6th International Symposium on Advances in Science and Technology
SASTech
Malaysia | Kuala Lumpur
24 - 25 March, 2012
Scope of the Symposium
Organised by:
Khavaran Institute of Higher Education
Hosted by:
Geospatial Association of South East Asia

Optimization Of Expenses For Manufacturing Company By Statistical Model

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Paper Reference Number: 6-12-18-990
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Abstract

This research is investigating effective factors to reduce expenses of car manufacturing industry supply chain. The mentioned effective factors under analysis considers to assembly parts of manufacturing company up to the target market. Utilizing mathematical and statistical models, also the research undertakes to use the best selection of vehicles and the number of human resource for reducing expenses in industry. For reach to this aim, first of all; the limitations are classifying, then in the next step the variables of mathematical modeling are optimization.

In this paper a response surface model (RSM) was established and numerical simulations were performed to study the impact factor. The effects of three parameters such as fuel consumption, total workforce, and volume of transport were investigated.

Key words: Optimization, RSM, manufacturing industry

1. Introduction

Supply chain (SC) has an exclusive system constitution as a body collection with frequently goals. Supply chain management has established substantial concentration in the management literature. Supply chain optimization is the practices application and tools using to guarantee the most select function of a manufacturing, industrialized and allocation of supply chain. This includes the optimal placement of inventory within the supply chain, minimizing operating costs (including manufacturing costs, transportation costs, and distribution costs). The supply chain is a constant procedure, from raw resources to complete commodities. Markets have developed into extremely aggressive and turbulent and are changing all the time. Market circumstances shift from being minimal one to multifaceted one, from stable form to dynamic shape, and from domestic to hostile shape (Neu and Brown (2005), Heiko Gebauer et,al (2011)). Manufacturing companies are conveying their hard works on the way to purchaser centricity and originality, in addition from supplies to services. As alternative simply innovating goods, groups are devoting in service separation. As a result, as a substitute services being addons to the outcomes, they develop into the hub of the entirety contribution, with goods as add-ons to the services. A variety of describe terms this service segregation in manufacturing firms, counting development of service business, privatization, service combination, high-worth keys and clarification from goods to services (Davies, 2004; Gustafsson 2010).

Regards a single wholesaler is providing an item to multiple buyers. The vendor produces the things in batches and at a fixed charge. The vendor then sends the finished items to

multiple buyers. In this procedure, the vendor acquire batch set-up and carrying expenses then the vendor and buyer both transfer the item holding charge relative to time.
First of all, the practices applying to supply chain optimization are declared for academically realistic. The majority of the professional companies have been formed as a consequence of investigated studies in educational organization or consulting companies and they point to make inquiries issues, white all aspects of papers, academic advisors and industry reviews to maintain their authority in field. The following step is the procedures are claimed to be profitable useful. The companies announce case studies that show how clients have realized decrease in supply at the same time as keeping up or making better accessibility. There is imperfect available information outside of these case studies, and disinclination for a number of practitioners to publish facts of their sensitive achievement, therefore hard indication is demanding to come by.

In supply chain, transportation cost is a major part of operational cost and focus on developing performance elements in operation group. Transportation time, cost, and capacity constraint play significant role in making decisions and stakeholders. In today's world, short life cycle and numerous specialties of similar products have made the global market highly competitive. In order to survive instead of difficulty of marketplace, per company has to be extremely aggressive in terms of characteristic of goods, cost and product provide. The current diagram of a single vendor multi buyer supply chain system is exposed in Figure 1.1.

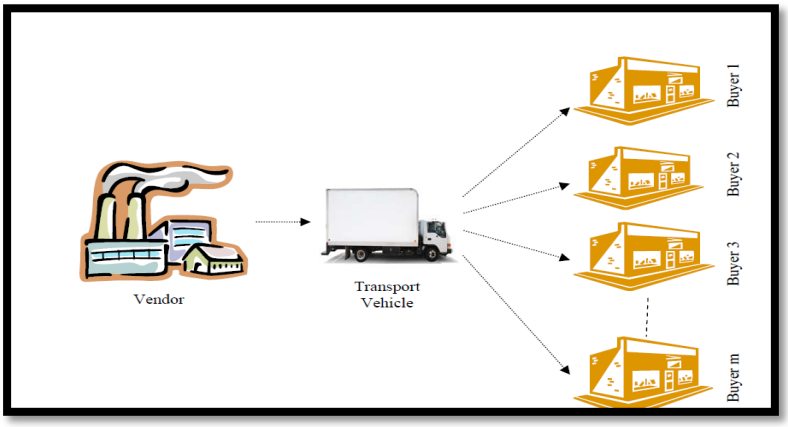

Figure 1.1: Flow diagram of a single seller multi buyer integrated supply chain

Customer service standards (is normally definite as the communications among a business and its consumers and is rated based on the business aptitude to congregate their customers' requirements.) that setting the production stage and willingness amount to which the logistics system must be react. Logistics expenses rise in quantity to the customer service level provided, such that the standards set for service also influences the logistics expenditures to carry that service level. Setting very high service requirements can force logistics costs to exceedingly high levels.

