

Influence of relief supplies distribution on resilient disaster relief operations: Evidence from humanitarian-organization's relief practitioners

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ABSTRACT

This study examined the influence of relief supplies distribution on resilient disaster relief operations in Tanzania, focusing on how various distribution factors enhance effective humanitarian outcomes. The study employed an explanatory research design. Data were collected via questionnaires and interviews from 192 humanitarian practitioners across Dodoma, Dar es Salaam, and Kigoma, sampled from a population of 369 using Slovin's formula. Both qualitative and quantitative data were analyzed using SPSS version 27, with multiple linear regression applied to assess the impact of six relief supply distribution variables (RSD1–RSD6). Relief supply distribution variables significantly influenced resilient disaster relief operations ($p = 0.000$). The model showed an R-squared of 0.71 and an Adjusted R-squared of 0.69, indicating strong explanatory power. Among the predictors, RSD1 ($\beta = 0.386$), RSD4 ($\beta = 0.332$), and RSD2 ($\beta = 0.314$) were the strongest contributors. The findings are limited to three Tanzanian regions—Dodoma, Dar es Salaam, and Kigoma—which may somehow restrict generalizability but may be appropriate for developing economies. Humanitarian organizations should implement needs-based, data-driven distribution strategies and formalize collaboration through memoranda of understanding (MoUs), standard operating procedures (SOPs), and joint contingency plans. Enhanced relief distribution promotes community resilience by ensuring timely and equitable aid, reducing human suffering, and strengthening social cohesion between affected populations and aid agencies. This study empirically supports Coordination Theory within humanitarian logistics by demonstrating the direct impact of relief supply distribution on disaster resilience.

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Relief supplies distribution, resilient disaster relief operations, disaster relief practitioners and humanitarian organizations.

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1. INTRODUCTION

The increasing frequency and severity of disasters, both natural and manmade, have drawn significant attention from researchers, policymakers, and humanitarian actors toward instituting effective models, procedures, and strategies to mitigate their devastating impacts (Negi, 2022). Natural disasters continue to strain logistics management systems, and supply chain systems, that ultimately complicate timely responses and equitable distribution of aids (Aghsami et al., 2024). Research analyzing disaster responses in countries for example India, Pakistan, and Malaysia highlights some challenging factor that are related to post-disaster relief coordination, waste management, and resource flow (Argollo da Costa et al., 2014; Argollo da Costa et al., 2015; Firdous & Ramish, 2023). Furthermore, in such a sense and consideration for human safety and security, governments, non-governmental humanitarian organizations and international humanitarian organizations, have increasingly recognized the critical need for coordinated relief operations, in disasters as they continue to threaten human life and well-being (Altay et al., 2018; Roy & Lebcir, 2021; Raillani et al., 2020). Reflecting from the statistics provided and published by the Centre for Research on the Epidemiology of Disasters (CRED), in 2019 alone, 395 disasters caused 11,756 deaths, impacted 95 million people, and this amounted in economic losses approaching \$130 billion (CRED, 2020). As according to Dubey et al., (2022), a similar pattern was seen in 2018, with 281 disaster events resulting in 10,733 fatalities. Jonkman et al., (2023) also narrates the devastating impact of floods globally from 1975 until 2022, which data set compiled from, EM-DAT disaster database, the authors provide that with these natural disasters its crucial to be more prepared and resilient for relief operations.

In the African context, specifically in sub-Saharan regions, research identifies major challenges and barriers to effective disaster relief operations. In this context, the key challenges discussed include poor planning, inadequate coordination, weak logistics systems, and negative public perception (Baidoo, 2018). There are proposed interventions to address these gaps, these interventions include improved stakeholder coordination,

better training, and increased funding (Okdinawati et al., 2019; Baidoo, 2018; Gupta et al., 2016; Okdinawati et al., 2019). Still, coordination inefficiencies persist, as evidenced in Ghana, where delays in response are linked to resource shortages, distributions issues and mismanaged coordination among stakeholders (Owusu-Kwateng et al., 2017). In East Africa, countries like Kenya, Rwanda, Uganda, and the DRC face the likely common challenges, including fragmented relief networks, limited preparedness, and poor logistics infrastructure (Komorowski & Karume, 2015; Agrawal, 2013; Bahal'Okwibale, 2018; Shears & Garavan, 2020; Sospeter, 2023). In Uganda, transport, inventory, relief supplies delay and information flow have been identified as critical areas needing improvement (Korir et al., 2023; Orach et al., 2013).

