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# Parking Fare Modelling of an Off -Street Parking Facility

Auwal Alhassan Musa<sup>1</sup>, Ibrahim Zakariyya Musa<sup>2</sup>, Yahaya Hassan Labaran<sup>3</sup>, Rabilu Ado<sup>4</sup>, Kabiru Abdullahi Farouk<sup>5</sup>

<sup>1</sup>Post Graduate Research Scholar, Civil Engineering Department, Mewar University, Chittorgarh, Rajasthan, India

<sup>2</sup>Post Graduate Research Scholar, Mathematics Department, Mewar University, Chittorgarh, Rajasthan, India

<sup>3</sup>Post Graduate Research Scholar, Civil Engineering Department, Sharda University, greater Noida, India

<sup>4</sup>Post Graduate Research Scholar, Mathematics Department, Mewar University, Chittorgarh, Rajasthan, India

<sup>5</sup>Lecturer I, Civil Engineering Department, Kano University of Science and Technology, Wudil, Nigeria.

**Abstract:** *This research works entails the use of the relevant parameters to develop the relationship that can be used to predict the monthly income from the vehicles parked within an off-street parking facility of kano central Eid-ground Kofar Mata, kano state, Nigeria. As for now there is no any existing quantitative and reliable relationship available which can be used to made such prediction. A build-in programme of multiple linear regression equation in SPSS software was used to developed the relationship. the independent variables considered are different vehicle classes and their respective cost of parking and dependent variable is the total monthly cost generated. The model is independent of parking duration as only long-term parking is considered. The model developed will serve as reliable and good estimator for future prediction, because the adjusted  $R^2$  value is 87.3 %. Therefore, the model developed remain valid and effective even if the independent variables keep varying in uniform nature. Otherwise, the result may not be reliable. In addition, the model can serve as driver to which the concern agency can rely upon for predicting monthly fare from the parking facility. The model reliability can be improved my using digital means of collecting and recording fares of individual vehicles.*

**Keywords:** Prediction, Parameter, Model, Reliability, Independent, Variables

## I. INTRODUCTION

Most developed cities in the world today are hindered with insufficient parking space, forcing road users to park their vehicles on road shoulders or outside the parking lots. This leads to the traffic congestion and frequent occurrence of accident in such areas due to inadequate parking facilities. The most appropriate way to tackle this issue of insufficient parking space is to analyze the existing available parking facilities based on demand and supply analysis and device improved measures that will possibly cater for future forecasted parking demand, however some urban centers have gone far in providing alternative solutions to the parking. Nonetheless, from environmental point of view, off street parking facilities provision would help in protection of environment i.e. exploitation of normal concurrent spaces available to be used as parking facilities would be significantly reduce the air pollution and cost controlling. Also, this can enhance the economic development and safer environment which can meet up with the required standards of well-planned developed cities.

Most of the relationship that exist between parameters involved in demand and supply of parking survey of an off-street parking facilities is linear and most appropriate means to represent them is either simple or multiple linear regression. Multiple regression is a statistical tool that is use to find the relationship between dependent variable and more than one independent variable while the simple liner regression considers only two parameters that is single dependent and single independent variables.

## II. NEED FOR THE RESEARCH

Parking is one of the major problems that affect traffic and roadway performance, the presence condition of insufficient parking lots for both off and on-street parking and establishing the reliable source of revenue to the government are of outmost topic which need attention from concern bodies. Therefore, forecasting the future amount of income that will be generated by a particular off-street parking facility such that of Kano Eid ground off-parking facility may impact positively to economic development of the state and reduced the level of concurrent congestion along the roads surround the facility.

## III. AIMS AND OBJECTIVES

### A. Aims

This research is aimed at forecasting the monthly income generated by an off-street parking facility located at kano central Eid-ground Kofar Mata from the fare paid by different vehicle owners.

### B. Objectives

- 1) To establish the economic impact of the facility to the governments at State and Local levels.
- 2) To developed mathematically relationship between the various parameters attributed to the parking facilities.
- 3) To suggest better ways to which the facilities can be improved in term of revenue generation to the government.

