



## A Multi-Level Factor Factorial Design for Solving Uncertainty Criteria in Establishing a Retail Business in Nigeria

U. P. Akra<sup>1\*</sup>, A. C. Etim<sup>2</sup>, A. I. Chiukpai<sup>3</sup>, U. J. Umondak<sup>4</sup>, E. E. Inyang<sup>5</sup>

<sup>1, 2</sup>Department of Statistics, Akwa Ibom State University, Ikot Akpaden

<sup>3</sup>Department of Vocational Education, University of Calabar

<sup>4</sup>Department of Basic Science, Federal College of Medical Laboratory Science and Technology, Jos

<sup>5</sup>Department of Statistics, School of Sciences, Maurid Polytechnic, Mbiase, Nsit Ibom, Akwa Ibom State

**Corresponding Author:** U. P. Akra ukemeakra@aksu.edu.ng

---

### ARTICLE INFO

*Keywords:* Retail, Business, Location, Advertisement, Factorial Design

*Received:* 19, December

*Revised:* 20, January

*Accepted:* 28, February

©2025 Akra, Etim, Chiukpai, Umondak, Inyang: This is an open-access article distributed under the terms of the

[Creative Commons Attribution 4.0 International](https://creativecommons.org/licenses/by/4.0/).



### ABSTRACT

In this paper, a multi-level factorial design is proposed to solve the uncertainty problem in establishing a retail business in Nigeria. A multiple-level linear model was set-up, and the model parameters and error component were estimated. Three independent factors; Location (L), Advertising campaign (A) and Day of work (D) were considered as the criteria each at different levels with a dependent factor (sales). A 3×4×6 design structure for factorial combinations of factor L, factor A, and factor D using a randomized complete block design with two replications was developed. A direct interview approach of probability sampling technique was used as an instrument for data collection. The result revealed that the independent variables (Location, Advertising campaign and Day of work) have high positive impact on the dependent variable (sales) for every retail business.

---

## **INTRODUCTION**

The assistance of microbusiness and macro business firm in an evidence-based economic system is very remarkable for the economic growth and development of a developing nation like Nigeria. The recent annual survey of Nigerian business owners and entrepreneurs revealed that one - quarter of businesses list is affected by hostile business environment which become a major impediment to the growth of their business. Other challenges are; high cost of business financing (lack of capital at affordable interest rates hinders the business growth in Nigeria), poor state of Infrastructure such as road network and electricity are the most challenging aspect that affect doing business in Nigeria which reduces the productivity of every business in the country (Aluko, 2014). These situations are presently being exasperated by the effect of nation growth and trade free-market capitalism, which make it hard for large business to contend local/home markets. On this premise, it's become more intimidating to an average or less average person to go into large business in Nigeria. Therefore, this paper aims to bring to a close door the necessary things to be considered before planning to establish a microbusiness such as a retail business in Nigeria.

According to Hamal et al (2023) Retail procedures become known as a major Area of study in recent years. Retail is one of the chains of distribution channels that play an important role in the delivery of good and services to the end customers. Retailing is an important economic sector that brings modification in markets.

The main factors needed for every retailer to be considered in a retailing business are location selection, pricing and promoting sales, market response, price matching and return policies, retailer - manufacturer interactions, day of work, retail branding, and customer satisfaction (Kamakura, Kopalle and Lehmann, 2014). This work placed emphasis on three principal factors namely location selection, price and promoting sales (advertising campaign) and day of work to elucidate how its effect a retail business in Nigeria. The location is an integral and crucial part of the retail strategy as it conveys a lot about its image. It also influences the merchandising mix and layout of the shop. Mendes and Themindo (2004) defined shop location as the physical space occupied and catchment area of a shop which experiences intense economic and commercial activities.

The location of a retail shop has a big impact on how visible to the public, how easy it is to navigate rush hour traffic and how much money could be made in the future (Turhan, Akahn and Zehir, 2013). Retail advertising is a marketing strategy focused on promoting products or services directly to consumers within a retail environment. It encompasses various advertising channels such as flyers, window displays (Television and Radio), point of sale materials, bill board displays and digital platforms. An effective retail advertising aims to enhance brand visibility, engage shoppers and boost overall revenue for the retailer (Srivastava, 2008)

## LITERATURE REVIEW

Several authors like (Onyeagwara, Agu and Aja, 2019; Okeke, 2020; Agarwal and Guirat, 2017; Igwe and Chukwu, 2016; Akekue-Alex and Kalu, 2016) have conducted a study on factors affecting consumer choice of retail shops from a consumer point of view. The 25 factorial designs to obtain optimal yield of carioaca papaya using various organic manure such as animal manure, green manure, mineral manure, compost manure and ash manure without replications in different block size were confounded (Akra and Bassey, 2017). Retail is any business that directs its marketing effort towards satisfying the final customer based upon the organization of selling goods and service as a mean of distribution (Gilbert, 2003). A retail business is also the sale of items and service in small quantities to customers in store or online. Grocery, Clothing, and drug stores are examples of retailing. Based on Vinod (2005) retailing is a very complex business.

Getting the right product to the right store with the right quantity at the right time with the right price at the lowest cost of delivery is a very challenging task. According to the price-based category, the most prominent types of retailing are discount stores, factory outlets, category killers, off-price stores, warehouse clubs and hypermarkets (Hameli, 2018). A retail store is a physical or virtual establishment where businesses offer a selection of products or services directly to consumers for purchase. Akra et al. (2024) explored mixed - level factorial experiment on different inorganic fertilizers such as Nitrogen (N), Phosphorous (P) and Potassium (K) to determine the main optimal effect and their interaction on the yield of crop. Retail business play an important role in the daily life of both young and old people in the society. It aids in supporting the growth of the country's economy by paying of taxes, provide people with jobs and reducing the level of unemployment.

