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INVENTORY MANAGEMENT IN A MANUFACTURING INDUSTRY: A CASE STUDY OF ZAKEN BAKERY INDUSTRY LIMITED, EKWULOBIA

Nwankwo Nnaemeka Herbert, Ani Moses Chukwuma and Nwosu Chijioke
Department of Mechanical Engineering Technology,
Federal Polytechnic Oko, Anambra State
Correspondence: 08068819721; nwankwo.nnaemeka@federalpolyoko.edu.ng

ABSTRACT

In all the manufacturing or production industries, inventory which is the act of stock taking could make or mar the profitability of the industries. By using manual efforts in the implementation of policy in the inventory management, the system could never be free from mistakes that could run down or eventually close down the industry. This research provides an overview of elimination of manual implementation of inventory control in Zaken Bakery Industry through computerization. In order to achieve this, the data obtained from the case company (Zaken Bakery Nigeria limited) were analyzed statistically using One-way Analysis of Variance (ANOVA) and well-known Response Surface Methodology (RSM). From the result of the one-way ANOVA analysis, Data Mean, standard deviation, mean square, sum of square, sample size and degree of freedom show the statistical analysis of every independent variable in the data. Coefficient of correlation of the data show that the variables are 78.63% correlated. The probability value (P-value) of the data is highly significant with a probability value of 0.00. This significance result shows that the data collected for each of the variables are highly significance in analysis of the inventory control system of the case company. The response surface analysis reveals the level of the impact of the set-up costs and holding cost to the total cost in any particular areas within the collected data limits.

Keywords: Inventory, Analysis of Variance, Response Surface Method, Set-up cost and Holding cost.

Introduction

Inventory refers to the goods and materials that an organization, company, or business holds to support production, support activities and for sale or customer service. A good inventory management is very important for an effective and efficient business organizational management for successful operations in any manufacturing industry. It is also essential in the control of materials and goods (especially spare parts) that have to be held (or stored) for later use in the case of production or later exchange activities in the case of services. Inventory is one of the most expensive and important assets of many companies, representing as

much as 50% of total invested capital (Nahmias,2005). Managers have long recognized that good inventory control is crucial. On one hand, a firm can try to reduce costs by reducing on-hand inventory levels. On the other hand, customers become dissatisfied when frequent inventory outages, called stock outs, occur. Thus, companies must make the balance between low and high inventory levels. As you would expect, cost minimization is the major factor in obtaining this delicate balance.

Inventory is any stored resource that is used to satisfy a current or future need. Raw materials, work-in-process, and finished goods are examples of inventory. Inventory levels for finished goods, such as clothes dryers, are a direct function of market demand. By using this demand information, it is possible to determine how much raw materials (e.g., sheet metal, paint, and electric motors in the case of clothes dryers) and work-in-process are needed to produce the finished product. Every organization has some type of inventory planning and control system. Companies have methods of controlling its inventory of raw materials and production output. Virtually every manufacturing and production organization are concerned with inventory planning and control. Studying how organizations control their inventory is equivalent to studying how they achieve their objectives by supplying goods and services to their customers. Inventory is the common thread that ties all the functions and departments of the organization together.

Inventory management involves a retailer seeking to acquire and maintain a proper merchandise assortment while ordering, shipping, handling, and related costs are kept in check. It also involves systems and processes that identify inventory requirements, set targets, provide replenishment techniques, report actual and projected inventory status and handle all functions related to the tracking and management of material. This would include the monitoring of material moved into and out of stockroom locations and the reconciling of the inventory balances. It will also include ABC analysis, lot tracking, cycle counting support, etc. Management of the inventories, with the primary objective of determining/controlling stock levels within the physical distribution system, functions to balance the need for product availability against the need for minimizing stock holding and handling costs. The researcher, having observed the non-implementation of the existing inventory control system in the case study, decided to appraise the inventory control system and its applications to the case study. The appraisal of the inventory control system will help the company for effective utilization of the system and optimization of the industrial output in the system.

Inventory is one of the major tools used to eliminate uncertainties in modern business inventory, both inventory in stock and inventory in production. Inventory is also employed to eliminate overstock and under stock of the raw materials and the finished product. In modern manufacturing, inventory

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is employed to eliminate these uncertainties. The researcher employed the inventory technique to eliminate economic uncertain as alternative ways to stay competitive and to also eliminate overstock and under stock in inventory planning and control system. Having observed the stated problem, the researcher went into developing a solution to the aforementioned company.

