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Determinants of the Use of Motorcycle Means of Transport Among Smallholder Dairy Farmers in Sotik Sub-County, Kenya

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Abstract
The poor state of roads and the financial inability of many smallholder dairy farmers to afford better means of transport have led more smallholder dairy farmers to rely mainly on motorcycles as a relatively accessible means of transport to access the market. This study, therefore, sought to establish the determinants of the use of motorcycle means of transport among smallholder dairy farmers in Sotik Sub-County, Kenya. The Rational Choice Theory guided this study. A sample size of 384 smallholder dairy farmers was selected to participate in the study. Data was collected using a questionnaire. The primary data were analysed using STATA. The Standard Poisson model results revealed that age, education, and marital status of the household head, herd size, road condition, milk volume, distance to milk output market, and household size were significant contributors to the use of motorcycle services. These findings suggest that the county government could facilitate the development of innovative organisational structures such as cooperatives and other forms of producer groups. The improvement of road infrastructure, milk collection and milk processing units of suitable capacity could help to increase market access and enhance output milk market participation.
Keywords: Motorcycle services, motorcycle means of transport, smallholder dairy farmers, and Standard Poisson model
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1. Introduction

Dairy farming in Kenya was first practiced in the mid-1950s, and after independence, the livestock was transferred to the local communities. This marked the beginning of the dairy industry in Kenya. The institutions involved in the dairy sector in the country include regulators, suppliers, service providers, research and development organisations, and dairy farmer's organisations (Wangu et al., 2021). In the country, the sector is dominated by small-scale dairy farmers who own one to three dairy animals. Over 70 percent of the dairy farmers in the country are small-scale dairy farmers who contribute to about 80 percent of the milk produced in the country. The sector has also faced several challenges, including poor infrastructure, which hinders market accessibility, and a lack of suitable cooling and storage facilities (Zavala & Revoredo-Giha, 2022).

Kenya's dairy sector is strengthened by the possession of over 3 million dairy cattle; this contributes to over 85 percent of the dairy cattle in Eastern Africa. The consumption of dairy products in Kenya is mainly in the form of raw milk (only boiled). The liberalisation of the dairy industry in the country in 1992 led to the growth of the informal milk trade, where small-scale traders were involved in marketing raw milk (Kihiu, 2021). Dibaba (2017) indicated that 86 percent of Kenya's milk, projected at 5.2 billion litres annually, was sold by unorganised, small-scale dairy farmers in informal markets or consumed directly at home. The dairy sector generates 70 percent of more than 40,000 jobs in dairy marketing and processing. Even though this significant contribution of both the formal and the informal sectors, transportation and milk processing challenges are dominant in rural areas, which culminate in post-harvest milk loss exacerbated by the current processing capacities estimated at 4.5 million litres per day which is below the average daily production-which is estimated at 14.2 million litres.

Kenya's economy is primarily based on agriculture, contributing over 25% of the GDP (Onyalo, 2019). Agriculture and the rural development sector provide over 80% of employment and 60% of national income. Close to 80% of the population live in rural areas and derive much of their livelihood from crops and livestock (Salami et al., 2017). Livestock contributes over 40% of the agricultural GDP. The dairy industry, dominated by smallholder farmers, is the most developed livestock sub-sectors in Kenya and is comparatively well developed equated to the dairy industries of other countries in sub-Saharan Africa. Dairy is the most significant contributor to the livestock GDP. Small-scale agriculture in Kenya is grounded in rural areas where it is highly relied upon

by smallholder farmers' particularly smallholder dairy farmers, for their own and their family's livelihoods (Giller et al., 2021).

Smallholder dairy farmers play a crucial role in social and economic development (Gichohi, 2020). Smallholder dairy farmers in Kenya face market access challenges despite many attempts by the Government of Kenya to enhance the development of suitable infrastructure, specifically rural roads development, to boost the market access by smallholder farmers, including smallholder dairy farmers (Boulanger et al., 2022). Improved market access eventually culminates in poverty reduction, increased employment, and increased development among the smallholder dairy farmers. Access to market by smallholder dairy farmers is paramount in obtaining high revenue on their dairy products (Mwanga et al., 2019). Some of the challenges associated with inadequate market access in the agricultural sector include restriction of income-generation opportunities, reduction in the profitability levels of agricultural products, increased input costs, enhanced post-harvest losses, and reduction of incentives to participate in the market (Berut, 2020).

Extensive infrastructural constraints hinder the exploitation of market opportunities by smallholder dairy farmers (Bullock & Crane, 2021). These constraints undermine the development of the dairy products marketing system and lead to high marketing costs, high milk prices, low income, barriers to entry, and expansion by traders. Diverse scholars have noted market access challenges amongst the smallholder dairy farmers (Tavenner & Crane, 2018). Infrastructural constraints undermine the development of the dairy products marketing system and lead to high marketing costs, high milk prices, low income, and barriers to entry and expansion by traders (Tyag et al., 2019). Market access challenges among the smallholder dairy farmers have various adverse effects on dairy farming as a commercial activity. Usman and Callo-Concha (2021) further noted that poor market access influences aspects such as demand for agricultural products, prices of these products, smallholder incomes, food security, rural employment, and sustainability of agricultural growth. Therefore, market access is a crucial component of agricultural productivity amongst smallholder dairy farmers.

