

Determinants of Price Fluctuations on Vegetables and Fruits in Karatina Open Air Market

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Abstract: This study sought to identify and assess the determinants of price fluctuations on fruits (oranges and avocado) and vegetables (peas and tomatoes) in Karatina Open Air Market. The study presents an analysis of the effects of availability of vegetables and fruits on their prices, the relationship between the quality and freshness of vegetables and fruits and their prices, the effect of product variety price changes on the price of fruits and vegetables and the effects of environmental market conditions on the price of fruits and vegetables. Primary data was used. We present a multiple linear model and a binary logistic model that explain the relationship between the variables. The level of significance employed was 5%. Availability was found to be significant in explaining price fluctuations of Oranges and Tomatoes. It was however found to be insignificant in explaining price fluctuations of Avocadoes and peas. Quality and Freshness was found to be significant in explaining price fluctuations of Avocado, Oranges, Peas and Tomatoes. Change of price in product varieties was found to have no influence on the price of Avocado, Oranges, Peas and Tomatoes. There was no significant difference in the price of a kilogram of Avocadoes and peas in the previous market and in the current market whereas there was a significant difference in the prices of a kilogram of Oranges and Tomatoes in the previous market and in the current market. To further assess the environmental conditions that had influenced the change in price, Garbage collection and Drainage were found to be very significant in explaining the difference in prices of a kilogram of oranges whereas Security of merchandise and Protection from rain and sunshine were found to be significant in explaining the change in prices of a kilogram of Tomatoes between the previous and the current market. The results of this study are highly recommended to traders, consumers and the market management.

Keywords: Open air market, vegetable, fruit, Variance inflation factor (VIF), Akaike Information Criterion (AIC).

INTRODUCTION

Prices of foodstuffs are raising more than three times faster compared to the average worker's pay package as the cost of living continues to rise [1]. Concerns related to the price determination of oils and agricultural commodities have predominantly fallen in the field of microeconomics [2]. There are specific times when most commodity prices are moving in the same direction such that it becomes impossible to ignore the subsequent effects of this microeconomic phenomenon. Food prices increases seem smaller but often have serious consequences on the purchasing power of the poor in the society.

Prices of agricultural products may vary due to quality or appearance difference of the individual lots sold [3]. Inflation and price rise of food items have become a major concern for policy makers worldwide and more particularly for India and other developing

countries [4]. Various factors that contribute to price fluctuations of fruits and vegetables include; production cost, the quality of the fruits and vegetables, availability of the various varieties of fruits and vegetables, changes in the prices of product varieties, demand and supply, the government policy, economic conditions, present market environmental conditions and the market methods employed in selling and distribution.

The price of an object or condition is determined by the sum of the costs of all the resources that went into making it. Fruits and vegetables are highly perishable, so the cost of getting them to and from the market will always be high for households in remote areas [5]. Given that fruits and vegetables are highly perishable, limited infrastructure in many developing countries and that many fruits and vegetables not available at all during some part of the year, are some of the constraints on their consumption.

Technology to extend the harvest period or facilitate storage is particularly important for fruit and vegetable as well as preservation methods in order to extend their period of availability [6].

In the current trend of global warming, most of the productive land in the world will probably suffer from heavy drought in the near future. If these pessimistic results become true, then prices of fresh fruits and vegetables will increasingly become more important with time. Therefore, understanding the pricing behavior of the supply-side market participants (farmers, wholesalers, and retailers) and figuring out the alignment of market power across these participants are important for developing the best policies to regulate the market for fruits and vegetables [7].

Kenya's horticultural sector (fruit and vegetable production and Marketing, but not flowers) has received a lot of attention over the past decade due to the rapid growth of its exports to Europe [8]. The main vegetables produced in Kenya are: Irish Potatoes, tomatoes, cabbages, snow peas, kales, spinach, runner beans, French beans, pepper, broccoli, indigenous vegetables, and Asian vegetables [9]. Tomatoes are the most lucrative, followed by cabbages and French beans. However, some factors hinder the potential of the industry. These include multiple taxation regimes, low incentives in terms of local market prices, high costs of inputs as well as water, energy, and the cost of air freight, and a generally unregulated environment leading to produce poaching and lack of quality control for local produce. There is need to invest in better production methods, post-harvest care and quality to improve consumer acceptance of produce in order to have more returns [9].