## IV. LITERATURE REVIEW

Due to inadequacy of parking facilities in university of Ibadan, implementing a Proper Management for Parking spaces that lead to appropriate and effective parking utilization of parking spaces may be effective. If parking charges were assigned to the existing facilities in university of Ibadan it will also serve as revenue generation sources which will used as maintenance cost and future expansion if condition warrant [1]. A-logit application was used by [2] for developing parking demand and supply model using factors that influence both off street and of street parking facilities in greater Athens of Greece which include parking fees and time spend during the parking process with the driver's behaviors. They found that cost of parking remains the dominant factor which determine the choice parking space by the drivers in comparison to other parameters i.e. the higher the parking cost the less the attraction and vice versa.

In her research of parking management and parking cost benefit analysis of Dharwad city [3] develop a parking demand model using build-in linear regression analysis in SPSS software packages, the result of the model shows that most appropriate condition is short term parking is recommended from the three conditions of parking tested i.e. long term, medium term and short term. As it generates relatively higher revenue based on the proposed project of parking facilities. She further suggested that when appropriately applied parking management can significantly reduce the number of parking spaces required in a particular situation, providing a variety of economic, social and environmental benefits. When all impacts are considered, improved management is often the best solution to parking problems.

A logistic regression model was used by [4], to estimate and forecast the parking demand based on the socioeconomic factors and level of parking attraction to commuters. They predicted that the parking cost is relatively high especially for those paying for long term parkin which need to be reduced.

According [5] Optimized bilevel model was developed to significantly identify the variation between the parking charges and supply for both multiple user and multiple parking facilities. Time-varying parking charges will be attributed to solve the variation in Parking time and parking demand and provide the future parking policies to the system. The relationship between the travel cost between different type of trips and the modes of travel of the subsystem was generated using dynamic system approach to predict the effect of parking charges and policies on traffic speed attributed to the roads. The model suggested that reducing the parking supply will cause the delay and reduce the actual level of service of the roads. [6] Also bi-level programme model was developed from the studies conducted by [7], from three different parking facilities which was solved by sensitivity based algorithm to predict the parking fees of different parking lots under different operational conditions upper- level of the model was used to analyze the drivers characteristic and price of parking while the lower part of the stand for the most proffered means to which the commuters uses to ease their trip such modes, routes of travel and parking facilities. The simulated result shows that only two of the three facility suffices the required profit expected. [8]. In most urban centers parking charges are implemented for proper improvement in most places where the packing demand exceeds parking supply by using proposed and compared techniques adopting three optimized parking policies in which the model provide suggestion to the policies makers and traffic regulatory agencies to which they may probably adhere with.

[9] use multiple linear regression in a research paper titled "a study on multiple linear regression analysis" to explore the relationship between student's lesson scores (measurement and evaluation, educational psychology, program development, counseling, and instructional techniques) and their 2012 KPSS score, and also use the model of the relationship to predict the KPSS score given student's lesson score. [10] use multiple regression analysis to predict the physical fitness of Turkish secondary school students, based on the predictor variables gender, age, body mass index (BMI), body fat, number of curl-up, and push-ups in 30 seconds. Also, multiple linear regression analysis was applied in order to predict student performance based on some independent variables by [11] in a research paper titled student's performance prediction using multiple linear regression and decision tree. [12] also use Multiple regression analysis to analyze the performance indicators in the ceramic industry, in which size of the profit was used as a dependent variable and self-financing capacity, return equity, degree of technical endowment, personnel cost per employee, and investment per person employed.



### V. METHODOLOGY

The data used for this research was collected from the kano state central Eid-ground Kofar Mata which was already converted to permanent off-street parking facility with the sole aim of generating revenue to the government and also to reduce the delay and concurrent congestion caused by random and prohibited on-street parking along the roads surround the Eid-ground. All the vehicle type and their respective fare paid were recorded which was used for the prediction of monthly cost that the facility is expected to generate in a given period of time. Due the linear relationship that exist between these parameters i.e. the cost of parking and the different type vehicles parked, the whole data collected was analyzed based on Multiple linear regression statistical analysis, multiple linear regression model which has the form shown below.

$$y = \beta_0 + \beta_1X_1 + \dots + \beta_nX_n + \varepsilon \dots\dots\dots (1)$$

