

The influence of infrastructure support on the performance of fruits and vegetables cold chain in Tanzania: A case of Arumeru and Hai districts

Bugunge J. Ndilibango¹
Albogast K. Musabila²
Paul M. Nsimbila³

¹bugunge.ndilibango@mocu.ac.tz

²akmusabila@mzumbe.ac.tz

³pmnsimbila@mzumbe.ac.tz

¹Moshi Co-operative University, ^{2,3}Mzumbe University, ^{1,2,3}Tanzania

<https://doi.org/10.51867/ajernet.6.4.52>

ABSTRACT

The study sought to establish the influence of infrastructure support on the performance of the fruits and vegetables cold supply chain in Tanzania. Both Resource-Based Theory (RBT) and Resource Dependency Theory (RDT) were used. The study adopted a convergent parallel design, and a census technique was conducted on 114 fruit and vegetable actors from Arumeru and Hai districts. Additionally, 12 firms were purposefully selected to collect interview data from the same targeted population. Descriptive and inferential analyses were used to analyze data. The findings indicate that transport facilities, storage facilities, and road access have a positive and significant impact on the performance of the fruits and vegetables cold chain. Based on these findings, the study concluded that the unwillingness of the fruit and vegetable actors to use and apply proper cold distribution systems for their post-harvest fruits and vegetables is contributed to by the immaturity of the cold supply chain in Tanzania. The study recommends that fruit and vegetable members preserve the quality of their fresh produce by adopting an appropriate cold distribution system. Moreover, the government should collaborate with fruit and vegetable stakeholders to ensure accessibility of roads, cold storage, and cold transport facilities near fruit and vegetable actors at affordable costs. Furthermore, policymakers should expand their preference for fruit and vegetable actors located in rural areas in their future policies to boost proper usage, reduce post-harvest losses, stabilize prices, and increase the exportation of fresh produce to neighboring countries like Kenya, Uganda, Rwanda, and Burundi.

Keywords: Cold Supply Chain, Fruits, Performance, Vegetables

I. INTRODUCTION

For the past few years, the development of the cold chain has been important in contributing to the economic growth of developed and developing countries (Gligor *et al.*, 2018; Pambudi *et al.*, 2022; Bottani *et al.*, 2022; Nguyen *et al.*, 2022). Several scholars have demonstrated that cold chains are key to improving human well-being, boosting economic growth, and delivering socioeconomic development through creating employment opportunities, reducing food loss, reducing poverty, and ensuring that all people enjoy health and prosperity (Peters & Sayin, 2022).

The key purpose of the cold supply chain is to ensure temperature is controlled from the point of production, through to the transportation stages, storage, distribution processes, and final delivery to the end-users (Nguyen *et al.*, 2022). This is important in perishable products, especially fruits and vegetables (Raut *et al.*, 2019). As a result, after the harvest, fresh fruits and vegetables need to pass through the precooling process, sorting, grading, and packaging, cold storage, transportation to the distribution center, temporally cold storage, distribution to wholesale/retail outlets, and then distribution to consumers (Peters & Sayin, 2022). However, in developing countries experiencing the growth trend of the cold chain, the main concern remains on the supply chain actors' capability to maintain the quality and safety of fruits and vegetables (Vrat *et al.*, 2018).

The infrastructure issue has been a matter of debate in developing countries, particularly in the fruits and vegetables cold supply chain. It has been claimed that what matters most is to invest in infrastructure, such as cold storage, refrigerated trucks, and better computer hardware, which may not only improve the performance of the firm but also facilitate the reduction of perishable food loss (Raut *et al.*, 2019). Mercier *et al.* (2018) highlighted that reefer trucks and cold warehouses are crucial in reducing the magnitude of fruit and vegetable loss. This contributes to the consistent availability of quality and adequate fruits and vegetables demanded by the customers, which in turn increases sales of the firm (Beretta *et al.*, 2019).

However, in Sub-Saharan Africa, access to cold storage facilities has been a major challenge, and this has been contributing to poor cold chain performance (Sibanda & Workneh, 2020). For instance, the magnitude of fruit and

vegetable loss in Sub-Saharan Africa is estimated to be 50%, whereby 32% of loss occurs after the harvest (Makule *et al.*, 2022; Gunarathna & Bandara, 2020). In Tanzania, there is a need to improve the supply chain system of fruits and vegetables. The majority of traders do not consider temperature monitoring systems in terms of using cold transportation and storage to extend the shelf-life of fruits and vegetables during the distribution process (Yahya, 2020). So, the effect becomes quite bigger, especially in terms of price variability and loss of government revenue (Yahya, 2020).

To solve the problem, stakeholders at some points have been trying hard to modernize the supply chain of fruits and vegetables in Tanzania (Wakiariro, 2020). However, their efforts have not yet provided the desired outcome. Most fruits and vegetables had been losing their quality before reaching their destination, and to a great extent, supply chain members are unwilling and/or incapable of using cooling rooms, refrigerated vehicles, or hiring expertise to deal with the storage of their fruits and vegetables (Rutta, 2022; Baltazari *et al.*, 2020). Several present studies have been conducted on the fruits and vegetables supply chain in Tanzania. Fewer focused on factors leading to post-harvest loss and waste of fruits and vegetables (Anand & Barua, 2022; Baltazari *et al.*, 2020). Few studies documented the role of intermediaries in the fruits and vegetables supply chain (Issa *et al.*, 2021; Mmasa, 2023). Msafiri and Mwombela (2021) focused on the competitiveness of the horticultural industry. While Wakiariro (2020) focused on horticultural logistics management in Tanzania.