As a nation, Tanzania has also witnessed multiple devastating natural and man-made disasters, including floods and maritime tragedies. For instance, between 2015 and 2020, floods alone caused 307 deaths and affected over 317,000 people (PMO, UNDRR, 2022). Other tragedies such like the MV Nyerere ferry disaster (2018) and MV Spice Islander (2011) exposed severe deficiencies in coordination, preparedness, relief operations and logistics management (PMO, UNDRR, and CIMA, 2019). Effectiveness in humanitarian logistics, as illustrated by Osumo & Omwenga (2024), can positively influences disaster response outcomes, although specifics are often lacking on this context. Moreover, climate change is intensifying disaster frequency and complexity, this also necessitate more resilient and adaptable logistics frameworks (Shen et al., 2023; Zhen et al., 2022). At this point, research affirms that coordination among supply chain actors is essential for successful humanitarian operations (Zhang et al., 2023), especially in fragile and high-risk regions where lives depend on effective, timely, efficient, and equitable relief delivery (Wang et al., 2024a; Ngah et al., 2022; Gopal et al., 2015). That's why this research aimed to focus on examining the influence of relief supplies distribution on resilient disaster relief operations in Tanzania: evidence from disaster relief practitioners in humanitarian organizations.

In this respect from the literature and practice: globally the protection of human lives and alleviating their suffering in these disastrous situations and events has long been a primary concern for governments and established

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humanitarian organizations (Holthus et al., 2020; Bizzarri, 2012). As disasters become more frequent and complex – some being caused far also by climate changes, effective coordination and timely relief supplies distribution in disaster relief operations are increasingly essential to reduce fatalities and support affected populations in disasters occurrence. In the Tanzania, the government, humanitarian organizations and other groups of humanitarian actors have made commendable moves and efforts in mitigating disaster impacts. These moves and efforts include launching public awareness campaigns to foster society and community engagement, partnering with private local organizations, and collaborating with international relief and non-governmental organizations (NGOs), efforts also included establishing policy frameworks for the sake of promoting Disaster Risk Management (DRM) (Majamba, 2023; Msemo et al., 2021; Rutaba, 2022; Rutaba, 2023). Adding to the efforts, under the governing law, the government of Tanzania have also managed to establish the Disaster Management Division under the Prime Minister's Office (PMO), that is aimed to coordinate relief operations across sectors such as health, environment, food security, and climate change (Daly et al., 2015; Mboera et al., 2012).

Despite these efforts and initiatives in Tanzania, the increasing severity of disasters has exposed systemic weaknesses in coordination, timely distribution of relief supplies and resource allocation in disaster situations (Zain et al., 2023; Salam & Khan, 2020; Sahay et al., 2016). While previous research in Tanzania that managed to examine some issues in humanitarian logistics and relief operations, like in examining disaster preparedness, logistics challenges, and flood management mechanisms (Masoud (2022), Rutaba (2022, 2023), Koka et al. (2018), and Mburu (2014), these research studies have not sufficiently addressed the contribution of relief supplies distribution in creating resilient and adaptive disaster relief operations. This study will explore on how relief supplies distribution can contribute to resilient disaster relief operations, specifically through the lens of humanitarian practitioners. The findings are expected to inform contingency planning and strengthen humanitarian logistics in Tanzania (Rutaba, 2022; Rutaba, 2023; Kovács & Spens, 2007; Apte, 2010).

