# Multiple regression analysis of performance Dependent & Independent indicators in the Automobile Company

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#### Abstract

In the present study most of the part involved in PhD thesis. The SCM is an integrated system that involves human resource, technology, operations, information sharing and resources to move a product or service from supplier to end user. Managing Inventory through the supply chain is the toughest task. This research focuses on optimizing the inventory towards lean manufacturing in the supply chain management. In this research the inventory management system of M/s XYZ industry is studied and few recommendations are made to predict Economic Order Quantity (EOQ), average inventory, and total annual cost of the products under study by developing the correlations using regression analysis. A comparative analysis clearly reveals that the cost incurred on products using existing practices in the firm vis-a-vis regression model proposed, is more and there is a significant saving in the total cost.

#### Introduction

Inventory is the spinal cord for any business enterprise. To run the smooth operations like production, delivery, procurement, etc. for any business entity, it plays an important role. In the beginning, to hold inventory was the best way to reach out to the potential customer at the right time. It also provides a competitive advantage to the manufacturing sector over the others in peak demand seasons. Early 1980, most of the manufacturing units were working on the pull production process in which the products were made in huge quantity and then sold according to the demand for that product. No-one was looking for the cost incurred on keeping the inventory in stock. Only, the main focus was on the production and thereafter sale of the products. In that scenario, the inventory level of a particular industry envisaged the broad vision of that industry. With the passage of time, holding inventory became a problem for every manufacturing industry for which there is no unusual solution. Every industry has different ways to target the customer demand so it becomes the problem to handle the inventory related issue in a common way for all the industries. In addition, there were numerous parameters which were kept in mind while taking a decision on the inventory levels i.e. cost of the product, transportation amount, inventory holding space required, money which is to be invested on purchase of raw material and tools for day-to-day operations and many more. Later on, the faster technological development in the manufacturing sector enforced the radical changes in the thought process of the manufacturers i.e. why they keep so many inventories when holding the products requisite the more investment? The supply chain is an integrated system that involves human resource,

technology, operations, information sharing, and resources to flow through the conversion process i.e. from the raw material to finished goods/services. The main activities involved in the SCM are transforming natural resources and raw material into finished product i.e. delivered to the end user [1-3]. Thus, it becomes very important to understand the complete structure of SCM. It was introduced in the year 1982 and has received ever-growing demand in literature as well as industries. Due to the dynamic nature of the SCM, the role and responsibility of the supply chain member varies from organization to organization. Supply chain management is shown in Figure 1.



Figure 1: Supply Chain Management [15]

Due to the rapid advances in the technologies and globalization, the nature of the supply chain has become more complex. It has also become a critical business function than ever before. Since SCM is a network of facilities in which the movement of the products takes place since its inception to delivery and finally reaching the customer, the selection of a proper distribution channel becomes the backbone of the supply chain system. Different components of supply chain management are the definition of hierarchical approach, planning of strategic approach of demand and supply, inventory management study of technological trends, market study and external regulation to achieve business goals [4-5]. The success of SCM depends on coordination of finance and routine activities which in turn helps to take a decision that adds value to the customer. Due to globalization and liberalization, SCM has become a modern tool for improving organizational competitiveness in the 21<sup>st</sup> century [6-8].

In most of the organizations, SCM addresses the following areas for the improvement purpose:

• The distribution network of goods along with configuration.

- Strategy of distribution.
- Developing an effective logistics strategy.
- Sharing of valuable information.
- Inventory control and management.
- The methodology of cash flow.

# **Literature Review**

For any research work, the literature review part plays a very important role. The review on literature is done to evaluate the published information for any object/situation critically. This will help in identifying the healthy research problem and provides a discussion on various alternatives provided by the researchers. The critical evaluation of literature reveals the present dilemma of the product or the process. This can be done through the established relationship between the research already done and the gaps in those studies.

In the present research work, the work done by the various researchers (academicians and practitioners both) stated in reputed journals/conferences/books is referred for finding the origin of the concept of inventory and how it can be managed. In addition, the gaps related to inventory management are also studied. This chapter provides an insight into the present work and discusses the following:

- What is inventory and how it helps in operating any business entity?
- Why and how inventory can be managed?
- Is it beneficial for the manufacturing industry to manage the inventory?

In the manufacturing context, inventory is essential for the smooth running of all the business activities. It not only helps in running the business but also works as a cushion for the enterprises during uncertainties in the market demand and supply. The literature reveals that it is the necessary evil for all kind of businesses. One of the noteworthy accomplishments of present day business is the application of supply chain management approach which enables the companies not only to compete but also to meet with the customer desire in said quantity and quality [48-50]. The variation in the demand products with short life cycles, quality based aspects, and the quantity based aspects forced the manufacturer's attention to invest more on developing the effective and efficient supply chain because the in effective supply chain becomes an inevitable challenge for the manufacturing industries [51-53]. Every organization would have the goal to survive on long term basis with prosperity. [54-55].

In the present era customers have a huge demand of customized products which is not possible in traditional manufacturing methods [55-57]. This shows the dynamism in the customer behaviour which varies according to time and situation. Thus, it becomes necessary to satisfy the customer needs as per their desire in all aspects [58-60]. Supply chain effectiveness has the impact on the operational excellence of the industry by optimum utilization of resources. This will further reduce the operating cost and increase the profit share of the organization [61-62]. In general term, the supply chain is the network of associated activities/ facilities (dependent on each-other) which begins from the procurement to the delivery to the end customer. [63-66]. It helps in ensuring the optimum utilization of

the resources and having a close look at the appropriate amounts of stocks which need to be maintained for healthy returns. [67].