However, little is known about the importance of cold transportation facilities, cold storage facilities, and road access in the fruits and vegetables business, especially when it involves temperature management systems in the supply chain process. This demonstrates that the performance of the cold chain for fruits and vegetables is still a problem that requires careful attention in Tanzania.

1.1 Research Questions

- i. What is the influence of transportation facilities on the performance of the fruits and vegetables cold supply chain?
- ii. How do storage facilities affect the performance of the fruits and vegetables cold supply chain?
- iii. What is the effect of road access on the performance of the fruits and vegetables cold supply chain?

II. LITERATURE REVIEW

2.1 Theoretical Framework

The resource-based and resource dependency theories were used in this study.

2.1.1 Resources-Based Theory (RBT)

This theory was introduced by Penrose in 1959. It was first known as the resource-based view (RBV), which holds that a company can achieve a competitive edge through the efficient utilization of a variety of its special resources (Ali *et al.*, 2018). This study prefers to use the term RBT because, up to 2011, the RBV had changed into the RBT, due to the justification that the RBV had become more sophisticated and resembled a theory than a viewpoint (Barney *et al.*, 2011). The performance of an organization stems from its unique set of valuable, rare, and costly-to-imitate resources. When a business possesses superior resources compared to rivals, it can achieve a competitive edge, leading to better performance (Ardaneswari *et al.*, 2020). A firm's success largely depends on effectively utilizing its tangible and intangible resources (Musa *et al.*, 2022). Resources can be classified into physical, human, and organizational capital (Davis, 2019). Physical resources encompass buildings, equipment, and technology (Murimi *et al.*, 2019), while human capital includes workforce skills, relationships, and experience (Lipwop & Achuora, 2021). Organizational capital relates to the firm's structure and culture (Chigara, 2021).

RBT is relevant to this study because it is believed that controlling the temperature of fresh goods is essential for ensuring their quality and safety (Li, 2021). However, inadequate physical resources, such as refrigerated vehicles and cold storage facilities, remain a challenge for the supply chain of fruit and vegetables (Anand & Barua, 2022; Bisht & Gupta, 2022). So, actors in the supply chain are advised to use special reefer trucks, cold warehouses, and facilities to maximize sales and profitability (Li, 2021; Dong *et al.*, 2021). Jafarpour *et al.* (2022) show that warehousing and quality of storage can improve the cold supply chain performance. Henceforth, the theory supports this study.

The RBT is only based on the firm's internal resources; in fact, the organization also needs external resources that are owned by other stakeholders, which would have been impossible for an individual firm. In this study, RBT was supplemented by the resource dependency theory by giving a detailed explanation of how a firm may coordinate with external stakeholders to gain access to unique resources and improve performance.

2.1.2 Resources Dependency Theory (RDT)

This theory is based on the principle that a firm must coordinate with other stakeholders operating in its environment (external environment) to acquire the resources it needs to differentiate itself from its competitors (Orakwue & Iguisi, 2020). It shows that the motive behind coordination across the organization interdepends on vital inputs that cannot be obtained elsewhere. This is due to the reason a firm does not possess all the resources that are

required in the entire process of value-creation (Gligor *et al.*, 2018). In addition, a firm lacking critical resources may be able to acquire them by forming an alliance or joint venture relationship with other business partners. In so doing, it would build capacities through merging unique resources, knowledge exchange, or investing in core resources required (Kim *et al.*, 2020). This theory is relevant to this study because an organization may opt to outsource or hire facilities such as cold warehouses, refrigerated trucks, and storage equipment to improve its performance (Raut *et al.*, 2019; Njoroge, 2022). Furthermore, small and large-scale farmers, distributors, and wholesalers depend on the government to improve road infrastructure and smooth the movement of fruit and vegetables from rural to urban areas (Pérez & Gómez, 2022).

2.2 Empirical Review

This part presents numerous studies related to the critical role of infrastructure support in the cold supply chain for fresh produce.

2.2.1 Transportation Facilities

The distribution system of fresh produce is supported by transportation models such as road transport, water transport, railway transport, and air transport (Lipwop & Achuora, 2021). In most cases, refrigerated trucks and air transport are preferred for the transportation of fruit and vegetables (Yusupjanovna, 2020). Refrigerated trucks are mostly used due to the remote location of farms and also facilitate door-to-door transportation, while air transport is used due to the speed of the model and long-distance purposes (Iordăchescu *et al.*, 2019). Nuthalapati and Sharma (2021) suggest that investing in refrigeration transport equipment like reefer trucks facilitates the movement of the fruit and vegetables to a distant market without changing their nature. Based on the explanation above, it suggests that investing in cold transportation facilities is inevitable as long as the fruit and vegetable industry is concerned.

2.2.2 Storage Facilities

Cold storage facilities such as cold warehouses, storage equipment, and refrigerated containers (Raut *et al.*, 2019). Help to extend the shelf life and preserve the freshness of fruit and vegetables, as well as to increase their availability (Yahaya & Mardiyaa, 2019). Moreover, cold storage facilities are important, especially during the storage, distribution, and sales of perishable crops (Bottani *et al.*, 2022). It also contributes much to balancing price fluctuation by providing stability in the demand and supply of fruits and vegetables (Bhatnagar *et al.*, 2022). Dimoso *et al.* (2021) stipulated that although cold storage facilities reduce the loss of fresh fruits and vegetables, in developing countries, a high number of perishable fruits and vegetables are lost due to the absence or inadequate cold storage rooms. This raises a concern that fresh fruits and vegetables should not be exposed to sunlight for a long time after harvest (Cloete *et al.*, 2021). Beckles *et al.* (2025) argue that postharvest loss caused by microbial, insect, and sunlight can also be reduced due to the use of a cold storage room, and finally ensure the availability of nutritious produce to end users. The dialog above highlighted how cold storage facilities play a crucial part in improving the performance of the fruits and vegetables cold supply chain.