To establish a retail business in Nigeria, the problem of where, and how to promote the business usually enclosed a retailer's mind which becomes the uncertainties that projected doubt whether or not to establish the business. Also, in view of the literature, a method to handle an independent variable at different level in accordance with the dependent variable in consonant with the subject matter have not been established in the previous works. To remedy this problem, a multi-level factorial design is proposed.

## METHODOLOGY

The material used is a direct interview of probability sampling technique for the purpose of data collection. Three factors considered are Shop Location (L), Advertising campaign (A) and Day of work (D). The locations are (Junctions, Streets and Major roads), Advertising campaign channels are (Television, Radio, Bill board and Flyer), and Days of work are (Monday-Saturday). The design was conducted with three levels of location, four levels of advertising campaign and six levels of days of work using a randomized complete block design (RCBD) with two replications which gives the total number of 144 observations. The design structure is presented in Table 1.

Table 1. The Design Structure for Three Levels of Location, Four Levels of Advertising Campaign and Six Levels of Day of Work Using RCBD

L	A	D					
		1	2	3	4	5	6
1	1	$l_1a_1d_1$	$l_1a_1d_2$	$l_1a_1d_3$	$l_1a_1d_4$	$l_1a_1d_5$	$l_1a_1d_6$
	2	$l_1a_2d_1$	$l_1a_2d_2$	$l_1a_2d_3$	$l_1a_2d_4$	$l_1a_2d_5$	$l_1a_2d_6$
	3	$l_1a_3d_1$	$l_1a_3d_2$	$l_1a_3d_3$	$l_1a_3d_4$	$l_1a_3d_5$	$l_1a_3d_6$
	4	$l_1a_4d_1$	$l_1a_4d_2$	$l_1a_4d_3$	$l_1a_4d_4$	$l_1a_4d_5$	$l_1a_4d_6$
2	1	$l_2a_1d_1$	$l_2a_1d_2$	$l_2a_1d_3$	$l_2a_1d_4$	$l_2a_1d_5$	$l_2a_1d_6$
	2	$l_2a_2d_1$	$l_2a_2d_2$	$l_2a_2d_3$	$l_2a_2d_4$	$l_2a_2d_5$	$l_2a_2d_6$
	3	$l_2a_3d_1$	$l_2a_3d_2$	$l_2a_3d_3$	$l_2a_3d_4$	$l_2a_3d_5$	$l_2a_3d_6$
	4	$l_2a_4d_1$	$l_2a_4d_2$	$l_2a_4d_3$	$l_2a_4d_4$	$l_2a_4d_5$	$l_2a_4d_6$
3	1	$l_3a_1d_1$	$l_3a_1d_2$	$l_3a_1d_3$	$l_3a_1d_4$	$l_3a_1d_5$	$l_3a_1d_6$
	2	$l_3a_2d_1$	$l_3a_2d_2$	$l_3a_2d_3$	$l_3a_2d_4$	$l_3a_2d_5$	$l_3a_2d_6$
	3	$l_3a_3d_1$	$l_3a_3d_2$	$l_3a_3d_3$	$l_3a_3d_4$	$l_3a_3d_5$	$l_3a_3d_6$
	4	$l_3a_4d_1$	$l_3a_4d_2$	$l_3a_4d_3$	$l_3a_4d_4$	$l_3a_4d_5$	$l_3a_4d_6$

**Multiple Linear Models for Three-Factor Factorial Design**

A 3×4×6 design structure model for factorial combinations of factor L, factor A, and factor D is given as;

$$S_{ijkv} = \mu + L_i + A_j + D_k + (LA)_{ij} + (LD)_{ik} + (AD)_{jk} + (LAD)_{ijk} + \ell_{ijkv} \begin{cases} i=1, 2, \dots, l \\ j=1, 2, \dots, a \\ k=1, 2, \dots, d \\ v=1, 2, \dots, r \end{cases}$$

Where  $S_{ijkv}$  is the observation corresponding to the  $i^{th}$  level of factor L,  $j^{th}$  level of factor A and  $k^{th}$  level of factor D in  $v^{th}$  replication,  $L_i = i^{th}$  level effect of factor L,  $A_j = j^{th}$  level effect of factor A,  $D_k = k^{th}$  level effect of factor D,  $(LA)_{ij} = i^{th}$  and  $j^{th}$  levels of factor L × A interaction,  $(LD)_{ik} = i^{th}$  and  $k^{th}$  levels of factor L × D interaction,  $(AD)_{jk} = j^{th}$  and  $k^{th}$  levels of factor A × D interaction,  $(LAD)_{ijk} = i^{th}$ ,  $j^{th}$  and  $k^{th}$  levels of factor L × A × D interaction and  $\ell_{ijkl} =$  random error term.

**Estimation of Model Parameters for Main and Interactions Effect**

To estimate the parameters in the model, least squares method is explored with the following assumptions.

