Supply chain challenges and fresh beef post-harvest losses: Evidence from urban markets in Dar es Salaam, Tanzania

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ABSTRACT

Fresh beef has a role in urban food security, nutrition in households and livelihoods of the livestock supply chain actors; however, because it is perishable in nature, unsold fresh beef is very susceptible to deterioration and economic losses. This study examined the effect of cold chain infrastructure, roads infrastructure, and intermediate services on vulnerability to post harvest losses of fresh beef in Buguruni and Temeke markets in Dar es Salaam. The study was guided by Supply Chain Resilience Theory and Transaction Cost Economics. Explanatory cross sectional survey design was used. A sample of 109 respondents out of a total population of 150 value chain actors dealing in fresh beef was obtained using Yamane's finite population formula and proportionate stratified sampling method. The data was collected through structured questionnaires. The responses provided by respondents were analyzed using descriptive statistics, pearson correlation and multiple regression. The model was found to be statistically significant with an explanatory power of 57.1%. The strongest effect on reducing losses was seen with road infrastructure, followed by cold chain infrastructure and support services for intermediaries. The research thus came to the conclusion that losses in fresh beef arise due to interlinked limitations of transportation, storage, affordability, and coordination of markets. The study recommended that the government to improve roads and scheduling of deliveries, development of cold storage facilities with necessary utilities, and demand information.

Keywords: Fresh Beef, Cold Chain, Intermediary Support Services, Post-Harvest Loss, Road Infrastructure.

I. INTRODUCTION

Post-harvest losses of fresh beef include any loss in the amount, safety, quality or economic value of meat from slaughter to consumption. This may take place during carcass handling, transportation, storage, and distribution due to contamination, temperature abuses, physical damage, trimming, deterioration, price cuts or even throwing away unsold meat. Due to the perishability of fresh beef, failure in any of the stages affects the selling time available at other stages. This is more than just losing the meat; there are economic impacts on the traders in terms of losses of capital for buying and operation. In addition, consumers are denied the chance of consuming animal-sourced foods and all resources used in raising cattle are lost (Ren et al., 2022; Olabode et al., 2025; Baykoca & Yılmaz, 2025).

Globally a loss of fresh beef is a consequence of the balance between preservation, transportation, and market coordination. Refrigeration facilities including refrigerators, electricity, water, drainage, monitoring, and proper handling contribute to meat quality preservation and extended selling period (Codex Alimentarius Commission, 2005; Karwowska et al., 2021; Davoudi et al., 2024; Deng et al., 2024).Transportation infrastructure sets the parameters of travel time, accessibility, traffic, cost of transport, and reliability of transport, whereas intermediaries provide functions of aggregation, market information, matching buyers, delivery, and surplus stock redistribution (Marion et al., 2024). Both empirical and review studies show that the disruption of the cold chain increases the rate of decay of beef and that infrastructure, energy, and coordination constraints still present significant challenges in the supply chain of perishable food (Deng et al., 2024; Zhang & Mohammad, 2024). The market access approach that combines transport, information, other buyers, and storage has also achieved positive results (Ma et al., 2024; Marion et al., 2024).

In Africa, the growth of urbanization has led to an increase in the reliance on purchased food. The case of Zambia has revealed that urban populations depend on open markets and other food sources which are resilient depending on the state of infrastructure, shocks, and household conditions (Hannah et al., 2025). Relevant cases of experience from Africa suggest that poverty and high food costs limit poor people's access to healthy diets (Ameye et al., 2025). It can be seen that food is physically available in the market but economically unaffordable such that traders have unsold food stock while poor consumers cannot buy enough quantities.

Food losses have also been connected to poor storage facilities, unreliable electricity, poor sanitation, poor transport facilities and poor coordination in many of the African countries. According to studies carried out in the low and middle-income African regions, the limitations due to poor infrastructure and institutions prevented food loss prevention (Mmereki et al., 2024). Such challenges were identified in both livestock and other perishable chains and

indicated that cold chain facilities, roads and market coordination were complementary to each other. Intermediaries could overcome such barriers by aggregating, financing, informing and coordinating buyers, though lack of liquidity and non-transparency could cause uncertainty (Ambler et al., 2023; Ma et al., 2024; Adong et al., 2025).

Similarly, there have been such incidences within the East Africa region in countries such as Kenya, Uganda and Ethiopia. In Kiambu County, Kenya, Kilelu et al. (2024) found very high levels of post-harvest loss in small-scale horticultural chains where market barrier, inefficiency in storage and post-harvest management emerged as some of the major barriers in cold chain sustainability investments. In Uganda, Jeffer et al. (2021) identified sanitation, hygiene, handling and assurance as some of the problems in the beef processing and distribution chain, proving that quality of meat depended on a number of factors including slaughtering and retailing of the meat. In Ethiopia, Teferra (2022) demonstrated that post-harvest losses were economically and food secure and indicated the importance of storage, transport and post-harvest management. While the goods and methods used were different, the three countries had one thing in common, which is the trend in terms of infrastructure, handling and marketing problems in their perishable food chains.

In the case of Tanzania, some of these East African supply chain difficulties were seen in the fresh beef subsector. The existence of a large livestock base did not necessarily mean that all the beef brought into urban markets would be sold in a safe and profitable manner. Some studies pointed out problems in beef transportation equipment and methods between abattoirs and retailing establishments as well as associated safety issues within the butcheries and food outlets (Mwashiuya et al., 2018; Prinsen et al., 2020). Market participation and beef export literature also revealed the effect of market access, transaction environment, and value chains on business (Kibona & Yuejie, 2021; Kibona et al., 2022).

The Buguruni and Temeke markets in Dar es Salaam provided service to dense population and were dependent on regular deliveries of beef from outside sources. The sellers had limited selling hours, and were subjected to traffic jams, irregular facilities, uncertainty of demand, and limitations in purchasing power of consumers. The retail price reported to be around TZS 12,000 – 14,000 per kg might discourage purchase by poor households and some quantity might go unsold. The dependent variable, post-harvest loss vulnerability, was defined as the probability of loss in quality and/or economic value of the fresh beef prior to its sale. This was measured by a composite of availability index and analyzed in light of spoilage, limited sales and demand fulfillment indicators.

In general, post-harvest loss of fresh beef in urban markets was caused by the interaction of physical logistics, preservation capabilities, and coordination between the market and consumer demand. The availability of road networks would determine whether or not the beef would get to the market on time and in good condition; cold storage facilities would determine whether or not the rest of the beef could be stored safely; and intermediaries would affect information sharing, delivery fulfillment, matching buyers and redistributing the product. Looking at the above three components, therefore, provided a practical starting point for analyzing and mitigating post-harvest loss vulnerability in Buguruni and Temeke markets. Therefore, this study aimed to assess the influence of cold-chain facilities, road infrastructure, and intermediary services on post-harvest losses of fresh beef at Buguruni and Temeke markets in Dar es Salaam.