One of the main challenges affecting market access amongst the smallholder dairy farmers in rural areas is the poor infrastructure, particularly roads, which hamper transportation of dairy products like milk to market (Maindi et al., 2020). Road infrastructure challenges include poor rural road networks and infrastructure, lack of feeder roads into farms, and poor road quality that are not all-weather roads (Nyawo & Mashau, 2019). The road and transportation challenges significantly influence the economic viability of smallholder dairy farming. Due to transportation challenges, the smallholder dairy farmers, who constitute 70% of the total dairy producers, end up experiencing a substantial decline in the quantity and quality of marketable milk (Otieno, 2020). The perishability of the milk further leads to increased post-harvest losses whenever there are poor road networks and means of transport (Caixeta-Filho & Péra, 2018). The situation is further exuberated among the smallholder dairy farmers by inadequate cooling facilities. In rural areas, most smallholder dairy farmers lack adequate means of transporting milk to the market. These farmers, therefore, resort to means of transport that are clearly within their reach in terms of affordability, accessibility, reliability, and timeliness. Over the years, the modes of transporting milk to the market adopted by smallholder dairy farmers have advanced from donkey-pulled carts to the present-day motorcycle taxis popularly known as *Bodabodas*. Motorcycle taxis, commonly known as *Bodabodas*, have evolved as a dominant means of transport within rural areas (Atugi & Chrispen, 2018).

Motorcycle taxis derived the name *Bodaboda* as a corruption of the term "Border Border," which denotes their initial use within the Kenya-Uganda border primarily for smuggling purposes across the 1960s (Mugwe, 2018). Omar (2021) noted that motorcycles were widely used in rural areas due to poor road networks, which are not suitable for motor vehicle passage, availability, convenience, affordability, effectiveness, and efficiency aspects. Atugi and Chrispen (2018) further note that the popularity of motorcycle use stems from its perceived cost efficiency compared to other motorised transport and ease of maneuvering in impassable areas for motor vehicles. Another aspect is the ability to transport the passengers point-to-point, unlike the public motor vehicles that transport the passengers to a designated drop-off point (Janusz et al., 2019).

Bomet County Integrated Development Plan (CIDP) for 2018 to 2022 indicated that the significant economic activities in Bomet County are dairy farming, tea farming, and beef farming (Wairimu et al., 2021). The County has one milk processing plant situated in Sotik. Milk production is a significant economic activity in Sotik Sub-County. The County has constructed and installed equipment in 19 dairy cooling plants which in return have improved markets and milk prices while still generating employment opportunities. In Bomet County, dairy farming contributes approximately 30% and 40% of the total household income. The County's dairy sector, however, faces the challenge of poor market access partly due to poor infrastructure and poor access to accurate and timely market information (Marwa et al., 2020).

Kiprotich (2017) noted that the Sotik sub-county is one of the highest milk-producing areas within Rift Valley, with an estimated 19,481 dairy farmers. Kiprotich (2017) further evaluates that 95% of these farmers are smallholder dairy farmers. Tavenner & Crane (2018) noted dairy farming in Sotik provides a means of livelihood on a small scale, with every household having at least a single dairy cow for household consumption and milk sale. Despite the high milk production in the Sotik sub-county, access to the markets is hampered by the poor

infrastructure, which is amplified during the rainy season. Poor roads, which are mainly feeder roads, have contributed to high costs of transportation in rural areas among smallholder dairy farmers. This has, in turn, raised the transaction costs among the smallholder dairy farmers, the middlemen, and the final consumer. High transaction cost incurred by the smallholder dairy farmers decreases profits which culminates in a negative effect on dairy farm income generation and poverty eradication.

Several factors, including socio-economic and institutional factors, play a paramount role in decision-making concerning the mode of transportation among smallholder dairy farmers (Munyori, 2019). Nyasio (2021) pointed out that motorcycles are commonly used means of transport in accessing remote and rural areas of Kenya. Smallholder dairy farmers in the Sotik sub-county mainly rely on motorcycle operations for transporting their produce and farm inputs. Due to the poor condition of roads and the financial difficulty of many smallholder dairy farmers to afford better modes of transport, many farmers have shifted their reliance on motorcycles as a relatively accessible mode of travel to market. Despite the widespread usage of motorcycles by smallholder dairy farmers in Kenya, there is insufficient evidence regarding their influence on market access for smallholder dairy farmers. Thus there is a need for research to determine the effect of motorcycle means of transport on market access by smallholder dairy farmers in the Sotik sub-county, Kenya.

1.1.1 Road Infrastructure in Rural Areas

Road infrastructure is important for overall economic development. Despite the fact that billions of dollars have been spent in Africa to improve and rehabilitate transportation infrastructure, it has long been recognised that the transport sector's poor performance is due to far more than a lack of funds or technical capacity constraints (Okungu & McIntyre, 2019).

