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Determinants of Choice of Marketing Outlet for Edible Insects among Smallholder Farmers and Traders in Western Kenya

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ABSTRACT

The edible insect sector has, in recent times, gained significant prominence and attention. Particularly, the government of Kenya has made remarkable steps to achieve a potentially large and valuable edible insect market, with a significant milestone being the passing of regulations on edible insects as a new source of proteins. However, research on the edible insect marketing environment is still indistinct. Therefore, the study sought to evaluate the determinants of the market outlets preferred or used by smallholder farmers and traders of domesticated and field-collected edible insects (including cricket, bees, winged termites, lake flies, and dung beetle) in Siaya and Vihiga counties. This cross-sectional study was done among 188 edible insects' farmers and traders. Purposive sampling identified the study area, while snowball sampling reached the study participants. Data was collected using structured questionnaires and analyzed using multinomial logit regression to assess independent-dependent variable relationships, yielding marginal effects. Study findings showed that at 95% confidence interval, the yield was significant to the three outlets used by the farmers. Gender was significant to both institution and open-air markets outlets but insignificant to selling at the farm gate. Age, education level, and experience in marketing were insignificant to all the three market outlets. Marketing training was significant to the institution and open-air markets**.** The study also showed that farmers and traders had limited choices to sell their edible insect produce, which was majorly affected by yield and age variables. In view of these findings, enhancing edible insect marketing and training through initiatives that would increase production among farmers and breaking the attitudes toward open-air marketing among male farmers is pivotal to the thriving of the novel food enterprise towards achieving food security in the region.

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Introduction

The rising human population and food insecurity upsurge, together with increasing concerns related to climate change, has called for an expert reassessment of diets (Durst et al., 2010). As such, the potential of edible insects for food security and commercial farming prospects has gained considerable momentum. Besides being nutritionally and environmentally promising, edible insects have a substantial opportunity to provide income and employment opportunities (McClure & Wynberg, 2020). Insects have been used as food and feed for a long time, but their full commercialization is now being recommended to create a source of livelihood for farmers/traders (Dobermann et al., 2017). It calls for the promotion of the commercialization of edible insects to meet the projected increase in demand for proteins. A wider market creation for edible insects could provide an economic incentive for the commercialization of the emerging enterprise.

The progress in Kenya's edible insect market, particularly within the counties of Vihiga and Siaya, as observed in the study titled "Consumer Acceptance of Edible Insect Foods for Non-Meat Protein in Western Kenya," signifies a noteworthy shift in dietary preferences and sustainability awareness. Drawing from data collected in a 2015 consumer survey involving 234 participants, it is evident that over 75% of respondents have not only embraced edible insects as a viable food source but also as a compelling alternative to conventional meat. This acceptance underscores a significant transition in food choices, driven by factors such as familiarity, convenience, social and environmental responsibility, economic incentives, barriers, risk attitudes, and altruistic concerns. Such high levels of acceptance provide clear evidence of the growing enthusiasm for edible insects in Kenya, reflecting an evolving consumer landscape where

sustainability and protein diversification are paramount considerations, thus paving the way for innovative approaches to address food security and environmental sustainability.

Studies have shown that edible insects bring socioeconomic benefits to farmers/traders (Tao & Yao, 2018; Tanga et al., 2021). In Kenya, Vihiga and Siaya are some of the regions experiencing food insecurity (WFP, 2016). Incidentally, there are instances of insect business with a number of farmers venturing into edible insect enterprises where they have proven to be of benefit both socially and economically (Oloo et al., 2020). However, this region has not portrayed a potentially large and valuable edible insect market. Hence, production is mostly subsistence, with a little amount sold in the local markets. Additionally, limited research has been done on the region's marketing environment of edible insects, particularly the outlets used by farmers in marketing this micro livestock.

Adopting insect farming and marketing as an enterprise is envisaged as a reliable source of income. Good marketing channels can make products made available at the right time, in the right place, and in the right amount. Therefore, convenient marketing channels and outlets help overcome time, place, and position gaps (Qadri, 2018). Subsequently, when insect products can be marketed even to high-end markets, it will most likely help boost farmers' incomes from what they currently earn. Therefore, this study sought to analyze determinants of market outlets used by farmers as a way of strengthening the novel food enterprise.