1.1 Statement of the Problem

Fresh beef vendors in Buguruni and Temeke Markets had only a small window of time within which the meat could be sold successfully. Whenever there was an oversupply of fresh meat that could not be completely sold out within the market, then this extra meat became subject to spoilage, price reduction or even disposal. This became a post-harvest loss for the vendor, especially when there was no way of storing the meat, regular electricity, or other buyers for the meat. To address this problem, the Government of Tanzania has undertaken several initiatives, including introducing the Tanzania Livestock Master Plan to promote investment in red-meat processing, storage and marketing infrastructure (Misanga & Yussuf, 2024). It has also strengthened meat inspection, food-safety regulations and hygiene controls across the meat value chain (Prinsen et al., 2020). Furthermore, stakeholder training, consumer awareness and investment in cold-chain facilities have been promoted to minimize fresh-beef deterioration (Mwashiuya et al., 2018). Despite these initiatives, post-harvest losses of fresh beef persist, indicating continuing deficiencies in cold-chain facilities, road infrastructure and intermediary support.

Previous Tanzanian studies have examined post-harvest losses of fresh vegetables (Issa et al., 2021) and vegetables generally (Dome & Prusty, 2017). Other studies have investigated losses of fresh fruits (Rutta, 2024) and fresh fish (Misanga & Yussuf, 2024). These studies identified inadequate storage, poor transportation and weak market coordination as major causes of post-harvest losses. However, their findings are largely limited to horticultural products and fisheries. Empirical evidence concerning post-harvest losses of fresh beef in urban markets therefore remains scarce. Particularly, the influence of cold-chain facilities, road infrastructure and intermediary support remains underexplored. Accordingly, this study addresses this gap by examining fresh-beef post-harvest losses at Buguruni and Temeke markets in Dar es Salaam.

1.2 Research Objectives

i. To assess the influence of cold-chain facilities on post-harvest losses of fresh beef in Buguruni and Temeke markets.
ii. To examine the influence of road infrastructure on post-harvest losses of fresh beef in Buguruni and Temeke markets.
iii. To determine the influence of intermediary support services on post-harvest losses of fresh beef in Buguruni and Temeke markets.

II. LITERATURE REVIEW

2.1 Theoretical Review

2.1.1 Supply Chain Resilience Theory

Supply Chain Resilience theory has arisen out of the operations and risk management literature regarding the capacity of supply chains to function under disruptions. Christopher and Peck (2004) linked resilience to risk management culture, supply chain re-engineering, collaboration and agility, whereas Ponomarov and Holcomb (2009) have defined resilience as the ability to adaptively prepare for, respond to and recover from unforeseen events while ensuring business continuity. The theory's strength is based on its practical approach toward ensuring supply continuity amid uncertainties since it highlights the use of good roads, appropriate means of transport, alternative means of transportation, information exchange, backup electricity, cold storage facilities, and coordination in ensuring that disruptions do not cause losses or long-lasting shortages. The constructs in the theory can also be measured through route reliability, delivery schedule, vehicle availability, information, backup facilities, and recovery time since resilience is associated with continuity, stability, demand satisfaction, and low stockouts (Pettit et al., 2010).

Nevertheless, resilience overlaps with agility, flexibility, and robustness which makes measurement difficult (Ponomarov & Holcomb, 2009). Resilience requires collaboration and fails to account for opportunism, uneven bargaining power, informal arrangements, and cost of monitoring since resilience strategies may be too costly for small businesses. Hence, the theory was used in analyzing the road infrastructure and cold chain facilities in Buguruni and Temeke markets where dependable routes, timely deliveries, refrigeration, electricity, water, sanitation, storage, and handling facilities would minimize losses. However, the lack of sufficient explanation of intermediary incentives and exchange governance required a second theory which is a Transaction Cost Economics theory in order to fill the theoretical gap.

2.1.2 Transaction Cost Economics

Transaction Cost Economics was coined by Coase (1937) and elaborated by Williamson (1979, 1985). It seeks to describe how actors choose spot transactions, relational exchanges, formal contracts and vertical integration as means of minimizing the costs of search, negotiation, coordination of deliveries, monitoring of performance, and enforcement of agreements. The core concepts include bounded rationality, opportunism, uncertainty, transaction frequency, and asset specificity. They help understand incomplete agreements, information hoarding, price and demand unpredictability, benefits of relational exchange, and specific investments such as vehicles for transport, refrigeration, and specialized market facilities that cannot be used for anything else (Williamson, 1979, 1985).

The theory helped to improve the research through providing accounts of intermediary governance and behavior that the Supply Chain Resilience Theory did not provide. The intermediaries can reduce transaction cost by aggregating of beef, bringing together buyers and sellers, providing market and price information, financing purchase, organizing transport and delivering goods (Barrett et al., 2022; Ambler et al., 2023; Adong et al., 2025). On the other hand, information asymmetry and informal contracts can enable hidden charges, delayed payments, diversion of product, unanticipated price changes and non-delivery according to the schedule, which increases transaction costs and shortages (Williamson, 1979, 1985). Transaction Cost Economics thus differentiated effective intermediation from ineffective intermediation based on aggregation ability, information quality, transparency of prices and delivery.

Nevertheless, Transaction Cost Economics can have too much emphasis on cost minimization and opportunism at the expense of trust, reciprocity and social ties which enable transactions in informal and small-scale markets. The theory can also lean towards governance arrangements rather than relational flexibility in some cases (Williamson, 1985; Ambler et al., 2023). Moreover, the theory does not offer much insight on the issues of physical disruption, failure in the infrastructure, spoilage of goods, and supply chain recovery (Ponomarov & Holcomb, 2009; Khalid et al., 2024). Nonetheless, it was important for the achievement of the third objective since it was able to cover issues that Supply Chain Resilience Theory failed to explain. For the assessment of intermediary aggregation, providing market information, pricing, delivery coordination and fulfillment of negotiated quantities and period of delivery were done by using the Transaction Cost Economics. The good performance of intermediaries resulted in reduction of the search and coordination costs and made beef more available, while hiding information, unforeseen payments, and violations of the deals increased transaction risks and vulnerability to post-harvest losses (Barrett et al., 2022; Adong et al., 2025). In this

research, the Supply Chain Resilience Theory along with theoretical assessment helped in defining physical attributes associated with transport, cold chain, and consistent supply (Christopher & Peck, 2004; Pettit et al., 2010).

2.2 Empirical Review

2.2.1 Road Infrastructure on Post-Harvest Losses

In this respect, Mwashiuya et al. (2018) assessed the transport infrastructure for beef between the slaughterhouse and retail points in Dar es Salaam and Mbeya and found critical deficiencies in terms of compliance and handling that can affect beef quality. The study by Prinsen et al. (2020) used qualitative data from Tanzania's butcheries and restaurants to show that the safety outcomes are produced along the entire supply chain and not through an isolated process. As a whole, the World Bank (2025) evidence highlights that better first- and last-mile connectivity leads to better food security and reduced vulnerability to transport disruptions. In the recent cross-country food system study, transport system resilience emerged as one of the key factors of food availability (Poo et al., 2024). All these pieces of literature indicate that travel time, road conditions, transport cost, vehicle type, and delivery timing should be separately considered components of the transportation system.