(i)  $\sum_{i=1}^l L_i = \sum_{j=1}^a A_j = \sum_{k=1}^d D_k = 0$  (ii)  $\sum_{ij=1}^{la} LA_{ij} = \sum_{ik=1}^{ld} AD_{ik} = \sum_{jk=1}^{ad} AD_{jk} = 0$  (iii)

$$\sum_{ijk=1}^{lad} LAD_{ijk} = 0$$

From equation (1), we obtained;

$$\sum_{i=1}^l \sum_{j=1}^a \sum_{k=1}^d \sum_{v=1}^r \ell_{ijkv}^2 = \sum_{i=1}^l \sum_{j=1}^a \sum_{k=1}^d \sum_{v=1}^r (S_{ijkv} - \mu - L_i - A_j - D_k - (LA)_{ij} - (LD)_{ik} - (AD)_{jk} - (LAD)_{ijk})^2$$

Let  $\sum_{i=1}^l \sum_{j=1}^a \sum_{k=1}^d \sum_{v=1}^r \ell_{ijkv}^2 = H$ , then

$$H = \sum_{i=1}^l \sum_{j=1}^a \sum_{k=1}^d \sum_{v=1}^r \left( S_{ijkv} - \mu - L_i - A_j - D_k - (LA)_{ij} - (LD)_{ik} - (AD)_{jk} - (LAD)_{ijk} \right)^2$$

Differentiating (2) partially w. r .t and equating them to zero, we have;

$$\frac{\partial H}{\partial \mu} = -2 \sum_{i=1}^l \sum_{j=1}^a \sum_{k=1}^d \sum_{v=1}^r \left( S_{ijkv} - \mu - L_i - A_j - D_k - (LA)_{ij} - (LD)_{ik} - (AD)_{jk} - (LAD)_{ijk} \right) = 0$$

$$\Rightarrow \sum_{ijkv=1}^{ladr} S_{ijkv} - ladr\mu - adr \sum_i L_i - ldr \sum_j A_j - lar \sum_k D_k - dr \sum_{ij} LA_{ij} - ar \sum_{ik} LD_{ik} - lr \sum_{jk} AD_{jk} - r \sum_{ijk} LAD_{ijk} = 0$$

$$\sum_{ijkv=1}^{ladr} S_{ijkv} - ladr\mu = 0 \Rightarrow \hat{\mu} = \frac{\sum_{ijkv=1}^{ladr} S_{ijkv}}{ladr} \quad (\text{By the above assumptions})$$

$$\frac{\partial H}{\partial L_i} = -2 \sum_{j=1}^a \sum_{k=1}^d \sum_{v=1}^r \left( S_{ijkv} - \mu - L_i - A_j - D_k - (LA)_{ij} - (LD)_{ik} - (AD)_{jk} - (LAD)_{ijk} \right) = 0$$

$$\Rightarrow \sum_{i=1}^l S_{i...} - adr\mu - adrL_i - dr \sum_j A_j - ar \sum_k D_k - dr \sum_{ij} LA_{ij} - ar \sum_{ik} LD_{ik} - r \sum_{jk} AD_{jk} - r \sum_{ijk} LAD_{ijk} = 0$$

$$\sum_{i=1}^l S_{i...} - adr\mu = adrL_i \Rightarrow \hat{L}_i = \frac{\sum_{i=1}^l S_{i...}}{adr} - \hat{\mu}$$

$$\frac{\partial H}{\partial A_j} = -2 \sum_{i=1}^l \sum_{k=1}^d \sum_{v=1}^r \left( S_{ijkv} - \mu - L_i - A_j - D_k - (LA)_{ij} - (LD)_{ik} - (AD)_{jk} - (LAD)_{ijk} \right) = 0$$

$$\Rightarrow \sum_{j=1}^a S_{.j..} - ldr\mu - dr \sum_i L_i - ldrA_j - lr \sum_k D_k - dr \sum_{ij} LA_{ij} - r \sum_{ik} LD_{ik} - lr \sum_{jk} AD_{jk} - r \sum_{ijk} LAD_{ijk} = 0$$

$$ldrA_j = \sum_{j=1}^a S_{.j..} - ldr\mu \Rightarrow \hat{A}_j = \frac{\sum_{j=1}^a S_{.j..}}{ldr} - \hat{\mu}$$

$$\frac{\partial H}{\partial D_k} = -2 \sum_{i=1}^l \sum_{j=1}^a \sum_{v=1}^r \left( S_{ijkv} - \mu - L_i - A_j - D_k - (LA)_{ij} - (LD)_{ik} - (AD)_{jk} - (LAD)_{ijk} \right) = 0$$

$$\Rightarrow \sum_{k=1}^d S_{.k.} - lar\mu - ar \sum_i L_i - lr \sum_j A_j - larD_k - r \sum_{ij} LA_{ij} - ar \sum_{ik} LD_{ik} - lr \sum_{jk} AD_{jk} - r \sum_{ijk} LAD_{ijk} = 0$$

$$larD_k = \sum_{k=1}^d S_{.k.} - lar\mu \Rightarrow \hat{D}_k = \frac{\sum_{k=1}^d S_{.k.}}{lar} - \mu$$

$$\frac{\partial H}{\partial LA_{ij}} = -2 \sum_{k=1}^d \sum_{v=1}^r \left( S_{ijkv...} - \mu - L_i - A_j - D_k - (LA)_{ij} - (LD)_{ik} - (AD)_{jk} - (LAD)_{ijk} \right) = 0$$

$$\Rightarrow \sum_{i=1}^l \sum_{j=1}^a S_{ij..} - dr\mu - drL_i - drA_j - r \sum_k D_k - drLA_{ij} - r \sum_{ik} LD_{ik} - r \sum_{jk} AD_{jk} - r \sum_{ijk} LAD_{ijk} = 0$$

$$L\hat{A}_{ij} = \sum_{i=1}^l \sum_{j=1}^a S_{ij..} - dr\mu - drL_i - drA_j \Rightarrow L\hat{A}_{ij} = \frac{\sum_{i=1}^l \sum_{j=1}^a S_{ij..}}{dr} - \hat{\mu} - \hat{L}_i - \hat{A}_j$$