The significance of the study is to develop a method of inventory control system. The research work will reveal an improved and appropriate cost estimate of the case company inventory. It will develop a standard of inventory control system to the production manager which will enhance production planning in the case company. However, this study will be of use to researchers who are willing to conduct further research on inventory control system. The concept of this research work will also be very significance in supply chain management and logistics.

Materials And Method

Sources of Data

In this work, relevant data for this study will be obtained from the case study company over a period of Three years. Seventeen final assembled products that would be considered to be high revenue level items will be chosen. Three years-worth of historical data will be obtained in other to see the products sales behavior due to its demand, to help with establishing a forecasting trend for each product. Along with the products historical data, the products ordering cost, purchasing cost and unit cost will be collected to calculate the products total annual cost. Once the data was collected, analyzing it will be the first initial step.

Method of Data Analysis

The result of the experimental observation which was carried out on the inventory control system of the aforementioned industry is presented in tables 4.1 and 4.2. The data were presented on the monthly record of the inventory control system over the years. As stated earlier, inventory control system is stated as the process for managing and locating objects or materials. In common usage, the term may also refer to just the software components. Inventory control is the forms and models of Inventory Management. Inventories refer to those products or goods a firm is manufacturing for sale and components that make up the product.

Table 2.1: Inventory Stock for the case Company

S/N	Products	2012	2013	2014	Total	Average
1	SUGAR	629,488	1,842,480	514,650	2,986,618	995539.3
2	SALT	1,133,137	245,050	88,300	1,466,487	488829
3	FLOUR	13,534,332	37,503,521	14,978,035	66,015,887	22005296
4	PRESERVATIVES	339,790	893,000	344,000	1,576,790	525596.7
5	YEAST	256,738	631,956	265,123	1,153,817	384605.7
6	BUTTER	155,700	362,020	68,050	585,770	195256.7
7	FRUIT	67,500	483,350	181,400	732,250	244083.3

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8	VAMMILA	74,400	225,500	80,900	380,800	126933.3
9	MILK (CONDENSED MILK)	69,260	234,884	76,200	380,344	126781.3
10	EGG YELLOW	16,340	271,200	70,200	357,740	119246.7
11	CHOCOLATE	47,140	348,100	93,500	488,740	162913.3
12	SWEETENER	102,800	44,617	52,222	199,639	66546.33
13	MUT MET	116,100	11,970	15,189	143,259	47753
14	ALPHA MALT	212,150	120,020	11,921	344,091	114697
15	SUOLA OIL	140,932	239,593	26,940	407,465	135821.7
16	TANTALIZER	109,446	310,506	138,477	558,429	186143
17	Turkey Oil	0	297,576	127,558	425,134	141711.3

Table 2.1 shows the inventory stock of the Zaken Bakery Industry. The table above shows the inventory records of the case company over a period of three years. The records portray the raw materials for bread production which are independent to the finished product. The raw materials are mixed in various specified quantities depending on the finished product size and product quantity specified by the company standard and / or customer demand.

Table 2.2: Unit Cost of the Inventory Products

S/N	Inventory Products		Unit cost
1	SUGAR	BAGS	9,840
2	SALT	BAGS	2,800
3	FLOUR	BAGS	7,165
4	PRESERVATIVES	BAGS	11,000
5	YEAST	Kg	312
6	BUTTER	Kg	4,800
7	FRUIT	Kg	9,000
8	VAMMILA	Liters	1,200
9	MILK (CONDENSED MILK)	Liters	2,100
10	EGG YELLOW	Kg	2,600
11	CHOCOLATE	Kg	2,660
12	SWEETENER	Kg	2,500
13	MUT MET	Kg	3,100
14	ALPHA MALT	Tube	1,700
15	SUOLA OIL	Gallon	1,258
16	TANTALIZER	Liters	1,720
17	Turkey Oil	Liters	2,300

Table 2.2 reveals the unit costs of each of the raw materials in the company's inventory control system and its specified quantity per unit cost. The costs of the materials help to determine the unit holding costs, annual setup costs and the annual holding costs.