Good roads make it easier to transport milk, which is a perishable commodity, in the agricultural sector, particularly the dairy sector. Where roads are not well developed, rural areas are the primary producers of large volumes of milk and other agricultural produce. In Kenya, bad roads are common in most areas with high agricultural potential, particularly rural areas. According to Mutemim and Sakwa (2017), the main barrier to market access for smallholder dairy farmers has been transportation constraints in the form of a poorly maintained rural road network. Poor rural road maintenance makes it difficult for smallholder dairy farmers to market their products, limiting their access to the market (Tashobya, 2018). Smallholder dairy farmers' market access is heavily influenced by the state of rural transportation infrastructure. Smallholder dairy farmers in rural areas lack efficient transportation to reach the market. As a result, these farmers turn to modes of transportation that are clearly within their reach, based on affordability and dependability. Motorcycles have become the primary mode of transport for milk transportation to markets among smallholder dairy farmers in rural areas (Workman et al., 2018).

1.1.2 Rural Transport

The state of road infrastructure has a direct impact on transportation. The state of the road has an impact on the mode of transportation used by dairy farmers to transport milk to the market. Places with good roads allow for a variety of modes of transportation, whereas places with bad roads limit market access and transportation options. Moving milk from the farm to the market requires a well-developed transportation system. Rural transportation, according to Tamene and Megento (2019), is important in dairy farming because it affects dairy farm growth by affecting market access among smallholder dairy farmers and milk price fluctuations. Poor rural transportation raises marketing costs, which has a direct impact on dairy farmers' income (Diwakar et al., 2020).

Poor roads, which are unreliable during the rainy season, and limited modes of transportation with limited capacity and high unit transport costs obstruct access to the markets in Sotik. The high transportation costs in rural areas are blamed for the high cost of the transaction between smallholder dairy farmers, middlemen, and the final consumer (Ziad et al., 2019). The high transportation costs borne by smallholder dairy farmers reduce profits or lead to subsistence dairy farming, both of which have a negative impact on income generation among smallholder dairy farmers.

1.1.3 Use of Motorcycles

Bicycles and motorcycles primarily employed in transporting passengers and goods are locally christened *Bodabodas*. Their use is not only synonymous with the Kenyan context, but also their use cuts across many countries around the world. Motorcycles are mainly used in rural and remote areas (Nyaga, 2019). They are also employed in areas and instances where transport using other means is considerably difficult or uneconomical.

A study was conducted by Amamou et al. (2018) on the efficiency measurement of dairy farmers under integrated cropping systems in Pakistan. The study's objective was to investigate the different forms of farmer participation in milk supply and their productivity and efficiency in the dairy sector. The logit model, multi-output distance function, and stochastic frontier analysis were the methodology techniques used. It was revealed that milk marketing was much disorganised and dominated by middlemen. The study found that intermediaries'

transport means are motorcycles. They benefit from quick payments and no quality control issues because they sell directly to consumers or sweet shops, hotels, and restaurants. The study further showed that younger farmers show more interest and adaptability to change than elderly farmers. The young farmers are more efficient and work against the theory of distance to market to their advantage as the farms rent far from the market are cheaper, yield more products, and use cheaper transport of motorcycles.

In Nigeria, Ogunleye et al. (2018) carried out a study on the effect of transport on agricultural productivity. The scholars were determined to assess the influence of transport on farmers' productivity. The results indicated that in addition to walking, the significant modes of transport were bicycles, motorcycles, and cars. Still, motorcycles have dominated the industry due to their cost effectiveness for all walks of life. An empirical study was conducted by Kailembo (2013) on linking rural smallholder milk producers to urban markets in the Kibaha district, Tanzania. The objective of the study was to identify the marketing channels which offered a remunerative price for smallholder milk producers. The major challenge revealed by the study was the high cost of transportation of milk to the market. A recommendation was to form farmer organisations and employ motorcycle transport for reliability.

The identification of livestock investment opportunities in Uganda was studied by Bjorn et al. (2019). The study's objective was to identify the underlying opportunities in dairy farming in Uganda. The study revealed that the Ugandan government had created a conducive environment for farmers in the dairy sector, attracting more investors to the area. The study showed that due to poor infrastructure in rural areas, the government had subsidised the cost of motorcycles that offer cheap transport for farmers to and from the market. Karema (2015) conducted a study on the role of the commercial motorcycle on the rural economy in Laikipia East Sub-County. The study's objective was to determine the contribution of commercial motorcycles in promoting agriculture and poverty eradication. Results showed that agriculture growth depended on the trips made by the commercial motorcycles, referred to as *Bodabodas,* to and from the market. The study found out that motorcycles helped farmers to transport agricultural inputs and outputs and that the motorcycles were faster as compared to carts.

2. Theoretical Framework

2.1 Rational Choice Theory

In 1958, George Homans proposed the Rational Choice theory. Homans established the foundations of exchange theory, which were based on assumptions from behaviourist psychology. A reasonable choice is one that is made after considering a variety of options. The rational choice theory is based on the concept that people are rational and make decisions based on what they believe is the most effective way to achieve their objectives (Blossfeld & Prein, 2019). The rational choice theory usually starts by looking at the decision-making behaviour of one or more individual decision-making units. The rational choice theorist frequently assumes that the decision-making unit in question represents a larger group, such as buyers or sellers in a specific market (Schäfer, 2019). After determining individual behaviour, the study usually focuses on how individual decisions interact to produce results. Rational choice theorists argue that we must view individuals as rational decision-makers in a world of scarcity in order to better understand how and why they behave in specific ways, whether individually or socially. Human beings are purposive and goal-oriented, and every activity is driven by a goal or purpose, according to rational choice (Power et al., 2019). The theory is based on psychology and economics, which is known as the study of human decision-making. Individuals strive to achieve their objectives by acting rationally as their knowledge, resources, and circumstances allow.