$$\frac{\partial H}{\partial LD_{ij}} = -2 \sum_{j=1}^a \sum_{v=1}^r (S_{ijkv} - \mu - L_i - A_j - D_k - (LA)_{ij} - (LD)_{ik} - (AD)_{jk} - (LAD)_{ijk}) = 0$$

$$\sum_{j=1}^a \sum_{v=1}^r S_{i.k.} - ar\mu - arL_i - r \sum_j A_j - arD_k - dr \sum_{ij} LA_{ij} - arLD_{ik} - r \sum_{jk} AD_{jk} - r \sum_{ijk} LAD_{ijk} = 0$$

$$\hat{L}\hat{D}_{ik} = \sum_{j=1}^a \sum_{v=1}^r S_{i.k.} - ar\hat{\mu} - ar\hat{L}_i - ar\hat{D}_k \Rightarrow \hat{L}\hat{D}_{ik} = \frac{\sum_{j=1}^a \sum_{v=1}^r S_{i.k.}}{ar} - \hat{\mu} - \hat{L}_i - \hat{D}_k$$

$$\frac{\partial H}{\partial AD_{jk}} = -2 \sum_{i=1}^l \sum_{v=1}^r (S_{ijkv} - \mu - L_i - A_j - D_k - (LA)_{ij} - (LD)_{ik} - (AD)_{jk} - (LAD)_{ijk}) = 0$$

$$\sum_{i=1}^l \sum_{v=1}^r S_{.jk.} - lr\mu - r \sum_i L_i - lrA_j - lrD_k - dr \sum_{ij} LA_{ij} - r \sum_{ik} LD_{ik} - lrAD_{jk} - r \sum_{ijk} LAD_{ijk} = 0$$

$$lrAD_{jk} = \sum_{i=1}^l \sum_{v=1}^r S_{.jk.} - lr\mu - lrA_j - lrD_k \Rightarrow \hat{A}\hat{D} = \frac{\sum_{j=1}^a \sum_{k=1}^d S_{.jk.}}{lr} - \hat{\mu} - \hat{A}_j - \hat{D}_k$$

$$\frac{\partial H}{\partial LAD_{ijk}} = -2 \sum_{v=1}^r (S_{ijkv} - \mu - L_i - A_j - D_k - (LA)_{ij} - (LD)_{ik} - (AD)_{jk} - (LAD)_{ijk}) = 0$$

$$\sum_{i=1}^l \sum_{j=1}^a \sum_{k=1}^d S_{ijk.} - r\mu - rL_i - rA_j - rD_k - rLA_{ij} - rLD_{ik} - rAD_{jk} - rLAD_{ijk} = 0$$

$$rLAD_{ijk} = \sum_{i=1}^l \sum_{j=1}^a \sum_{k=1}^d S_{ijk.} - r\mu - rL_i - rA_j - rD_k - rLA_{ij} - rLD_{ik} - rAD_{jk}$$

$$\Rightarrow \hat{L}\hat{A}\hat{D}_{ijk} = \frac{1}{r} \sum_{i=1}^l \sum_{j=1}^a \sum_{k=1}^d S_{ijk.} - \hat{\mu} - \hat{L}_i - \hat{A}_j - \hat{D}_k - \hat{L}\hat{A}_{ij} - \hat{L}\hat{D}_{ik} - \hat{A}\hat{D}_{jk}$$

### Estimation of Error Component

The partition total sum of squares is used to estimate error component. From equation (1), the error component can be estimated as;

$$\hat{\ell}_{ijkv} = S_{ijkv} - \hat{\mu} - \hat{L}_i - \hat{A}_j - \hat{D}_k - (\hat{L}\hat{A})_{ij} - (\hat{L}\hat{D})_{ik} - (\hat{A}\hat{D})_{jk} - (\hat{L}\hat{A}\hat{D})_{ijk}$$

Substitute equation (4), (6), (8), (10), (12), (14), (16), (18) into (19), gives:

$$\hat{\ell}_{ijkv} = \sum_{i=1}^l \sum_{j=1}^a \sum_{k=1}^d \sum_{v=1}^r S_{ijkv} - \hat{\mu} - \left( \frac{\sum_{i=1}^l S_{i...}}{adr} - \hat{\mu} \right) - \left( \frac{\sum_{j=1}^a S_{.j..}}{ldr} - \hat{\mu} \right) - \left( \frac{\sum_{k=1}^d S_{.k.}}{lar} - \hat{\mu} \right) -$$

$$\left( \frac{\sum_{i=1}^l \sum_{j=1}^a S_{ij..}}{dr} - \hat{\mu} - \hat{L}_i - \hat{A}_j \right) - \left( \frac{\sum_{i=1}^l \sum_{k=1}^d S_{i.k.}}{ar} - \hat{\mu} - \hat{L}_i - \hat{D}_k \right) - \left( \frac{\sum_{i=1}^l \sum_{v=1}^r S_{.jk.}}{lr} - \hat{\mu} - \hat{A}_j - \hat{D}_k \right) -$$

