

# Designing a Mechanism for Evaluating the Business Activities with Focus on the Inventory System through Supply Chain Approach

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**To Link this Article:** <http://dx.doi.org/10.6007/IJAREMS/v2-i4/97> DOI:10.6007/IJAREMS/v2-i4/97

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**Published Online:** July, 2013

## Abstract

The purpose of this study is to design a mechanism for evaluating business activities with focus on the inventory system through supply chain approach and to implement it in the energy industry. It is necessary to identify the main business purposes through supply chain approach for achieving purpose of the study. In order to design the rational mechanism for evaluating business activities, the characteristics of the markets in which the energy industry is working should be recognized. Also supply chain strategies, their relations with the related measures and supply chain goals, and operationalizing the purposes through a four-step process have been described. Finally, a model has been described that facilitates the continuous improvement process of inventory system through measuring efficiency and effectiveness indexes.

**Keywords:** Business Activities, Inventory System, Supply Chain.

## Introduction

Complexity of the competitive business environment and increase in the customers' expectations necessitate identifying organizational weaknesses and strengths and continuous improvement. The inventory systems have an effective role in the industries' success and so

it is necessary to screen and improve their conditions continuously. This is why that the present study is aimed to design a mechanism for evaluating the business activities with focusing on the inventory systems through supply chain approach and to implement it in the energy industry. The competitiveness has been moved from inter-companies to inter-chains in the era of markets and products development. On the other hand, focus on the improvement of supply chain performance is the only method for achieving competitive advantage in the global business market [1]. Therefore, it is necessary to identify the main business goals with supply chain approach. These goals include customer services, internal efficiency, demand flexibility, and product development that some of them should be corrected and modified with regard to the markets. These goals can be operationalized in the frame of a four-step process of inventory system that includes planning, resourcing, production, and delivery in industry. The designed mechanism in this study measures the effective and determinant indexes in the inventory system so exactly that paves the grounds for continuous improvement through defining activities and projects. On the other hand, this model measures and compares the industry position through determining its score. This model has been designed and then implemented in the energy industry and its results and findings have been presented in this study.

### Literature Review

Several studies have been done about evaluating product property and supply chain across the world. Some of these studies have focused only on the inventory system and evaluated based on different models. Another part of these studies used other methods for evaluating such as batch deterministic and stochastic Petri Nets [2], stochastic multi-echelon inventory system [3], or make-to-order supplier. These studies have been done in different industries such as automobile [5]. Also some of these studies evaluated supply chain. On the other hand, some of these studies evaluated supply chain performance through Data Evolvement Analysis (DEA) through unification of the supply chain activities, and supply performance [6]. Other study reviewed systems and measures of the performances and performance indexes in the supply chain and then evaluated them [7]. One of the most popular models in evaluating supply chain management is Supply Chain Operations Reference (SCORE). It includes four processes of business in the first time. These include planning, resourcing, production, and delivery in the industry in the organizations and sometimes among them. Reference is the fifth process in this model that has been introduced in 2001. It includes describing managerial standard processes, framework for expressing the relationship between these standard processes, standard indexes for measuring processes performance, and managerial experiences with the best performance in these processes. The SCORE model offsets the horizontal perspectives (inter-processes) and vertical (inter-processes hierarchy) and also has an effective role in the improvement of overall supply chain performance through a common terminology and standard processes. The SCORE in the first model that can be used in forming a supply chain based on the business strategies [8], [9].

Designing a mechanism for evaluating business activities with focus on the inventory system through supply chain approach in order to promote and improve inventory systems is the main characteristic of our study that differentiates it from similar studies. Main characteristics of this study have been indicated in the following section:

- **Quality management:** this model designed with regard to the stakeholders' needs and organizational goals for developing present system.

- **Complementary and comprehensiveness of the model:** this model not only considers the process measures, but also attends the goal-related measures. It also identifies the relationship between measures and each of the effective processes on the present system improvement.
- **General application:** the designed model can be used in different organizations.
- **Paying attention to improvement:** the main improvement goals and system promotion are consistent with the organizational goals. The mechanism of this model can be used for improving related processes in the inventory area.

### **Designing A Mechanism For Evaluating Inventory Management System With Focus On The Supply Chain Approach**

It is necessary to recognize the industry's goals for evaluating inventory system. It paves the grounds for measuring efficiency and effectiveness of inventory system through evaluating measures in the inventory activities area. In order to design the rational mechanism for evaluating business activities, the characteristics of the markets in which the energy industry is working should be recognized. Also supply chain strategies, their relations with the related measures and supply chain goals, and operationalizing the purposes through four-step process have been described. Finally, a model has been described that facilitates the continuous improvement process of inventory system through measuring efficiency and effectiveness indexes.