Design of Experiment

To aid the factors screening/modeling of the combined effects of the seventeen identified independent variables which include; Sugar, salt, flour, preservatives, yeast, butter, fruit, vanilla, milk, egg, chocolate, sweetener, Nut Met, Alpha malt, Suola Oil, Tantalizer and Turkey oil, an experimental design was first

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conducted. The design was somewhat compounded by the relatively increased number of the variables over the months under study which ordinarily calls for increased number of investigation points at the factorial levels. To avoid increasing the total number of investigation points in the experimental design, a fractional factorial design was adopted. The 2^{5-1} -fractional factorial array (ffA) was linked to the classical central composite design (CCD) to account for the overall variability.

Statistical screening and modeling of the Inventory system

Inventory system is basically a process which is affected by a number of process variables. The statistical analysis recommended for this type of study where moderate system nonlinearities are expected involves correlation of experimental data on a multivariate regression basis using appropriate fitting function(s). Considering the distribution of the experimental data, the performance of polynomial fits to the data up to the third order was tested following the well-known response surface methodology (RSM). The adequacies of the RSM fits were ascertained using standard statistical criteria. The selection of the most influential variables in the detailed statistical screening of the leaching processes was based on ANOVA results.

$$Y = \beta_0 + \sum_{j=1}^{k} \beta_j X_j + \sum_{j=1}^{k} \beta_{jj} X_j X_j + \sum_{j=1}^{k} \beta_{jjj} X_j X_j X_j + \sum_{i<} \sum_{j=2} \beta_{ij} X_i X_j + \varepsilon (3.27)$$

The detailed system analyses leading to analysis and results of the inventory system including the investigation of the linear, quadratic and cubic effects of the main process variables and the significant quadratic interaction effects were implemented on design expert software using the response surface methodology (RSM). The RSM algorithm enables the estimation of the unknown parameters of generalized third-order matrix polynomial equation to give the actual predictive model utilized in the analysis.

Result And Discussion

One-way ANOVA Analysis of the Inventory Control System Data

Table 3.1: One-way ANOVA Analysis of the Data

Source	DF	SS	MS	F	P
Factor	16	1.33854E+15	8.36585E+13	7.82	0.000
Error	34	3.63725E+14	1.06978E+13		
Total	50	1.70226E+15			

R-Sq = 78.63% R-Sq(adj) = 68.58%

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Table 3.2: Statistical Analysis of the Data

Level	N	Mean	StDev
SUGAR	3	995539	735716
SALT	3	488829	563464
FLOUR	3	22005296	13441254
PRESERVATIVES	3	525597	318188
YEAST	3	384606	214253
BUTTER	3	195257	150924
FRUIT	3	244083	214895
VAMMILA	3	126933	85423
MILK (CONDENSED MILK)	3	126781	93684
EGG YELLOW	3	119247	134323
CHOCOLATE	3	162913	162043
SWEETNER	3	66546	31626
MUT MET	3	47753	59212
ALPHA MALT	3	114697	100221
SUOLA OIL	3	135822	106419
TANTALIZER	3	186143	108675
TURKEY OIL	3	141711	149292