The rational choice theory will be used to guide the research into how smallholder dairy farmers make transportation decisions. Smallholder dairy farmers are expected to make logical judgments about the mode of transportation to use to access the market. Smallholder dairy producers' transportation decisions are influenced by socio-economic factors, according to the study. As a result, smallholder dairy farmers are likely to be influenced by rational choice when it comes to mode of transportation.

When compared to the social exchange theory, the rational choice theory was the most acceptable theory to utilise as a guide for this study since it helps explain smallholder dairy farmers' individual and collective behaviours. It also aids in determining why people, communities, and society as a whole tend toward specific decisions that are based on specific costs and benefits. Furthermore, what appears to be "irrational" behaviour can be explained using the concept of rational choice. Because rational choice theory claims that all actions are rational, any activity can be analysed to discover if it is driven by rational considerations. The application of rational choice theory can foster inquiry and understanding, allowing various parties, such as a client and a vendor, to recognise and comprehend the thinking of the other (Bag et al., 2021).

2.2 Conceptual Framework

The link between the independent and dependent variables was visualised using the conceptual framework. This study was guided by the conceptual framework, which assumes that factors (Sex of household head, age of household head, education of household head, household size, marital status of household head, herd size and

distance to milk output market influence the frequency of motorcycle use as a means of transport among smallholder dairy farmers in Sotik Sub-County, Kenya as presented in figure 1.

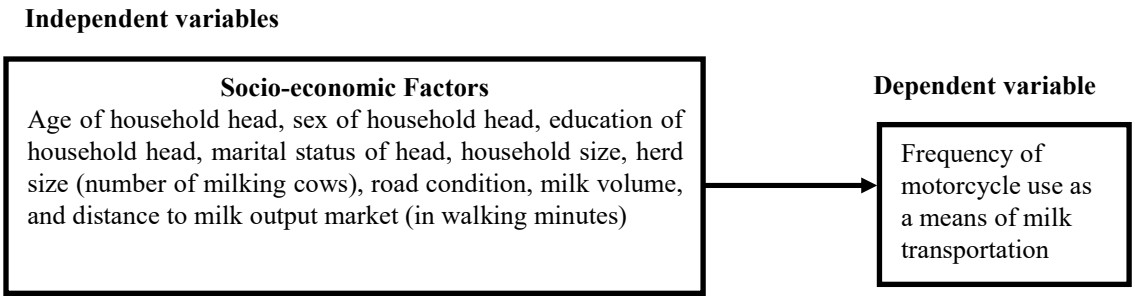

Figure 1. Conceptual Framework

3. Methodology

3.1 Study Area

The study was conducted in Sotik Sub-county, Bomet County. Bomet County lies between latitudes 0º 29′ and 1º 03′ South and between longitudes 35º 05′ and 35º 35′ East (Ronoh, 2020). Four counties, namely border it: Kericho to the north, Nyamira to the west, Narok to the south, and Nakuru to the north-east covering an area of 2,037.4 Km2. The higher altitudes (2,300m above sea level) in the northeastern parts of the County are particularly suitable for tea and dairy farming (Odero-Waitituh, 2017). The County has vast breeds of cattle such as Friesians, Ayrshire, Jersey, and crosses, among several others.

Nonetheless, dams are found in the drier zones of Chepalungu and parts of the Sotik sub-county, which has greatly influenced dairy farming in the area. Sotik Sub-county lies on the western part of Bomet County and is characterised as a highland zone. The Sub-county is the second-largest Sub-county in Bomet County, with an acreage covering an area of 479.2 Km2 with an estimated population of 227,855 people and a population density of 419 people per Km^2 (KPHC, 2019). The Sub-county has the Kipsonoi River, which flows through it to Lake Victoria. Sotik Sub-county comprises five wards; Ndanai/Abosi, Kipsonoi, Kapletundo, Chemagel, and Manaret/Rongena. Rainfall in the Sub-county is mostly evenly distributed, with a recorded annual rainfall of between 1000mm and 1400mm except for the short dry season in January and February. The temperature levels range from 16^0C to 24^0C, with the coldest months being between February and April, whereas the hot seasons fall between December and January. The even distribution of rainfall almost throughout the year promotes dairy production, the main economic activity in Sotik Sub-county. Friesian, Ayrshire, Jersey, and crosses are the main dairy breeds reared in the Sub-county. The average agricultural land area is estimated at 1.5 hectares per household. The largely rural Sub-county is constrained by a poor road network which mostly became impassable during the heavy rains. This makes accessing the market challenging for smallholder dairy farmers (Were, 2018). The study was conducted in three wards (Rongena, Chemagel, and Kipsonoi) of Sotik Sub-County in Bomet County since it hosts many smallholder dairy farmers who use motorcycle means of transport to transport milk to the market (CIDP, 2018). The map of the study area is shown in figure 2.

