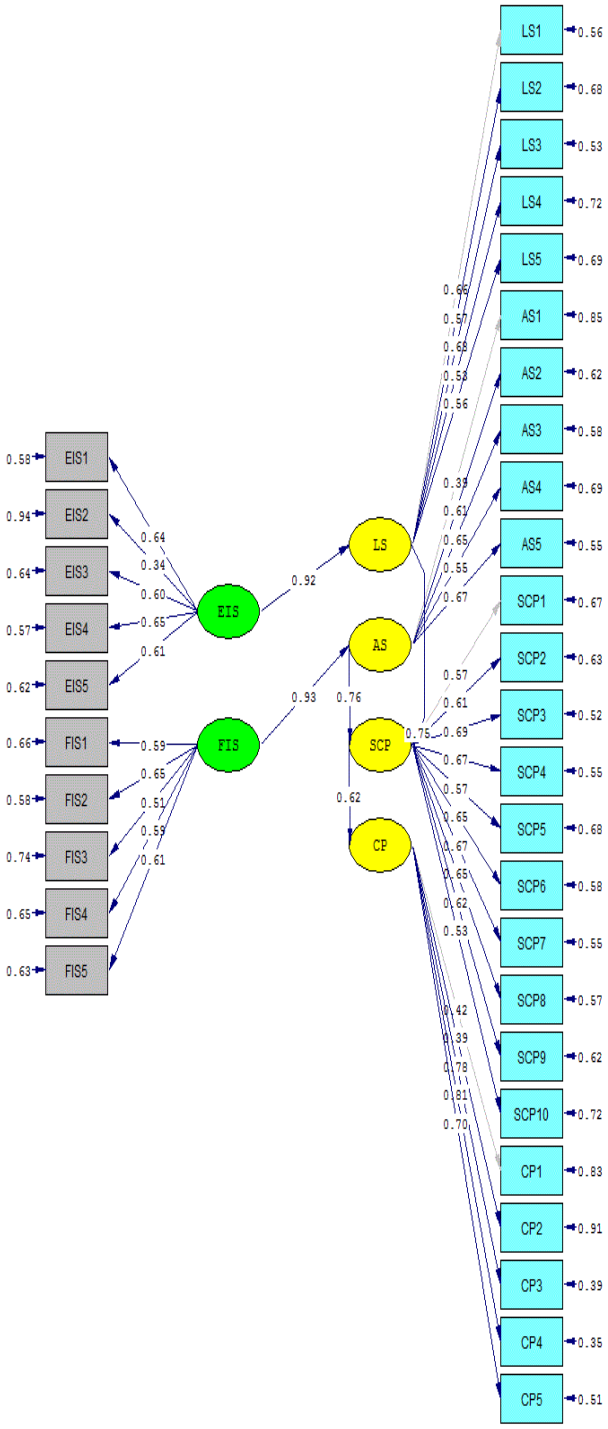
Lean supply chain strategy has correlation with higher function levels of supply chain. According to the calculations, standard load factor of noble supply chain's structure and supply chain strategy is 0.56 that shows there is a favorable and strong relationship between these two. T load factor is 2.74 which show that the correlation is meaningful. Therefore hypothesis 3 is accepted; it means that noble supply chain strategy has correlation with higher function levels of supply chain.

Agile supply chain strategy has correlation with higher level of supply chain performance.

Agile supply chain strategy has correlation with higher level of supply chain function. According to the calculations, standard load factor of fast supply chain's structure and supply chain is 0.51 that shows there is a favorable and strong relationship between these two. T load factor is 2.21 which show that the correlation is meaningful. Therefore hypothesis is accepted; it means that fast supply chain strategy has correlation with higher level of supply chain function.

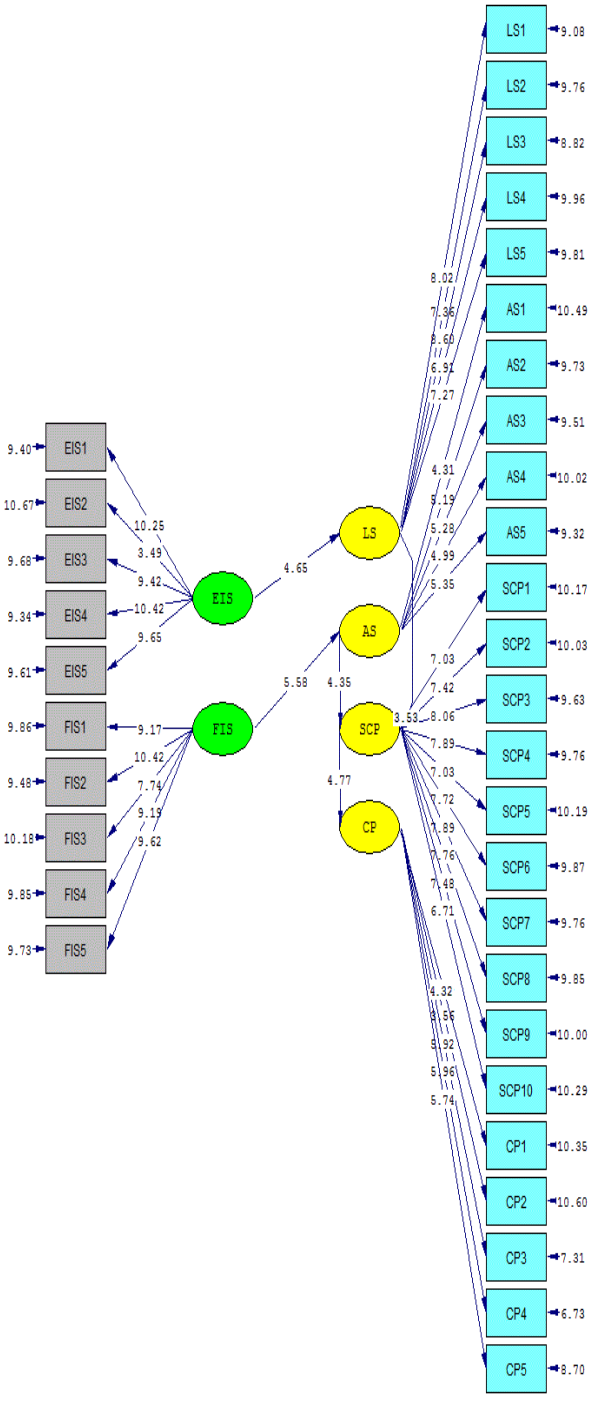
Improved function of supply chain improves total function of company.