$$\begin{aligned}
 & \left( \frac{1}{r} \sum_{i=1}^l \sum_{j=1}^a \sum_{k=1}^d S_{ijk} - \hat{\mu} - \hat{L}_i - \hat{A}_j - \hat{D}_k - \hat{L}\hat{A}_{ij} - \hat{L}\hat{D}_{ik} - \hat{A}\hat{D}_{jk} \right) \\
 &= \sum_{i=1}^l \sum_{j=1}^a \sum_{k=1}^d \sum_{v=1}^r S_{ijkv} - \frac{\sum_{i=1}^l S_{i...}}{adr} - \frac{\sum_{j=1}^a S_{.j..}}{ldr} - \frac{\sum_{k=1}^d S_{.k.}}{lar} - \frac{\sum_{i=1}^l \sum_{j=1}^a S_{ij..}}{dr} - \frac{\sum_{i=1}^l \sum_{k=1}^d S_{i.k.}}{ar} - \frac{\sum_{i=1}^l \sum_{v=1}^r S_{.jk.}}{lr} \\
 & \frac{1}{r} \sum_{i=1}^l \sum_{j=1}^a \sum_{k=1}^d S_{ijk} + 6\hat{\mu} + 3L_i + 3\hat{A}_j + 3\hat{D}_k + \hat{L}\hat{A}_{ij} + \hat{L}\hat{D}_{ik} + \hat{A}\hat{D}_{jk} \\
 &= \sum_{i=1}^l \sum_{j=1}^a \sum_{k=1}^d \sum_{v=1}^r S_{ijkv} - \frac{\sum_{i=1}^l S_{i...}}{adr} - \frac{\sum_{j=1}^a S_{.j..}}{ldr} - \frac{\sum_{k=1}^d S_{.k.}}{lar} - \frac{\sum_{i=1}^l \sum_{j=1}^a S_{ij..}}{dr} - \frac{\sum_{i=1}^l \sum_{k=1}^d S_{i.k.}}{ar} - \frac{\sum_{i=1}^l \sum_{v=1}^r S_{.jk.}}{lr} \\
 & \frac{1}{r} \sum_{i=1}^l \sum_{j=1}^a \sum_{k=1}^d S_{ijk} + 6\hat{\mu} + 3 \left( \frac{\sum_{i=1}^l S_{i...}}{adr} - \hat{\mu} \right) + 3 \left( \frac{\sum_{j=1}^a S_{.j..}}{ldr} - \hat{\mu} \right) + 3 \left( \frac{\sum_{k=1}^d S_{.k.}}{lar} - \hat{\mu} \right) + \\
 & \left( \frac{\sum_{i=1}^l \sum_{j=1}^a S_{ij..}}{dr} - \hat{\mu} - \hat{L}_i - \hat{A}_j \right) + \left( \frac{\sum_{i=1}^l \sum_{k=1}^d S_{i.k.}}{ar} - \hat{\mu} - \hat{L}_i - \hat{D}_k \right) + \left( \frac{\sum_{i=1}^l \sum_{v=1}^r S_{.jk.}}{lr} - \hat{\mu} - \hat{A}_j - \hat{D}_k \right) \\
 &= \sum_{i=1}^l \sum_{j=1}^a \sum_{k=1}^d \sum_{v=1}^r S_{ijkv} - \frac{\sum_{i=1}^l S_{i...}}{adr} - \frac{\sum_{j=1}^a S_{.j..}}{ldr} - \frac{\sum_{k=1}^d S_{.k.}}{lar} - \frac{\sum_{i=1}^l \sum_{j=1}^a S_{ij..}}{dr} - \frac{\sum_{i=1}^l \sum_{k=1}^d S_{i.k.}}{ar} \\
 & - \frac{\sum_{i=1}^l \sum_{v=1}^r S_{.jk.}}{lr} \\
 & \frac{1}{r} \sum_{i=1}^l \sum_{j=1}^a \sum_{k=1}^d S_{ijk} + 6\hat{\mu} - 6\hat{\mu} + 3 \frac{\sum_{i=1}^l S_{i...}}{adr} + 3 \frac{\sum_{j=1}^a S_{.j..}}{ldr} + 3 \frac{\sum_{k=1}^d S_{.k.}}{lar} + \frac{\sum_{i=1}^l \sum_{j=1}^a S_{ij..}}{dr} - 2 \frac{\sum_{i=1}^l S_{i...}}{adr} \\
 & + \frac{\sum_{i=1}^l \sum_{k=1}^d S_{i.k.}}{ar} - 2 \frac{\sum_{j=1}^a S_{.j..}}{ldr} + \frac{\sum_{i=1}^l \sum_{v=1}^r S_{.jk.}}{lr} - 2 \frac{\sum_{k=1}^d S_{.k.}}{lar} \\
 &= \sum_{i=1}^l \sum_{j=1}^a \sum_{k=1}^d \sum_{v=1}^r S_{ijkv} - \frac{1}{r} \sum_{i=1}^l \sum_{j=1}^a \sum_{k=1}^d S_{ijk}
 \end{aligned}$$

### Sums of Squares for the 3×4×6 Design

The computing formulas for the sums of squares are given below;

(1) Total sum of squares for the three factor is obtained as;

$$SS_T = \sum_{i=1}^l \sum_{j=1}^a \sum_{k=1}^d \sum_{v=1}^r S_{ijkv}^2 - \frac{S_{....}^2}{ladr}$$