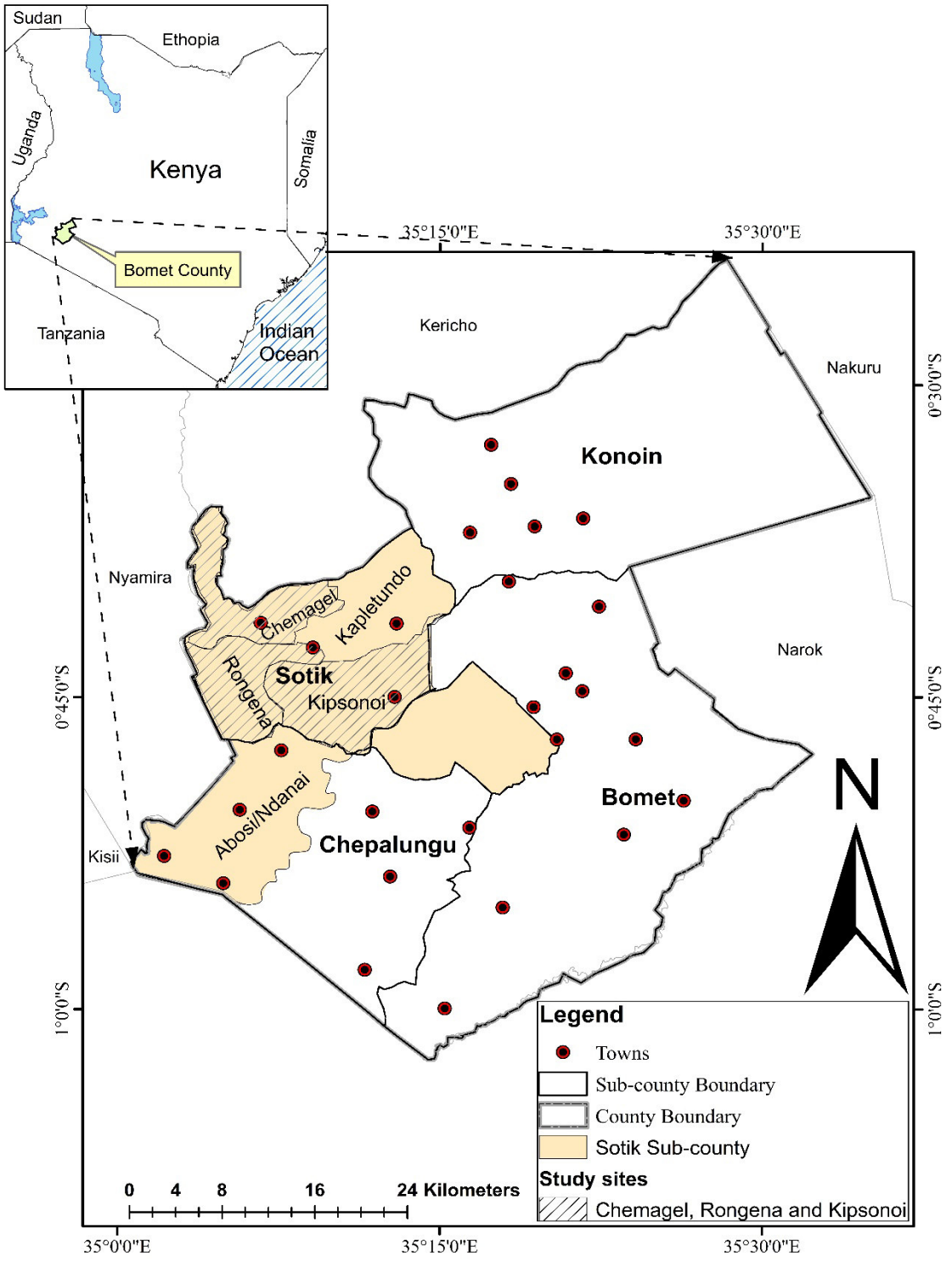

Figure 2: Map of Study Area (Sotik Sub-county)
Source: Egerton University Geography Department

3.2 Sampling Technique and Sample Size Determination

The study population comprised smallholder dairy farmers using a motorcycle in Sotik Sub-county. The multistage sampling procedure was used whereby in stage one, Sotik Sub-county was purposively selected since it has high dairy milk production potential. In stage two, three wards (Rongena, Chemagel, and Kipsonoi) were purposively selected from the five wards since they had many smallholder dairy farmers, according to the County Government of Bomet Integrated Development Plan 2018-2022. Finally, in the last stage, simple random sampling was used to select smallholder dairy farmers for interview proportionate to the population of each ward with farm households as the sampling unit. The required population sample for each ward was derived by

dividing the total population by award divided by the total population in all the three wards, then multiplied by the desired sample estimate of 384 households (Table 1).

The population of smallholder dairy farmers using motorcycle transportation was unknown; therefore, to determine the desired sample size, the formula specified by Cochran (2007) was used as shown below:

$$n = \frac{pqz^2}{E^2} \quad \text{.....1}$$

$$n = \frac{0.5 \times 0.5 \times 1.96^2}{0.05^2} = 384 \quad \text{.....2}$$

Where; n = Sample size; Z= confidence level (α=0.05); p = proportion of the population containing the major interest q = 1-p E= allowable error. Since the proportion of the population is not known, p= 0.5, q = 1- 0.5 = 0.5 and Z = 1.96. E (allowable error) = 0.05 was used since corresponds to a value of α = 1 - 0.95 = 0.05 (95% level of confidence). When a high level of precision is necessary, a researcher can increase or decrease the value of the margin of error, according to Story and Tait (2019). Because the study was based on primary data, which heavily relies on the recall method and is prone to inaccuracies, a 5 percent acceptable error was employed in this study. Three hundred eighty-four smallholder dairy farmers were chosen from the study region based on this. The sampling size distribution by ward is shown in table 1.