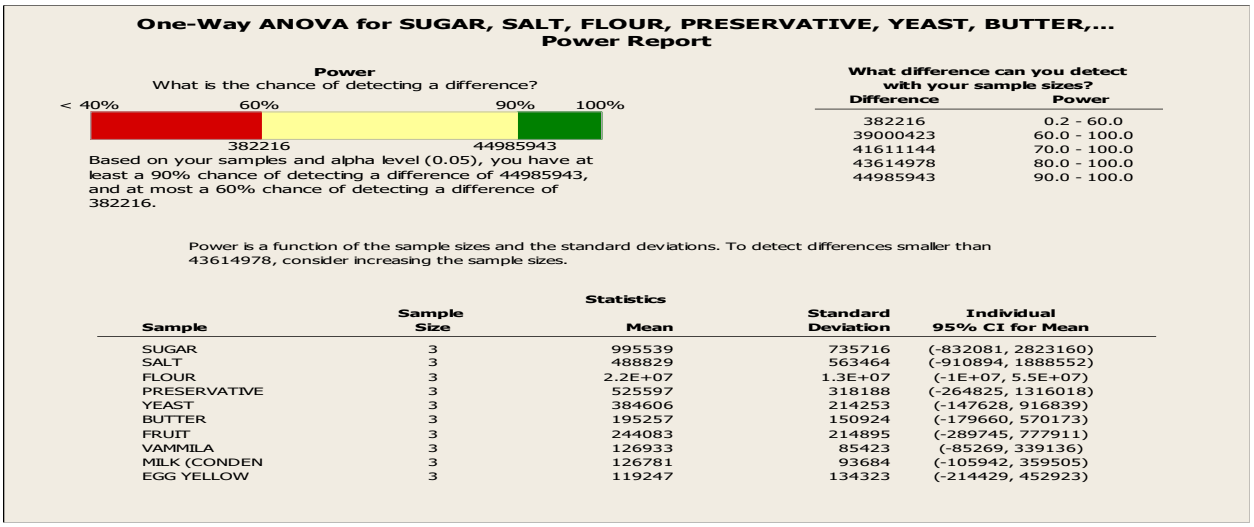


Figure 3.1 Power Report of One-Way ANOVA for Some Data

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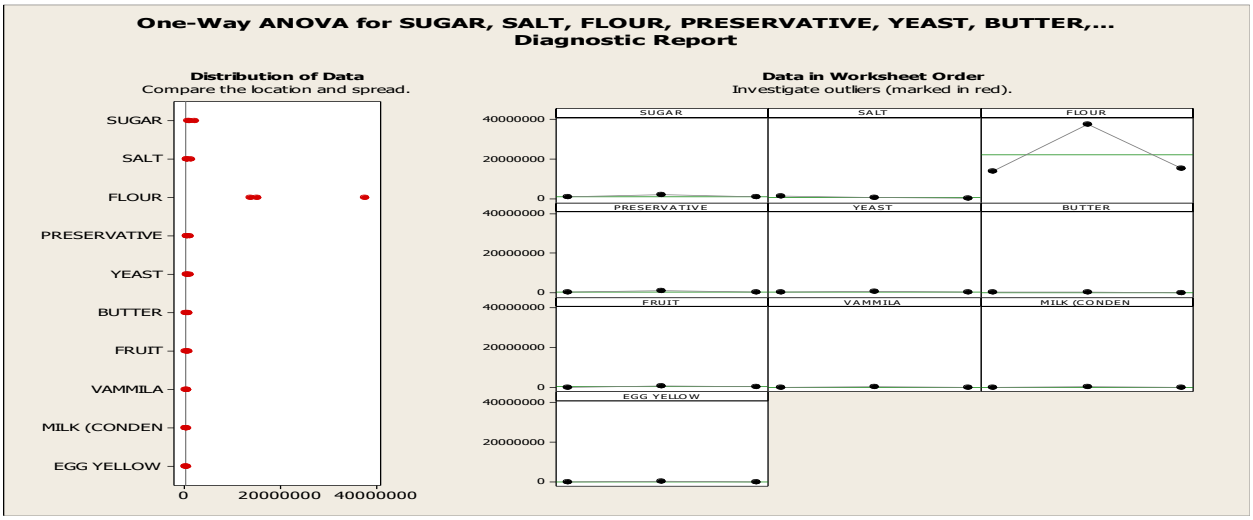