2.2.3 Road Access

The transportation process of fresh fruits and vegetables requires access to suitable infrastructures like roads that link farmers and the markets to facilitate the movement and enhance the availability of fresh produce to the outlet area (Makule *et al.*, 2022). It is believed that roadblocks and congestion are major inconvenient situations that may cause unexpected delays during delivery (Turan & Ozturkoglu, 2022). Xie *et al.* (2022) reveal that enhancing multimodal transportation requires improving the road infrastructure because it makes it easier to coordinate and integrate the networks for rail, sea, and air transportation. Dube *et al.* (2018) argue that in order to reduce post-harvest loss, roads must be in good shape. This is done by reducing travel time to markets and minimizing transit damage. Similarly, Gunarathna and Bandara (2020) argue that the lack of infrastructure, such as roads in rural areas, is the reason for the postharvest loss of vegetables. However, in fewer areas, there are roads that link farmers and markets, but the main obstacle remains the bad condition of available roads, especially during rainy seasons (Dube *et al.*, 2018). These perceptions indicate that the performance of the cold chain for fruit and vegetables relies heavily on the condition of roads.

III. METHODOLOGY

3.1 Research Design

This study employed a convergent parallel design. This parallel design requires the collection of both quantitative and qualitative data collected simultaneously and then comparing them to see similarities or differences (Liu *et al.*, 2022; Sileyew, 2019). Due to the complexity of this approach, under this study, the quantitative statistical results were provided first, followed by qualitative quotes to support or disconfirm the quantitative results. This design

was adopted because it offers a chance to combine both quantitative (QUANT) and qualitative (QUAL) data to develop a comprehensive understanding of the research problem and help in drawing the research conclusion. Also, to reconcile the disparities in methodology between the quantitative and qualitative paradigms. So, this design allowed the researcher to conduct the study in a wide area at a reasonable cost and time.

3.2 Study Area

This study was carried out in the Arumeru and Hai districts, situated in the Arusha and Kilimanjaro regions, respectively. The two geographical locations were selected because of the long historical investment in the production of fruits and vegetables that feed the Arusha and Moshi regions (De Blasis, 2020). Moreover, the proximity of both districts to Kilimanjaro International Airport (KIA) is significant, as the airport offers facilities, such as cold storage, to most farmers, wholesalers, and exporters using KIA for the export of their fruits and vegetables (ITC, 2022). Finally, the existence of entities such as Tanzania Horticulture Association (TAHA) Fresh Handling Ltd (TFHL), which provides refrigerated transportation and associated services, indicates familiarity with cold chain procedures among participants in these areas (TAHA, 2021).

3.3 Population, Sampling Technique, and Sample Size

The population of this study was fruit and vegetable members (large producers, smallholder farmers, wholesalers, retailers, manufacturing companies, and exporters) found in Arumeru and Hai districts. This study consisted of a population of 114 respondents, and a census technique was used, whereby data were collected from every single element of the population in order to deliver information that is more accurate and precise. Thus, the sample of this study is the entire population of 114 respondents. Similarly, 12 firms from the same targeted population were selected purposively for collecting qualitative data through the interviews. The qualitative respondents included officials from two small-scale farmers, three larger-scale farmers, two retailers, one logistics company, two exporters, and one cold packinghouse.

3.4 Data Collection

This study used primary data only, whereby structured questionnaires were distributed to 114 respondents, while an interview guide was used to conduct in-depth interviews with 12 key informants during data collection. The structured questionnaires in a 5-point Likert scale (1- strongly agree to 5- strongly disagree) were applied to all variables to warrant consistency of responses. An interview guide with questions related to the fruits and vegetables cold chain was used through phone calls and face-to-face interviews to gain insights that enrich the quantitative results. To ensure data validity and reliability, a pilot study was undertaken where 15 questionnaires were issued to 12 firms, and 13 were returned. Following the guidance of Saunders et al. (2023), the sample size was 10% of the entire population. This technique allowed the researcher to discover and resolve problems in both the questionnaire and interview guide before the actual data gathering.

3.5 Data Analysis

In this study, data were analyzed using descriptive statistics and inferential analysis with the help of SPSS version 27. Descriptive statistics were applied using mean and standard deviation, while skewness and kurtosis values were used to assess normality of the data (Kline, 2023). In addition, Cronbach's alpha was used to measure the internal consistency of the constructs. The study involved a factor analysis in order to deduce poorly loading items for both independent and dependent variables before inferential analysis. Further, the multiple regression analysis was carried out to verify the contribution of each sub-variable.

IV. FINDINGS & DISCUSSION

4.1 Findings

4.1.1 Response Rate

The questionnaire was sent to 114 firms, with 107 (93.9%) returned without missing values. All 12 respondents participated in interviews without missing responses. Skewness and kurtosis were used to assess data normality, with Kline (2023) indicating that values should be less than 3 and 10, respectively, for normal distribution. The results in Table 1 indicate skewness values between 0.652 and 1.453, and kurtosis values ranging from -0.561 to 1.1708, suggesting the data is normally distributed. It also presents the mean scores for each sub-variable. According to Yang (2023), a mean score of 1 to 1.80 indicates high agreement from respondents, 1.81 to 2.60 suggests moderate agreement, 2.61 to 3.40 reflects neutrality, 3.41 to 4.20 indicates disagreement, and 4.21 to 5 denotes strong disagreement. Descriptive statistics are further supported by interview findings.