Improved function of supply chain improves total function of company. According to the calculations, standard load factor of supply chain's structure and company's function is 0.61 that shows there is a favorable and strong relationship between these two. *T* load factor is 4.69 which show that the correlation is meaningful. Therefore hypothesis is accepted; it means that improved function of supply chain improves total function of company.



Chi-Square=1279.16, df=554, P-value=0.02051, RMSEA=0.045

Fig. 5. Results of accepting final model of relationship between research variables



Chi-Square=1279.16, df=554, P-value=0.02051, RMSEA=0.045

Fig. 6. Results of accepting final model of relationship between t-value

In order to fit structural research model a number of goodness of fix indexes are used. One of the general indexes for measuring free parameters in calculating fitness indexes is Chi square index which is calculated via dividing Chi do to freedom degree. If it is between 1 to 5, the amount is favorable.

$$\frac{\chi^2}{df} = \frac{1279.16}{554} = 2.309$$

In order to determine fitness of model some of goodness fit indexes are used which are shown in Table 4. Because RMSEA is less than 0.1, model fitness is good. Other goodness of fit indexes is also acceptable.

Table 4. *Goodness* of Fit *Index*

Fitness index	SRMR	RMSEA	GFI	AGFI	NFI	NNFI	IFI
Acceptable amounts	<0.1	<0.1	>0.9	>0.9	>0.9	>0.9	0-1
Calculated amounts	0.036	0.045	0.93	0.97	0.94	0.95	0.96

H1: Information systems improve lean supply chain strategy for functionality.

According to the calculations, standard load factor of functional information systems' structure and lean supply chain strategy is 0.92 that shows there is a favorable and strong relationship between these two. T load factor is 4.65 which show that the correlation is meaningful. Therefore hypothesis 1 is accepted; it means that information systems improve lean supply chain strategy for functionality.

H2: Flexible information system improves agile supply chain strategy.

According to the calculations, standard load factor of flexible information systems' structure and agile supply chain strategy is 0.93 that shows there is a favorable and strong relationship between these two. T load factor is 5.58 which show that the correlation is meaningful. Therefore hypothesis 2 is accepted; it means that flexible information system improves agile supply chain strategy.

H3: Lean supply chain strategy has correlation with function of supply chain performance.

According to the calculations, standard load factor of lean supply chain's structure and supply chain strategy is 0.56 that shows there is a favorable and strong relationship between these two. T load factor is 2.74 which show that the correlation is meaningful. Therefore hypothesis 3 is accepted; it means that lean supply chain strategy has correlation with higher function levels of supply chain.

H4: Agile supply chain strategy has correlation with higher level of supply chain performance.

According to the calculations, standard load factor of agile supply chain's structure and supply chain is 0.51 that shows there is a favorable and strong relationship between these two. T load factor is 2.21 which show that the correlation is meaningful. Therefore hypothesis 4 is accepted; it means that agile supply chain strategy has correlation with higher level of supply chain function.

H5: Improved function of supply chain improves total function of company.

According to the calculations, standard load factor of supply chain's structure and company's function is 0.62 that shows there is a favorable and strong relationship between these two. T load factor is 4.77 which show that the correlation is meaningful. Therefore hypothesis 5 is accepted; it means that improved function of supply chain improves total function of company.

5. Conclusion

In this paper, the impact of information systems on supply chain strategies and performance were investigated. One of the significant outcomes of the research was that strengthening information systems lead to improve the relationship between supply chain and supply chain strategies. Therefore, it can be said that creating balance between informational system strategy and supply chain strategies finally result in improvement of supply chain functionality and company's operation.

Further Research Suggestions:

1. According to the fact that green strategy of supply chain is of great importance today, evaluation of the most suitable information system strategy for this strategy and effectiveness of information systems on them can be good.
2. Information system strategies have the ability to create two by to and multiple links. In case of link between these strategies, how will the balanced information systems act?

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