Figure 3.2 Diagnostic Report of One-Way ANOVA

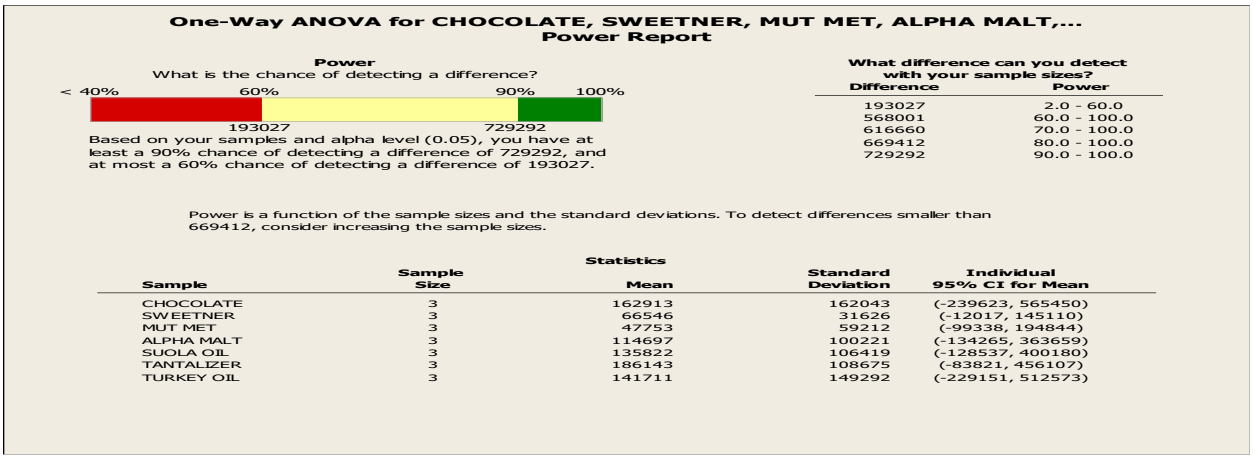


Figure 3.3 Power Report of One-Way ANOVA

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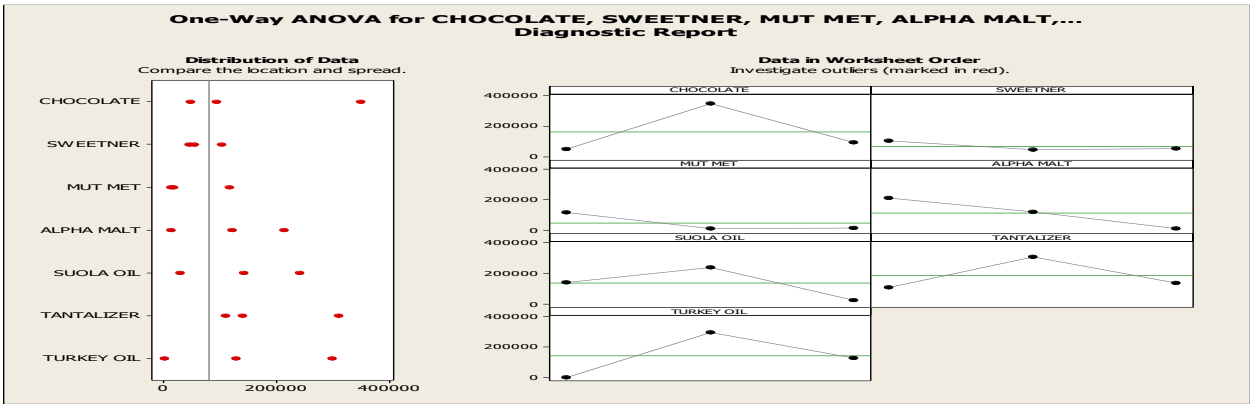


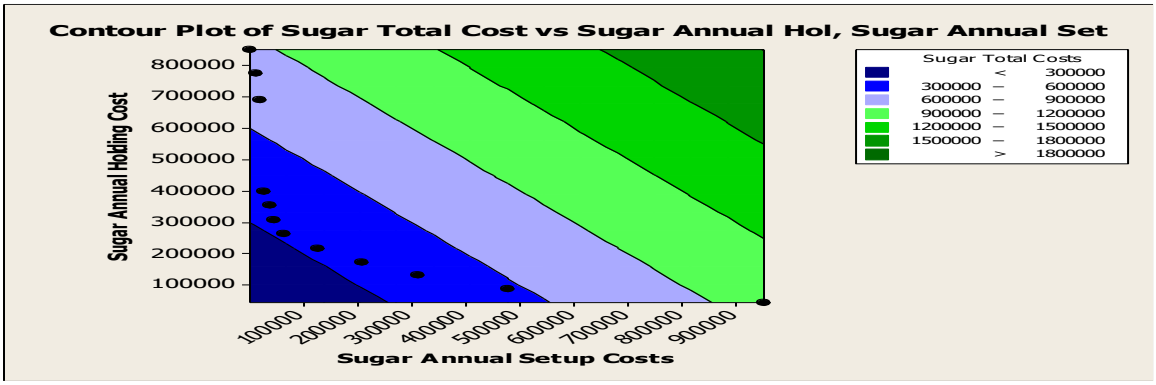
Figure 3.4 Diagnostic Report of One-Way ANOVA

One-way Analysis of Variance (ANOVA) reveals what the data portrays statistically, to understand the statistical results of variables and its implications using the data. In the case Company, the data collected were analyzed statistically using One-way ANOVA as shown in tables 3.1 and 3.2 and also in figures 3.1, 3.2 and 3.3 to study the variance in the case Company variables. From the results of the One-Way ANOVA analysis, it reveals the data mean, the standard deviations, mean square, sum of square, degree of freedom, sample size, individual confidence levels, coefficient of correlations of the data, diagnostic reports, power report and the probability value (p-value) of the data.