Karatina town is rich in agricultural products hence most commercial activities involve agricultural commodities. It is an ideal mix of rural and urban lifestyle. Some of the vegetables sold in this market include tomatoes, onions, spinach, kales, carrots, frenchbeans, peas, cabbages, green banana. The fruits sold are oranges, avocados, bananas, guavas, watermelons, apples, thorn melons, sweet melons, grapes, tree tomatoes, kiwi fruits and pineapples.

LITERATURE REVIEW

There have been surges in commodity prices in the last decade and so many explanations have been provided. A few studies have sort to investigate whether it's possible to forecast global commodity prices[10,11], used an autoregressive distributed lag approach to analyze short and long-run effects of macroeconomic variables such as agricultural commodity prices, interest prices and exchange rates

[4], Using descriptive statistics found that production and transport prices have an impact on vegetable prices.

Characterized the built nutritional environment in terms of types of food commodities and the cost of selected food items in a rural area [13].

Compared changes in prices for four processed foods with prices for 11 fruits and vegetables in the US cities [12]. Severally, little difference was seen in changes of food prices in the two groups, although the main attention was drawn to tomatoes and broccoli, which had risen in price while the prices of other fruit and vegetables and the processed foods had decreased. This was explained by two changes in quality. One, some varieties of produce had changed over time. Tomatoes were increasingly being marketed as vine tomatoes and other specialist tomatoes, which were sold at high prices: the average price of tomatoes will hence be biased upwards over time. Two, while in the past some fruit and vegetables were only available seasonally, by the mid-2000s most were on the shelves throughout the year.

The economic value of food derived from plants depends on its quality and methods of preservation over the entire production chain till it gets to the intended consumer. Quality covers several aspects such as the external appearance, nutritional value, presence of health related compounds, security and safety. Freshness, on the other hand is strictly connected to the age of the product. Nowadays it is impossible to evaluate the quality of a product on the basis of its freshness only. During harvests, a product's quality is well defined by its physical appearance: shape, color and dimension but during distribution, quality is mainly defined by the technological properties of the fruits or vegetables such as firmness and storage ability [14].

A trader in the market is well aware that a consumer is always attracted by the appearance of fruits and vegetables first but later on he has to obtain satisfaction by the taste and aroma. Visual appearance is very important since it attracts the consumer whereas the edible quality and the correct information about nutritional aspects will always make the customer to re-purchase the products. Quality and freshness play a big role in pricing of vegetables and fruits. Traders will always ensure their good quality commodities are well compensated for in terms of monitory returns obtained from consumers. Quality and freshness are directly proportional to price hence the better the quality, the higher the price [15].

The amount of a good in the market is the supply and the amount people want to buy is the demand. Factors influencing supply include the price of that commodity. If the price rises, its supply rises because producers will be more willing to manufacture the product because of its high profitability [16]. If the

cost of production of a commodity increases, supply falls because it will be less profitable for a manufacturer to produce the commodity. Change in available resources also affects supply since as the resources become scarce, supply will fall. Factors affecting demand include income of the consumer, tastes and preferences, prices of related goods, expectations of the customer about the future prices and incomes that can be checked.

Theory of Supply and Demand uses an economic model used for price determination in markets. The unit price for a good will always vary until it settles to a point where the quantity demanded by consumers will be equal to the quantity supplied by the producers at the current price. Hence this will result to equilibrium of price and quantity [16].

The market theory and price system by [17] views the market as a process of adjustment where individual market participants are continually being forced to adjust their activities according to patterns imposed by the activities of others. Therefore this theory essentially consists of crucial analysis of the step by step adjustments and of the way the information required for these adjustments is communicated. Equilibrium positions are not treated as important. They are seen as merely limiting cases where the market process has nothing further to do with all other activities being mutually adjusted to the fullest extent [18]. The bulk of economic explanation must be on the continual adjustment of market activities guided by relative price movements and the lure of pure economic profit and the penalty of loss [18].

MATERIALS AND METHODS

Systematic random sampling as a probability sampling method was used to select the respondents in this study. Data were gathered using two research instruments: A comprehensive semi-structured questionnaire that had been developed in answer to the objectives set and an observation checklist with closed ended section to indicate the vegetables and fruits that were on display and how fresh they were, based on appearance

Model Specification

A chi-square test for independence was done to determine whether there was a significant relationship between two nominal variables. Basically the p-value associated with the statistic

$$x^2 = \sum_{j=1}^c \frac{(O_{i,j} - E_{i,j})^2}{E_{i,j}}$$

where, $O_{i,j}$ - Observed frequency and $E_{i,j}$ - Expected frequency, was employed.