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

2.1 Theoretical perspective

This study is grounded by the Coordination theory, according to Malone, (1988), coordination theory can be defined as a body of principles about how the operations, functions or activities of different actors can be coordinated. Malone and Crownston (1990) were the pioneers in emphasizing the importance of coordination theory. According to Jahreet al (2016), disaster relief responses necessitate inter-organizational coordination, which entails the recipient community involving the local engagement, the collaboration and coordination with local infrastructure, resilience, and a response chains that involve diverse stakeholders, such as corporations, humanitarian organizations, humanitarian agencies and government. Coordination Theory suggests the feasibility of harmonizing different humanitarian organizations and their operations (McEntire, 1997; Seybolt, 1997). Researchers argue that effective coordination is pivotal for delivering services proficiently (Karanja et al., 2015). The motivation behind stakeholder coordination is predominantly rooted in achieving effectiveness (Minear, 2002). Additionally, the imperative of minimizing duplicated efforts underscores the need for enhanced coordination in emergency response procedures for these organizations (McEntire, 1997). Parmar (2007) managed to highlight on the need for increased coordination and collaboration among responding organizations, while Maghsoudi (2018) illustrates that resource sharing and standardization positively impact the performance of humanitarian organizations. On the other hand, Nolte (2012) suggests that common incentives and a high degree of equality among humanitarian organizations (Hos) improve network coordination, and Wuni (2008) emphasizes the significance of inter-agency coordination in achieving efficient distribution and delivery of relief.

2.2 Empirical Literature and hypothesis development

Recent researches in humanitarian logistics increasingly emphasizes the need for adaptive, dynamic, and context-aware approaches to relief supply distribution in disaster relief operations. Reflecting from Mishra et al. (2022) and Sakiani et al. (2021), the authors developed models that respond to shifting demand patterns, resource constraints, and evolving disaster conditions. From Mishra et al. (2022) and Sakiani et al. (2021) perspectives: is that we have recurring issues in managing relief demand during disasters and stating that this is also linked to resource coordination and constraints. These models by Mishra et al. (2022) and Sakiani et al. (2021) integrate real-time data to enhance responsiveness, prioritizing high-risk and severely

affected areas. Additionally, the integration of emerging technologies, like the Internet of Things (IoT) and Geographic Information Systems (GIS) is also discussed being critically considered in leveraging relief operations, is seen as essential for improving situational awareness and decision-making capabilities in humanitarian operations (Mishra et al., 2022; Cruz-Cantillo, 2014). Kovács and Moshtari (2019) in their work and reflection, they emphasized on the value of high-quality empirical studies that capturing contextual uncertainties, safe to enable practitioners to tailor interventions more effectively. On this, this current study should aim to contribute on the void with respect to distribution of relief goods and items in during disasters.

In this specific context of distributing relief items, Royero, Galindo, and Yie-Pinedo (2020) managed to present a rolling horizon framework for relief kit distribution that factors in dynamic variables like resource capacities, changing demand levels, and varying urgency among affected populations. Highlighting the most specific issues, the study by Royero, Galindo, and Yie-Pinedo (2020) underscores the critical role of assembling relief kits and prioritizing deliveries to the most vulnerable populations or groups—an often overlooked but critical factor in physical distribution planning of relief supplies. There's a range of studies that has further advanced the understanding of effective supply dispatch, for instance Lee et al. (2009) and Pérez-Rodríguez and Holguín-Veras (2016), the authors focused on optimizing supply cross-leveling between distribution points and Takahagi et al. (2014) who introduced visualization tools to enhance supplies allocation at evacuation centers, and Balci et al. (2008) and Barahona et al. (2013) who emphasized on cost-effective routing and resource allocation in servicing effected population in disasters. Collectively these research papers' contribution narrates on the distribution issues that need critical attention for strengthen relief services.

Formalizing these logistical challenges, recent work identifies three core problems in relief distribution, that include: optimal location of distribution centers, supply-demand matching, and task assignment to fleets based on road conditions and geographic reach (Clemente et al., 2022; Moreno et al., 2018; Manopiniwes & Irohara, 2014; Maya et al., 2016). These challenges in a nutshell present the major issues in providing relief aids to affected population. On the other way, procurement and storage are also discussed to be tightly linked with the distribution of relief supplies. Nikkhoo and Amiri (2018), along with Wankmüller and Reiner (2021), highlight that coordinated procurement within humanitarian supply chains ensures smoother flows of goods and enhances collaboration between actors. However, they fall short of explaining how such procurement systems can tangibly increase the resilience of disaster relief operations. Kur and Singh (2018) propose mathematical models for both proactive and reactive procurement strategies to reduce supply chain disruptions, though they also lack a clear link between coordinated procurement and operational resilience. Baporikar and Shangheta (2018) reinforce these points by identifying major logistical challenges—including sourcing, allocation, and transportation—that hinder disaster response effectiveness.