#### **Type of Markets**

It is necessary to determine type of the market in which the industry is working. There are four types of markets in grouping. These include stable, mature, growing, and developing markets. Each of these markets has their own characteristics that have been indicated and described in the following section.

**Stable market:** this market is a structured market that its supply and demand is stable. The opportunities of this market are derived from coordinating and optimizing the internal activities so that achieve the most efficiency and total profitability.

**Mature market:** the supply is more than demand is this market. The opportunities of this market is derived from coordination with supply chain members for supplying diversified products to the market and coordination with product demand fluctuations during preserving high levels of customer services.

**Growing market:** the demand is more than supply is this market. The opportunities of this market are derived from achieving market share and recognizing supply chain members for achieving high levels of the customer services. This can be measured through indexes such as timely delivery and rate of customer satisfaction.

**Developing market:** the demand and supply of the new products is low. The opportunities of this market are derived from cooperation with other supply chain companies for recognizing the customers' wants and providing them with appropriate products and services.

#### **The Relationship Between Supply Chain Strategies And Goals**

There are two main strategies in the supply chain including efficiency and accountability strategies. These strategies observe themselves in the frame of four measures including customer services, internal efficiency, demand flexibility, and product development in different markets.

### **Determining The Relationship Between Market, Goals, And Measures Of Supply Chain Performance**

The market measurement can be different based on the market types and goals. Generally, there are four different goals for markets including customer services, internal efficiency, demand flexibility, and product development.

The goals of every market have been indicated in the following section.

- There are two main goals in the stable markets including customer services and internal efficiency.
- There are three main goals in the mature market including customer services, internal efficiency, and demand flexibility.
- There is a main goal in the growing markets including customer services.
- There are two main goals in the developing markets including customer services and product development.

### **Determining The Purpose-Related Measures**

Every macro organizational goals is divided into different micro purposes of inventory in the supply chain. These can be measured through some indexes that each of them has been indicated in the following section.

#### **Customer services**

- The committed time for responding the customers
- Rate of timely delivery
- Value of the delayed orders
- Frequency of the delayed orders
- Period of the delayed orders
- Frequency of the product return and repairs

#### **Internal efficiency**

- Inventory value

This is measured in every time and every period. The supply chain seeks to decrease inventory and maintain high customer services levels. The companies seek to increase their inventory in the growth period.

- Inventory turnover

It is an index for measuring the inventory profitability that can be achieved through examining the sale speed or inventory turnover in an annual period. It also refers to the ratio of annual sale period to the value of annual average inventory. High level of this ratio is a good indicator. On the other hand, it is should be attended that this ratio should be adjusted with regard to the customer services and demand flexibility. Also it is necessary to decrease inventory turnover for improving these measures.

- Sale turnover

It refers to how an appropriate operation is done. This index measures amount of the sound management in terms of fixed and variable costs and net profit. This refers to the ratio of income before tax to the sales. Higher levels of sale refer to better sale turnover. The company may decrease this measure for acquiring more market share or maintaining it.

- Cash to cash cycle

This measure refers to the intervals between receiving raw materials from supplier and receiving money from customers. Shorter levels of this measure refer to better cash to cash cycle

**Demand flexibility**

- Operation period

This period refers to the period that the supply chain is working for satisfying orders, designing product, assembling the products, or another production activities. On the other hand, meeting the order of final customer is the most important cycle.

- Increase flexibility

This refers to the company's ability or supply chain in responding the increase in the orders quantity.

- External flexibility

This refers to the company's ability in delivering the customers' unexpected orders.

- Product development

Percentage of total sold products that are introduced to the market in the past year

The ratio of new products sale percentage to the total sale

Development and introduction of a new product period [10].

**The Activities Of Promoting Goals And Determining The Relationship Between Measures And Activities**

It is necessary to improve the supply chain capabilities in four groups of activities for achieving supply chain goals and measures. These have been indicated in the following section [11].

- Planning
- Resourcing
- Production
- Delivery

The relations of these activities and goals have been indicated in the table 1.

