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Original Article

Presenting a model for evaluation of the effect of information sharing on the supply chain performance (Case study: Ahvaz Pipe Mills Co.)

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ABSTRACT

One of the pillars in establishing coordination is information sharing. Information sharing could be defined as the extent to which a company communicates a range of information with its supply chain partners. The purpose of this study was providing a model for evaluation of the effect of information sharing on the supply chain performance - case study: Ahvaz Pipe Mills Co. In the present study, by reviewing the company's past history and documents and using the opinions of the experts, the data with uncertainty were specified. Then the required numerical data in the company were collected to provide the context required for simulation. After that, simulation was done in MATLAB software and finally, the results of the simulation were extracted and analyzed. The results indicated that the two goals of increasing efficiency and reducing costs led to presentation of many studies and research projects, ending in ongoing development of supply chain systems. Here, one of the solutions able to find a special place in research of supply chain is information sharing.

Keywords: Information sharing, supply chain performance, Ahvaz Pipe Mills Co.

Introduction

The availability and transparency of information are always seen as a critical advantage in different communities and systems. As a community or a system faces more complexity, the accessibility and transparency of information will be more valuable. Supply chains are considered as one of the most complex economic and social systems today, so the ease of access and transparency of information are essential and can lead to advantages such as cost and risk reduction of supply chain. Thus, the integration of effective supply chain operation with the effective sharing of information is vital for improving the supply chain performance. Sharing information is a key element of any supply chain management system. Today, due to the speed of environmental change, technological advances and the globalization of markets, organizations increasingly need to optimize the entire supply chain performance. Hence, sharing of information in the supply chain is very useful for survival and competition.

The study has dealt with the role of information sharing in the supply chain.

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Theoretical Basics

Supply chain includes all activities that have to do with the flow and exchange of goods and services, from the raw material stage to the final product stage consumable by the customer. Besides material flows, these transfers include information flow and

financial flows [1]. In the 1980s, the organizations used to focus mostly on systems such as timely production, comprehensive quality management, and so on to achieve sustainable competitive advantage. However, since competitors started to imitate these competitive advantages, they were not sustainable. In fact, attempts to optimize organizational processes, regardless of external companies, especially suppliers and customers, appeared to be in vain and the organizations working together to achieve common goals worked better. The concept of the supply chain was born here [2]. One of the main aspects of establishing coordination is information sharing. The sharing of information can be defined as the extent to which a company communicates a variety of information with supply chain partners [3].

Today, due to the speed of environmental change, technological advancement and globalization of markets, the organizations increasingly need to optimize the performance of the entire supply chain instead of individual organizations. Thus, for survival and successful competition in this environment, the companies try to be more consistent with their supply chain partners to create advantage of resources and the knowledge of suppliers and customers. Supply chain coordination is a kind of close and long-term partnership in which supply chain members work together and share a range of information, resources and risks to achieve mutual goals.

One of the main angles of coordination is the sharing of information, so that in the context of the supply chain coordination, the high level of interdependence with the level of information sharing depends on the level of information interchange [4]. Sharing of information is defined as "base" [5], "essential element" [6], "neural center" [7], and "essential need" [8]. The sharing of information can be defined as the extent to which a company communicates a variety of information with supply chain partners [3]. There are, in general, two main streams of information sharing studies. The first one is focused on the value of information sharing. These studies, by comparing it with traditional strategies or other decision-making processes, identify the value of sharing information and discuss how to appraise the value of sharing information and factors affecting the value of it. The second stream has to do with supporting frameworks or technologies and the factors needed to share information. This class of studies focuses on factors needed to ensure timely and accurate sharing of information.

Today, different areas are used for the supply chain, of which the following can be cited.

- Supply chain simulation
- Risk management of supply chain
- Supply chain follow-up
- Supply chain reengineering
- Advanced supply chain planning
- Management of supply chain projects
- Management of distribution and supply networks
- Fleet management
- Human resource management
- Information management
- Chain information system

Literature Review

Many studies have shown that information sharing has a significant effect on the supply chain performance and the reduction of bullwhip effect [9].

Information sharing enables the companies to make better decisions for their operations, resulting in better utilization of resources and lower costs for the supply chain. Better information management allows the company to more responsive to customer demand [10].

Through a mathematical model, Lee et al. analyzed four different causes of bullwhip effect - demand forecast updating, rationing and shortage gaming, batch ordering, and price fluctuations. They suggested information sharing and simplified bidding table as countermeasures [11].