Table 1*Descriptive Statistics and Normality Test*

Variable	N	Mean	Std. Dev.	Skewness	Kurtosis
Transport facilities	107	1.97	.787	.970	1.069
Storage facilities	107	2.30	.979	.959	.276
Road access	107	2.04	.895	1.453	1.708
Performance of the fruits and vegetables cold chain	107	1.97	.563	.652	-.561

4.1.2 Transport Facilities

Table 1 shows that transport facilities have a total mean score of 1.97, representing a moderate level of agreement. The practical implication is that the increase in foreign earnings from US \$ 64 million in 2004 to US \$ 779 million in 2019 for fruits and vegetable exportation from Tanzania as per TAHA (2021) was highly contributed by the rise of awareness and willingness to fruits and vegetable actors in using or investing in cold infrastructure like cold transport facilities which is a crucial requirement for the most of foreign markets. Despite this improvement revealed in the fruits and vegetables sub-sector, there are still constraints revealed during interviews between the researcher and officers in Maji ya chai and Machame, representing the Arumeru and Hai districts, respectively. One respondent said:

“Our organization faces the challenge of inadequate refrigerated vehicles. The reefer vans we own are not enough to accommodate all the fruits and vegetables we produce. Therefore, sometimes when there is a need, we hire them from neighbors to move fresh produce from the farm to storage or the airport for exportation purposes” (Respondent 1, 2023).

Another respondent said that:

“In case of handling equipment, we have adequate, stable, and durable plastic bins that we always use to facilitate storage in our cold warehouse and transport of fresh green beans. However, we don't own any refrigerated vehicles; instead, we are in partnership with another firm that carries our product” (Respondent 3, 2023).

4.1.3 Storage Facilities

The respondents moderately agreed that cold storage facilities are an important aspect of enhancing the performance of the fruits and vegetables cold chain, as shown by a mean score of 2.30. This finding implies that the majority of actors of fruits and vegetables included in this study were using cold rooms for the storage of their fruits and vegetables, which appeared to be vital for the better performance of their businesses. This result is supported by interview results, as one respondent stated that:

“Even though we are doing great and able to store large quantities of our and customers' fresh produce, we still face challenges of inadequate plastic bins, as sometimes we hire from other packing houses, and the space of our cold rooms is not adequate to accommodate all farmers' fruits and vegetables around our area” (Respondent 7, 2023).

Another respondent said that:

“The increase in the number of fruit and vegetable exporters has increased the need for modern cold storage infrastructures due to different standards established in foreign countries' markets. Hence, these fewer available cold packing houses at Arusha and Kilimanjaro are not enough to handle all fresh produce, even from Arusha and Kilimanjaro” (Respondent 8, 2023).

4.1.4 Road Access

The mean score of 1.99 exposed that accessibility of roads is a crucial factor in facilitating the performance of the cold chain for the fruits and vegetables cold chain. This implies that the majority of fruit and vegetable actors allocated at Arumeru and Hai districts can move their fresh produce from farms or business areas to other places for consumption, due to the availability of roads that are in good condition and accessible. The quantitative finding differs from the interview result because one respondent said:

“The issue of ensuring the availability of good and accessible roads is still a problem that needs to be addressed, especially roads that connect interior farms and main roads. The problem becomes much bigger in the rainy season as the majority of transporters refuse to pick up produce from our temporary stores. So, we have to incur additional costs of road maintenance to smooth the operations” (Respondent 10, 2023).

4.1.5 Reliability Test and Factor Analysis

The study assessed the internal consistency of all constructs, with Saunders *et al.* (2023) indicating that a minimum Cronbach's alpha of 0.70 is necessary for reliability. As shown in Table 2, all constructs met this criterion:

transport facilities (0.812), storage facilities (0.841), road access (0.723), profitability (0.705), and responsiveness (0.710). This confirms the data set's suitability for further analysis.

The study conducted a factor analysis to identify poorly loading items for both independent and dependent variables, utilizing Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of Sphericity to assess data suitability. Kalkbrenner (2021) emphasizes that a KMO value of 0.6 or higher and a P-value below 0.05 are necessary for effective factor analysis. Principal Component Analysis (PCA) was used for extraction to reduce dimensionality, with VARIMAX rotation applied for non-orthogonal factors. A minimum eigenvalue of 1.0 was selected as a standard, aligned with Reddy & Kulshrestha (2019), while a loading cut-off of 0.6, endorsed by Taherdoost et al. (2022), marked items as very good.

The results indicated that all infrastructure support constructs were suitable for factor analysis, with a KMO test of 0.808 and a significant Bartlett's Test of Sphericity (Chi-square = 850.851, df = 78, $p < 0.001$). For FVCC performance, the KMO was 0.725, and Bartlett's Test was significant (Chi-square = 201.078, df = 21, $p < 0.001$). Table 2 shows the rotated factor matrix, using a cut-off of 0.6. For infrastructure support, items V401e, V402c, V402d, V40b, and V403e were discarded, while for FVCC performance, only item V802c was removed.

Table 2

Rotated Factor Matrix and Scale Analysis for Constructs

Variable	Code	Constructs	Cronbach's Alpha	Question Code	Scores
				V401b	.892
				V401d	.891
	V401	Transport facilities	.812	V401f	.767
				V401a	.728
				V401c	.649
				V402a	.820
				V402f	.789
Infrastructure support	V402	Storage facilities	.841	V402b	.769
				V402g	.753
				V402e	.643
	V403	Road access	.723	V403a	.839
				V403d	.781
				V403c	.717
				V801a	.753
	801	Profitability	.705	V801d	.721
				V801b	.689
Performance of FVCC				V801c	.667
				V802d	.829
	802	Responsiveness	.710	V802b	.758
				V802a	.730

4.1.6 Regression Analysis

The multiple linear regression analysis was used to determine the statistical relationships between predictors (independent variables) and dependent variables, as well as to indicate the contribution of each predictor to the dependent variable, as presented in the coefficient table.