The literature is further enriched by contributions from Yan (2021), Chukwuka (2024), Maghsoudi (2018), Liu (2021), Yao (2018), and Kaur (2020), who stress the significance of integrated logistics systems and long-term strategic planning in strengthening both efficiency and resilience of relief operations. Roy et al. (2012), Smilowitz and Dolinskaya (2011), and Lee et al. (2009) emphasize that physical distribution is central to humanitarian logistics. It involves multiple stages: logistics planning, transportation, warehousing, and final distribution. Horner and Downs (2010) argue that planning must consider the extent of damage, accessibility, and coordination with local stakeholders. According to Raillani et al. (2020), the authors highlighted on the need for flexible transportation routes and methods, while Roh et al. (2016) and Renkli and Duran (2015) emphasized on the strategic placement of warehouses to enable rapid deployment and effective distribution. The distribution phase itself in relief operation, as envisaged and discussed by Sebbah et al. (2013), must consider and ensure equitable and timely delivery, reinforced by transparent communication with affected communities.

Despite these advances and contributions, challenges still persist and there's limited research contribution linking relief supplies distribution and resilient disaster relief operations. In this regard, further empirical studies are essential to assess on how transportation infrastructure, warehousing capacity, and distribution coordination can influence the speed and effectiveness of humanitarian operations (Singh et al., 2018; Vargas-Florez & Alva-Cabrera, 2019). Understanding these critical aspects and their interdependencies is critical, crucial and vital for designing more resilient disaster relief operations that can withstand increasing disaster frequency and intensity. In such narrations, thus, the following hypothesis is proposed:

H1: relief supplies distribution positively influences resilient disaster relief operations

2.3 Conceptual Framework

Independent Variables

Relief supplies distribution
- Condition of Supplies on Arrival
- Distribution Network Coverage
- Delivery Lead time

Dependent Variables

Resilient Disaster relief operations (DROs) - RDRO
- Timely DROs
- Efficient DROs
- Agile DROs

Figure 1. The Conceptual model framework

Source: Figure by authors

3. METHODS

This current study adopted a positivism research philosophy, as it aligns well with the study's objectives due to its emphasis on observable and measurable phenomena. Explanatory research design was employed in the study by incorporating a mixed research approach that aimed to integrate both quantitative and qualitative data. This study was conducted in Tanzania considering three specific regions - Dar es Salaam, Dodoma, and Kigoma, targeting humanitarian logistics practitioners working in Humanitarian Organizations (HOs). The three regions were selected based on the United Nations High Commissioner for Refugees (UNHCR) Humanitarian Situation Report of 2022, this report indicates a high concentration of humanitarian activity in these regions, with a target population of 369 humanitarian practitioners engaged in logistics and disaster relief operations. The sample size was determined using Slovin's formula, which is effective for achieving statistical accuracy with known confidence levels and acceptable margins of error (Creswell, 2014; Magigi, 2015). A 5% margin of error was used, resulting in a sample of 192 respondents. The sample included logistics officers, procurement and supply chain specialists, rescuers, warehouse staff, and health logistics experts. These professionals were drawn from 16 identified HOs, which were treated as strata in the sampling frame. A proportional stratified sampling technique was employed to ensure that each HO was adequately represented, with a sampling ratio of 0.520 (192/369). Data were collected through questionnaires, observations, and interviews. Quantitative data were analyzed using descriptive statistics (frequencies, percentages) and Multiple Linear Regression Analysis to determine the relationships between dependent and independent variables (Dupont, 2009). Prior to data analysis, data were edited, coded, and cleaned to ensure reliability and accuracy. For the case of qualitative data, thematic analysis was used to identify themes and patterns emerging from interview.

3.1 Testing Assumptions of Linear Regression

3.1.1 Normality

Linear regression assumes that the dataset follows a normal distribution (Ryan, 2020). In this study, normality was evaluated using skewness and kurtosis values. According to Kline (2011), acceptable skewness values range from -1 to +1, though some scholars extend the acceptable range to between -2 and +2. As for kurtosis, values between -3 and +3 are considered acceptable (Balanda & MacGillivray, 1988). The results of skewness and kurtosis for the observed variables (RSD1–RSD6) fell within these thresholds, indicating that the data satisfied the normality assumption. This confirms that the sample distribution was suitable for regression analysis and accurately represents the underlying population characteristics.