By comparing the three scenarios for sharing full information, sharing partial information and the lack of information sharing, Kachen et al. concluded that the sharing of full information over the other two scenarios would be the most cost-effective [12].

Fio used the information sharing mechanism to establish coordination and found that supply chain coordination (through information sharing) improves the distributor's performance. This flow, which can also be called quantitative or mathematical flow, is generally methodologically based on research models in operation and optimization; in most cases, the value of information sharing is the result of elimination or reduction of uncertainty in the random operating management models in the supply chain. The results of this dominant approach, although obtained from valuable and unquestionable information about the value of information sharing, due to the methodology of the research and the parameters studied, are limited to examining and showing quantitative results, especially for cost reduction and efficiency improvement at the supply chain level. Moreover, it is inappropriate for studying the qualitative outcomes, backgrounds, effective factors, organizational challenges, etc., which are not the main concern of managers in decisions related to information sharing [13].

Yu et al. reviewed the importance of information sharing in nine different scenarios; they showed that sharing information only for inventory and capacity would not improve chain performance, but should also be applied to customer demand [14].

Kukglou et al. (2010) examined top 500 Turkish companies, which have been affected by the simultaneous integration of supply chain and information sharing on supply chain performance. They showed that the integrity of the information sharing and information sharing on the chain performance are effective [15].

Zhou et al. (2011) compared the effect of information sharing on the inventory system (s, s) of the periodic review with

instant review, showing that the sharing of information in the instant review system leads to a reduction in inventory costs [16]. Su et al. (2008) have emphasized the importance of the quality of relationships and cooperation throughout the supply chain [17]. The relationship between supply chain elements is one of the most important factors for the success of the organization. Other results also showed that the variables for rapid detection of newly emerging cases using trained experts and the continuous review of product guidance and relief services have the highest correlation with the agility factor. Considering the importance of the flexibility of new goods and services, Charles argued that non-cash donations might be precisely what are not needed. Therefore, they need to be investigated, and the trained people using emergency goods guide should do this. On the other hand, every calamity is unique, and some requirements may be specified that are not even in the guidance of relief goods and are quite new. Thus, the publication of the guideline for the supply of goods is also required after all [18]. Hence, given to the mentioned studies, one can state that there is a significant effect between some of the components of information sharing and the supply side of the supply chain. In this study, a combination of the above components is considered as the variables in this section and their relationship with supply chain performance is dealt with.

Research model

This study uses LST (Lee, Sue, and Tang) mathematical model. In this model, information sharing and non-sharing of information are discussed. In 2000, Lee, Sue and Tang examined two levels of supply chain management by the customer and the buyer ordered on request. The purpose of this study was to maximize the seller's profit and provide the buyer with the goods in a timely manner.

Prior to describing the model, we explain the symbols used in the formulation

$$\gamma_t = D_t + \frac{\rho(1-\rho^{l+1})}{(1-\rho)}(D_t - D_{t-1})$$

Yt - Buyer's order quantity at the end of the period

Dt- Order by the buyer at the time

$$M_t = \frac{d}{1-\rho}\left\{(L+1) - \frac{\rho(1-\rho^{L+1})}{1-\rho}\right\} + \frac{\rho(1-\rho^{L+1})}{1-\rho}\gamma_t$$

L- Time delay of the supplier's supply and delivery

T- The time interval is 0,1,2,4 (shows the number of periods)

St - Maximum buyer order level for the time period

Tt - Maximum optimal order of the seller for the time interval t without sharing information

I- Seller's average assets in non-sharing mode

I'- Seller's average assets in sharing mode

l- Time delay of procurement of goods by the buyer

H- Maintenance fee for the seller's period

h- Maintenance fee for the buyer's period

p- The cost of the deficit (deficit) for the period of the buyer's goods

P- The cost of the deficit (deficit) for the period of the seller's goods

The assumptions used in LST method are as follows

* The demand model is as follows

$$Dt = d + \rho D_{t-1} + \varepsilon_t$$

In this model, the εt parameter is normal in the range of zero and deviation variable is 2σ

$$d\sigma <<$$

$$0<\rho<1$$

A- Non-sharing information mode

B- $y_{t+1} = \frac{1-\rho^{l+2}}{1-\rho}\ d + \frac{\rho^{l+2}(1-\rho)}{1-\rho^{t+2}}\sum_{i=o}^{t-1}\left(\frac{\rho-\rho^{l+2}}{1-\rho^{l+2}}\right)y_{t-i} + \rho^{l+2}\left(\frac{\rho-\rho^{l+2}}{1-\rho^{l+2}}\right)D_0 + \frac{1-\rho^{l+2}}{1-\rho}\varepsilon_t + 1$