Where, y= dependent variable

$X_i$  = independent variable

$\beta_i$ = parameter

$\varepsilon$  = error

With regard to this work, the dependent variable which is also called response variable (y) is monthly parking cost whereas the independent or predictor variables consist of two sets. Set one which is the set of number of vehicle as follows: Number of bicycles ( $X_1$ ), Number of motorcycles ( $X_3$ ), Number of tricycles ( $X_5$ ), Number of cars ( $X_7$ ), Number of buses ( $X_9$ ), whereas Set two contain the cost of each vehicle as follows cost of parking bicycle ( $X_2$ ), cost of parking motorcycle ( $X_4$ ) cost of parking tricycle ( $X_6$ ), cost of parking car ( $X_8$ ), cost of parking bus( $X_{10}$ ), Number of trucks ( $X_{11}$ ) and cost of parking Truck ( $X_{12}$ ). all the variables were recorded per month and the data was analyzed using the SPSS software.

### VI. RESULT AND DISCUSSION

The main purpose of this model is to be able to predict the total monthly cost given all the other variables and the data of these variables was taken for twelve months, that is the sample size is 12 and the data was analyzed using the SPSS software and below is the model developed.

$$Y = 25200 + 2.251X_1 + 2.768X_2 + 2.108X_3 + 11.019X_4 + 2.568X_5 - 2.78X_6 + 1.03X_7 - 1.187X_8 + 7.061X_9 - 0.110X_{10} + 6.589X_{11} + 0.673X_{12} \dots\dots\dots (11)$$

Adjusted  $R^2=0.873$  it is telling us that 87.3% of the variation in the dependent variable (Monthly cost) is explained by the independent variables. So, this adjusted  $R^2$  is explaining how good the model is, and can be used for future prediction.

Also, from the above Model there is a constant value ( $\beta_0= 25200$ ). It is the intercept of the regression line. It is mean response when all the other predictors or independent variables are zeros, it is telling us that this is the amount that the independent variables were not able to explain. The first coefficient ( $\beta_1=2.251$ ) its telling us that as number of bicycle increase by one, we are going to see 2.251 change in the income of that month that is we can say one bicycle is associated with 2.251 increase in the total income of that month likewise all the other variables with positive coefficients given one unit of that variable will increase the total income of the month by rate of its corresponding value. However,  $\beta_6 = -2.78$  is the coefficient of  $X_6$  this tell us as the cost of Tricycle increase by one unit the total income of the month will decrease by 2.78. likewise, all the variables with negative coefficients is telling us as the variable increase with one unit the monthly income will decrease by the corresponding value of the coefficient.

### VII. CONCLUSIONS

Based on the model developed it can be concluded that:

- 1) The model assumed that the relationship between number of each vehicle and its respective cost are linear, the model generated remain valid and effective even if the independent variables keep varying in uniform nature i.e. the parking fare and the number of vehicles. Otherwise, the forecasted result may be affected.
- 2) The model is independent of the parking duration means it is based on the amount of vehicles entered in to the facilities not the actual time spent by the vehicles during the parking, because the facility was structured based on the in-and-out parking payment as most of the parkers are businessmen with all days long activities so it's based on the assumption that most of them are long term parkers.
- 3) The model can serve as driver to which the concern agency can rely on to predict the likely revenue that the parking facility could generate on monthly basis. This is because a standard relationship between the parameters used have high reliability and also it can be noted that the parking cost does not depend on a single parameter, but all the parameters used contribute equally to the fare generation.

## VIII. RECOMMENDATIONS

For this model to be effective for predicting monthly basis output, the following point were recommended.

- A. To increase level of generating income from the facility and to reduce the level of inconsistency in the process of collecting the fare from the commuters. a computerized system means of payment should be introduced.
- B. Affordability of payment should be considered to attract more commuters, therefore the parking fares for individual vehicles should not be altered since the current assigned cost to each vehicle is affordable.
- C. Because this model did not consider the short, medium-parking it only long-term parking as a result of more than 90% of the parkers uses the facility for long period of time. Therefore, there is need to provide means to which short time parkers and medium parkers can be accommodated in facility therefore another relationship can be developed based on parking duration variation.
- D. Facility should be standardized as off- street parking facility through proper designing and constructing parking lots. parking sign posts and direction signs should also be provided with appropriate landscaping and drainage system. This will enhance the maximum utilization of the facility and as standard source of revenue to the government.
- E. The performance of the facility can be improved from the current level by employing better and effective management which involve law enforcement that will prohibit on-street parking on the roads surrounding the facility.

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