Test for normality was done using the Shapiro Wilk test. A scatter plot showed whether outliers were present in the data. Homoscedasticity was checked using the scatter plot where heteroscedasticity is confirmed if the scatter plot shows a funnel shape.

Regression model

The model was used to show the relationship between availability of fruits and vegetables and the corresponding prices and also the relationship between price and quality and freshness of fruits and vegetables.

The model is; $Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + e$

Where: Y is a variable dependent on the independent variables (X's) with coefficients β_s .

Binary logistic regression model

The model is $\log \text{it}(Y) = \log \left(\frac{p(Y=1)}{1-p(Y=1)} \right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + e$

Where; Y is a variable with two categories which is dependent on the independent (X's) with coefficients β_s .

RESULTS AND DISCUSSION

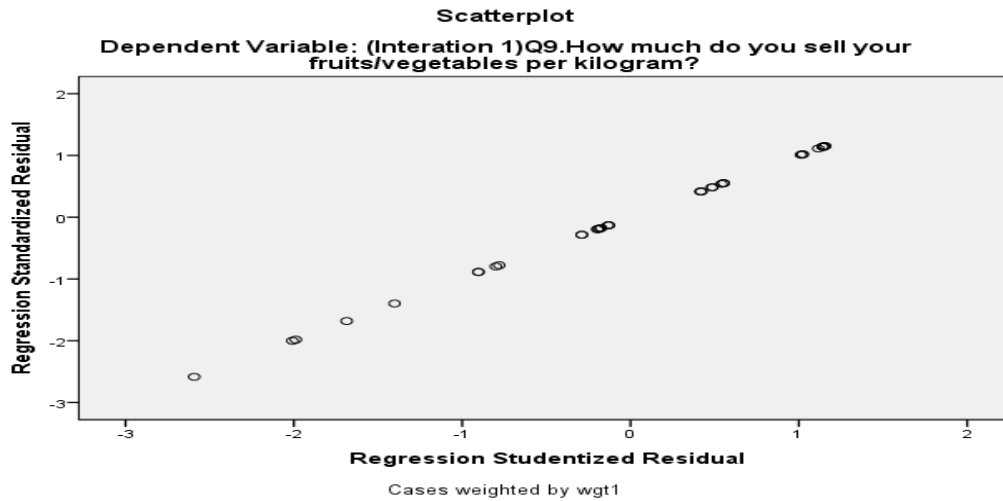
Diagnostic tests for Multiple Linear model

Normality of the error term

The Shapiro Wilk test for normality test, where $W = 0.81907$, $p\text{-value} = 0.04263$ indicates that the error terms are normal at 0.05 confidence level. This implies that the data collected was fit to make exact inferences about the whole population.

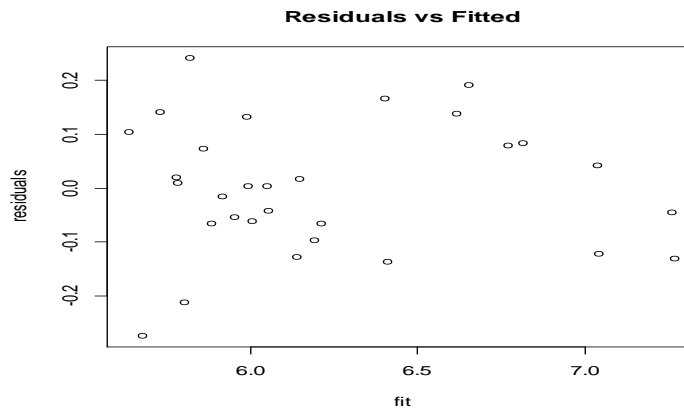
Linear relationship between the variables

Test for linearity and Outliers



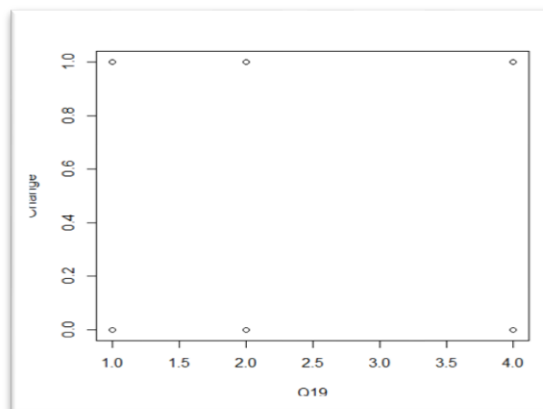
A linear relationship was found to exist between price and the distance from which fruits and vegetables are obtained, hence proof of the linearity assumption. Also, there were no outliers in the data set.