B- sharing of information mode

C- $\left[\left(\rho^{t+2}\left(\frac{\rho-\rho^{t+2}}{1-\rho^{t+2}}\right)\right) + \left(\frac{1-\sigma^{t+2}}{1-\rho}\right)\right]\rho^2 < \left[\left(\frac{1-\rho^{t+2}}{1-\rho}\right) + \rho^2\left(\frac{1-\rho^{t+1}}{1-\rho}\right)\right]\rho^2$

Methods

The present study was argumentative as it seeks to identify a model for research.

Research Realm

Spatial Domain: The population was a pipe company based in Ahvaz (Ahvaz Pipe Mills Co.).

Subject Domain: The subject matter was the sharing of knowledge and performance of supply chain management.

Population, sample and sampling method

The population was of all the purchasing, selling and selling personnel of Ahvaz Pipe Mills Co., who are 1400 people, where using Cochran formula, 100 individuals will be considered as the sample size. The sample of this study was Ahvaz Pipe Mills Co. Cochran formula is one of the most commonly used methods for calculating sample size.

Data collection tool

Two methods were used to collect data in this research, which are the first-hand data, which were collected to examine the research hypotheses through field surveys and using a questionnaire. The library method (literature review, books, articles, etc.) was used to formulate theoretical foundations and literature. Data collection method was a combination of various methods such as observation, library study, Internet usage, and interviewing and discussion.

Analysis

In order to apply the research model in Ahvaz Pipe Mills Co., which is a simulation model, it is necessary to collect the required data and numerical information. The numerical data needed in this research can be categorized into two general groups. The first group is definitive numerical information, and this data is obtained relatively verbally by examining the documents, especially the industrial accounting records of the company. Another group of data needed is the data associated with uncertainties. This type of data is mainly related to the probable data required in the research. Obtaining data associated with uncertainty becomes more difficult than definitive data. In the present study, data associated with uncertainty is determined by reviewing the company's history and documents, as well as by experts' opinions.

Data analysis

Given the research purpose, which is a numerical study in Ahvaz Pipe Mills Co., it is necessary to collect the numerical data required in this company to provide the necessary conditions for simulation. After that, simulation was done in MATLAB. Finally, the results of the simulation were extracted and analyzed.

Collecting and estimating required numerical values and model simulation in Ahvaz Pipe Mills Co.

In order to apply the research model in Ahvaz Pipe Mills Co., which is a simulation model, it is necessary to collect the required numerical data. The numerical data needed in this research can be categorized into two general groups. The first group of data and numerical information is definitive data, obtained by examining the documents, especially the industrial accounting records of the company, obtained as relative definitive. Another group of data needed is data associated with uncertainties. This type of data is mainly related to the probable data required in the research. Obtaining data associated with uncertainty becomes more difficult than definitive data. In the present study, data associated with uncertainty is determined by reviewing the company's past history and records, and by experts' opinions. According to the above description, the numerical data for Ahvaz Pipe Mills Co. is as follows:

1.	d=100	This means the average of minimum demand in each period; this parameter is usually estimated according to the long-term contracts and long-term orders of the company relative to the length of the simulation period.
2.	P=0.35	This means the impact of demand for the previous period in this period. As customers usually do not complete their purchase period and usually purchase in several periods, this coefficient is used as a parameter to represent this feature.
3.	$\varepsilon \sim N(0,300)$	Given the presence of uncertainty in demand in each period, the normal distribution function with mean zero and standard deviation of 300 is used to represent this uncertainty.
4.	$t = 1000$	t represents the number of simulation periods.
5.	$l = 5$	l is the time needed to reach the order demanded by the retailer. This time includes the time required for office work, loading and shipping.
6.	$L = 5$	L is the manufacturer produces the time taken to prepare the product for sale after the order. The mentioned time includes start-up time, production time, and time to transfer to the warehouse.
7.	$H = 1200$	H is the cost of maintaining the product for the producer, which includes the cost of storage and money sleep.
8.	$P = 4000$	P is the cost of a shortage, which is mainly due to a reduction in the credibility of the company in the market.