The sum of squares for main effects are found from the totals for factors  $L(S_{i...})$ ,  $A(S_{.j..})$  and  $D(S_{..k.})$  as follows;

$$SS_L = \frac{1}{adr} \sum_{i=1}^l S_{i...}^2 - \frac{S^2}{ladr}$$

$$SS_A = \frac{1}{ldr} \sum_{j=1}^a S_{.j..}^2 - \frac{S^2}{ladr}$$

$$SS_D = \frac{1}{lar} \sum_{k=1}^d S_{..k.}^2 - \frac{S^2}{ladr}$$

Two factor interaction sums of squares for location and advertising campaign ( $L \times A$ ), location and day of work ( $L \times D$ ) and advertising campaign and day of work ( $A \times D$ ) are given as:

$$SS_{LA} = \frac{1}{dr} \sum_{i=1}^l \sum_{j=1}^a S_{ij..}^2 - \frac{S^2}{ladr} - SS_L - SS_A \Rightarrow SS_{Subtotal} - SS_L - SS_A$$

$$SS_{LD} = \frac{1}{ar} \sum_{i=1}^l \sum_{k=1}^d S_{i..k.}^2 - \frac{S^2}{ladr} - SS_L - SS_D \Rightarrow SS_{Subtotal} - SS_L - SS_D$$

$$SS_{AD} = \frac{1}{lr} \sum_{j=1}^a \sum_{k=1}^d S_{.jk.}^2 - \frac{S^2}{ladr} - SS_A - SS_D \Rightarrow SS_{Subtotal} - SS_A - SS_D$$

The three-factor interaction sum of squares of location, advertising campaign and day of work is computed from the three-way cell totals ( $S_{ijk.}$ ) as:

$$SS_{LAD} = \sum_{i=1}^l \sum_{j=1}^a \sum_{k=1}^d S_{ijk.}^2 - \frac{S^2}{ladr} - SS_L - SS_A - SS_D - SS_{LA} - SS_{LD} - SS_{AD}$$

The general ANOVA Table illustrating the three - factor factorial design is given in Table 2:

Table 2. ANOVA Table for a Three-Factor Factorial Design with r-Replicates

S/V	df	SS	MS	F - ratio
Block	$r - 1$	$SS_{rep}$	$\frac{MS_{rep}}{r - 1}$	$\frac{MS_{rep}}{MS_E}$
Treatment				
L	$l - 1$	$SS_L$	$\frac{MS_L}{l - 1}$	$\frac{MS_L}{MS_E}$
A	$a - 1$	$SS_A$	$\frac{MS_A}{a - 1}$	$\frac{MS_A}{MS_E}$
D	$d - 1$	$SS_D$	$\frac{MS_D}{d - 1}$	$\frac{MS_D}{MS_E}$
LA	$(l - 1)(a - 1)$	$SS_{LA}$	$\frac{MS_{LA}}{(l - 1)(a - 1)}$	$\frac{MS_{LA}}{MS_E}$
LD	$(l - 1)(d - 1)$	$SS_{LD}$	$\frac{MS_{LD}}{(l - 1)(d - 1)}$	$\frac{MS_{LD}}{MS_E}$
AD	$(a - 1)(d - 1)$	$SS_{AD}$	$\frac{MS_{AD}}{(a - 1)(d - 1)}$	$\frac{MS_{AD}}{MS_E}$

<i>LAD</i>	$(l-1)(a-1)(d-1)$	$SS_{LAD}$	$\frac{MS_{LAD}}{(l-1)(a-1)(d-1)}$	$\frac{MS_{LAD}}{MS_E}$
Error	$lad(r-1)$	$SS_E$	$\frac{MS_E}{lad(r-1)}$	
Total	$ladr-1$	$SS_T$		

**RESULT AND DISCUSSION**

The data obtained from the design in section 2 is recorded in Table 3 and the full analysis is presented in Table 4. The two Figures (1) and (2) below is the demonstration of how the main factors and their interactions affect the response variable (sales).

Table 3. Data Arrangement for Factor Levels Design

Treatments		Replications (blocks)		
L	A D	I	II	
1	1	1	2	4
		2	7	6
		3	9	9
		4	3	3
		5	6	4
		6	8	8
	2	1	9	9
		2	4	3
		3	6	4
		4	5	2
		5	7	7
		6	8	4
	3	1	11	9
		2	13	12
		3	14	17
		4	8	12
		5	8	8
		6	9	7
	4	1	18	16
		2	9	14
		3	8	10
		4	14	11
		5	16	13
		6	12	11
1	1	4	2	
	2	6	7	
	3	9	9	
	4	3	3	
	5	4	6	

2	2	6	8	8
		1	9	9
		2	3	4
		3	4	6
		4	2	5
		5	7	7
	6	4	8	
	3	1	9	11
		2	12	13
		3	17	14
		4	12	8
		5	8	8
		6	7	9
	4	1	16	18
		2	14	9
		3	10	8
		4	11	14
		5	13	16
6		11	12	
3	1	1	3	5
		2	5	4
		3	4	3
		4	5	2
		5	3	5
		6	2	3
	2	1	6	4
		2	3	6
		3	4	3
		4	7	8
		5	8	7
		6	7	7
	3	1	11	14
		2	10	11
		3	14	10
		4	16	7
		5	11	16
		6	7	11
	4	1	16	9
		2	12	10
		3	9	16
		4	10	12
		5	10	14
		6	14	10

Table 4. General Analysis of 3x4x6 Variance of Design

Source Value	DF	Adj SS	AdjMS	F-Value	P-Value
Model	72	2274.89	31.596	17.95	0.000
Blocks	1	0.00	0.000	0.00	1.000
Linear	10	1529.24	152.924	86.86	0.000
L	2	7.35	3.674	2.09	0.032
A	3	1464.33	488.111	277.25	0.000
D	5	57.56	11.511	6.54	0.000
2-Way Interactions	31	681.94	21.998	12.49	0.000
L*A	6	38.71	6.451	3.66	0.003
L*D	10	17.24	1.724	0.98	0.049
A*D	15	626.00	41.733	23.70	0.000
3-Way Interactions	30	63.71	2.124	1.21	0.256
L*A*D	30	63.71	2.124	1.21	0.256
Error	71	125.00	1.761		
Total	143	2399.89			