Data mean, standard deviation, mean square, sum of square, sample size and degree of freedom show the statistical analysis of every independent variable in the data. Coefficients of correlation of the data shows that the variables are 78.63% correlated. The probability value (p-value) of the data is highly significance with a probability value of 0.000. This significance result shows that the data collected for each of the variance (or variables) are highly significance in analysis of the inventory control system of the case Company. One-way diagnostic report reveals variables influence in the data and data distribution influence in inventory control system. Furthermore, one-way power report reveals variables differences that can be detected with the sample sizes. It also reveals the sample size, data mean, standard deviation and individual confidence levels. The data has 95% individual confidence level, which means that increase in sample size has 95% probability to fall within the estimated confidence levels of the data.

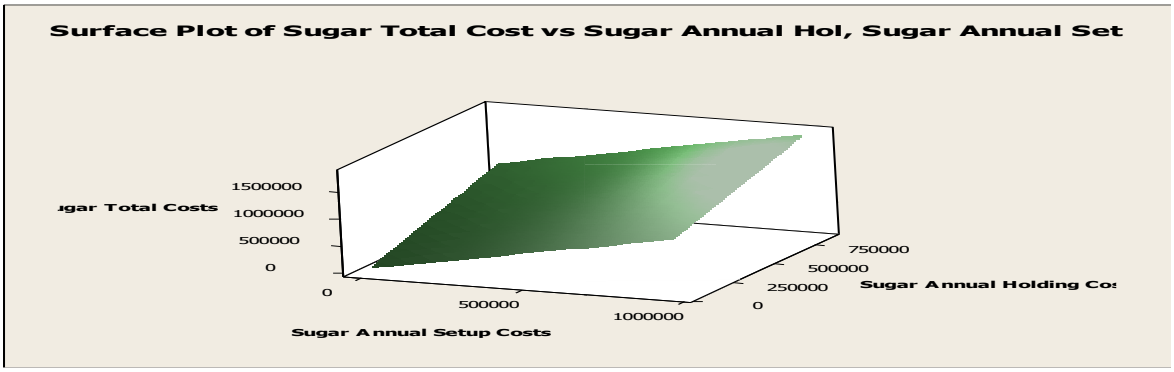
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Response Surface Analysis for Sugar Product



Contour Plot of Sugar Total Cost vs Sugar Annual Holding, Sugar Annual Setup Cost

The contour plot reveals the contour and the area of influence between the annual setup cost and annual holding costs to the total costs of Sugar product. It reveals the level of impact of the setup costs and holding costs in any particular areas within the collected data limits. The colors and the contour lines were used for the separation of the impact levels in the Sugar product.

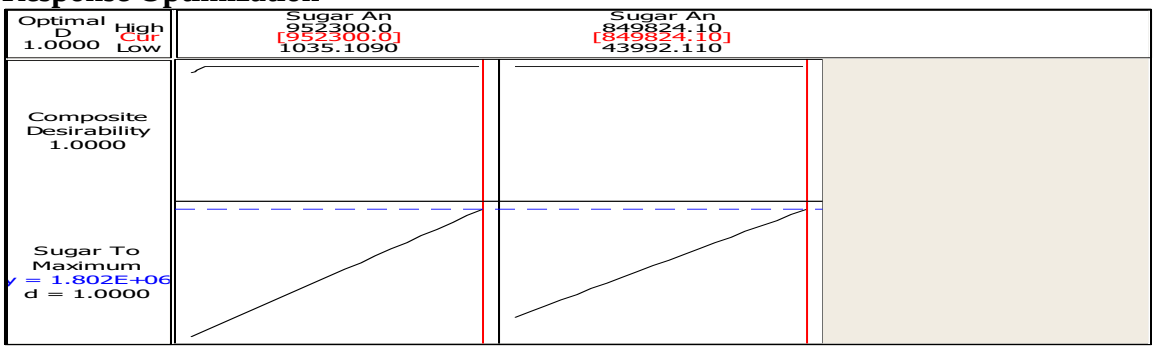


Surface Plot of Sugar Total Cost vs Sugar Annual Holding Cost, Sugar Annual Setup Cost

In surface plot analysis, it reveals the three-dimensional view of two factors variables and the response variable in the product. The plot investigates the effect of any two factor variables to the response variable. In sugar product, it reveals that the increase in annual holding costs increases the total costs. Furthermore, it also shows that the increase in the setup costs increases the total costs of the product. The surface plot does not hold any other factor or factors mean value because it has only two factors to respond.