Homoscedasticity



The errors terms are equally distributed hence have a constant variance.

Test for Assumptions of a Binary logistic model
Non linearity



Clearly there is no evidence of linear relationship between the dependent and independent variables.

Dependent variable
 The Dependent variable had two categories (Yes, No)

Availability and Quality & Freshness

A multiple linear regression model was used to show the relationship between availability of tomatoes, peas, oranges and Avocado and their respective prices

and examine the effect of Quality and freshness of the vegetables and fruits on their respective prices.

Tomatoes

Table-1: Availability and Quality & Freshness in tomatoes

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate		
1	.885 ^a	.782	.780	10.088		
2	.916 ^b	.839	.836	8.710		
a. Predictors: (Constant), Distance						
b. Predictors: (Constant), Distance, Quality and freshness						
Coefficients ^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	29.394	1.847		15.912	.000
	Availability	.357	.019	.885	18.722	.000
2	(Constant)	18.235	2.485		7.338	.000
	Availability	.329	.017	.814	19.154	.000
	Quality and freshness	5.265	.899	.249	5.855	.000

This reveals that holding all other factors constant, both the Availability of Tomatoes and their Quality and Freshness based on physical appearance are significant in explaining a change in their prices at 5% level of significance. Clearly for model 1, Availability explains 88.5% of variations in the price of Tomatoes while model 2 indicates that both Availability and the Quality and Freshness of tomatoes explain 91.6% of the variations in the price. Therefore model 2 would be the preferred model. The model is;

$$Y = 18.235 + 0.329 (Availability) + 5.265 (Quality\ and\ Freshness).$$

It indicates a positive relationship between price, availability and Quality and freshness of tomatoes. For this model, VIF=6.211 confirming that there was no correlation between availability and Quality & Freshness of Tomatoes.

Peas

Table-2: Availability and Quality & Freshness of peas model

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics		
					R Change	Sig. Change	F
1	.850 ^a	.723	.661	8.542	.723	.003	
a. Predictors: (Constant), Quality and freshness, Availability							
Coefficients ^a							
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	
		B	Std. Error	Beta			
1	(Constant)	36.955	8.220		4.496	.001	
	Quality and freshness	.123	.028	.772	4.359	.002	
	Availability	5.282	3.445	.271	1.533	.160	

This reveals that holding all other factors constant, the model with Quality & Freshness alone as the predictor variable explains 72.3% of the variations on the price of peas. Quality and Freshness has a p value of 0.002 hence highly significant in explaining the price of Peas. Availability has a p value of 0.160 hence insignificant in the model. The model therefore is,

$$Y = 36.955 + 0.123(Quality\ and\ Freshness)$$

Showing a positive relationship between price and Quality & Freshness of Peas.

Oranges

Table-3: Availability and Quality & Freshness

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate		
1	.840 ^a	.706	.699	5.355		
2	.895 ^b	.801	.792	4.459		
a. Predictors: (Constant), Availability						
b. Predictors: (Constant), Availability, Quality and freshness						
Coefficients ^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	27.939	1.162		24.053	.000
	Availability	.019	.002	.840	10.393	.000
2	(Constant)	38.808	2.567		15.116	.000
	Availability	.024	.002	1.086	12.607	.000
	Quality and freshness	6.342	1.388	.393	4.570	.000

The results show that holding all other factors constant, both the Availability of Oranges and their Quality and Freshness based on physical appearance are significant in explaining a change in their prices at 5% level of significance based on their p values of 0.000. Certainly, model 1 indicates that Availability explains 70.6% of variations in the price of Oranges whereas model 2 indicates that both Availability and the Quality and Freshness of oranges explain 80.1% of the variations in the price. Therefore the preferable model

would be model 2 with both Availability and Quality & Freshness. The model is;

$$Y = 38.808 + 0.024(Availability) + 6.342(Quality\ and\ Freshness)$$

For this model, VIF =5.025, hence there was no correlation between availability and Quality & Freshness of Oranges.