3.1.2 Linearity

Linearity assumes a proportional relationship between independent and dependent variables (Saunders et al., 2016). In this study, linearity was tested using Pearson correlation coefficients (r), which revealed statistically significant correlations among the study variables at the 0.01 level (2-tailed). These results confirm the presence of linear relationships suitable for regression modeling. The linear association between relief supplies distribution and resilient disaster relief operations thus validates the assumption that changes in RSD variables predict corresponding changes in disaster relief resilience outcomes.

3.1.3 Outliers

Outliers refer to data points that deviate substantially from other observations and can distort regression results or lead to biased conclusions (Kline, 2011). An examination of the dataset showed no extreme values or significant outliers, confirming that the data were consistent and free from anomalies. This supports the reliability and robustness of the statistical analysis conducted.

3.1.4 Multicollinearity

Multicollinearity occurs when independent variables are highly correlated, potentially destabilizing coefficient estimates (Schinka et al., 2003). To test for this, tolerance values and Variance Inflation Factors (VIF) were used. According to Flynn & Davis (2017), Ryan (2020), and Saunders et al. (2016), tolerance values above 0.10 and VIF values below 10 indicate no multicollinearity. In this study, VIF values for all six predictors (RSD1–RSD6) ranged between 1.75 and 2.15, suggesting no multicollinearity concerns and confirming that each predictor contributed unique information to the model.

Table 1: Multicollinearity Diagnostics – VIF

Predictor Variable	Tolerance	VIF
RSD1	0.57	1.8
RSD2	0.55	1.8
RSD3	0.52	1.9
RSD4	0.5	2
RSD5	0.49	2.1
RSD6	0.46	2.2

Source: Data from Survey (2025).

3.2 Reliability and Validity

Reliability and validity tests were conducted to determine the consistency and accuracy of the Relief Supplies Distribution (RSD) construct. Table 5 presents the factor loadings, Average Variance Extracted (AVE), Composite Reliability (CR), and Cronbach's alpha values for the six indicators. All factor loadings ranged from 0.77 to 0.86, surpassing the recommended threshold of 0.70 (Hair et al., 2022), indicating that all items contributed significantly to the construct. The AVE values ranged from 0.67 to 0.75, exceeding the 0.50 benchmark, confirming convergent validity. The Composite Reliability (CR) value of 0.89 and Cronbach's alpha of 0.88 demonstrate high internal consistency among the items. Variance Inflation Factor (VIF) values below 3.3 confirm the absence of redundancy, while Common Method Bias (CMB) values ranging from 0.26 to 0.32 suggest minimal bias in the dataset.

Table 2: Cronbach's α , CR, AVE and Factor Analysis

Indicator	Factor Loading	AVE	CR	Cronbach's α	CMB (VIF Factor)	/
RSD1	0.86	0.8	0.9	0.88	0.26	
RSD2	0.84	0.7	0.9	0.88	0.28	
RSD3	0.8	0.7	0.9	0.88	0.3	
RSD4	0.82	0.7	0.9	0.88	0.29	
RSD5	0.79	0.7	0.9	0.88	0.31	
RSD6	0.77	0.7	0.9	0.88	0.32	

Source: Data from Survey (2025).

The Relief Supplies Distribution construct demonstrates strong reliability and validity. All indicators surpassed minimum thresholds for factor loadings, AVE, CR, and Cronbach's alpha, confirming the measurement model's integrity. The results indicate that the dataset is free from multicollinearity and measurement bias, supporting the robustness of subsequent regression and structural analyses. Therefore, the RSD construct provides a statistically reliable foundation for evaluating its effect on resilient disaster relief operations in the studied regions.

3.3 Measurement items

Table 3 presents the study variables

Table 3: Measurement items

Variable	source	Definition/	Measurement	Instrument
Relief Supplies Distribution	-	Condition of Supplies on Arrival	5-point Likert scale	Questionnaire and interview guide
	-	Distribution Network Coverage		
	-	Delivery Leadtime		
		(Clemente et al., 2022; Balcik et al., 2008; Nolz et al., 2011)		

Variable	Definition/	Measurement	Instrument
source			
Resilient Disaster Relief Operations (RDRO)	- Timely Disaster relief operations - Efficient Disaster relief operations - Agile Disaster relief operations	5-point Likert scale	Questionnaire and interview guide
(Hussain et al.,2022)			

Source: Table by the authors

3.4 Ethical consideration

In conducting research studies, it is mandatory to adhere to some ethical issues and established institutional norms. This study commenced when research clearance was issued to the researcher from Mzumbe University. Secondly before collecting data from respondents in established organization settings, the procedures including request for introduction letter and permission for conducting research in those organizations was adhered to prior to data collection procedure. Third this research study is also observed the ethical principle of Beneficence as the study is aimed to be carried out to benefit the community while promoting their welfare and safety. In the process of collecting data from individual respondents the consent forms were provided to respondents.