In Western Kenya's Siaya and Vihiga Counties, income for those involved with the edible insect industry hinges on the selection of the appropriate marketing outlet. This decision carries significant economic consequences as pricing, demand, and payment structure varies among outlets. Smallholder farmers and traders are the focus of this study, and identifying the optimal market outlet choice is of paramount importance. Furthermore, market outlets that are sustainable play a critical role in securing the industry's longevity. Understanding what factors drive these decisions is key to establishing and upholding such outlets. The edible insect value chain also benefits from uncovering the connections between producers and consumers, which can lead to increased efficiency and potential diversification opportunities that promote resilience. Ultimately, this research has policy and development implications, as it can help policymakers and organizations develop interventions that allow smallholders to choose market outlets that best support their financial and livelihood goals.

Materials and Methods

Study Area

The study was conducted in Siaya and Vihiga Counties in the year 2021. The two counties were selected due to their high edible insect occurrences (Alemu et al., 2015). Moreover, communities living in these two counties have traditionally consumed edible insects (Pambo et al., 2016). Further, the areas are uniquely suitable for the study since they have hosted interventions that promote foods from edible insects through projects like the GREEiNSECT and INSFeed (Ayieko et al., 2010). The study areas fall under agro-ecological zones of Lower Midland (LM) and Upper Mid Land (UM), with temperatures ranging between 18°C and 24°C and annual rainfall ranging from 1000mm to 2000mm, depending on the distance from the lake shores. These zones provide favorable conditions for the survival of edible insects and hence the possibility of thriving of such enterprises.

Study Design

This study employed a cross-sectional research design to assess the determinants influencing smallholder farmers' and traders' choice of marketing outlets for edible insects in Siaya and Vihiga Counties, Western Kenya. By collecting data at a single point in time, this de-sign provides a snapshot of the variables affecting marketing outlet choices within the study population.

Data

Both primary and secondary data were collected in this study. The primary data was collected by administering a structured questionnaire and conducting key informant interviews. Secondary data was collected from existing literature and through a review of agricultural reports.

Sampling Procedure

During sampling, a multistage-stage sampling procedure was employed. In the first stage, the two counties, Vihiga and Siaya, were purposively selected due to high edible insect occurrence and the heterogeneous edible insect practices of the occupants. In the second stage, the two areas of Luanda and Bondo sub-counties were purposively selected based on insect trading and farming. In the last stage, the snowballing sampling method was used to identify insect farmers/traders and this was done until the saturation point was reached (Parker et al., 2019). Snowballing was appropriate as the population of insect farmers in the region was not detailed. A sample of 188 farmers who also doubled as traders were selected.

Determinants of Edible Insects Farmers' Choice of Market Outlets

The study identified three major market outlets predominantly used by insect traders in the study region during reconnaissance. The outlets included research institutions, open-air markets, and farm gate. Different variables such as gender, age, marketing experience, education level, and marketing training were hypothesized to influence the market outlet choice of the farmers and were therefore adopted for the study, as illustrated in Table 1. These variables resonated with the major factors that significantly affect market outlet choice as investigated by researchers in agricultural fields (Dessie, Abate & Mekie's, 2018).

Study Variables

In this study, the dependent variable is the choice of marketing outlets for edible insects among smallholder farmers and traders in Siaya and Vihiga Counties, Western Kenya. The study examines how various independent variables influence this choice. These independent variables include gender, age (categorized into four groups: 18-25 years, 26-33 years, 34-41 years, and above

41 years), education level (divided into four categories: no formal education, primary, secondary, and post-secondary), experience in edible insect business (categorized based on the number of years involved in the business: less than a year, between 1 and 5 years, and over 5 years), training in edible insect production or marketing (a binary variable: Yes/No), and yield of edible insects, which was quantified by weighing the produce using a precise weighing scale, measured in kilograms. Gender is categorized as male or female, and the study aims to analyze how these factors influence the selection of marketing outlets, which include farm gates, institutions (such as research institutions), and open-air markets.