Avocado

Table-4: Availability and Quality & Freshness of Avocado

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate		
1	.762 ^a	.581	.522	16.036		
a. Predictors: (Constant), Quality and freshness						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	22.500	10.774		2.088	.015
	Quality and freshness	12.500	4.009	.762	3.118	.017
2	(Constant)	49.051	11.869		4.133	.006
	Quality and freshness	11.946	2.805	.729	4.258	.005
	Availability	.764	.264	.495	2.892	.058

This indicates that a model with Quality & Freshness alone as the predictor variable, holding all other factors constant, explains 58% of the variations on the price of Avocados. Quality and Freshness has a p value of 0.017, implying that it is significant in explaining the price of Avocados. Availability has a p value of 0.058, hence its insignificance in the model. The model is; $Y = 22.5 + 12.5(Quality\ and\ Freshness)$, This indicates a positive relationship between price and Quality & Freshness of Avocados.

Change in price of goods related to fruits and vegetables.

This factor was analyzed using responses on whether prices of related types of fruits and vegetables had their prices changing frequently and whether this, in turn affected the price of the fruits and vegetables in study. Chi square test for independence was employed that indicated interesting results. For tomatoes, it was evident that a change in the price of a kilogram of Tomatoes is independent of a change in price of types of Tomatoes. (X-squared=2.6290, df=1, p-value =0.4571). For peas, a change in the price a kilogram of

Peas was found to be independent of a change in the price of types of Peas (X-squared = 1.6643, df = 1, p-value = 0.9932). A change in the price of a kilogram of Avocado was found to be independent of a change in the price of types of Avocados. (X-squared = 0.88889, df = 1, p-value = 0.3658). It was evident that a change in the price of a kilogram of oranges was independent of a change in the price of types of oranges. (X-squared=0.98879, df = 1, p-value = 0.3458).

Effects of Environmental Market Conditions on the price of fruits and vegetables

Model Variables	AIC value
Garbage, Drainage, Rain & Sunshine, Sanitary conditions, Security of merchandise	26.6
Garbage, Drainage, Rain & Sunshine, Security of merchandise	24.66
Garbage, Rain & Sunshine, Security of merchandise	22.81
Rain & Sunshine, Security of merchandise	20.99

Comparing the AIC, The model with Garbage, Drainage, Rain and Sunshine, Sanitary conditions and Security of merchandise is less significant compared to the other three models. Change in price of tomatoes is well explained by Protection from rain and sunshine and Security of merchandise since this model has the least AIC. The best model therefore is

$$\text{Logit (Change in price)} = 16.50 + 20.01(\text{Rain_Sunshine}) + 17.19 (\text{Security})$$

This Implies that holding all other factors constant, a unit increase in Security of merchandise leads to an increase in the log odds of Change in price by 17.19 and holding all other factors constant a unit increase in Protection from rain and sunshine leads to an increase in the log odds of Change in price by 20.01

Model Variables	AIC value
Garbage, Drainage, Rain & Sunshine, Sanitary conditions, Security of merchandise	12
Garbage, Drainage, Rain & Sunshine, Security of merchandise	10
Garbage, Drainage Rain & Sunshine	8
Garbage, Drainage	6

Basing on the AIC, the logistic model with all the five environmental factors has the least significance with an AIC of 12 compared to the other three logistic models. Furthermore, the model with Garbage and Drainage as the predictors in the model has the least AIC of 6. This implies that Garbage and Drainage are the most significant environmental factors in explaining why the price of Oranges in the previous market and the price in the current market are different at 5% level of significance. The model therefore is,

$$\text{Logit (Change in price)} = 20.89 + 91.84(\text{Garbage}) - 23.04(\text{Drainage})$$

A paired t test was used to test whether there was a significant change in the price of a kilogram of tomatoes, avocado, peas and oranges in the previous and current market. When found to be significant, a further test to determine which environmental factors had contributed to this change was performed.

It was evident that the price of tomatoes in the previous and the current market are different at $\alpha=5\%$ ($t = 2.1754$, $df = 29$, $p\text{-value} = 0.04722$). To further test which environmental conditions led to the change in price of Tomatoes, the following results for models with various explanatory variables were employed.

For peas, we found out that the price of peas does not change from market to market ($t = 1.8202$, $df = 23$, $p\text{-value} = 0.09601$). The price of avocado was also found to be the same from market to market ($t = -0.49614$, $df = 26$, $p\text{-value} = 0.6374$).