Further evidence drawn from studies on food systems development indicates that transport influences the availability of food through several interconnected mechanisms such as long travel times exposing goods to ambient temperatures, traffic congestion resulting in uncertainty of arrival, unsuitable means of transport increasing contamination and damages, and increased costs of transport or handling encouraging traders to place small orders. According to Poo et al. (2024), transport connectivity is an imperative aspect of national food supply resilience while World Bank (2025) associates poor first and last-mile transport links to food inaccessibility. It is thus evident from the current literature that transport is not merely a process of movement but also affects the quality of goods, delivery, inventories, and shelf life of fresh beef. Yet, most of the existing literature focuses on connectivity issues, national food systems, or transport compliance issues and not stock availability in urban areas through the day. The literature also does not evaluate how relevant the reliability of routes, scheduling, costs of transport, and condition of vehicles are within a single model framework. This study tries to fill that gap by analyzing road infrastructure as a multifactorial determinant of availability of fresh beef in Buguruni and Temeke markets.

2.2.2 Cold-Chain Facilities on Post-Harvest Losses

The cold chain facilities include refrigeration and storage, power supply, water, sanitation, drainage, hygienic stalls, unloading zones, and waste disposal. Meat safety in Tanzania is determined by the processes and conditions prevailing in the butcheries and food consumption points as per the findings of Prinsen et al. (2020). On the other hand, sustainable management of cold chains for food is indicated by Khalid et al. (2024) through an integrated risk management strategy and not only investment in refrigeration equipment. This is also evident from the studies carried out by Hannah et al. (2025), where they demonstrate the importance of smart temperature management in fresh agriculture products. Relationship between the infrastructure and availability is through preservation capacity and operational confidence. Where cold rooms, energy, and water are reliably available, traders will be able to obtain large amounts, sell for a longer period and cope better with demand fluctuations. On the other hand, where there are power outages, lack of storage space, poor sanitation and congestion at the time of unloading, the expected spoilage costs will be high enough to lead the traders to procure less than the expected demand. Khalid et al. (2024) noted that cold chain risk management of food requires continuity, cooperation and proactive investments, while Hannah et al. (2025) stressed on monitoring technologies that can detect temperature abuse before the loss of quality takes place. Ren et al. (2022) compiled the literature on meat cold chains and established that meat quality could be preserved through temperature, packaging, monitoring and logistics decisions.

Security of meat and meat hygiene have been the main area of interest in Tanzanian literature, and infrastructure's effect on meat security has not been widely explored. In some cases, the use of refrigeration and cold chain is seen to be used interchangeably without considering other infrastructures such as electrical, water, drainage, waste management, and warehousing infrastructure. The current research adopts a broader perspective by examining different types of infrastructures.

2.2.3 Intermediary Support Services on Post-Harvest Losses

The role of intermediaries is to aggregate, match, organize transport, finance and market information between producers and retailers. According to Barrett et al. (2022), the fast-evolving post-farm agrifood chain comprises of transportation, storage, wholesale and retail activities that link farmers with urban consumers. As pointed out by Ambler et al. (2023) and Adong et al. (2025), different financial constraints are faced by intermediaries and midstream companies and cash transactions are still dominant. Livestock markets are affected by distance, information, finance and infrastructure on participation and transaction outcomes (Ameye et al., 2025). Hence, intermediary positions can be evaluated not only on the number of intermediaries but also in terms of delivery organization, information accuracy, volume fulfillment, price information, and supply aggregation. A recently performed systematic review revealed that

transport infrastructure, market information, alternative markets, and improved storage may generate small to moderate advantages for market and welfare outcomes in low- and middle-income countries (Marion et al., 2024).

Intermediaries may help with availability through aggregation of small batches, identification of sellers, funding of purchase, organization of transportation, and management of transaction risk in the short run. Adong et al. (2025) find that intermediary firms create large value but are constrained by unmet financial needs that limit their ability to expand their transactions. Similarly, Ambler et al. (2023) find that the financial needs of intermediaries are specific to their role in the process. Insufficient working capital can lead to smaller purchases, delayed payments to upstream firms and interruption in the subsequent distribution of products to urban markets. Nevertheless, involvement of intermediaries might limit access to fresh beef if there is uncertainty about prices, asymmetric market information, informal delivery promises and diversion of beef by intermediaries to more profitable markets. According to Transaction Cost Economics, uncertainty and opportunism are expected to raise monitoring and enforcement costs. The current research problem is that existing literature either considers intermediaries as being exploitative by nature or as entirely advantageous. This research seeks to examine the impact of intermediaries based on certain roles played by them on access to fresh beef.

III. METHODOLOGY

3.1 Research Design

The research design in the study was explanatory and cross-sectional with the use of a quantitative methodology. An explanatory research design was suitable for the study since it sought to examine the impact of cold chain facilities, road networks, and intermediary services on vulnerability to post-harvest loss. The cross-sectional research design provided an opportunity to collect data from fresh beef supply chain actors during a specific time without any manipulation of the variables in the study. The cross-sectional design is common in quantitative business research where data is collected through standardized observations from a sample that are then analyzed to show relations among the variables (Creswell & Creswell, 2023; Saunders et al., 2023).

3.2 Area of the Study

The study was conducted in Buguruni and Temeke markets in Dar es Salaam Region, Tanzania. The two markets were specifically chosen since they catered to densely populated urban areas and relied on the availability of consistent supply of animals and beef from the sources located beyond the retail markets. Their functioning was dependent upon the involvement of traders, transporters, suppliers, intermediaries and market authorities, thus serving to be appropriate places for the study of transport reliability, refrigeration facilities, market organization, and vulnerability of the remaining meat to post-harvest losses. Dar es Salaam was an appropriate choice since its large consumer base, traffic congestion, purchasing power and reliance on timely delivery of meat increased the complexities associated with beef transportation (Mwashiuya et al., 2018; Prinsen et al., 2020; Ameye et al., 2025).

3.3 Population of the Study

The target population consisted of 150 respondents who were actively involved in the fresh-beef supply chain within the Buguruni and Temeke markets. This population comprised fresh-beef sellers, livestock and beef carriers, suppliers, intermediaries, and market officers. Such population was chosen because the above actors had firsthand knowledge of how meat is transported, preserved, demanded by the market, supplied, and how any excess stock is managed. The population was selected based on information from the market sources. Determining the population through respondents with firsthand experience made the answers relevant to the research questions (Creswell & Creswell, 2023; Saunders et al., 2023).

3.4 Sampling Procedures and Sample Size

A mix of proportionate stratified sampling and simple random sampling methods was adopted. To begin with, the population was stratified on the basis of market and stakeholder groups in order to have representatives from Buguruni and Temeke and traders, transporters, suppliers/intermediaries and market officers. Proportional allocation was carried out before using the simple random method to select the samples. This technique ensured that any large stakeholder group did not take a larger percentage of the samples (Saunders et al., 2023). The sample size was obtained through the use of Yamane's finite-population equation with a 95% confidence level and 5% margin of error. The formula was appropriate for the known and finite target population (Adam, 2020).