Table 1:

*The Relationship Between Supply Chain Activities And Goals*

		<b>Customer services</b>	<b>Internal efficiency</b>	<b>Demand flexibility</b>	<b>Product development</b>
<b>Planning</b>	<b>Demand prediction</b>	*	*	*	
	<b>Product pricing</b>	*	*		
	<b>Inventory management</b>	*	*	*	
<b>Resourcing</b>	<b>Supplies</b>		*	*	
	<b>Collection and validation</b>	*	*		
<b>Production</b>	<b>Product designing</b>	*			*
	<b>Production scheduling</b>		*	*	
	<b>Equipment management</b>	*	*		
<b>Delivery</b>	<b>Orders management</b>	*	*		*
	<b>Delivery scheduling</b>	*	*		
	<b>Turnovers processing</b>	*			*

**The Activities Criteria And Measures**

The supply chain activities can be measured and evaluated in two levels through performance, complexity, configuration, and experiential measured. The relationship between mentioned activities and measures has been indicated in table 2 [10].

Table 2:

*The Relationship Between Supply Chain Activities And Measures*

Level 2		Level 3		
	Performance measures	Complexity measures	Configuration measures	Experiential measures
<b>Planning</b>	<ul style="list-style-type: none"> <li>• Planning costs</li> <li>• Days of inventory supply</li> </ul>	<ul style="list-style-type: none"> <li>• Percentage of change in the order</li> <li>• Production volume</li> <li>• Inventory maintaining costs</li> </ul>	<ul style="list-style-type: none"> <li>• Volume of products in every channel</li> <li>• Frequency of the channels</li> <li>• Frequency of the locations for supply chain</li> </ul>	<ul style="list-style-type: none"> <li>• Planning period</li> <li>• Prediction precise</li> <li>• Obsolete inventory in hands</li> </ul>
<b>Resourcing</b>	<ul style="list-style-type: none"> <li>• Raw materials supply costs</li> <li>• Supply period</li> </ul>	<ul style="list-style-type: none"> <li>• Frequency of the suppliers</li> <li>• Percentage of the purchased materials that decreased during time</li> </ul>	<ul style="list-style-type: none"> <li>• Geographic distribution of the purchased materials</li> </ul>	<ul style="list-style-type: none"> <li>• Supplier's delivery performance</li> <li>• Payment period</li> </ul>
<b>Production</b>	<ul style="list-style-type: none"> <li>• Frequency of the defection and complaints</li> <li>• Production period</li> <li>• Product quality</li> </ul>	<ul style="list-style-type: none"> <li>• Flexibility in increasing production</li> </ul>	<ul style="list-style-type: none"> <li>• Using different opportunities and capacities</li> </ul>	<ul style="list-style-type: none"> <li>• Percentage of added-value</li> <li>• Percentage of change in orders in the internal orders</li> <li>• Balance during the production</li> </ul>
<b>Delivery</b>	<ul style="list-style-type: none"> <li>• Orders management costs</li> <li>• Period of orders satisfaction</li> <li>• Rate of the produced goods</li> </ul>	<ul style="list-style-type: none"> <li>• Percentage of product turnover</li> <li>• Frequency of the produced and transported goods through every channel</li> </ul>	<ul style="list-style-type: none"> <li>• Geographic position of the delivery centers</li> <li>• Frequency of the channels</li> </ul>	<ul style="list-style-type: none"> <li>• Percentage of the defected bills</li> <li>• Delivery time</li> </ul>

**The Model**

In order to design the model, the concept of quality management has been used for measuring organizational success in the inventory system effectiveness and performance.

This model consists of four main sections. These include goals, processes, measures, and review. The processes are the heart of this model. Based on the past studies, these processes are the main activities that include planning, resourcing, production, and delivery. Final goals include customer services, internal efficiency, demand flexibility, and production development that some of them have been attended based on the market and industry types. The inventory system leads to several results. These results can be measured through criterions and their evaluation results in the goals and operations review and system improvement.

## **Evaluating Inventory System Management Through Supply Chain Approach In The Energy Industry**

### **Introducing The Case Study**

The under study organization of our research had mission for supplying the sustainable and safe energy for customers through developing and exploiting energy networks equipment. With regard to the mission of this organization in terms of energy supply and transition, the company is a service and project-based organization.

The main characteristic of this industry is that its final product is not storable.

### **Markets of The Energy Industry**

This industry has the characteristic of the growing market. Demand is more than supply in the market of this industry. The opportunities of this market are derived from achieving market share and recognizing the market during working with supply chain members. The main goal of this market is customer services.

### **Goal Measures**

With regard to this fact that the main goal of this industry is customer services, the focus is placed on the goal-related measures. The measures of customer services have been discussed in the different common sessions among authors and organizational executives and then the following measures have been finalized.