Good logistics management is base of each activity in the supply chain as causal to accumulation the value process and One of the most significant inputs to a achievement a high level in business field is having plan for logistics management which it is deal with the requests of the most important people as consumers .If little cost can be added, it is an open to discussion issue whether the action must be present in society and consumers. On the other hand, cost is addition to primary cost when customers are ready to recompense extra meant for goods or service than the cost to locate it in the supply of them. Markets of

principal investment may be moderately ‘equipped’ in character and form or have a more ‘strategic’ edge point. Therefore a lot of company all the way through the world, logistics has happened to a more and more vital value-adding procedure intended for a motivations number.

2.Problem Statement

According to available data, conducted researches in Iran’s management and planning organization, cost of transport from origin to destination has got the highest effect on increasing the prices (30%). on the other hand, proper planning in transporting IKCO products, the above mentioned costs can be decreased noticeably that it means about 30% of high cost of product related to transportation costs as a result should be find the effective way to decrease this kind of cost and it be able to reduce expenditure efficiency that effect on the final price.

3. Study Area

Iran Khodro Company, also known as IKCO, is the leading Iranian automaker with headquarters in Tehran. The company's original name was Iran National. IKCO was founded in 1962 and it produced 688,000 passenger cars in 2009. IKCO manufactures vehicles including sedans, trucks, minibuses and buses. Iran Khodro (IKCO) is a public joint stock company with the objective of creation and management of factories to manufacture various types of vehicles and parts as well as selling and exporting them. IKCO produces vehicles under 13 brand names.

The company has become the largest vehicle manufacturer in the Middle East, Central Asia and North Africa. In Iran, it is the largest vehicle manufacturing company, having an average share of 65 percent of domestic vehicle production.

In 1997, IKCO broke its own production record by producing 111,111 units of various passenger cars and vans. By 2006 Iran Khodro was producing 550,000 vehicles (for the Iranian year 1384, starting on 21 March 2006).

The opening of the country’s largest car assembly plant in Khorassan in July 2008 is expected to increase capacity with the ability to turn out 100,000 vehicles per annum by late 2009. However, it will not necessarily increase production.

Iran Khodro, the largest car manufacturer in the Middle East, produced 774,965 units of passenger cars and commercial vehicles in 2010 and aims to produce and market 850 thousand cars in 2011.

4. Methodology

The using method of response surface methodology is efficient (base on has done research) in the goal of reducing the mentioned cost in manufacturing company activities.

Response Surface Method (RSM) presents statistical tools; they guide design of experiment (DOE) for performance of the peak procedure that looks at the dealings among numerous descriptive variables and one or further response variables . RSM can be classified as a statistical technique that utilizes quantitative data from proper experimentations to conclude and at the same time solve multi-alternative equations. RSM produces precise maps is base on the numerical outline. It can locate all your responses with each other through sophisticated optimization approaches, which lastly lead to the sweet spots discovery where all qualifications are shown at minimal cost.

There are four main steps in the request of RSM that are including experimental setup, experimental design, model selection and statistical analysis.

The related steps in the data analysis are forming into three stages. At first fitted the model and analysis of variance to approximation parameters then canonical analysis for considering the shape of the forecasting response surface and finally ridge's analysis to investigate the optimal reactions in form of answers to the region.

5. Result And Discussion

In this research, multiple regression analyses were performed via response surface analysis to fit mathematical models to the experimental data purpose at an best region for the response variables studied and to describe the relationship between four independent variables and the criteria of two response variables as clarify in Table 1.The response surface analysis allowed the development of an empirical relationship where each response variable (Y1 and Y2) was assessed as a function of, X1(personal number), X2(van 4 ton), X3(lorry 7 ton), and X4(lorry 10 ton), and predicted as the sum of constant (β0), four first-order effects (RSQM Model terms in X1, X2, X3 and X4, six interaction effects (interactive terms in X1, X2, X3, X4, X1 X4, X2 X3, X2 X4 and X3 X4). The obtained results were analyzed by ANOVA to assess the ‘‘goodness of fit’’. Only terms found statistically significant ($p<0.05$) were included in the reduced model.