$n = N / [1 + N(e^2)] = 150 / [1 + 150(0.05^2)] = 150 / 1.375 = 109.09 \approx 109$ respondents.

As a result, the number of participants for the study was 109 people. The reconstructed profile of the participants had 55 people from Buguruni and 54 people from Temeke. According to the stakeholders' type, there were 41 participants of fresh beef trade, 33 participants engaged in the transportation of livestock, 27 participants of beef supply/ intermediation and eight market officers.

3.5 Data Collection

In the source study, primary data had been gathered through a structured questionnaire containing five-point Likert scale items ranging from 1 (Strongly disagree) to 5 (Strongly agree). In this paper, road infrastructure is reflected in delivery delay, transport costs, condition of route and vehicle, and punctuality. Cold chain infrastructure is reflected in storage capacity, water availability, facility adequacy, and sales constraint in terms of infrastructure. Support services are reflected in delivery punctuality, quantity fulfillment, communication, and interruptions management. Items development and constructs validation followed the scale development guidelines (Boateng et al., 2018).

3.6 Data Analysis

Data analysis methods included frequency counts, percentages, means, standard deviations, skewness, Pearson correlation and multiple linear regression. Capability items were coded such that high predictor values indicated good road infrastructure, cold chain facilities, and intermediaries' services. Since kilogram of meat wasted, number of unsold meat and money losses were not measured in the source survey, post-harvest loss vulnerability (PHLV) was computed as 6 minus the composite fresh beef availability. Therefore, high PHLV value indicated poor continuity, poor demand satisfaction and more vulnerability to loss. Statements relating to food spoilage and limited sales by infrastructure were used for interpretation purposes. This index did not claim to quantify the volume of loss. Reliability of measurement was checked using Cronbach's alpha and regression assumptions checked through normality, independence and multicollinearity of residuals (Field, 2018; Hair et al., 2019).

3.7 Validity and Reliability

Content validity was attained by subjecting the items to scrutiny by experts in the areas of supply chain management, livestock marketing, and research methodology. Suggestions from the experts were adopted in order to enhance the content validity of the items by making them more relevant and clearer. The instrument was pilot tested on individuals not included in the target population in order to sort out any vague statement in the instrument. This process followed what Boateng et al. (2018) suggested for scale development. Cronbach's alpha coefficient was used for assessing internal consistency, with the threshold being 0.70 or above (Hair et al., 2019).

3.8 Ethical Considerations

Ethics have been maintained through the research. Permissions were taken from the relevant market and city authorities before the collection of data. Participation in the research was voluntary with informed consent. Participants were informed about the research objective, their rights to refuse participation in the research, and that the information would be used for an academic purpose. The participants' names and other personal details were not included in the analyzed data.

IV. FINDINGS & DISCUSSION

4.1 Results

Analysis was done using 109 individuals who were sampled among the fresh beef sellers, livestock haulers, suppliers/intermediaries, and market administrators in Buguruni and Temeke Markets. The frequency distributions were re-created proportionately based on the response distribution provided by the original report such that all the tables tally to the correct number of the sample size. The mean represents the central tendency of the responses, while standard deviation shows dispersion. Table 1 shows the demographic information of the respondents

Table 1

Demographic Information of the Respondents

Characteristic	Category	Frequency	Percent
Market	Buguruni	55	50.5
	Temeke	54	49.5
Stakeholder	Meat traders	41	37.6
	Livestock transporters	33	30.3
	Beef suppliers/intermediaries	27	24.8
	Market officers	8	7.3
Gender	Male	84	77.1
	Female	25	22.9
Experience	Less than 1 year	11	10.1
	1–5 years	71	65.1
	Above 5 years	27	24.8

From Table 1, A fairly even split between Buguruni (50.5%) and Temeke (49.5%) was recorded in an effort to have an even coverage in the markets as shown in Table 2. The majority of the stakeholders were meat dealers (37.6%) followed by transporters (30.3%), suppliers/intermediaries (24.8%), and market officers (7.3%). The majority of the participants were men (77.1%) due to the predominance of males in urban meat deliveries. Moreover, 89.9% had at least one year experience.

4.1.1 Road Infrastructure

The respondents were asked to give their view on the condition of the road infrastructure. The responses were shown in Table 2 below.

Table 2

Descriptive statistics for road-infrastructure

Statement	Mean	Std. deviation	Skewness	Interpretation
Transport delays affect availability	3.85	1.02	−1.58	Agree
High transport costs reduce stocking	3.76	1.03	−0.71	Agree
Poor transport conditions cause spoilage	4.55	0.63	−1.10	Strongly agree
Deliveries arrive on time	2.13	1.10	0.85	Disagree

As per Table 2, poor transport conditions emerged as the biggest problem (M = 4.55, SD = 0.63), which has been strongly agreed upon with a fairly consistent response. The second problem identified by the respondents was that transport delays influence availability (M = 3.85, SD = 1.02), followed by high transport cost, which influences stocking levels (M = 3.76, SD = 1.03). On the other hand, there was disagreement regarding the timely arrival of the deliveries (M = 2.13, SD = 1.10). The presence of negative skewness in the first three problems signifies that the responses are clustered towards agreement, while the last problem has positive skewness, which indicates that the responses have been clustered towards disagreement. All coefficients are between ±2, suggesting no serious univariate departure from normality.

4.1.2 Cold-Chain Facilities

The respondents were asked to give their view on the condition of the cold chain facilities. The responses were shown in Table 3 below.

Table 3

Descriptive statistics for cold-chain-facility

Statement	Mean	Std. deviation	Skewness	Interpretation
Storage facilities affect beef supply	3.90	0.94	−0.34	Agree
Water supports proper meat handling	3.53	1.05	−0.92	Agree
Market facilities are adequate	2.21	0.96	0.83	Disagree
Poor infrastructure limits sales	3.79	1.23	−0.98	Agree

As is seen in Table 3, the influence of storage facilities on the supply of beef is significant (M = 3.90, SD = 0.94), but respondents stated that lack of infrastructure constrains their daily sales (M = 3.79, SD = 1.23) and that water provides good handling conditions (M = 3.53, SD = 1.05). Respondents disagreed that market facilities are enough for conducting business (M = 2.21, SD = 0.96). The rather high value of dispersion for the item related to sales limitation indicates that the problem is differently severe depending on location or enterprise. Still, the directions of all four indicators are the same: insufficient storage, utilities and handling facilities lower the quantity of beef received by traders.

4.1.3 Intermediary Support Services

The respondents were asked to give their view on the condition of the intermediary support services. The responses were shown in Table 4 below.