**CSI: clients:** This criterion includes measuring the clients' perception about delivered services by the organization. A self-administrated questionnaire has been used for measuring and analyzing the clients' perspectives. The calculated score refers to the clients' satisfaction rate.

**CSI: applicants:** This criterion includes measuring the applicants' perception from electric energy about delivered services. This also has been measured and analyzed through a self-administrated questionnaire. The calculated score refers to the clients' satisfaction rate.

**Unsatisfied demand:** when there are extra energy applicants and the company is not able to satisfy their demand, it can be concluded that the demand is unsatisfied. This results in the applicants' dissatisfaction and so the unsatisfied demand has been defined. Decrease in this criterion refers to the organization's success.

**Saliency rate:** this refers to the unsatisfied energy demand in the network and can be measured through following formula.

$$\text{Saliency rate: } \frac{1000 * \text{unsatisfied energy demand}}{\text{unsatisfied energy demand} + \text{satisfied energy demand}}$$

**Energy quality:** any deviation from standards is recognized as turbulence and can leads to disturbance in the total network and consumers. This also refers to the ratio of out of standard energy standard to total energy.

### **Criteria of Processes and Operations**

It is necessary to empower planning, resourcing, production, and delivery activities in order to achieve the supply chain goals. On the other hand, it is necessary to design several



criteria for measuring the conditions of these activities. A team was determined for examining payment and its related criteria based on the sub-activities in the main activities area and its related criteria. These have been indicated in the following section.

The following criteria have been attended in the planning activities:

- Accuracy of predicting maximum consumption: it is an important criterion that is used for preventing from possible events and being aware for services. In order to this, it is necessary to predict it soundly.
- Accuracy of predicting different regions' consumption: different regions have different consumptions and it is necessary to improve services based on the regions' readiness. Sound consumption prediction plays an important role in the appropriate services planning.
- Percentage of useless inventories in the store
- Used capacity

The following criteria are used the resourcing activities:

- Attracting budget for project A: this criterion is resulted from the costs for creating energy equipment.
- Attracting budget for project B: this criterion is resulted from costs for improving fossilized equipment to the allocated budget.
- Receipts from the sale: the company sales the energy to its customers and the sold energy has monetary value that the customers pay to the company monthly. Some customers may pay their liabilities with delay. The ratio of collected monetary by the company from customers' payment to the total energy value is measured by this criterion.
- Tributary: the customers should pay cost for buying energy in order to exploiting the energy. This cost is known as tributary.
- Amount of the attracted capitals from investors.

The following criteria are used in the production activities:

- Distribution equipment readiness: this refers to the distribution equipment readiness.
- Transition equipment readiness: this refers to the transitions equipment readiness.
- Production readiness: this refers to the expressed readiness of the production departments for participating in the energy market.
- Distribution equipment over 80%: the purpose of this criterion is to measure the use of distribution equipment.
- Distribution equipment less than 30%: the purpose of this criterion is to measure distribution equipment.
- Distribution equipment less than 55%: the purpose of this criterion is to measure distribution equipment.
- Distribution equipment less than 80%: the purpose of this criterion is to measure distribution equipment.

The following criteria are used in the delivery activities:

- Losses: this criterion refers to the amount of energy that is lost in the distribution and transition networks. It can be calculated through following formula.

$$\text{Losses: } \frac{\text{delivered energy to the network} - \text{output energy from network}}{\text{delivered energy to the network}}$$

- Not provided energy: this refers to the planned and unplanned energy losses.
- Scheduled performance criteria of the projects: this refers to the ratio of actual cumulative progress to the planned progress that the energy will be delivered to the

customers after creating them. If there is any delay in this process, the delivery process will have delay.

### Evaluation Mechanism

It is necessary to set the goals of the above-mentioned criteria after recognizing the criteria through defining goal-setting period and area. There are several effective criteria on the goals. This is why that it is necessary to measure the effective criteria on the goals and recognizing their actual deviation from predicted values for doing corrective activities. On the other hand, there are several criteria that influence each of the processes and operations that were recognized in the following section and their effects also were identified in this section.

### Evaluation Stage And The Results

There are three main criteria in our study that are known as green, yellow, and red by which we can perceive every criterion's condition.

- Green color means that the predicted goal is achieved more than goals.
- Yellow color means that the predicted goal is achieved about 95% to 100%.
- Red color refers to the projects and goals that about 95% of them have been achieved.