Table 1: Sampling Size Distribution per Ward

Ward	Approximate population 2019 census	Proportionate distribution formula	Sample size
Rongena	38,702	30,473*384/95,252	123
Chemagel	42,810	33,709*384/95,252	136
Kipsonoi	39,459	31,070*384/95,252	125
Total	120,971	Total	384

Source: Kenya National Bureau of Statistics 2019

Simple random sampling was used to select smallholder dairy farmers in each ward based on the sample size with farm households as the sampling unit.

3.3 Data Collection

A semi-structured questionnaire was utilised to collect primary data from smallholder dairy farmers for this study. Individual scheduled interviews were conducted by trained enumerators. The primary data was then analysed using STATA computer-aided programs.

3.4 Model Specification and Analysis

3.4.1 Factors Influencing the Use of Motorcycle Services

In this study, the use of motorcycles was measured as the frequency of use per month. The metric for the frequency of use is the number of times the farmer uses motorcycle services for milk transportation. Most studies measure specific means of transport service as a single outcome because it is an individual's specific choice to use a transport service. Hence, the study will model the determinants of transport service use poison regression model since the frequency of use is a count outcome. Following Cameron and Trivedi (2013), the observed frequency of use of motorcycle service by dairy farmers y_i , conditioned by a vector of covariates x_i , is a count variable that can be specified as follows:

$$f(Y = y_i) = \Pr(Y = y_i) = \frac{e^{-\lambda_i} \lambda_i^{y_i}}{y!} = \qquad y_i = 0,1,2 \quad \text{.....3}$$

Where a parameter μ_i is the conditional mean number of events for each explanatory variable. The parameter μ_i is given by

$$\mu_i = \text{Exp}(x_i'\beta) \quad \text{.....4}$$ Where β is a $(k+1)\,\text{x}1$ parameter vector with the β_0 parameter being the coefficient for the intercept, and $\beta_1, \beta_2, \beta_3, \ldots, \beta_k$ are coefficients associated with k regressors.

The Poisson model (Eqn. 3) was appropriate in estimating the relationship between the frequency of use of motorcycles and regressors. The Poisson model is based on the assumption that the count outcome variable's conditional variance equals the conditional mean (Cameron & Trivedi, 2013). Extensions of the Poisson, such as the over-dispersed Poisson, negative binomial and two-stage (hurdle) or zero-inflated models, were adopted

appropriately in case the assumptions regarding the distribution of the data (in particular, that the mean equals the variance are not tenable. The assumption that the mean equals the variance is expressed as follows:

$$V(y_i \mid x_i) = E(y_i \mid x_i) = \mu_{i,} \quad \ldots\ldots 5$$

Where y_i is the frequency of use of motorcycle services (non-negative integer), x_i is the vector of frequency of the use of motorcycle services, and μ_i is the conditional mean of the frequency of use of motorcycle services. The frequency of motorcycle use by farmers is a choice that is conditioned by individual preferences and other factors. As a result, it is expected that the number of times farmers use motorcycle services differs substantially.

The study anticipated that several factors influenced dairy farmers' frequency of motorcycle use. The factors reviewed in the literature include age, sex, marital status and educational attainment of the household head, road condition, household size, milk volume(marketable surplus), distance to milk output market (in walking minutes) and herd size (number of milking cows). The age, sex, marital status, distance to milk output market (in walking minutes) and educational attainment of the household head were expected to either positively or negatively affect the frequency of use of the motorcycle. Household size, road condition, milk volume (marketable surplus) and herd size were expected to be negatively or positively associated with the frequency of motorcycle use. Equation 6 presents the empirical model for the determinants of the frequency of motorcycle use, and table 2 shows the description of variables used and their apriori assumptions.

$$FBU = \beta_0 + \beta_1 AGE + \beta_2 SX + \beta_3 EDUC + \beta_4 MARST + \beta_5 HSZ + \beta_6 HERD + DST\beta_7 + RDC_8 + \beta_9 MILKVOL + \mu \quad \ldots\ldots 6$$

Table 2: Definition of Variables Included in the Poisson Model

Variable	Description	Measurement	Apriori Assumption
Dependent Variable			
FBU	Frequency of motorcycle use	Count	
Independent Variables			
AGE	Age of household head (Year)	Discrete	±
S.X	Sex of household head (1=Male, 0 Otherwise)	Binary	±
EDUC	Education of household head (years completed)	Discrete	±
MARST	Marital status of head (1=Single, 2=Married, 3=Widowed, 4=Divorced, 5=Separated)	Categorical	±
HSZ	Household size	Discrete	±
HERD	Herd size (no. of milking cows)	Discrete	±
DST	Distance to milk output market (in walking minutes)	Continuous	±
RDC	Road condition (1=All weather roads 2=Dry weather)	Categorical	±
MILKVOL	Milk volume(marketable surplus)	Continuous	±

4. Results and Discussion

4.1 Descriptive Statistics of Social Economic Factors of Study Population

The majority (52.86%) of the smallholder dairy farmers in Rongena, Chemagel, and Kipsonoi wards in the Sotik Sub-county were male compared to 47.14% female. The results imply that most households in Rongena, Chemagal, and Kipsonoi wards in the Sotik sub-county were male-headed. Consequently, the majority of the smallholder dairy farmers in Rongena, Chemagal, and Kipsonoi wards in the Sotik sub-county were married (90.10%) as compared to the 9.9% who were single. Table 3 presents percentage distribution results for the highest level of education attained by the household head.