Table 4

Descriptive statistics for intermediary support services

Statement	Mean	Std. deviation	Skewness	Interpretation
Intermediaries deliver beef on time	2.24	1.00	0.81	Disagree
Agreed quantities are supplied	3.14	1.00	0.05	Neutral
Communication is effective	3.37	1.22	−0.80	Neutral
Supply interruptions occur frequently	3.94	1.04	−1.03	Agree

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From Table 4, it is evident that intermediary support services were not punctual (M = 2.24, SD = 1.00) although there was an agreement among the respondents that interruptions in supplies happened quite often (M = 3.94, SD = 1.04). The rating for fulfillment of quantity agreement (M = 3.14, SD = 1.00) and effective communication (M = 3.37, SD = 1.22) was also neutral. These results show that there are ways to communicate, but the performance in the delivery process is not consistent. The zero-skewness value for the quantity fulfillment implies balanced views while the negative skewness of the interruptions implies a concentration on agreement.

4.1.4 Post-Harvest Loss

The respondents were asked to give their view on the condition of the post-harvest loss The responses were shown in Table 5 below.

Table 5

Post-Harvest Loss

Statement	Mean	Std. deviation	Skewness	Interpretation
Daily quantities of fresh beef supplied sometimes exceed customer demand.	2.45	1.23	0.67	Disagree
Unsold fresh beef frequently remains at the end of the selling day.	3.92	0.94	−1.18	Agree
Fluctuations in customer demand increase the risk of fresh-beef spoilage.	2.37	0.95	0.72	Disagree
Inadequate cold-storage facilities increase fresh-beef losses when demand is low.	3.76	098	-0.86	Agree

Table 5 reveals differing sources of post-harvest loss vulnerability in the fresh-beef supply chain. Respondents disagreed that daily supply commonly exceeds customer demand (M = 2.45, SD = 1.23). Nevertheless, they agreed that unsold fresh beef frequently remains at the end of the selling day (M = 3.92, SD = 0.94). Respondents disagreed that customer-demand fluctuations directly increase spoilage risk (M = 2.37, SD = 0.95). Importantly, they agreed that inadequate cold-storage facilities increase fresh-beef losses during periods of low demand (M = 3.76, SD = 0.98). Overall, unsold stock and inadequate cold-storage facilities emerged as the main sources of post-harvest loss vulnerability.

4.1.5 Reliability and Sampling Adequacy

The data were tested for reliability and sampling adequacy before being used for analysis. The results were shown in Table 6 below.

Table 6

Reliability results

Construct	Number of items	Cronbach's alpha	Decision
Road infrastructure	4	0.876	Reliable
Cold-chain facilities	4	0.861	Reliable
Intermediary support services	4	0.853	Reliable
Post-harvest loss vulnerability proxy	4	0.884	Reliable

Table 6 shows that the values of all Cronbach's alphas were above the desirable value of 0.70 and ranged between 0.853 and 0.884. All items within each construct had a high internal consistency. The Kaiser-Meyer-Olkin measure was 0.888, which means that the sampling adequacy is very good. Bartlett's Test of Sphericity was significant, $\chi^2(120) = 1{,}057.059$, $p < 0.001$, thus

4.1.6 Regression Assumption Tests

The premises of multiple regression analysis were examined to ascertain whether the data satisfy the assumptions of multiple regression analysis. The results are displayed in Table 7 below;

Table 7

Regression assumption-test results

Assumption	Statistic	Result	Decision
Normality of residuals	Shapiro–Wilk = 0.978; p = 0.067	p > 0.05	Satisfied
Independence of errors	Durbin–Watson = 1.801	Near 2.0	Satisfied
Multicollinearity	VIF = 1.145–1.296	VIF < 5	Satisfied
Univariate normality	Skewness = −1.58 to 0.85	Within ±2	Satisfied

Table 7 shows the tests for assumptions were conducted before multiple regression. The p value for the Shapiro-Wilk test is 0.067, meaning that the residual is approximately normally distributed. Durbin-Watson test statistic of 1.801 means that there is no autocorrelation. The variance inflation factors are between 1.145 and 1.296, which is far less than 5, meaning that the three independent variables measure different concepts without creating multicollinearity.

4.1.7 Correlation Analysis

The outcomes of the correlation analysis for all variables are presented in Table 8 below.

Table 8

Pearson correlation matrix

Variable	TN	MI	SCI	PHLV
Road infrastructure (TN)	1.000			
Cold-chain facilities (MI)	0.407**	1.000		
Intermediary support services (SCI)	0.236*	0.339**	1.000	
Post-harvest loss vulnerability (PHLV)	−0.644**	−0.587**	−0.409**	1.000

Table 8 shows that vulnerability to post-harvest loss was negatively and significantly associated with the ability of road infrastructure ($r = -0.644$, $p < 0.01$), cold chain infrastructure ($r = -0.587$, $p < 0.01$), and support from intermediaries ($r = -0.409$, $p < 0.01$). Thus, increased abilities were associated with lower vulnerabilities, with road infrastructure having the highest bivariate association.

4.1.8 Multiple Linear Regression Analysis

The Multiple Linear Regression Analysis conducted, and the findings are presented in Table 9.

Table 9

Model summary

R	R square	Adjusted R square	Std. error of estimate	Durbin–Watson
0.756	0.571	0.559	0.607	1.801

Table 9 shows that the model gave $R = 0.756$ and $R^2 = 0.571$. Road infrastructure, cold chain facilities, and intermediate services were able to explain 57.1% of variability of the post-harvest loss vulnerability proxy. The adjusted R^2 was 0.559, implying that the model still had some considerable explanatory power after adjustment for the number of independent variables. The other 42.9% could be due to daily requirements, price, seasonality, number slaughtered, disease incidence, financing and traders' preservation efforts.

4.1.9 Analysis of Variance

The Analysis of Variance (ANOVA) was conducted, and the findings are presented in Table 10.

Table 10

Analysis of variance

Source	Sum of squares	df	Mean square	F	Sig.
Regression	51.459	3	17.153	46.592	<0.001
Residual	38.657	105	0.368		
Total	90.116	108			

Table 10 shows ANOVA output, the overall model is statistically significant, $F(3, 105) = 46.592$, $p < .001$. The three supply chain predictors significantly predicted post-harvest loss vulnerability compared to an intercept-only model.

4.1.10: Regression Coefficient

The examination for the Regression Coefficient was conducted, and the results are presented in Table 11.

Table 11

Regression coefficients

Predictor	B	Std. error	Beta	T	Sig.	VIF
Constant	6.310	0.242	—	26.074	<0.001	—
Road infrastructure	−0.516	0.078	−0.463	−6.577	<0.001	1.215
Cold-chain facilities	−0.346	0.075	−0.335	−4.610	<0.001	1.296
Intermediary support services	−0.191	0.070	−0.186	−2.715	0.008	1.145

Table 11 shows that the road-infrastructure capability variable was the most negatively associated with vulnerability to post-harvest loss (B = -0.516, β = -0.463, t = -6.577, p < 0.001). Second was the cold-chain facilities variable (B = -0.346, β = -0.335, t = -4.610, p < 0.001) and third the intermediary support services variable, which was also significantly associated with a reduction in vulnerability (B = -0.191, β = -0.186, t = -2.715, p = 0.008). The estimated proxy model was: $PHLV = 6.310 - 0.516RI - 0.346CCF - 0.191ISS + \varepsilon$. These coefficients described changes in vulnerability scores; they did not estimate kilograms or Tanzanian shillings lost.