After collecting the numerical data needed, each briefly explained, one can simulate the problem; MATLAB software was used to simulate and the simulation steps were coded in MATLAB. The simulation results are presented as follows:

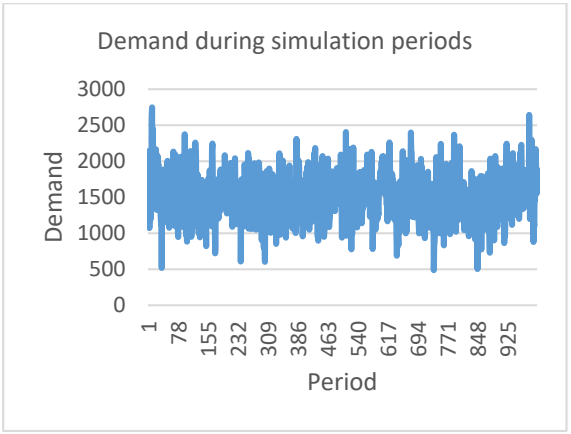

Figure 1: Demand during simulation periods

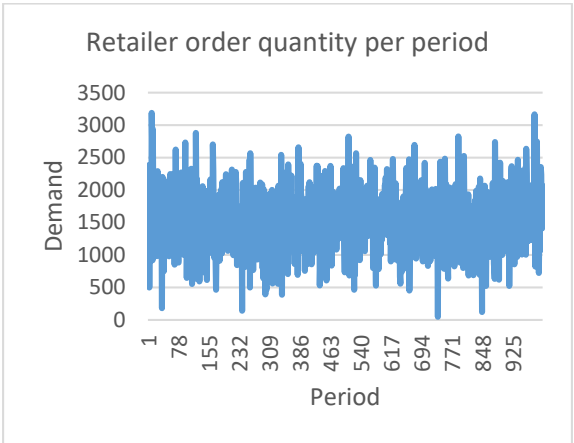

Figure 2: Retailer order quantity per period

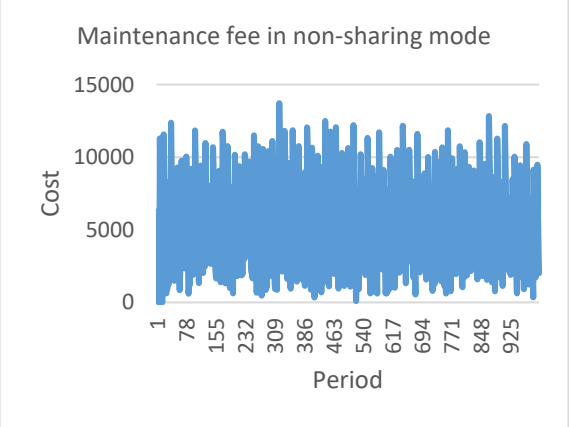

Figure 3: Maintenance cost in non-sharing mode

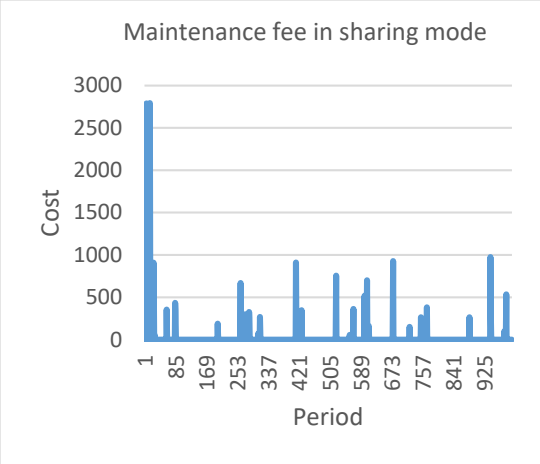

Figure 4: Cost of deficits in the non-sharing mode

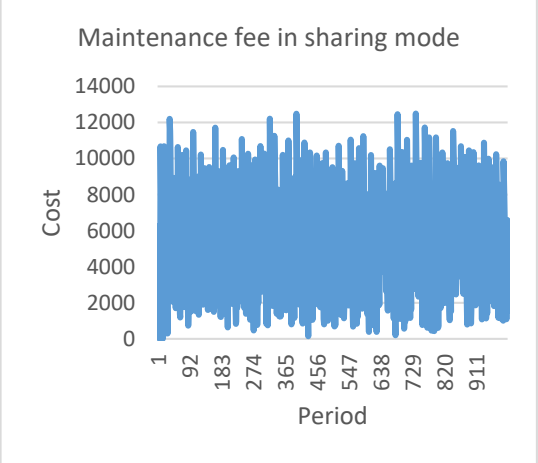

Figure 5: Maintenance cost in information sharing mode

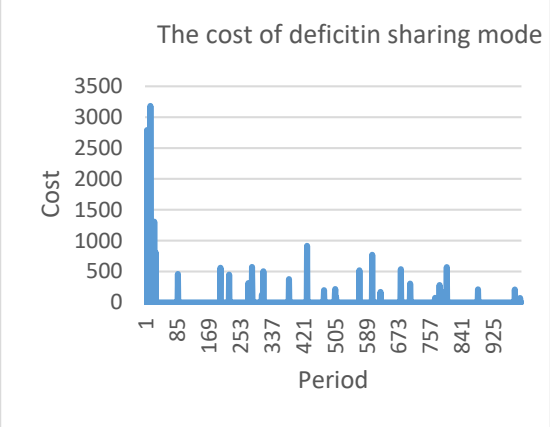

Figure 6: Cost of deficits in information sharing mode

Figures 1 to 6 shown above indicate the results of the simulation of the problem. Figure 1 shows the demand for retailers in each period. As is seen in the figure, demand varies from about 500 units to around 2800 units.

Figure 2 shows the retailer's order quantity to the manufacturer. As shown in the model, the retailer's order quantity is based on market estimates, so given the demand fluctuations in the market; the retail order quantity is fluctuating as shown in Fig. 2.

Figure 3 shows the cost of maintaining an inventory in each period in the non-sharing mode of information. Given that the inventory varies in each period, the cost varies from zero to about 14000.

Figure 4 shows the cost of deficits in each period in the non-sharing of information. Figure 4-4 shows that in many courses cost of deficit is zero, which means that retailer orders have been fully met in those periods.

Figures 5 and 6 are similar to Figures 3 and 4, except that these figures refer to simulation results in information sharing mode. For comparing the effect of sharing information on company costs, one needs to compare the costs of maintenance and deficits in each of the above situations. With the total cost of the above simulation, the total cost of non-information sharing mode is 6243596210. However, in information sharing mode, this cost is reduced to 6085519796, so in information sharing mode saving is 158076414 units of currency, which is a significant figure. This shows the importance of sharing information.

Summary of the Results

Supply chain systems are always of particular interest to researchers and policy makers given their importance and the role they play in business enterprises. Hence, researchers try to find solutions to improve the efficiency of the supply chain and reduce costs. The two goals of increasing efficiency and reducing costs have resulted in numerous research and research projects that have led to the ever-increasing development of supply chain systems. Here, one of the solutions able to find a special place in research of supply chain is information sharing.