#### **Case study**

In the present scenario, the use of computers is increased in analyzing the input data. Software's like Minitab, Stats-pro are used for analyzing purpose. In addition, with the help of these software's one can find the regression values. The regression analysis is basically done for the identification of relationship among more than one quantitative variable i.e. dependent and independent in nature. The regression reports has the objectives to determine the values of parameters for a function that cause the function to best fit. The equation below represents the simple case of regression analysis which represents the relationship an independent variable X and a dependent variable Y is linear, using the simple linear regression equation:

Y = a + b X (Where a and b are constants)

 $Y = a + bX_1 + cX_2 + dX_3$  (Multiple Regression - where a, b and c are constants)

# a. Development of Correlation for EOQ as a function of raw materials quantity, Per order ordering cost, purchase price per order, and material cost

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	4	3.25663E+12	8.14159E+11	*	*
Raw Materials Qty	1	284592502	284592502	*	*
Per order ordering cost	1	58892811177	58892811177	*	*
Purchase price per unit	1	5857584565	5857584565	*	*
Material Cost	1	4139965451	4139965451	*	*
Error	0	0	*		
Total	4	3.25663E+12			

**Table 1:** Analysis of Variance for prediction of EOQ for product 1

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
*	100.00%	*	*

Coefficients

Term	Coef	SE	T-Value	P-Value	VIF
Constant	800949	*	*	*	
Raw Materials Qty	-0.8764	*	*	*	673.29
Per order ordering cost	311.4	*	*	*	12.63
Purchase price per unit	-54353	*	*	*	19.12
Material Cost	0.06456	*	*	*	700.83

**Regression Equation** 

Year	Calculated by	Estimated by	Absolute	Percentage Error
2017-18	5453674	5452694	0.0001796	0.0155972
2016-17	4657030	4656151	0.0001887	0.0167243
2015-16	3982244	3981590	0.0001642	0.0159480
2014-15	3790287	3789642	0.0001701	0.0169831
2013-14	3654479	3653814	0.0001847	0.0169676

EOQ = 103852 + 0.1058 Ordering Cost - 0.2785 Average Inventory + 0.1237 Carrying Cost



Figure 2: Year versus Actual and Estimated EOQ

Figure 2shows the year wise Economic order quantity (EOQ) for product 1. It can be clearly seen in the figure the EOQ is different for different years and this is due to the fact that annual demand, unit price rates and carrying costs are not the same in different years. The value of EOQ predicted by analytical method (EOQ Model) has been compared with the regression model. In the graphs shown in this chapter the 'actual' refers to the values obtained EOQ model and 'estimated' refers to the results given by regression analysis correlations. There is a high degree of prediction accuracy by the regression model values compared to the EOQ model values as shown in the figures below.



Figure 3: EOQ equation number versus R<sup>2</sup> Values for Product 1

Figure 3 shows the predicted  $R^2$  values versus equation numbers. All input parameters such as raw material quantity, per order ordering cost, the purchase price per unit, material cost and carrying cost taken as a function to predict EOQ. The  $R^2$  values of correlation number 3 ( $R^2 = 8.82$ ), 5 ( $R^2 = 7.06$ ), 7 ( $R^2 = 18.41$ ), from individual parameters and whereas 21 ( $R^2 = 42.15$ ) from dual parameters shown less correlation with EOQ. The remaining correlations have shown accuracy for  $R^2$  values prediction ranging from 80.54 – 100.

## Validation of model

For validation the values of developed correlations from the regression analysis are compared with the available data for the year 2018-19.

Items	Units	2018-19
Raw Materials Qty	Kg	1400602
Ordering Cost per Order	INR	23583
Purchase price per unit	INR	49
Material Cost	INR	68629498
Carrying Cost	%	4.25
Number of Order	No	8
Order Size	Kg	178107

**Table 3:** Observation Table for Input parameters for validation of correlations

#### **Regression Correlations**

EOQ =802567 - 0.7865 Raw Materials Qty + 296.4 Ordering Cost per Order - 53467 Purchase price per unit + 0.07856 Material Cost

Itoma	Unita	EOQ	Regression	Absolute
Items	Units	Model	Model	Error
EOQ	INR	786456	786322	0.00002
Ordering Cost	INR	178964	178962	0.00001
Average Inventory	INR	90534	90526	0.00002
Carrying Cost	INR	178964	178948	0.00008
Total Annual Cost	INR	365479	365445	0.00003

<b>1 able 4:</b> Observation 1 able for Output parameters for validation of correlation	Table 4:	4: Observation	Table for	Output par	rameters for	validation	of correlation
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#### Conclusions

Inventory control system is a vital component for the effective execution of supply chain management. Balancing inventory and finance is the key to success of any organization. A substantial cost is involved in inventory and therefore a careful inventory management and balance between material management and financial management is the key to business.

**Table 5:** Cost comparison with existing system for Product 1

Cost comparison with existing system for Product 1							
Year	2013-14	2014-15	2015-16	2016-17	2017-18		
Cost with Existing System	1166689	1170824	837445	905802	1314236		
Cost with Regression Model	1106624	1141258	796000	860400	1272879		
Yearly Savings in INR	60065	29566	41445	45402	41357		
% Saving	5.14833	2.52523	4.948982	5.012354	3.146847		

## Scope of further research

In future, the correlations can also be estimated by various statistical techniques and methods as follows:

- SPSS, SYSTAT, SAS and Minitab the statistical software's can also be used for analysis to improve the accuracy of the analysis.
- ANOVA, Design of the experiment, and Taguchi methods can also be used for analysis to achieve strong correlations.

• While calculating the correlations the graphs and charts can also be used to improve the results.

The existing methodology is applied to a manufacturing firm; a preliminary result can also be obtained by applying the said methodology to a service firm.

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