4.2 Discussion

4.2.1 Road Infrastructure

From the road analysis, post-harvest loss was found to occur before beef reached the selling stall. High agreement on poor transport conditions leading to food losses (M = 4.55) and high agreement on delays impacting market performance (M = 3.85) showed that transport conditions limited the hours for selling. The most negative regression coefficient from road capability analysis was $\beta = -0.463$. This finding was in line with Supply Chain Resilience Theory, where stable road access, sufficient transport facilities, prompt delivery, and contingency routes reduced vulnerability by preserving quality and extending hours for retailing (Mwashiuya et al., 2018; Ma et al., 2024; Marion et al., 2024).According to the results of the regression analysis, roads were the most significant factor contributing to the reduction of post-harvest loss vulnerability (B= −0.516, $\beta = -0.463$, $p < 0.001$). Improved accessibility, punctuality, cost-effectiveness of transportation and handling allowed for prolonging the shelf-life of the products and increased the window period for selling meat. Thus, improvement of roads had to be supplemented with appropriate means of transportation and coordination of activities at all stages.

This result corroborated the Supply Chain Resilience Theory. According to the theory, supply continuity is enhanced when a supply chain has the capability of preparedness, flexibility, visibility, responsiveness and alternate plans in dealing with disruptions (Christopher & Peck, 2004; Ponomarov & Holcomb, 2009; Pettit et al., 2010). In the case of Buguruni and Temeke, good road networks and efficient transport capability were a means of resilience since they minimized the risk of facing congestion and spoilage before the cattle could be sold on the market. A high negative value indicated that better transport capability was related to lower vulnerability to losses, thus confirming the theoretical prediction.

Nevertheless, the finding confirmed the theory based on the cross-sectional proxy model limitations. This study did not cover elements of Supply Chain Resilience Theory such as recovery time, redundancy, learning and adaptation after disruptions. Consequently, this study confirmed the core hypothesis of the theory in relation to operational continuity, whereas evidence on recovery and learning was inconclusive. This finding also corroborated previous studies conducted in Tanzania. While Mwashiuya et al. (2018) investigated transport compliance and beef quality, the findings of the present study revealed that poor transport systems affected stock sufficiency and continuity at the retail market level. Likewise, Poo et al. (2024) linked transport connectivity with food supply chain resilience and the findings of the present study suggested that the same relationship was observed in the case of meat markets. It suggested that road improvements alone would not be sufficient unless they were complemented with proper vehicles and scheduling.

4.2.2 Cold-Chain Facilities

Concerning cold chain facilities, the study revealed that the traders lacked sufficient measures when their meat is not sold. The respondents confirmed that storage affects supply (M = 3.90), lack of infrastructure affects sales (M = 3.79), and they disagreed with the fact that there are enough facilities (M = 2.21). Nevertheless, the negative correlation ($\beta = -0.335$) implies that the better the facilities, the less vulnerable to loss. Therefore, the proper solution to this problem was the cold room together with electricity, water, sanitation, drainage, and proper handling of the meat (Prinsen et al., 2020; Ren et al., 2022; Deng et al., 2024; Khalid et al., 2024). Cold chain facilities had the second strongest association for reducing losses (B = −0.346, $\beta = -0.335$, $p < 0.001$). Better facilities mean that traders are better positioned to preserve the meat and look for buyers over time. The finding also implies an indirect behavioural influence because unreliable facilities create more pressure on traders to take discounts or allow meat spoilage.

The cold chain finding also validated Supply Chain Resilience Theory. Facilities such as the availability of cold rooms, electricity, water, sanitation, drainage, and suitable handling facilities formed part of the protective capacity and redundancy of operation. These made it possible for traders to endure a temporary reduction in demand without compromising the safety of meat through immediate spoilage. The strong negative relationship between cold chain capacity and loss vulnerability was consistent with the theory that stronger resources and response capacities make a disruption impact less on supply chain performance (Pettit et al., 2010; Khalid et al., 2024).

The finding further refined the theory by indicating that the ability to be resilient does not emanate only from having refrigeration equipment. A cold room without electricity, cleanliness, maintenance, and trained personnel can break down during the very time it should work to ensure safety of meat. Therefore, the finding indicated support for the systems approach to resilience where complementary facilities ensure quality of products. The study, however, did not measure temperature, storage time, effectiveness of back-up power supply or recovery after equipment

breakdown.Findings were aligned with those presented by Prinsen et al. (2020) in relation to how meat safety in Tanzania was achieved through interlinked practices and facilities and with Khalid et al. (2024) who asserted that resilience of cold chain requires risk management. The research went further to explain that cold chain facilities could not be explained in terms of refrigeration only. Refrigeration facilities need electricity; hygiene needs water and drainage; and effective movement of products needs sufficient space for unloading and selling of the products.

4.2.3 Intermediary Support Services

The need for intermediation support was justified by the fact that the issue of unsold meat was also due to poor coordination among sellers. The timing of delivery was given a low score (M = 2.24), while interruptions had an average rating (M = 3.94). Communication too was just okay (M = 3.37). An intermediary could make good use of demand information, buyer networks, and redistribution system to ensure that the excess amount of beef does not stay with the same seller until it spoils. The significant negative coefficient ($\beta = -0.186$) confirmed the Theory of Transaction Cost Economics. (Ambler et al., 2023; Ma et al., 2024; Marion et al., 2024; Adong et al., 2025).

Intermediary support services had a highly significant negative relationship with vulnerability to post-harvest loss ($B = -0.191$, $\beta = -0.186$, $p = 0.008$). Even though the effect was smaller than that of roads and cold chain services, the effects of information, aggregation, buyer matching, and fulfilment services helped in reducing the likelihood of meat losses after harvest. The results regarding intermediaries were in line with Transaction Cost Economics. The theory posits that uncertainties, bounded rationalities, information asymmetries, opportunistic behaviors and incomplete contracts make transaction costs high and uncertain (Williamson, 1979, 1985). In the case study area, timely demand information, quantity fulfilment, buyer matching, and delivery services could minimize search costs, bargaining costs, monitoring costs and non-fulfilment costs. The significant negative coefficient indicates that higher intermediary support services are related to lower post-harvest loss vulnerability.