Data Analysis

Data analysis was guided by the Multinomial Logit regression model (MNL) represented by equations 1,2, and 3. The Multinomial Logit regression model was considered fit for the analysis in this study because of the nature of the dependent variable and the aim of the study. The dependent variable (choices of market outlets) had three categories, thus, finding the association between the dependent variable and the independent variables was best done by the MNL regression model.

$$Y_I = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_6 X_6 + \varepsilon_I \quad (1)$$
$$Y_{II} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_6 X_6 + \varepsilon_I \quad (2)$$
$$Y_{III} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_6 X_6 + \varepsilon_I \quad (3)$$

Where Y_I, Y_{II}, and Y_{III} represents institution, open-air markets, and farm gate outlets, respectively. X_1 to X_6 represents the explanatory variables as illustrated in Table 1. β_0 is the intercept. β_1 to β_6 represents coefficients associated with each explanatory variable. εi is the error term.

Choosing a specific market outlet is a discrete choice from among the alternative outlets for the farmers. Because only the farmers' choice of a specific market outlet was observed, the following latent structure univariate logit model for the choice of each outlet can be modelled as follows;

$$p_i = \{1 \; if \; p_i = x\beta + u_i > 0; 0 \; if \; p_i \leq \quad (4)$$

Where p_i is the binary latent variable for outlet choice observed if $p_i > 0 \; and \; 0 \; otherwise$.x is the specific factor determining the choice of market outlet. However, a producer might choose more than one outlet at a single point. The potential for simultaneous choice across the outlets implies that a multinomial logit regression model would be desirable to ascertain the association, thus combining equations 1,2,3. The model can then be rewritten as:

$$p_{ij} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n + \varepsilon_i \quad (5)$$

Where p is the market outlet chosen by the farmer, i takes values 1,2,3, each corresponding to the choice. $x_1, x_{2,} x_n$ are factors influencing market choice, and ε_i is a randomized error with j alternative choices.

Results and Discussions

Socio-demographic characteristics of the edible insect farmers'/businesspeople.

Descriptive statistics of demographic and socioeconomic characteristics (Table 2) showed that more than half (57.45%) of the respondents who were dealing in insect farming and trading were female, with their counterparts only contributing 43%. Siaya County had more respondents (male 48.33%, female 51.67%) participating in insect enterprise than Vihiga County (male 32.55%, female 67.65%)) in addition to the highest number of youth participants. This can be linked to the existence of a major research institution in edible insect farming in western Kenya, Jaramogi Oginga Odinga University of Science and Technology, that has endeavored to have a successful edible insect project within its environs. As part of the project's (Insects as Food and Feed) rationale, a number of farmers in the locality of Siaya county were trained to kick start the project's aims. Therefore, many people within this locality ventured into the project relative to their counterparts in Vihiga County.

Table 1. Selection of dependent and independent variables for multinomial logit regression

Variable	Description and Unit of Measurement	Expected sign		
Dependent variable		Farm gate	Institutions	Open-air market
Market outlet				
Independent variable				
Gender	Gender of the farmer (Dummy variable. 0=Male, 1= Female)	+	+	+
Age	Age of the farmer/trader in years Continuous Variable: Age of respondents in years)	-	+	+
Education Level	Education level of the farmer in years (Categorical Variable: 1 if None, 2 Primary and 3 if post-primary)	+	+	+
Experience	Experience in marketing of the farmer Continuous variable: experience in years	+	-	+
Training	Whether the farmer have received training or not regarding insect marketing (Dummy variable Yes=1, No=2)	-	-	-
Yield	Quantity produced or collected by the farmer. Continuous variable: yield in kilograms	+	-	+

Table 2. Socio-demographic characteristics

Characteristics	Sites		
	Siaya	Vihiga	Totals
Gender			
Male	48.33%	32.55%	42.55%
Female	51.67%	67.65%	57.45%
Age			
18-25 years	4.17%	1.47%	3.19%
26-33 years	8.33%	23.53%	13.83%
34-41 years	32.50%	23.82%	32.98%
Above 41	55%	41.18%	50%
Education level			
No formal education	0.83%	0	0.53%
Primary	45%	38.24%	42.55%
Secondary	36.67%	50%	41.49%
Post-Secondary	17.50%	11.76%	15.43%
Experience in insect business			
Less than a year	19.17%	1.47%	12.77%
Between 1 and 5 years	47.50%	30.88%	41.49%
Over 5 years	33.33%	67.65%	45.74%
Training on production and marketing			
Yes	10.83%	2.94%	7.98%
No	89.17%	97.06%	92.02%

Regarding the education level, the majority of the farmers had attained primary level (43%), with only 15% accounting for post-secondary and a paltry 1% having no formal education. Half of the farmers (50%) were above the age of 41, with only 3.2% of the respondents having ages of 18 and 25 years. The results show less youth participating in such enterprises. Youths within the study area view the practice of edible insects as not-so-cool activity.