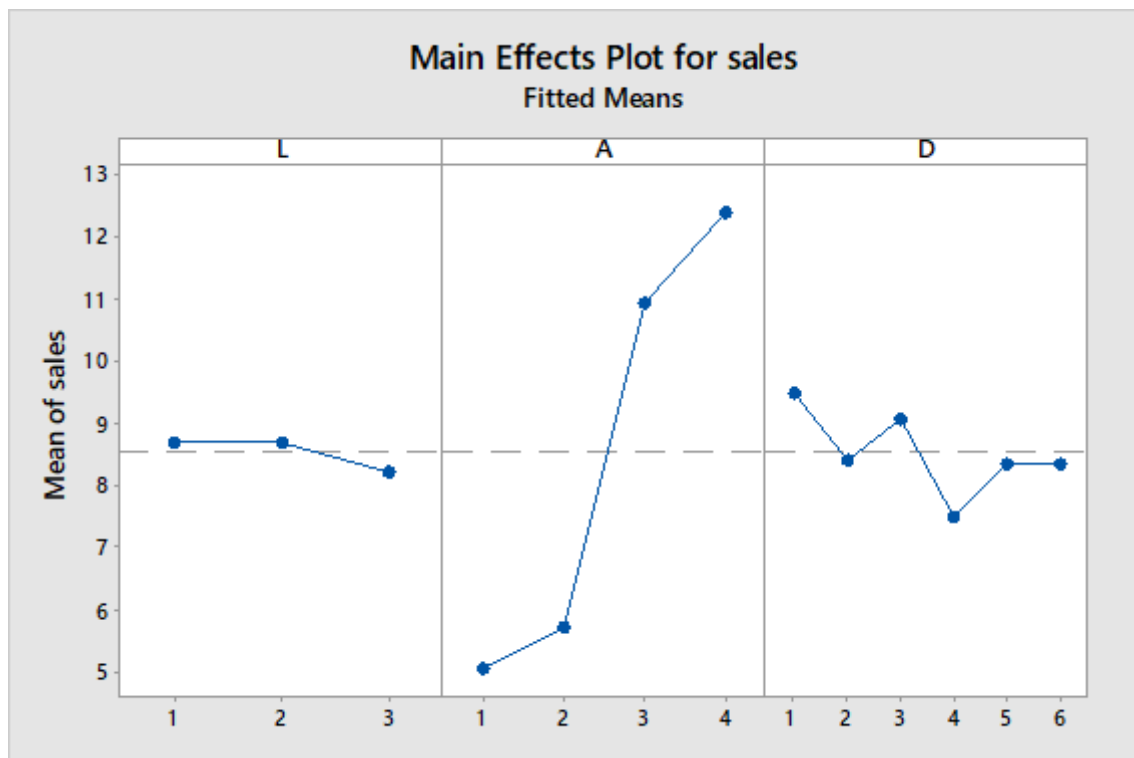


Figure 1. Showed the Effect of the Factors on the Response Variable (Sales)

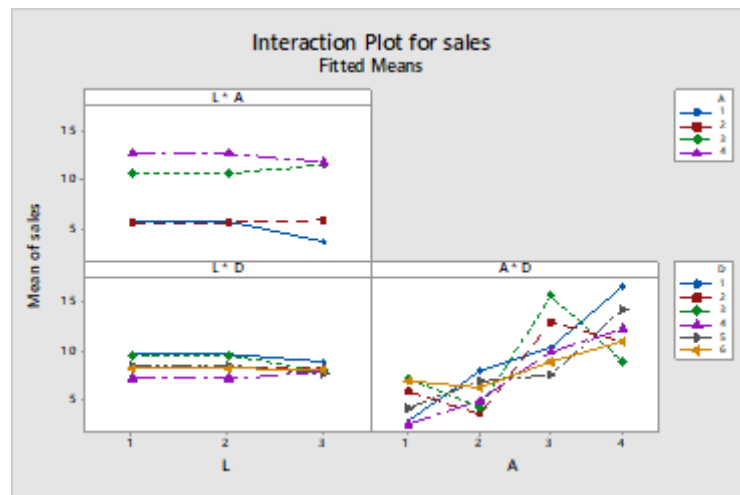


Figure 2. Showed the Interactions Effect on the Response Variable (Sales)

Based on the results obtained in Table 4 at 5% level of significance, the main effects are significant implying that location, advertising campaign and day of work have positive effect on sales for every retail business. The results for factorial components revealed that the three-factor interaction effect are also significant which is evidence that the variables play an important role for the growth of any retail business. The R-value of 0.974 indicate a strong positive correlation between the independent variables. Thus, the variables showed a non-negative impact on the sales. Result of Figure 1, revealed that retail shop business at the junction prompt more sales than other two locations (Streets and Major Road). Sharing of flyers as one of the moods of advertising campaign is found to be the most useful tool that promote sales and provide a rapid growth to a retail business than the other three campaigning units because of the cost involved. Result also revealed that Mondays is the most valuable day all business personnel consider more important not to be absent from their businesses. Hence, among the three independent variables, advertising campaign is more significant that it should not be underestimated in opening a retail shop business and other businesses. Figure 2, is the variables visualization for interaction which showed that the factors are interacted. The finding is consistent with the finding by Ogbunankwor and Madumere (2023) which studied the influence of store location, customer service and product quality on consumer choice of retail shops. Finding also revealed that shop location has a significant influence on consumer choice of retail shops, which is consistent with the findings by (Iloamaeke et al, 2022; Panda, 2013; Zameer and Mukherjee, 2011; Iton and Ewan, 2016).