The projects with green and red colors refer to desirable or undesirable projects and also green color refers to the desirability of the project's progress. Since the importance rate of the projects may not be similar to each other, coefficients have been considered for every criterion and project. The  $I_{TLR}$  refers to the color criterion that can be calculated through the following formula.

$$\text{Formula 1: } I_{TLR} = \frac{\sum_{i=1}^{n'} w_i' + \sum_{j=1}^{m'} w_j'}{(\sum_{i=1}^n w_i + \sum_{j=1}^m w_j) - \sum_{i=1}^{n''} w_i''}$$

j: projects

i: criteria

j': green projects

i': green criteria

i'': yellow criteria

n: total number of the criteria

m: total number of the projects

n': number of the green criteria

m': number of the green projects

n'': number of the yellow criteria

w: weight of the criteria or projects

End of 2012 has been considered as basis for our study. The projects have not involved in calculations in this period. The projects have been defined after the first evaluation period and have been considered in measuring criteria after its progress. Measurement of criteria's weights was considered similar in this mechanism. It is possible to change the criteria's weights based on their importance.

The predicted values have been indicated in the following tables for every measure and value of the secondary criteria and their related criteria in terms of planning, resourcing, production, and delivery. Also it should be remembered that the positive sign (+) refers to

its increase and the negative sign (-) vice versa. Table 3 summarizes the predicted and achieved values for goal criterions.

Table 3:

*The Predicted And Achieved Goal Criterions*

Evaluation groups	Criteria	Predicted value (goal)	Actual value
<b>Goal</b>	CSI+	73	70.71
	CSI+	75	73.1
	Unsatisfied demand	0	15
	Rate of unsupplied energy	0.3	7
	Energy quality	0	1

Four criterions have been considered in the planning activities that none of them had not desirable conditions.

Table 4:

*The Predicted And Achieved Evaluation Criterions*

Evaluation groups	Criteria	Predicted value (goal)	Actual value
<b>Evaluation</b>	+ Accuracy of predicting maximum consumption	90	78
	+ accuracy of predicting rations' consumption	90	85
	-Percentage of the useless inventory	5	8
	+ ratio of the used capacity to predicted one	100	85

Table 5

*Summarizes The Predicted And Actual Resourcing Criteria*

Evaluation groups	Criteria	Predicted value (goal)	Actual value
<b>Resourcing</b>	+ percentage of attracting budget to project A	82	36
	+ percentage of attracting budget to project B	70	64.2
	+ Percentage of sale receipts	97	100
	+ percentage of payments	93	93
	+ percentage of attracting capitals from applicants	100	80

The results of table 6 and 7 show the predicted and actual values for production and delivery sections.

Table 6:

*The Predicted And Actual Production Criteria*

Evaluation groups	Criteria	Predicted value (goal)	Actual value
<b>Production</b>	+ readiness of equipment A	98	99.33
	+ readiness of equipment B	98	83.68
	+ Production readiness	352	351.93
	-distribution equipment over 80%	1	0
	-distribution equipment less than 30%	3	3
	-transition equipment over 55%	0	0
	-transition equipment over 80%	0	0

Table 7:

*The Predicted And Actual Delivery Criteria*

Evaluation groups	Criteria	Predicted value (goal)	Actual value
Delivery	-losses	2.3	1.62
	-unsupplied energy	0.4	0.1048
	+ scheduled performance criterions of projects	100	92.71

The scores of every goal groups and their total scores have been indicated in table 8.

Table 8:

*The Scores of Evaluating Every Criterion Groups And Their Total Scores*

Evaluation groups	Criteria of every group	Total criteria
Goal	0.33	0.53
Planning	0	
Resourcing	0.4	
Production	0.83	
Delivery	0.66	

The score will be 1 if all of the criterions of the industry achieve the predicted goals. The results revealed that the industry should improve the planning and resourcing sections. Also it is necessary to be careful in goal-setting and especially in the delivery operations.

### Conclusion

As the score of every criterion indicated, the planning and resourcing had the least score and so it is necessary to improve their conditions. On the other hand, some of other sub-criterions had low scores and so they need improvement for improving conditions. After discussion among operational and senior managers, the necessary efforts and projects have been described as following:

- Establishing the projects pricing systems
- Modifying the consumption prediction methods
- Making agreement for attracting sales income for production departments
- Selling the company's extra tangible and intangible inventories
- Obtaining loans from bank
- Suggesting the regulations of energy tariffs
- Integrating the operational information turnover system
- Establishing the project management system
- Deciding about condition of reproducible energy development in the company
- Designing and establishing the quality screening system

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