The majority of the farmers, represented by 45.74%, had the experience of more than five years in the business, with only 12.77% having less than a year of experience. Farmers in Vihiga county showed a remarkable experience in insect trading compared to the Siaya farmers. This is because Vihiga county has the existence of rain forests such as the Kibiri and Guenno Congolian that harbors many insect species (NEMA, 2013). This gives the residents access to insects for a better part of the year than the Siaya occupants, which commonly have intermittent seasonality of edible insects (NEMA, 2013).

Regarding training in the production or marketing of edible insects, only 8% of the farmer had prior training, with the majority (92%) having no training in this novel enterprise. The noticeable- difference in training rate-s between the- two study sites can be attributed to the- presence of a re-search institution within Siaya County. Jaramogi Oginga Odinga University of Science- and Technology plays a crucial role by offering training and capacity-building programs to local farme-rs, providing them with the nece-ssary knowledge and skills for edible-insect farming and marketing. There-fore, the differe-nce in training experie-nces emphasizes how re-search institutions like the one- in Siaya County contribute to promoting better opportunitie-s for education within the edible- insect industry.

Insects' Species Dealt by the Farmers and Sources of Edible Insect

Farmers majorly dealt with five species of edible insects (Winged termites, house crickets, bees, lake flies, and *Carebara vidua Smith*), either domesticated or collected from the wild. Over 80% of the farmers were collecting from the wild, with only 6.38% combining both production and wild collection (Figures 1 and 2). Only 12% of the farmers were engaged entirely in the production of edible insects. It was noted that *Carebara vidua* Smith was mostly seasonal, and only 40% collected it whenever they were available.

Factors Influencing the Choice of the Market Outlet Used by Farmers

The variables included in the multinomial logit regression model explained 26% variation in the dependent variable (choice of marketing outlets) (Pseudo R^2=0.2623). While this is a low R^2 value and may not warrant the preferred goodness of fit, this can be attributed to the few dependent variables used. Also, Onditi (2013) justifies that any research that deals with humans may have a low R^2 as humans are simply harder to predict than physical processes. Further, King (1986) points out that the low R^2 does not show that the model is not fit, and conclusions should be made based on the significance coefficients regardless of the value.

Age, educational level, and experience of edible insect farmers did not have a statistically significant influence on the choice of insect marketing outlet at 0.05 significance level (Table 3). Age did not significantly influence the choice of any outlet, an outcome which two reasons can plausibly explain: First, the respondents indicated that there were no restrictions to the market participants based on age as the young, middle-aged, and old had equal participation in the market.