Table 3: Percentage Distribution of Household Head by Level of Education

Level of education	Frequency	Percent
Masters	3	0.78
Bachelor	6	1.56
Diploma	36	9.38
Certificate	13	3.39
Secondary	162	42.19
Primary	155	40.36
No formal education	9	2.34
Total	384	100.00

Most smallholder dairy farmers' household heads were holders of the Kenya Certificate of Secondary School Education (KCSE) as indicated by Secondary level of education (42.19%). A small percentage (15.11%) of smallholder dairy farmers had attained the tertiary level of education (Table 3). Table 4 shows the percentage distribution of road conditions.

Table 4: Percentage Distribution of Road Condition

Road Condition	Frequency	Percent
All-weather roads	65	16.9
Dry weather roads	319	83.1
Total	384	100.0

Most (83.07%) of the roads in Rongena, Chemagal, and Kipsonoi wards in the Sotik sub-county are dry-weather roads, indicating that they are efficiently used only during dry seasons. Contrastingly, 16.93% of the roads in Rongena, Chemagal, and Kipsonoi wards in the Sotik sub-county were all-weather roads, indicating that they are usable during wet and dry seasons. Table 5 shows the descriptive statistics of continuous socio-economic variables used in the study.

Table 5: Descriptive Statistics of Continuous and Discrete Socio-Economic Variables (N=384)

Variable	Mean	Std. Dev.	Min	Max
Age	40.97	12.83	20	85
Household size	5.23	1.98	1	11
Herd size (number of milking cows)	2.13	0.85	1	5
Milk volume in litres (marketable surplus)	7.74	6.82	5	100
Distance to milk output market (in walking minutes)	48.85	68.68	10	900
Frequency of motorcycle use (monthly)	26.56	2.28	12	28

Averagely, smallholder dairy farmers in Rongena, Chemagel, and Kipsonoi wards in Sotik Sub-county were older people above 40 years old, suggesting that the youth believe that older people do dairy farming. Approximately five people reside in most smallholder dairy farmers' households (Table 5). The small dispersion from the mean number of milking cows could be attributed to the household income and the type of dairy production system practiced by the smallholder dairy farmer.

The average milk volume in litres (marketable surplus) produced by smallholder dairy farmers in Rongena, Chemagel, and Kipsonoi wards in Sotik Sub-county was approximately eight litres per day. The disparity in milk volume per day could be attributed to the breed of dairy cow, where pure breed produces more milk compared to cross breed and local breed. Household size could also affect the volume of marketable surplus, whereas a larger household size could result in a less marketable surplus because of household consumption. The average distance to the market in walking minutes was approximately 49 minutes, with the shortest distance at ten minutes and the longest distance at 900 minutes.

There was a small dispersion from the mean monthly frequency of motorcycle use (Table 5). This could be attributed to the milk volume in litres (marketable surplus) and the number of times the milk is collected from the smallholder dairy farmer per day, for instance, morning and evening.

4.3 Preliminary Diagnostics of Variables Included in the Standard Poison Model

Preliminary diagnostics for statistical problems of multicollinearity and heteroskedasticity were conducted for variables to be used in the econometric model analysis.

4.3.1 Multicollinearity Test

Multicollinearity, which is a state of very high inter-correlations or inter-association among the proposed independent variables, was tested using the variance inflation factor (VIF) for all continuous variables, and the results are presented in Table 6.

Table 6: Variance Inflation Factor Test Results for Continuous and Discrete Explanatory Variables

Variable	VIF	1/VIF
Milk volume	1.30	0.77
Herd size (number of milking cows)	1.27	0.79
Age of household head (Year)	1.14	0.87
Household size	1.13	0.88
Distance to the market (walking minutes)	1.71	0.59
Mean VIF	1.31	

There was no multicollinearity as indicated by 1/VIF > 0.2 and Variance Inflation Factor (VIF<10), agreeing with the finding of the study done by Thompson et al. (2017).

4.3.2 Heteroscedasticity Test

The White test was used to detect heteroscedasticity for all hypothesised explanatory variables, and the results are presented in Table 7. Unlike the Breusch-Pagan test, which would only detect linear forms of heteroscedasticity, the white test was preferably applied as it incorporates both the magnitude and the direction of the change for non-linear forms of heteroscedasticity (Uyanto, 2019). White's general test is a particular case of the Breusch-Pagan test, where the assumption of normally distributed errors has been relaxed.

Table 7: Test for Heteroscedasticity

Source	chi^2	df	*P*
Heteroscedasticity	76.58	185	1.0000
Skewness	9.20	18	0.9549
Kurtosis	1.02	1	0.3135
Total	86.80	204	1.0000

$chi^2(185) = 76.58$
Prob > $chi^2 = 1.0000$

There was no presence of heteroscedasticity detected, as a chi^2 of 76.58 was not significant (Table 7).