Therefore, in this research, a field study was conducted to analyze the cost of sharing information.

Problem modeling process

In analyzing and optimizing problems, various methods are used to model the problem. Given the method used for modeling, various tools are also used to solve the model. Simulation models are one of the modeling methods that apply to uncertainty problems. These models have the ability to properly capture the real world conditions, so are attention-worthy. The present study used simulation model and simulation model was solved by MATLAB.

Advantage of the study and its output

Studying the literature showed that although many studies have been conducted on the role of information in the supply chain, few studies have been conducted regarding economic studies in this field. Additionally, due to the importance of cost in large factories and enterprises, economic studies are necessary in this regard. Hence, the advantage of the present study is adding economic studies and analyses to investigate the role of information sharing in the supply chain, and the output of this research is economic analysis in this regard. These analyses are mainly presented as diagrams.

Points and recommendations about the model

In this section, a few points and recommendations are addressed briefly.

To examine a simulation model, firstly, effective factors and parameters of the model should be extracted. Thus, in this regard, it is important to determine the boundary of the model's effect. Many factors can be effective in the model, but the ones with insignificant effects are ignored, that is to say, an effective boundary is formed for the model.

We try to determine the auxiliary variables to help understand the model. Excessive use of auxiliary variables leads to an increase in the model and hardening of its analysis. Moreover, using auxiliary variables less than the limit causes the model to become incomprehensive.

Determining the relationship between the model and the information used is very accurate and sensitive here and the mistake in this section leads to a lack of proper conclusion from the model.

Suggestions for future studies

As there are no studies completely without weaknesses and limitations, there are also areas for further studies in this study, some of which are stated below.

Extraction of other factors and elements in simulated models

Using statistical methods to determine the relationships and some numerical data

Making the model multi-agent with collaborative and competitive approaches.

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