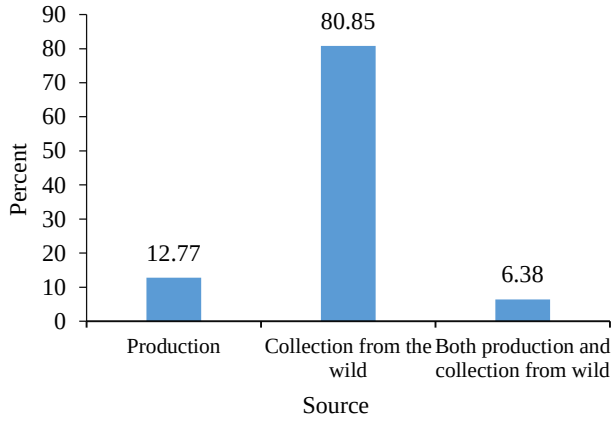

Figure 1. Source of Edible Insect

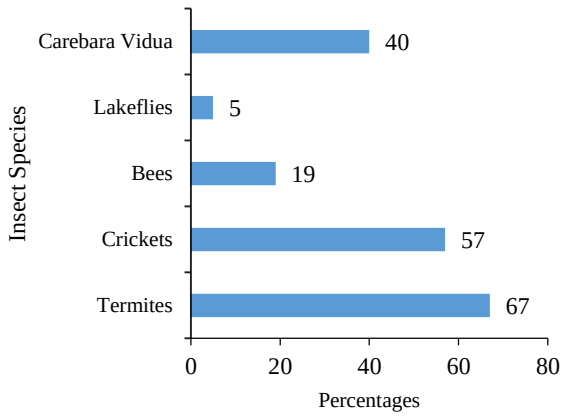

Figure 2. Insects species dealt by the farmers

Table 3. Marginal effect from Multinomial logit on the choice of edible insect marketing outlets.

Market Choice Outlet	Farm Gate		Institution		Open Air Market	
Explanatory Variable	δy/δx	P-Value	δy/δx	P-Value	δy/δx	P-Value
Gender(0-male,1-female)	-0.035***	0.094	-0.149**	0.045	0.184**	0.035
Age	-0.002	0.788	-0.011	0.786	0.014	0.786
Education Level	-0.002	0.795	0.012	0.794	-0.015	0.794
Experience	-0.019	0.204	-0.082	0.166	0.102	0.155
Training	-0.056***	0.052	-0.238**	0.02	0.295**	0.011
Yield (in Kilograms)	0.033**	0.04	0.139*	0.005	-0.173*	0.002

Note: *, **, *** significant at 1%, 5% and 10% respectively. Number of observations=99(Number of active farmers in trading); LR Chi-Square (6) = 37.57; Pseudo R^2=0.2623; Log likelihood= -52.83; Prob > chi^2 = 0.0000.

Secondly, no cultural values inhibit any person, regardless of age, on market participation. Of interest is the negative insignificant influence of age on the institution. An institution requires quality products, and the old are less likely to observe quality standards gained through training. This result is consistent with Jalang'o, Otieno & Oluoch-Kosura's (2016) findings that age did not influence market outlet participation. By contrast, Dessie, Abate & Mekie's (2018) study showed that age directly influenced the decision to sell at the outlet. The trio found out that older farmers often decided to choose better outlets that would give higher pay. Moreover, older farmers preferred rural markets to urban markets due to the complicated logistics of transporting to urban markets, which makes the old shun away (Arinloye et al.,2015).

Conventionally, it would be expected that education would increase one's ability to search for access and process information and thus help in making rational decisions based on the market outlet. However, the result of this study is the contrary. This contrasting outcome can be attributed to the fact that market outlets available for the insects in the region are limited and that farmers do not have more options to evaluate to determine the best. But, of interest is the fact that the increase in the level of education resulted in less likelihood of selling (2%) in the open market. This is further supported by Jalang'o et al.'s (2016) findings that farmers who attained more years of formal education are more likely to participate in high-end value markets that attract considerable prices. Therefore, they are more likely to shun the open-air market that attracts relatively lower prices.

Experience showed insignificant influence in the choice of all the marketing outlets. This can be linked to limited market options. Conventionally, the experience would enable farmers to make rational decisions in choosing the marketing outlet with the highest returns. The result is consistent with a study by Geoffrey et al. (2014) that found a negative relationship between experience in farming and the choice of farm gate as a marketing outlet. It showed that an increase in the farmer's experience would make them less likely to sell at the farm gate. The reason could be that the farmer has learned about the insect market and that he would be sourcing for new and attractive prices with significant output.

The marginal effect of gender at institution (p-value= 0.045) and open-air market (p-value= 0.035) were found significant (Table 3). Implying that being a female decreases the chances of choosing an institution as an insect marketing outlet by about 15% and increases the possibility of choosing an open-air market by 18%. This shows that female farmers were less likely to sell their output in an institution than their male counterparts. Nonetheless, they had a more probability of selling in an open-air market. A plausible explanation for this trend is that male farmers are vibrant and source for high-paying outlets. This is concurrent with Geoffrey et al.'s (2014) findings that male farmers are resource endowed and active in sourcing for high-end markets. Hence, they can produce the required quality produce. Comparatively, female farmers were more active in the open-air markets than men. This could be attributed to the fact that women own most stalls and small businesses in open-air markets in Kenya (Xinhua, 2021), and men view small businesses in the open air as female-oriented, thus shying away from open-air markets. This further explains the low likelihood of females selling to the institutions. However, gender did not influence selling at the farm gate.