Table 3

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.841 ^a	.707	.698	.30908

a. Predictors: (Constant), Road access, Transport facilities, Training, Storage facilities, Experience

b. Dependent Variable: Performance of the fruits and vegetables cold chain

In Table 3, the results indicate that predictors had a stronger relationship with the performance of the fruits and vegetables cold chain, as evidenced by a correlation coefficient (R) of 84.1%. The R-squared shows 0.707 percent, illustrating that the model explains 70.7% of the variance in the performance of the fruits and vegetables cold supply chain and leaves 29.3% unexplained. This means the model used was a good predictor for the relationship between independent variables and dependent variables. Moreover, Table 4 presents the analysis of variance. The concern in the

ANOVA table was on the P-value, as it indicates whether the model is significant or not. For a model to be significant, the P-value must be equal to or less than 0.05.

Table 4

Analysis of Variance (ANOVA)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	23.741	3	7.914	82.839	.000 ^b
	Residual	9.840	103	.096		
	Total	33.581	106			

a. Dependent Variable: Performance of the fruits and vegetables cold chain

b. Predictors: (Constant), Road access, Transport facilities, Storage facilities

The results represented in Table 4 revealed that the overall model was statistically significant because $F(7.914 \div 0.096) = 84.686$, and the P-value was 0.000. The result implies that the overall regression analysis was statistically significant. This means predictors such as transport facilities, storage facilities, and road access influenced the performance of the fruits and vegetables cold supply chain. Furthermore, the regression coefficient was used to show the extent to which each predictor explains the variance of a dependent variable while holding other predictors constant. Vide Table 5 below;

Table 5

Coefficient Table

Model	Variables	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.625	.095		6.610	.000
	Transport facilities	.235	.053	.328	4.465	.000
	Storage facilities	.281	.043	.489	6.566	.000
	Road access	.116	.036	.185	3.184	.002

From Table 5, the result shows that storage facilities had the highest significant contribution to the performance of the fruits and vegetables cold chain (beta = 0.281, P-value = 0.000). Transport facilities followed, which had a significant contribution (beta = 0.235, P-value = 0.00), and finally, road access had a significant contribution (beta = 0.116, P-value = 0.002) on the performance of the fruits and vegetables cold chain.

4.2 Discussion

4.2.1 Transportation Facilities and the Performance of the Fruits and Vegetables Cold Supply Chain

The descriptive analysis and qualitative results indicate that cold transportation is important in ensuring the availability of fresh fruits and vegetables in the markets. The study findings are in line with the findings of the study conducted by Lipwop and Achuora (2021) and Alulu *et al* (2023), who found that cold transport facilities influence the performance of fresh produce firms. In addition, Raut *et al* (2019) exposed that the lack of proper cold transportation facilities affects the efficiency of the fruit and vegetable supply chain because it causes a mismatch of fresh produce quality as well as an imbalance between the supply and demand of fruit and vegetables. In Tanzania, road transport seems to be mostly used as a model of transport. Hence, fruit and vegetable businessman should purchase enough handling facilities, refrigerated vehicles, and reefer trailers that will be used to accommodate their fresh produce and simplify the distribution process while maintaining product quality and reducing loss.

4.2.2 Storage Facilities and the Performance of the Fruits and Vegetables Cold Supply Chain

However, the study uncovered that storage facilities had a significant contribution to the performance of the fruits and vegetables cold chain. In Tanzania, the distribution system particularly for fresh fruit and vegetables still not doing well because the majority of supply chain members are using bamboo baskets (tenga) to carry fresh produce from farm to other destinations, fresh produce is exposed to sunlight for a long time after harvest, inadequate of cold warehouse and the majority of available cold warehouse do not meet the standard for instance, most of them have no appropriate cooling units that ensure proper management of warehouses, and lack of cold room at airports and ports for example, the report provided by Ministry of Agriculture (MOA) exposed that currently, only Kilimanjaro International Airport (KIA) provide cold storage service (MOA, 2019). Rutta (2022) in his study exposed that the slow growth of fruit and vegetable industries in Tanzania is highly associated with the unwillingness of supply chain actors, including small-scale farmers, to use cold storage infrastructure in their respective businesses due to the belief that it increases unnecessary expenses, especially when the focus is on a local market. All these act as the reasons that weaken the growth of the fruits and vegetables cold supply chain in Tanzania.

4.2.3 Road Access and the Performance of the Fruits and Vegetables Cold Supply Chain

The study found that road access influences the performance of the fruits and vegetables cold supply chain. This finding agrees with a study conducted by Makule *et al* (2022), which suggested that to increase the availability of fresh fruits and vegetables in the market areas, the improvement of road conditions should be taken into consideration. So, the government and private sectors should collaborate to ensure that well and adequate roads are constructed, especially from rural and some urban areas to main roads. Additionally, these findings confirm the resource dependency theory that a firm cannot possess all the resources needed, but can attain other crucial resources through coordinating with its external environment. In this case, better coordination between the government and the fruits and vegetables stakeholders can alleviate the bad condition of roads. Doing so will facilitate the smooth flow of fruits and vegetables and reduce postharvest loss of perishable produce due to timely delivery. Thus, improving the performance of the fruit and vegetable cold supply chain in Tanzania.

V. CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

The immaturity of the cold supply chain in Tanzania, particularly in the fruits and vegetables industry, in terms of the willingness of the supply chain members to use and apply proper distribution systems for their post-harvest fruits and vegetables, motivated this study to be conducted. Hence, the predictors included in this study provide new insight to all stakeholders on how to improve the performance of the fruits and vegetables cold chain in developing countries like Tanzania. Apart from contributions, the study also came across some limitations that could limit the generalization of the study findings. First, the study lacked a sampling framework due to the availability of a small population of fruit and vegetable actors who could offer detailed and sufficient information about the cold supply chain. This resulted in the adoption of the census technique. Furthermore, the generalization provided in this study cannot be guaranteed to be used in developed countries because the study was conducted in one of the developing countries (Tanzania).

5.2 Recommendations

The study provides a lesson to all supply chain members of fruits and vegetables operating their businesses in developing countries like Tanzania, particularly on increasing willingness to use appropriate cold distribution systems to ensure that fresh products reach ultimate customers of high quality and good for their health. Doing so will increase the availability of fruits and vegetables not only in local markets but also in neighboring countries, especially Kenya, Uganda, Rwanda, and Burundi. Also, it will contribute to stabilizing the price of fresh produce within the country.

The study findings recommend that a Private-Public Partnership (PPP) could effectively enhance cold chain infrastructure in Tanzania. By building more cold storage and transport facilities and improving access roads with the close cooperation of fruit and vegetable stakeholders, these services can become more available and affordable for local fruit and vegetable producers. This approach can encourage the adoption of proper cold distribution systems, reduce post-harvest losses, and boost exports and national income.

Regardless of the policymakers' efforts to address fresh produce loss and waste in Tanzania. Only, some larger-scale farmers are investing in proper cold supply chain management, many local small-scale farmers and distributors continue using inadequate methods, such as storing fruits and vegetables in tenga and exposing them to sunlight during transport and storage. Future policies and programs should involve a wide range of stakeholders, particularly those in rural areas, to effectively tackle the challenges faced in the fruit and vegetable supply chain. This includes improving transportation and storage technologies to reduce post-harvest losses.

REFERENCES

- Ali, I., Nagalingam, S., & Gurd, B. (2018). A resilience model for cold chain logistics of perishable products. *The International Journal of Logistics Management*, 29(3), 922-941.
- Alulu, J., Makyao, M., Huyskens-Keil, S., Lenz, B., Muendo, K. M., Mganilwa, Z., & Mithöfer, D. (2023). Distribution, transportation, and coordination in African indigenous vegetable value chains: A scoping review. *Frontiers in Environmental Economics*, 2, 1113826. <https://doi.org/10.3389/frevc.2023.1113826>
- Anand, S., & Barua, M. K. (2022). Modeling the key factors leading to post-harvest loss and waste of fruits and vegetables in the Agri-fresh produce supply chain. *Computers and Electronics in Agriculture*, 198, 106936. <https://doi.org/10.1016/j.compag.2022.106936>
- Arduaneswari, D. P. C., Novi, H., & Andan, L. R. (2020). The influence of internal factors on business performance: A resource-based view of mushroom SME in Indonesia. *Russian Journal of Agricultural and Socio-Economic Sciences*, 97(1), 107-112.