Table 1 Central composite design independent (Xi) and response variables (Yj)

No	Personal .No X_1	Van .No X_2	Lorry .No X_3	Truck .No X_4
1	2205	3041	2533	1591
2	2396	3374	2659	1754
3	2525	3471	2939	1793
4	2411	3398	2706	1731
5	2223	3065	2553	1608
6	2484	3430	2846	1795
7	2675	3699	3068	1926
8	2375	3288	2722	1710
9	2289	3148	2617	1647
10	2508	3477	2863	1808
11	2619	3613	3013	1883
12	2382	3286	2831	1724
13	2387	3297	2738	1720
14	2434	3352	2796	1763
15	2533	3512	2899	1821
16	2427	3380	2808	1750
17	2351	3250	2699	1690
18	2494	3449	2856	1798
19	2534	3501	2906	1829

20	1967	3214	2830	1774
21	2362	3255	2720	1698
22	2463	3416	2817	1773
23	2755	3806	3155	1994
24	2521	3488	2885	1819

Values of "Prob > F" less than 0.0500 indicated model terms are significant.In this case X1, X2, X3, X4, X1 X4, X2 X3, X2 X4 and X3 X4 are significant model terms.
Values greater than 0.1000 indicate the model terms are not significant.
If there are many insignificant model terms (not counting those required to support hierarchy), model reduction may improve your model.
A negative "Pred R-Squared" implies that the overall mean is a better predictor of your response than the current model.

Table 2: ANOVA for Response Surface quadratic Model of the Average seasonally Spare Part IKCO (2004-2010)

Source	Sum of Squares	Mean DF Square	F Value	Prob>F	
Model	5.830	144.16	154.03	<0.0001	Significant
A	1.892	11.89	0.70	0.4245	
B	7.181	17.18	2.66	0.1376	
C	7.704	17.70	2.85	0.1257	
D	4.021	14.02	14.87	0.0039	
A2	6.023	16.02	0.22	0.6482	
B2	2.697	12.69	1.00	0.3440	
C2	7.140	17.14	2.64	0.1386	
D2	2.591	12.59	9.58	0.0128	
AB	2.895	12.89	0.11	0.7510	
AC	3.292	13.29	1.22	0.2985	
AD	1.514	11.51	0.56	0.4734	
BC	7.172	17.17	2.65	0.1378	
BD	3.285	13.28	12.15	0.0069	
CD	1.276	11.27	4.72	0.0579	

The Model F-Value of 154.03 implies the model is significant. There is only a 0.0001 chance that a “Model F Value” this large could occur due to noise.

Values of “Prob>F” less than 0.0500 indicate model terms are significant model terms are significant. In this case D, D2, BD is significant model terms. Values greater than 0.10000 indicate the model terms are not significant.

Analysis of variance also confirmed that the models were highly significant ($p<0.05$) for all response variables. The probability (p) values of all regression models were less than 0.05, which had no indication of lack of fit. The values for these response variables were higher than 0.80 (0.9958), thus ensuring a satisfactory fitness of the regression models to

the experimental data. The following response surface models Equation 1 were fitted to the response variable (Y1) four independent variables (X1, X2, X3 , X4, and six interaction effects (interactive terms in X1, X2, X3, X4, X1 X4, X2 X3, X2 X4 and X3 X4).

Y1= -6953.58+ 5426.17- 2807.29+ 4075.56-2233.72+ 3062.01-688.39+ 4629.31+ 7712.49+2936.12+13611.48+3161.38+5061.14+3970.05
(1)

Table 3: Constraints Of Planing For Collection And Transportation Of Spare Part IKCO

Name	Goal	Lower Limit	Upper Limit
Personal	is in range	1980	3200
Van	is in range	2500	4200
Lorry	is in range	1800	3000
Truck	is in range	1200	2700
Spare Part Weight	maximize	3831.4	5500
Cost	minimize	591400	838817

Therefore, founded on the existing convenience and other parameters that were mentioned and according to Quadratic model, the best applying of machinery and manpower for demonstrating the minimum cost in the manufacturing company obtained and has been presented in Table 4.
Proceed to Diagnostic Plots (the next icon in chain). Attentions to these cases are important:

1) Normal probability plot of the studentized residuals to check for normality of residuals.
2) Studentised residuals versus predicted values to check for constant error.
3) Outlier t versus run order to look for outliers, i.e., influential values.
4) Box-Cox plot for power transformations.

Table 4 Compare Result before and after optimization

Years	Personal	Van	Lorry	Truck	Spare Part (Ton)	Cost US$
Win 2010	2521	3488	2885	1819	4279.6	191427
Sum 2012	2769	4041	2905	1994	6684.2	169560

6- Conclusion

The most significant and unique part of this model is that for the first time cost optimization of spare parts of Iran khodro products in supply chain management has been done by the statistical analysis of response surface Quadratic model and also combining the amount of weight, fuel consumption, total manpower and quantity and quality of transport as input data.

According to statistics presented, the amount of money that Iran khodro spent for manpower (worker's salary), fuel and vehicles for transporting spare parts was US$191427 in winter 2010. In addition, the value of machinery used in this section is

equivalent to US$169560. According to prediction done, weight of spare parts will be 6684.2ton in summer 2012. Using response surface Quadratic model, the costs can be decreased to US$ 21867.

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