## CONCLUSIONS AND RECOMMENDATIONS

Factors considered in this research are necessary if not sufficient conditions to be checked before venturing into a retail shop business especially in Nigeria. According to the finding, the selected independent variables (location, advertising campaign and day of work) contribute immensely to promote the growth of the dependent variable (sale). Result showed that establishing a retail business at the junction prompt more sales than other

locations, sharing of flyers as an advertising campaign reduces cost and found to be the most useful tool that promote sales and the inflow of sales are high on Mondays. Hence, based on the non-negative correlation impact of the three factors, we recommended that the variables should be a priority to every retailer before planning a retail business especially in Nigeria.

### **FURTHER RESEARCH**

This research still has limitations so further research is still needed on this proposed method.

### **REFERENCES**

- Agarwal, S., and Guirat, R. B. (2017). An empirical study of various factors influencing the behaviour of consumers towards fast food joints in Indian markets. *Independent Journal of Management and Production*, 8(4): 1341-1364. <https://doi.org/10.14807/ijmp.v8i4.657>
- Akekue-Alex, N., and Kalu, S. E. (2016). Positioning strategies and customer patronage of fast-food firms in Port v Harcourt, Nigeria. *European Journal of Business and Management*, 8(36): 63-74. <https://doi.org/10.7176/EJBM>.
- Akra, U. P.; E. E. Bassey; A. C. Etim; U. J. Umondak; A. I. Chiukpai and U. A. Akpan. (2024), A Mixed-level Factorial Experiment to Elucidate the Impact of Inorganic Fertilizers on Crop Yield. *Research Journal of Agricultural Economics and Development* 3(1): 61-73.  
<https://doi.org/10.52589/RJAED-MLJYW3AX>
- Akra, U. P., and Bassey, E. E. (2017). Confounding 2K Factorial Design to Obtain Optimal yields using Different Organic Manure. *Journal of Scientific and Engineering Research*, 4(11); 75-85.
- Aluko, N. (2014). The main challenges of doing business in Nigeria. *Kpakpakpa*, <https://kpakpakpa.com/doing-business-in-nigeria>
- Gilbert, D. (2003). *Retail Marketing Management*. Financial Times Practice Hall, Harlow.
- Hameli, K. (2018). A Literature Review of Retailing Sector and Business Retailing Types. *ILIRIA International Review – Vol 8, No 1*. Felix-Verlag, Holzkirchen, Germany and Iliria College, Pristina, Kosovo.
- Hamal, V.; Y. Maheshwari and R. Solanki. (2023). A Research Paper on Study of Retail Store Management. *International Research Journal of Modernization in Engineering Technology and Science*, 5 (1): 1 - 7.
- Kamakura, W.; P. K. Kopalle and D. R. Lehmann (2014). Empirical Generalization in Retailing. In: *Journal of Retailing*, 90 (2): 121 - 124.

- Igwe, S. R., and Chukwu, G. C. (2016). Demographic variables and retail choice pattern amongst urban Nigerian consumers. *Journal of Asian Business Strategy, Asian Economic and Social Society*, 6(6): 125-135.
- Iloamaeke, N.C.; I. C. Nwaizugbo and C. E. Ogbunankwor. (2022). Application of the attribution theory to consumers' choice of retail outlets in a Nigerian setting. *European Journal of Business and Innovation Research*, 10(4): 54-73. <https://doi.org/10.37745/ejbir.2013/vol10no4pp.54-73>.
- Iton, C.W. A., and Ewan, S. (2016). Traditional retail outlet or supermarket: A probit analysis of shoppers in Trinidad and Tobago. *Applied Studies in Agribusiness and Commerce*, 10(4-5): 69-76.
- Mendes, R., and Themindo, C. J. (2004). *Retail Locations as a Competitive Strategy*. Pearson Education, New Dehli.
- Ogbunankwor, C. E., and Madumere, H. I. (2023). Retailers' Perceptions of Consumer Choice of Retail Outlets: A Test of Three Attributes. *European Journal of Logistics, Purchasing and Supply Chain Management*, 11(3): 27 - 49. <https://doi.org/10.37745/ejlp SCM.2013/vol11n32749>.
- Okeke, L. N. (2020). Determinants of customers' choice of retail outlets in South-East, Nigeria. *International Journal of Business & Law Research*, 8(1): 22-32.
- Onyeagwara, C. A.; G. A. Agu, and E. E. Aja. (2019). Predictors of consumers' choice of buying outlets in Imo and Abia States Nigeria. *Archives of Business Research*, 7 (3.2): 34-48. <https://doi.org/10.14738/abr.73.2.636>.
- Panda, A. (2013). Customer patronage toward food and grocery retail: A case study. *Global Journal of Management and Business Studies*, 3(9): 955-960.
- Srivastava, R. K. (2008). Changing retail Science in India. *International Journal of Retail and Distribution Management*, 36 (9): 714-721.
- Turhan, G.; Akalm M., and Zehhir, C. (2013). Literature Review on Selection Criteria of Store Location Based on Performance Measures, *Procedia-Social and Behavioural Sciences*, 99: 391 - 402.
- Vinod, B. (2005). Practice Papers: Retail revenue management and the new paradigm of merchandise optimization. *Journal of Revenue Pricing management*, 3(4): 358 - 368.
- Zameer, A., and Mukherjee, D. (2011). Food and grocery retail: Patronage behaviour of Indian urban consumers. *South Asian Journal of Management*, 18 (1): 119-149.