- Baltazari, A., Mtui, H., Chove, L., Msogoya, T., Kudra, A., Tryphone, G., & Mwatawala, M. (2020). Evaluation of post-harvest losses and shelf life of fresh mango in the Eastern zone of Tanzania. *International Journal of Fruit Science*, 20(4), 855-870.
- Barney, J. B., Ketchen, D. J., & Wright, M. (2011). The future of resource-based theory: Revitalization or decline? *Journal of Management*, 37(5), 1299-1315.
- Beckles, D. M., Kader, A., Reid, M. S., Jiang, C. Z., & Cantwell, M. I. (2025). *Postharvest technology of horticultural crops* (4th ed., Vol. 21661). UCANR Publications.
- Beretta, W., Wu, W., Cronje, P. C., Hellweg, S., & Defraeye, T. (2019). Environmental trade-offs in fresh-fruit cold chains by combining virtual cold chains with life cycle assessment. *Applied Energy*, 254, 113586. <https://doi.org/10.1016/j.apenergy.2019.113586>
- Bhatnagar, A., Shankar, R., & Vrat, P. (2022). Demand-supply planning and the sustainability aspect for agro-based perishables in the cold chain. *International Journal of Industrial and Systems Engineering*, 40(1), 79-103.
- Bisht, S., & Gupta, A. (2022). An insight into Indian fruits and vegetables SMEs supply chain: Indian agrarian sectors. *ECS Transactions*, 107(1), 11169.
- Bottani, E., Casella, G., Nobili, M., & Tebaldi, L. (2022). An analytic model for estimating the economic and environmental impact of the food cold supply chain. *Sustainability*, 14(8), 1-16. <https://doi.org/10.3390/su14084771>
- Chigara, H. (2021). Resource-Based View and competitiveness: An empirical study. *International Journal of Economic Performance (IJEP)*, 4(1), 432.
- Cloete, L., Picot-Allain, C., Ramasawmy, B., Neetoo, H., Ramful-Baboolall, D., & Emmambux, M. N. (2023). Drivers and barriers for the commercial uptake of edible coatings for the fresh fruits and vegetables industry: A review. *Food Reviews International*, 39(6), 3481-3514.
- Davis, P. J. (2019). Training employees to be a source of sustained competitive advantage. *The Journal of Applied Business and Economics*, 21(5), 29-39.
- De Blasis, F. (2020). Global horticultural value chains, labor, and poverty in Tanzania. *World Development Perspectives*, 18, 100201. <https://doi.org/10.1016/j.wdp.2020.100201>
- Dimoso, N., Aluko, A., Makule, E., & Kassim, N. (2021). Challenges and opportunities toward sustainable consumption and value addition of cashew apples in Tanzania. *Outlook Agriculture*, 50(2), 169–177.
- Dong, Y., Xu, M., & Miller, S. A. (2021). Overview of cold chain development in China and methods of studying its environmental impacts. *Environmental Research Communications*, 2(12), 1-15.
- Dube, S., Paremoer, T., Jahari, C., & Kilama, B. (2018). Growth and development of the fruit value chain in Tanzania and South Africa. *SSRN Electronic Journal*. <https://dx.doi.org/10.2139/ssrn.3244308>
- Gligor, D., Tan, A., & Nguyen, T. N. T. (2018). The obstacles to cold chain implementation in developing countries: Insights from Vietnam. *The International Journal of Logistics Management*, 29(3), 942-958.
- Gunarathna, R. T., & Bandara, Y. M. (2020). Post-harvest losses and the role of intermediaries in the vegetable supply chain. *2020 Moratuwa Engineering Research Conference (MERCon)*, IEEE, 378-383. <https://doi.org/10.1109/MERCon50084.2020.9185197>
- International Trade Centre. (2022). United Republic of Tanzania: Invisible barriers to trade. *Business perspectives*. Geneva: ITC.
- Iordăchescu, G., Ploscutanu, G., Pricop, E. M., Baston, O., & Barna, O. (2019). Postharvest losses in transportation and storage for the fresh fruits and vegetables sector. *Journal of International Scientific Publications*, 7, 244-251.
- Issa, I. M., Munishi, E. J., & Mubarack, K. (2021). Constraints to intermediaries' role in the provision of market and marketing services for the urban fresh fruits and vegetables supply chain. *Business Education Journal (BEJ)*, 10(3), 12. <https://www.ajol.info/index.php/bej/article/view/234745>
- Jafarpour, M., Shojaei, P., & Alimohammadlou, M. (2022). A model for improving cold supply chain performance: An integrated FISM/BWM/ANP approach. *International Journal of Procurement Management*, 15(5), 599-624.
- Kalkbrenner, M. T. (2021). Enhancing assessment literacy in professional counseling: A practical overview of factor analysis. *Professional Counselor*, 11(3), 267-284.
- Kim, S. T., Lee, H. H., & Hwang, T. (2020). Logistics integration in the supply chain: A resource dependence theory perspective. *International Journal of Quality Innovation*, 6(1), 1-14.
- Kline, R. B. (2023). *Principles and practice of structural equation modeling* (5th ed.). Guilford Publications.
- Li, G. (2021). Development of cold chain logistics transportation system based on 5G network and Internet of Things system. *Microprocessors and Microsystems*, 80, 1-6.
- Lipwop, M. C., & Achuora, J. (2021). Cold chain logistics and the performance of fresh produce firms in Nairobi City County, Kenya. *International Research Journal of Business and Strategic Management*, 2(2), 489-504.
- Liu, J., Hung, P., Liang, C., Zhang, J., Qiao, S., Campbell, B. A., & Li, X. (2022). Multilevel determinants of racial/ethnic disparities in severe maternal morbidity and mortality in the context of the COVID-19 pandemic