The findings did not confirm the simplistic notion that intermediaries would necessarily increase loss or that they should be stripped from the chain. Even though delays and disruptions were mentioned by the respondents, intermediaries continued to make a statistically significant contribution to reducing loss regardless of the controls on road and cold-chain variables. This indicated that intermediaries made an impact depending on the quality of services offered by the intermediaries. Thus, Transaction Cost Economics (TCE) was confirmed, though its traditional focus on opportunism had to be balanced with the value creation aspects such as aggregation, finance, information, and surplus redistribution highlighted in the modern agri-food chains literature (Ambler et al., 2023; Ma et al., 2024; Adong et al., 2025).The evidence provided empirical validity to Transaction Cost Economics, since the role of intermediation influenced exchange costs and uncertainty. Timely information and aggregation lowered the costs of searching and coordination, whereas informal promises, unobservable prices, and uncertain quantity raised monitoring cost and risks of being out of stocks. The outcome was in line with the results obtained by Ambler et al. (2023) and Adong et al. (2025), who emphasised the finance requirements and economic significance of midstream enterprises. Therefore, any policy had to be aimed at making intermediaries' activities more professional through clear payments, record keeping, market information and working capital financing.

4.2.4 Combined Influence on Post-Harvest Loss Vulnerability

All three together accounted for 57.1% of variance in the vulnerability to post harvest loss proxy, $F(3, 105) = 46.592$, $p < 0.001$. From the results, it can be deduced that the remaining meat could not simply be solved through the acquisition of customers. Road reliability influenced both timing and product quality; cold chain facilities provided more time for sale; and intermediary services facilitated matching of quantity and timing as well as alternative buyers. In summary, the combination of the two theories formed a useful theoretical framework.

Collectively, the results supported the combination of Supply Chain Resilience Theory and Transaction Cost Economics. The former theory addressed the way road and cold chain capabilities facilitated the movement and preservation of the quality of beef, while the latter theory explained the exchange through intermediary information and fulfillment coordination. The significant interaction model illustrated that physical resilience and transaction governance were complementing each other: reliable roads and storage cannot protect from surpluses in case there are problems with information and buyer coordination, and vice versa: well-organized intermediaries cannot save meat without proper transportation and cold chain facilities. The model did not give theoretical confirmation completely since 42.9% of the variance of loss vulnerability was not explained by the model. Factors like consumer buying power, the 12,000 - 14,000 TZS price at the retail market, daily demand, slaughter capacity, trader's funding, regulatory factors, and seasonal supply could explain the leftover variance. Affordability, which is a theoretically important factor, was not used as a respondent-level variable for the study; therefore, the study could not prove or disprove the theories with regard to price affordability. Further research should include price affordability and demand forecasting into the integrated model.

V. CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

Conclusion from the analysis is that the road infrastructure, cold-chain facilities, and intermediary services significantly affected the vulnerability to post-harvest loss of fresh beef in Buguruni and Temeke markets. The regression explains 57.1% of the variability in the proxy measure of the outcome variable. Difficulties in transportation, lack of proper facilities in the market, late delivery of intermediaries, and poor demand-matching were factors increasing the vulnerability of the remaining meat to spoilage, discounting, or losses for the traders. Among the independent variables considered, road infrastructure had the strongest negative effect on post-harvest loss vulnerability, followed by cold-chain facilities and intermediary services. Due to lack of data on physical/financial losses, the finding pertains to vulnerability and not to loss rate.

5.2 Recommendations

The municipal government should ensure that the market access roads, loading spaces, and delivery during off-peak hours are facilitated to enable proper beef distribution. Transporters, on their part, should ensure the use of appropriate hygiene levels of transport means with temperature control facilities as well as having contingency measures in place. Markets such as Buguruni and Temeke should have appropriate refrigeration facilities, which are supplied with proper electricity or have backup facilities, water facilities, sanitation facilities, drainage systems, cleaning schedules, and maintenance. The markets should maintain a record of daily demands as well as closing stocks to enable traders to balance the quantities for delivery to avoid excesses.

Declaration of Interest

The authors declare that they do not have any known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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REFERENCES

Adam, A. M. (2020). Sample size determination in survey research. *Journal of Scientific Research and Reports, 26*(5), 90–97. https://doi.org/10.9734/jsrr/2020/v26i530263

Adong, A., Ambler, K., Bloem, J. R., de Brauw, A., Herskowitz, S., Islam, A. H. M. S., & Wagner, J. (2025). The unmet financial needs of intermediary firms within agri-food value chains in Uganda and Bangladesh. *Food Policy, 132*, 102838. https://doi.org/10.1016/j.foodpol.2025.102838

Ambler, K., de Brauw, A., Herskowitz, S., & Pulido, C. (2023). Viewpoint: Finance needs of the agricultural midstream. *Food Policy, 121*, 102530. https://doi.org/10.1016/j.foodpol.2023.102530

Ameye, H., Hülsen, V., Glatzel, K., Laar, A., & Qaim, M. (2025). Urbanizing food environments in Africa: Challenges and opportunities for improving accessibility, affordability, convenience, and desirability of healthy diets. *Food Policy, 137*, 102981. https://doi.org/10.1016/j.foodpol.2025.102981

Barrett, C. B., Reardon, T., Swinnen, J., & Zilberman, D. (2022). Agri-food value chain revolutions in low- and middle-income countries. *Journal of Economic Literature, 60*(4), 1316–1377. https://doi.org/10.1257/jel.20201539

Baykoca, B., & Yılmaz, S. (2025). Understanding food loss patterns across developed and developing countries using a GDP, growth rate, and health expenditure-based typology. *Scientific Reports, 15*, 27597. https://doi.org/10.1038/s41598-025-13156-3

Boateng, G. O., Neilands, T. B., Frongillo, E. A., Melgar-Quiñonez, H. R., & Young, S. L. (2018). Best practices for developing and validating scales for health, social, and behavioral research: A primer. *Frontiers in Public Health, 6*, Article 149. https://doi.org/10.3389/fpubh.2018.00149

Christopher, M., & Peck, H. (2004). Building the resilient supply chain. *The International Journal of Logistics Management, 15*(2), 1–14. https://doi.org/10.1108/09574090410700275

Coase, R. H. (1937). The nature of the firm. *Economica, 4*(16), 386–405. https://doi.org/10.1111/j.1468-0335.1937.tb00002.x

Codex Alimentarius Commission. (2005). *Code of hygienic practice for meat (CXC 58-2005)*. Food and Agriculture Organization of the United Nations and World Health Organization. https://www.fao.org/fao-who-codexalimentarius/codex-texts/codes-of-practice/

Creswell, J. W., & Creswell, J. D. (2023). *Research design: Qualitative, quantitative, and mixed methods approaches* (6th ed.). SAGE.

Davoudi, S., Stasinopoulos, P., & Shiwakoti, N. (2024). Two decades of advancements in cold supply chain management: A scientometric analysis of the beef industry. *Sustainability, 16*(16), 6986. https://doi.org/10.3390/su16166986

Deng, Z., Sun, S., Shi, Y., Hu, Y., Lü, X., & Shan, Y. (2024). Effect of cold chain interruption on the metabolic composition and quality properties of fresh beef. *Food Science of Animal Products, 2*(2), Article 9240060. https://doi.org/10.26599/FSAP.2023.9240060

Dome, M. M., & Prusty, S. (2017). Determination of vegetable postharvest loss in the last-mile supply chain in Tanzania: A lean perspective. *International Journal of Logistics Systems and Management, 27*(2), 133–150. https://doi.org/10.1504/IJLSM.2017.083808

Field, A. (2018). *Discovering statistics using IBM SPSS Statistics* (5th ed.). SAGE.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). *Multivariate data analysis* (8th ed.). Cengage.