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Response Optimization



Optimization Plot

The optimization plot was developed by using response surface experimental tool in design of expert. The optimization plot can reveal either the minimum, target or the maximum optimal value(s) of the system and the experiment. The plot reveals the current experimental factor variables, the optimal value response of the current factors and its composite desirability. From the optimization plot result, it shows the maximum optimal response value of ₦1,802,134 with an optimal desirability of 100%.

Conclusion

It has been shown that inventory management approaches from manufacturing organizations can be improved. Use of just-in - time inventory model allows the firm to reduce overhead expenses while ensuring that raw materials are available for manufacturing products. The analyses conducted on the data from the case study company have enabled the company to estimate how much of an item should be ordered and when it should be ordered. The company orders that optimal quantity for an item of stock that minimizes cost. The total inventory – associated cost curve has a minimum point and this is the point where total inventory costs have been successfully minimized.

Recommendations

The study recommends that the firm should focus on investing in an affordable, smart and effective inventory management software solution to help ensure that profitability is maintained and that the firm accurately keeps track of everything that it sells, when a certain item is either reaching overstock or under stock levels. The study also recommends adoption of lean inventory systems in inventory management as this will help in preventing stock outs, overstocking, deterioration, obsolescence and high carrying cost. The firm should make use of a sound inventory system for decision making in the procurement function.

REFERENCES

Mennell R.F (1961). "*Early history of the economical lot size*," APICS Quart. Bull., vol. 2, no. *2*, 1961, 14.

Moinzadeh, Kamran & Hau Lee (1989). "*Approximate Order Quantities and Reorder Points for Inventory Systems Where Orders Arrive in Two Shipments*." *Operations Research*, 37.l 1989, v37, n2 (1989): 277.

Morris C 1995. *Quantitative Approach in Business Studies*: London: Pitman Publisher. Nigeria Bottling Company. 2004. *Annual Report.*

Nahmias, Steven (2005). Production and operations analysis. McGraw Hill Higher Education.

Okudo, O. C. and Obumse, N.A. (2023). Adolescents' Appraisal of The Contributions of Parents Toward their Social Behaviour and Motor Skill Development in South Eastern States of Nigeria. *Sapientia Global Journal of Arts, Humanities and Development Studies (SGOJAHDS)*, 6 (1); 123 – 134.

Okudo, C.O. (2024). Influence of Parental Career on the Psychosocial Development of Secondary School Students in Awka South Local Government Area of Anambra State. *Sapientia Foundation Journal of Education, Sciences and Gender Studies;* 6(4) 161-166.

Okudo, O. C. (2021). Elements Of Psychological Adjustment Among Contemporary Nigerian Adolescents. *IMT International Journal of The Arts and Sciences, 4*(3), 88-109.

Peterson. & Silver. E.A (1977); "*Decision systems for inventory management and production planning.* New York: Wiley, Chapter 5.

Piasecki & Dave (2001). "*Optimizing economic order quantity*." IIE Solutions 33.1, 2001 30. Academic Search Elite. Web. 12 May. 2011. <http://search.ebscohost.com/login.aspx?direct=true&db=afh&AN=4770913&site=ehost-live>

PMI. (2008). A guide to a project management body of knowledge (4th. ed.). *The Project Management Institute*. Newton Square, PA: PMI Publications

Rajaniemi, J. (2012) *www.leadtimes.org* Lead Time Terminology in Manufacturing.

Roach (2005); "*Origin of the Economic Order Quantity formula; transcription or transformation? "*Management Decision 43.9 (2005): 1262-268. Emerald Group Publishing Limited. School of Business, Washburn University, Topeka, Kansas, USA, Bill.

SAXENA R. S. (1 December 2009). INVENTORY MANAGEMENT: Controlling in a Fluctuating Demand Environment. Global India Publications. pp. 24–. ISBN 978-93-8022-821-1. Retrieved 7 April 2012.

Stevenson, W. J. "Operations Management" PowerPoint slide 19, The McGraw-Hill Companies (2005).