In the case of oranges, it was vividly evident that the price of a kilogram of oranges is different in the previous and in the current market at $\alpha=5\%$. ($t = 2.7386$, $df = 24$, $p\text{-value} = 0.04086$)

To asses the environmental factors that were actually significant in explaining price fluctuations in Oranges, the following results of models with different explanatory variables were employed.

This Implies that holding all other factors constant, a unit increase in Drainage systems leads to a decrease in the log odds of Change in price by 23.04 and holding all other factors constant a unit increase in Garbage Collection methods leads to an increase in the log odds of Change in price by 91.84.

CONCLUSIONS

This study was intended to investigate the determinants of price fluctuations on fruits and vegetables. We realized interesting findings:

Availability

Price fluctuations on Oranges were found to be greatly influenced by both availability and their Quality and freshness. A model with these two factors as the predictor variables had an R squared of 72.3%, implying that with all other factors held constant, both availability and quality & freshness of Oranges explain 72.3% of price variations in Oranges. Price fluctuations on Tomatoes were also found to be influenced by Availability and Quality & Freshness. A multiple linear model with both Availability and Quality and Freshness had an R squared of 91.6%, implying that with all other factors held constant, Availability and Quality and freshness explained 91.6% of the variations in the price of tomatoes at 5% level of significance. This was in line with results of (Ashar, 2015) in India that Transport prices were not likely to go down since they rely on imported oil. However, Availability was found to be insignificant in explaining the change of price in Avocados and Peas at 5% level of significance.

Quality and Freshness

The selling price of avocado in Karatina open air market was found to fluctuate due to the level of Quality and Freshness. A linear model with Quality and Freshness as the predictor variable gave an R squared of .581. Therefore 58.1% of price fluctuations on Avocados are explained by their Quality and Freshness at 5% level of significance. Fluctuations of the price of Peas were also attributed to Quality and freshness. A linear model with Quality and freshness as the predictor variables gave an R squared of .723, implying that Quality and freshness of the peas explain 72.3% of variations in their prices. (Zeithaml, 1988) also found out that Quality and freshness are directly proportional to price. The better the quality, the higher the price.

Change of price in product varieties

A change in the price of different types of Tomatoes (p value=.814), was found to be insignificant in explaining a change in the price of Tomatoes. A change in the price of different types of avocado (p value=.8786) was also found to be insignificant in explaining price fluctuations on Avocados. Changes in the price of different types of peas (p value=.0918) were found to be insignificant in explaining price fluctuations on peas. A change in the price of different types of Oranges was also found to be insignificant (p value=0.1158) in explaining price fluctuations on Oranges.

Environmental Market Conditions

The price at which a kilogram of oranges was sold in the previous market was found to be significantly different from the price at which a kilogram is being sold in the current market (p value=0.04086). The traders attributed this difference to a change in the environmental conditions in the current

market. The most significant environmental factors were Garbage collection and Drainage systems. Price of a kilogram of tomatoes in the previous market was found to be significantly different from the price of a kilogram of tomatoes in the current market (p value=0.04722). The traders mainly attributed this change to environmental factors namely; Protection from rain and sunshine and the Security of merchandise. Prices of a kilogram of Peas and Avocado were found to be the same in the previous and current market at 5% level of significance with p values of Peas (0.09601) and Avocado (0.6374).

RECOMMENDATIONS

Traders are recommended to outsource their vegetables and fruits near their selling place as a measure of cost reduction and in order to attract more customers with friendly and affordable prices. Customers are mostly attracted by the physical appearance of fruits and vegetables. How pleasing the vegetables and fruits look leads to higher sale. Therefore traders should improve their storage methods and reduce the number of days with which their goods stay at the market. Traders are encouraged to have a variety of goods, having in mind that a change in the price of one type rarely leads to a change in price of the other types. They should ensure that their fruits and vegetables are protected from rain and sunshine for reasonable pricing and minimization of losses.

The management of the market should improve the market environmental conditions by having a good drainage system. Water should be in surplus in order to maintain good sanitation and cleanliness of the fruits and vegetables sold in Karatina Open air Market. This will in turn improve hygiene and the health of both the traders and the customers at large.

Most of the traders sighted that they are eagerly waiting for the completion of the modern market which they hope will be free from the factors affecting them in the new temporary market.

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