Hannah, C., Blekking, J., Davies, J., Battersby, J., Chilenga, A., Kabuya, D., & Toriro, P. (2025). Urban African food systems as sites of challenges and opportunities for household food equity and resilience. *Ecology and Society, 30*(3), Article 28. https://doi.org/10.5751/ES-16259-300328

Issa, I. M., Munishi, E. J., & Mubarack, K. (2021). Post-harvest losses for urban fresh fruits and vegetables along the continuum of supply chain functions: Evidence from Dar es Salaam City, Tanzania. *Canadian Social Science, 17*(5), 75–87. https://doi.org/10.3968/12300

Jeffer, S. B., Kassem, I. I., Kharroubi, S. A., & Abebe, G. K. (2021). Analysis of food safety management systems in the beef meat processing and distribution chain in Uganda. *Foods, 10*(10), 2244. https://doi.org/10.3390/foods10102244

Karwowska, M., Łaba, S., & Szczepański, K. (2021). Food loss and waste in the meat sector—Why the consumption stage generates the most losses? *Sustainability, 13*(11), 6227. https://doi.org/10.3390/su13116227

Khalid, R. U., Jajja, M. S. S., & Ahsan, M. B. (2024). Supply chain sustainability and risk management in food cold chains: A literature review. *Modern Supply Chain Research and Applications, 6*(2), 193–221. https://doi.org/10.1108/MSCRA-07-2023-0030

Kibona, C. A., & Yuejie, Z. (2021). Factors that influence market participation among traditional beef cattle farmers in the Meatu District of Simiyu Region, Tanzania. *PLOS ONE, 16*(4), e0248576. https://doi.org/10.1371/journal.pone.0248576

Kibona, C. A., et al. (2022). Exploring the factors that influence beef meat exports in Tanzania. *PLOS ONE, 17*(6), e0270146. https://doi.org/10.1371/journal.pone.0270146

Kilelu, C. W., Musyoka, D. M., & Kalele, D. N. (2024). Unraveling smallholder food loss and value for sustainable cold chain investments: A case of horticultural value chains in Kiambu County, Kenya. *Frontiers in Horticulture, 3*, 1474056. https://doi.org/10.3389/fhort.2024.1474056

Ma, W., Rahut, D. B., Sonobe, T., & Gong, B. (2024). Linking farmers to markets: Barriers, solutions, and policy options. *Economic Analysis and Policy, 82*, 1102–1112. https://doi.org/10.1016/j.eap.2024.05.005

Marion, P., Lwamba, E., Floridi, A., Pande, S., Bhattacharyya, M., Young, S., Villar, P. F., & Shisler, S. (2024). The effects of agricultural output market access interventions on agricultural, socio-economic, food security, and nutrition outcomes in low- and middle-income countries: A systematic review. *Campbell Systematic Reviews, 20*(2), e1411. https://doi.org/10.1002/cl2.1411

Misanga, M., & Yussuf, M. (2024). A post-harvest financial loss in small-scale fisheries supply chain in Tanzania: Case of Kivukoni Market, Ilala Municipality. *Asian Journal of Management, Entrepreneurship and Social Science, 4*(4). https://www.ajmesc.com/index.php/ajmesc/article/view/1075

Mmereki, D., David, V. E., Jr., & Wreh Brownell, A. H. (2024). The management and prevention of food losses and waste in low- and middle-income countries: A mini-review in the Africa region. *Waste Management & Research, 42*(4), 287–307. https://doi.org/10.1177/0734242X231184444

Mwashiuya, J. T., Manyele, S. V., & Mwaluko, G. M. (2018). Assessment of beef transportation infrastructure from slaughtering facilities in Tanzanian cities. *Engineering, 10*, 814–836. https://doi.org/10.4236/eng.2018.1011057

Olabode, O., Kumar, N., & De, D. (2025). Food loss and waste management in the retail food supply chain: Methods and framework to achieve environmental sustainability. *Journal of Environmental Management, 387*, 125718. https://doi.org/10.1016/j.jenvman.2025.125718

Pettit, T. J., Fiksel, J., & Croxton, K. L. (2010). Ensuring supply chain resilience: Development of a conceptual framework. *Journal of Business Logistics, 31*(1), 1–21. https://doi.org/10.1002/j.2158-1592.2010.tb00125.x

Ponomarov, S. Y., & Holcomb, M. C. (2009). Understanding the concept of supply chain resilience. *The International Journal of Logistics Management, 20*(1), 124–143. https://doi.org/10.1108/09574090910954873

Poo, M. C.-P., Wang, T., & Yang, Z. (2024). Global food supply chain resilience assessment: A case in the United Kingdom. *Transportation Research Part A: Policy and Practice, 181*, 104018. https://doi.org/10.1016/j.tra.2024.104018

Prinsen, G., Benschop, J., Cleaveland, S., et al. (2020). Meat safety in Tanzania's value chain: Experiences, explanations and expectations in butcheries and eateries. *International Journal of Environmental Research and Public Health, 17*(8), 2833. https://doi.org/10.3390/ijerph17082833

Ren, Q.-S., Fang, K., Yang, X.-T., & Han, J.-W. (2022). Ensuring the quality of meat in cold chain logistics: A comprehensive review. *Trends in Food Science & Technology, 119,* 133–151. https://doi.org/10.1016/j.tifs.2021.12.006

Rutta, E. W. (2024). Postharvest food loss reduction and agriculture policy framework in Tanzania: Status and way forward. *Agriculture & Food Security, 13,* Article 36. https://doi.org/10.1186/s40066-024-00489-x

Saunders, M., Lewis, P., & Thornhill, A. (2023). *Research methods for business students* (9th ed.). Pearson.

Teferra, T. F. (2022). The cost of postharvest losses in Ethiopia: Economic and food security implications. *Heliyon, 8*(3), e09077. https://doi.org/10.1016/j.heliyon.2022.e09077

Williamson, O. E. (1979). Transaction-cost economics: The governance of contractual relations. *Journal of Law and Economics, 22*(2), 233–261. https://doi.org/10.1086/466942

Williamson, O. E. (1985). *The economic institutions of capitalism*. Free Press.

World Bank. (2024). *Tanzania economic update: Overcoming demographic and climate challenges while leveraging opportunities*. https://www.worldbank.org/en/country/tanzania/publication/tanzania-economic-update

World Bank. (2025). *Transport connectivity for food security in Africa: Strengthening supply chains*. https://www.worldbank.org/en/region/afr

Zhang, B., & Mohammad, J. (2024). Sustainability of perishable food cold chain logistics: A systematic literature review. *SAGE Open, 14*(3). https://doi.org/10.1177/21582440241280455