- in the USA: Protocol for a concurrent triangulation, mixed-methods study. *BMJ Open*, 12(6), e062294. <https://doi.org/10.1136/bmjopen-2022-062294>
- Makule, E., Dimoso, N., & Tassou, S. A. (2022). Precooling and cold storage methods for fruits and vegetables in Sub-Saharan Africa—A review. *Horticulturae*, 8(9), 1-15. <https://doi.org/10.3390/horticulturae8090776>
- Mashenene, R. G., & Kumburu, N. P. (2023). Performance of small businesses in Tanzania: Human resources-based view. *Global Business Review*, 24(5), 887-901. <https://doi.org/10.1177/0972150920927358>
- Mercier, S., Mondor, M., Villeneuve, S., & Marcos, B. (2018). The Canadian food cold chain: A legislative, scientific, and prospective overview. *International Journal of Refrigeration*, 88, 637-645. <https://doi.org/10.1016/j.ijrefrig.2018.01.006>
- Ministry of Agriculture. (2019). *National Post-Harvest Management Strategy (NPHMS) 2019-2029*. United Republic of Tanzania.
- Mmasa, J. J. (2023). Partial intermediary value-chain coordination and its effects on the productivity of sweet potato in Tanzania. *African Journal of Food, Agriculture, Nutrition and Development*, 23(3), 22624-22649.
- Msafiri, D., & Mwombela, S. (2021). Enhancing competitiveness of the horticultural industry in Tanzania. *Research on Poverty Alleviation (REPOA)*. <https://www.repoa.or.tz/wp-content/uploads/2021/06/Horticulture-PB.pdf>
- Murimi, M. M., Ombaka, B., & Muchiri, J. (2019). Influence of strategic physical resources on performance of small and medium manufacturing enterprises in Kenya. *International Journal of Business and Economic Sciences Applied Research*, 12(1), 20-27.
- Musa, D., Ghani, A. A., & Ahmad, S. (2022). Resource-based view theory on business performance and firm strategic orientation. *International Journal of Education, Islamic Studies and Social Science Research*, 7(1), 89-97. <http://dx.doi.org/10.6007/IJARBSS/v12-i10/15103>
- Nguyen, N. A. T., Wang, C. N., Dang, L. T. H., & Dang, T. T. (2022). Selection of cold chain logistics service providers based on a Grey AHP and Grey COPRAS framework: A case study in Vietnam. *Axioms*, 11(4), 1-24. <https://doi.org/10.3390/axioms11040154>
- Njoroge, K. K. (2022). Cold supply chain management and financial performance of pharmaceutical companies in Nairobi, Kenya (Doctoral dissertation). University of Nairobi.
- Nuthalapati, C. S., & Sharma, R. (2021). Requirement and availability of cold-chain for fruits and vegetables in the country. *Research Study Report*, Ministry of Agriculture and Farmers' Welfare, Government of India.
- Orakwue, A., & Iguisi, O. (2020). Conceptualizing entrepreneurship in human resource management. *International Journal of Research in Business and Social Science*, 9(3), 85-93.
- Pambudi, N. A., Sarifudin, A., Gandidi, I. M., & Romadhon, R. (2022). Vaccine cold chain management and cold storage technology to address the challenges of vaccination programs. *Energy Reports*, 8, 955-972. <https://doi.org/10.1016/j.egy.2021.12.039>
- Pérez, L. F., & Gómez, M. I. (2022). Public-private strategies to establish a successful avocado export cycle: Cases from Colombia. *Journal of Agribusiness in Developing and Emerging Economies*, 12(4), 620-640.
- Peters, T., & Sayin, L. (2022). The cold economy. *ADB Working Paper 1326*. Tokyo: Asian Development Bank Institute. <https://www.adb.org/publications/the-cold-economy>
- Raut, R. D., Gardas, B. B., Narwane, V. S., & Narkhede, B. E. (2019). Improvement in food losses in the fruits and vegetable supply chain from a cold third-party logistics approach. *Operations Research Perspectives*, 6, 100117. <https://doi.org/10.1016/j.orp.2019.100117>
- Reddy, L. S., & Kulshrestha, P. (2019). Performing the KMO and Bartlett's test for factors estimating warehouse efficiency, inventory, and customer satisfaction for the e-retail supply chain. *International Journal for Research in Engineering, Application & Management*, 5(9), 1-13.
- Rutta, E. W. (2022). Barriers impeding the deployment and uptake of solar-powered cold storage technologies for postharvest loss reduction in the tomato value chain in Africa (Doctoral dissertation). Queen's University (Canada).
- Saunders, M. N. K., Lewis, P., & Thornhill, A. (2023). *Research methods for business students* (9th ed.). Pearson.
- Sibanda, S., & Workneh, T. S. (2020). Potential causes of postharvest losses and low-cost cooling technology for fresh produce farmers in Sub-Saharan Africa. *African Journal of Agricultural Research*, 16(5), 553-566.
- Sileyew, K. J. (2019). Research design and methodology. In *Cyberspace*. IntechOpen. <https://www.intechopen.com/books/cyberspace/research-design-and-methodology>
- Taherdoost, H. A. M. E. D., Sahibuddin, S., & Jalaliyoon, N. E. D. A. (2022). Exploratory factor analysis: Concepts and theory. *Advances in Applied and Pure Mathematics*, 27, 375-382. <https://ssrn.com/abstract=417868>
- Tanzania Horticulture Association. (2021). *TAHA strategic plan 2022-2026*. <https://taha.or.tz/taha-strategic-plan-2022-2026-final>
- Turan, C., & Ozturkoglu, Y. (2022). A conceptual framework model for an effective cold food chain management in a sustainable environment. *Journal of Modelling in Management*, 17(4), 1262-1279.



- Vrat, P., Gupta, R., Bhatnagar, A., Pathak, D. K., & Fulzele, V. (2018). Literature review analytics (LRA) on sustainable cold chain for perishable food products: Research trends and future directions. *Opsearch*, 55(3), 601-627.
- Wakiariro, C. P. (2020). The state of horticultural logistics management of international trade in Tanzania (Doctoral dissertation). Institute of Accountancy, Arusha.
- Xie, R., Huang, H., Zhang, Y., & Yu, P. (2022). Coupling relationship between cold chain logistics and economic development: An investigation from China. *PLOS ONE*, 17(2), e0264561. <https://doi.org/10.1371/journal.pone.0264561>
- Yahaya, S. M., & Mardiyya, A. Y. (2019). Review of post-harvest losses of fruits and vegetables. *Biomedical Journal of Scientific & Technical Research*, 13(4), 10192-10200.
- Yahya, A. (2020). Assessment of factors affecting vegetable supply chain performance in Tanzania: A case of selected regions (Doctoral dissertation). Mzumbe University.
- Yang, M. (2023). The impact of blended learning on Chinese middle school students' interest in learning during COVID-19. *Lecture Notes in Education, Psychology and Public Media*, 6, 144-153. <https://doi.org/10.54254/2753-7048/6/20220219>
- Yusupjanovna, T. R. (2020). Fruits and vegetables: Problems of their delivery to the consumer and solutions. *International Journal on Integrated Education*, 3(12), 336-338. <https://doi.org/10.31149/ijie.v3i12.1031>

APPENDIX I*Interviewee Details*

Respondent ID	Type of business	Category of the firm's experience
Respondent 1	Larger-scale farmers	Above 20 years
Respondent 2	Farmers' organization	16-20 years
Respondent 3	Larger-scale farmers	6-10 years
Respondent 4	Small-scale farmers	16-20 years
Respondent 5	Logistics company	11-15 years
Respondent 6	Retailer	6-10 years
Respondent 7	Exporter	16-20 years
Respondent 8	Cold packinghouse	Below 5 years
Respondent 9	Exporter	6-10 years
Respondent 10	Larger-scale farmers	6-10 years
Respondent 11	Small-scale farmers	11-15 years
Respondent 12	Retailer	11-15 years