4.4 Determinants of the Use of Motorcycle Means of Transport Among Smallholder Dairy Farmers

In a poison regression analysis, the determinants of the use of motorcycles as a means of transport among smallholder dairy farmers in the Sotik Sub-County were determined. The results for the Poisson regression model are presented in Table 8.

Table 8: Standard Poisson Model Results for Factors Influencing Use of Motorcycle Services

Variables	**Coefficients**	**Dy/dx**
Age of household head	0.00071**	0.01876**
Sex of household head (1=Male, 0 Otherwise)	-0.00042	-0.01125
Education of household head	0.00850***	0.22573***
Household size	0.00437*	0.11617*
Marital status of household head	0.02759*	0.73286*
Herd size (number of milking cows)	-0.02127***	-0.56497***
Milk volume (marketable surplus)	0.00096*	0.02556*
Distance to the market (in walking minutes)	-0.00159***	-0.00343***
Road condition (1=All weather roads 2=Dry weather)	-0.01138***	-0.70688***
Road condition# Distance to the market(in walking minutes)	0.00080***	
cons	3.21150***	
Number of obs = 384		
Wald $chi^2(9) = 104.33$		
Prob > chi^2 = 0.0000 ***		
Pseudo R^2 = 0.0074		

Legend: * p<.1; ** p<.05; *** p<.01
Interaction

The age of the smallholder dairy farmers in Rongena, Chemagel, and Kipsonoi wards in the Sotik Sub-county was positively and significantly associated with the use of motorcycle services at a 5% level of significance. This implies that older farmers were more likely to use motorcycle services compared to younger ones. Factors associated with old age, such as a loss of energy and being more risk-averse, could contribute to the positive effect of age on the use of motorcycle services. This observation is consistent with that of Brar et al. (2018), who noted that the age of the dairy farmer was positively associated with the market channel choices, including mode of transport.

The sex of the household head had a negative and insignificant association with using motorcycle services.

The results suggest that the sex of the smallholder dairy farmer's households head in Rongena, Chemagel, and Kipsonoi wards in the Sotik Sub-county did not determine the use of motorcycle services. The findings are consistent with Salon and Gulyani's (2010) study, which found that the sex of the household head was an insignificant determinant of the mode of transportation choice.

The education of the household head was positively and significantly associated with the use of motorcycle services at a one percent significance level. This implies that educated smallholder dairy farmers in Rongena, Chemagel, and Kipsonoi wards in Sotik Sub-county were more likely to use motorcycle services. This could be attributed to a better understanding of post-harvest milk losses during milk transportation to the market. This observation conforms to Ndungu et al. (2019), who noted that educated smallholder dairy farmers better understand post-harvest milk losses during milk transportation to the market. The household size and marital status of the head were positive and significantly associated with using motorcycle services at a ten percent significance level. At a one percent significance level, herd size (number of milking cows) had a negative and significant influence on the use of motorcycle services. This implies that the number of milking cows does not translate to more milk volume. Instead, the breed of the dairy cow could result in more milk surplus enhancing the use of motorcycle services.

At a one percent significance level, road conditions had a negative and significant influence on the use of motorcycle services. The results suggested that poor state of the roads during wet seasons when the roads became nearly impassable in the Sotik sub-county, particularly in Rongena, Chemagel and Kipsonoi wards, reduce the use of motorcycle services by smallholder dairy farmers to access the market. These findings are consistent with the findings of Mbabazi (2019), who emphasised that unpaved road conditions negatively influenced rural transport services.

The distance to the market in walking minutes had a significant negative effect at a one percent significance level on the use of motorcycle service. This implies that the shorter distance in walking minutes reduced the frequency of use of motorcycle service since the smallholder farmer could carry the milk to the local market instead of using motorcycle service. The interaction between road conditions and distance to the market in walking minutes had a significant positive effect at a one percent significance level on the use of motorcycle service. This implies that the relationship between the poor state of roads and the distance to the market particularly in Rongena, Chemagel and Kipsonoi wards, favour motorcycle services by smallholder dairy farmers to access the market. The longer the distance to the market and the poor the state of roads culminates to increased use of motorcycle service.

At a ten percent significance level, milk volume had a positive and significant influence on the use of motorcycle services. The results suggested that higher milk volumes favour motorcycle services by smallholder dairy farmers to access the market. These findings are similar to Mutura et al. (2015), who accentuated that the volume of milk produced by the dairy farmer per day influences the choice of transport mode.

5. Conclusions and Recommendations

The significant contributors to the use of motorcycles as a means of transport among smallholder dairy farmers in Sotik Sub-County, Kenya, were; the age of household head, education of household head, distance to the market (in walking minutes), herd size (no. of milking cows), road condition, milk volume (marketable surplus), household size, and marital status of the household head.

The study recommends specific policy measures that seek to ensure that the county government makes significant improvements to road infrastructure to guarantee that dairy products such as milk, which are transported by motorcycle, reach the market on time, resulting in a reduction of post-harvest milk losses like milk spillage and milk spoilage. Milk value addition could enhance market access through motorcycle services.

Conflict of interests

The authors have not declared any conflict of interest.

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