Having participated in trainings on insect farming significantly influenced the choice of institution (dy/dx=-0.238, p-value=0.02) and open-air market (dy/dx=0.295, p-value=0.011) as edible insects marketing outlets. Thus, participation in training reduces the chances of choosing an institution as a marketing outlet by about 24% and increases the chances of choosing an open-air market by about 29%. The more the farmer is trained, the more they look for new outlets with attractive prices. The training imparts farmers with marketing strategies and sourcing for attractive prices that farm gate does not give. It can be deduced that training makes farmers knowledgeable of producing quality products and thus could sell even to more demanding yet strict sources like the institutions. Also, because farmers are adept in marketing, they believe they can make informed decisions without the interference of any factor. Jalang'o et al. (2016) contradict these findings by stating that training has no impact on the choice of a marketing outlet

Comparatively, yield positively influenced the choice of the three market outlets. A unit increase in yield increases the chances of choosing a farm gate marketing outlet by 3%, an institution by about 14%, and reduces the chances of choosing an open-air market outlet by 17%. Notably, an increase in the yield would make the farmer more likely to sell to the institutions that source in bulk for further production processes. The results are consistent with Tsougiannis et al. (2008), who reported a positive relationship between output and social institutions, such as cooperatives, with an increase in yield. However, the result contradicts the finding of a study by Mutura et al. (2015), who reported a negative relationship of the choice of the farm gate outlet with an increase in the yield. Interestingly, the yield was negatively significant to the open-air market, implying a unit increase in the yield makes a farmer less likely to sell in the open-air market. High volumes would prompt the farmer to seek high-value markets such as institutions (Boutelle, 2018). Selling in the institution is more remunerative, and significant profits can be attracted with sufficient quantities.

Conclusion and Recommendations

Edible insects play a critical role in improving the smallholders' economic standards and a quantifiable nutritional component in consumers' diets. However, the insights of this study revealed that edible insect production and marketing is yet to gain prominence in Siaya and Vihiga Counties. The study concluded that gender, participation in the training programs and yield are the determinants of choice of marketing outlet for edible insects among smallholder farmers and traders in Western Kenya. Additionally, it is important to note that the study did not explicitly address potential seasonal variations in edible insect farming and trading, which could influence marketing choices, particularly for seasonal insect species.

Based on the findings, the study proposed several recommendations aimed at fostering a thriving edible insect market in Siaya and Vihiga Counties. First, there is a need to encourage the establishment of more institutions and value chain coordination organizations that facilitate marketing edible insects. This could create additional outlets for farmers, enhancing their access to high-value markets. Second, implementing tailored training programs for farmers in edible insect production and marketing is essential. The training should focus on marketing strategies and quality assurance to empower farmers to access higher-paying markets, such as institutions. Third, promoting awareness among farmers about the potential benefits of education and its connection to market opportunities is recommended. Emphasize how increasing educational attainment can open doors to more profitable outlets. Fourth, the farmers should be supported in improving their production techniques to increase yields. This can be achieved through knowledge transfer and best practices, potentially leading to greater access to institutions. Fifth, consumer education campaigns should be initiated to enhance the acceptability of edible insects. Addressing misconceptions and promoting the nutritional and environmental benefits of edible insects can expand market options.

The study also recommends that future research should explore the nuanced gender-related factors impacting marketing choices, investigate the specific content and delivery of training programs that yield the most effective results, and investigate the broader economic implications of edible insect trading within these counties. Such investigations will provide valuable insights to inform policies and strategies aimed at promoting sustainable development within the edible insect industry in the region.

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Declaration of conflict of interests

Authors declare no competing interest.

Ethical Approval

Authors were granted Ethical Approval by Jaramogi Oginga Odinga University of Science & Technology Ethical Review Committee, and the National Commission for Science, Technology, and Innovation (NACOSTI)

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