4. FINDINGS

4.1 Demographics of the respondent

The demographics of respondents were assessed based on region, organization category, location, age group, experience, and specialization in disaster relief operations. As Saunders et al. (2016) note, demographic data help explain differences in opinions and behaviors, and evaluate how well the sample represents the population. Practitioners from humanitarian organizations in Dodoma, Kigoma, and Dar es Salaam completed the questionnaires. Both technical and support staff were represented, with specializations in relief procurement, humanitarian supply chains, operations, and disaster management. Results showed that most respondents (39.6%) were from organizations based in Dar es Salaam, followed by Dodoma (32.3%) and Kigoma (28.1%). Dar es Salaam led due to the concentration of head offices there. In terms of organization category, 41.1% were from Local NGOs, 35.9% from International NGOs, and 22.9% from government institutions. Age-wise, the respondents were fairly distributed: 9.9% were aged 18–27, 53.1% aged 28–37, 29.2% aged 38–47, 7.8% aged 48–57, and none were above 57. This suggests that the majority were middle-aged, which, according to Kiage (2013), correlates with having adequate work experience. Experience in disaster relief and humanitarian logistics was also evaluated. About 24.0% had more than 10 years' experience, 46.4% had 5–10 years, 28.1% had 3–5 years, and only 1.6% had less than 3 years. These findings suggest that most respondents were knowledgeable and had practical exposure to the issues studied, confirming their suitability for the research. These narrations align with Tan and Wong (2015) and Goel (2016), who stress the link between experience and informed insights into organizational performance.

Table 4: Demographic Characteristics of Respondents (N = 192)

Variable	Category	Frequency	Percent	Valid Percent	Cumulative Percent
Age Group	18 – 27 Years	19	9.9%	9.9%	9.9%
	28 – 37 Years	102	53.1%	53.1%	63.0%
	38 – 47 Years	56	29.2%	29.2%	92.2%
	48 – 57 Years	15	7.8%	7.8%	100.0%
	Total	192	100.0%	100.0%	
Work Experience	0 – 3 Years	3	1.6%	1.6%	1.6%
	3 – 5 Years	54	28.1%	28.1%	29.7%
	5 – 10 Years	89	46.4%	46.4%	76.0%
	More than 10 Years	46	24.0%	24.0%	100.0%
	Total	192	100.0%	100.0%	
Type of Organization	Government	44	22.9%	22.9%	22.9%
	Non-Government (Local)	79	41.1%	41.1%	64.1%
	Non-Government (International)	69	35.9%	35.9%	100.0%
	Total	192	100.0%	100.0%	
Organization Location	Dodoma	62	32.3%	32.3%	32.3%
	Dar es Salaam	76	39.6%	39.6%	71.9%
	Kigoma	54	28.1%	28.1%	100.0%
	Total	192	100.0%	100.0%	
Practitioner Specialization	Rescuer	16	8.3%	8.3%	8.3%
	Supply Chain	40	20.8%	20.8%	29.2%
	Logistics Officer	24	12.5%	12.5%	41.7%

Relief Officer	31	16.1%	16.1%	57.8%
Relief Operations Coordinator	30	15.6%	15.6%	73.4%
Medical Supply Specialist	18	9.4%	9.4%	82.8%
Distribution Officer	33	17.2%	17.2%	100.0%
Total	192	100.0%	100.0%	

Source: Table by the authors

4.2 Descriptive statistics: mean, Standard deviation, skewness and kurtosis

Skewness in this context is defined as a measure of symmetry or lack of symmetry. Asymmetric in the data set tend to occur when most of the scores are above or below the mean. Skewness in this context is discussed to appear in three forms (left: skew < 0, normal: skew ~ 0, and right: skew > 0). In the case of skewness, according to Kline (2011), the author stated an acceptable range for normality is between -1 to 1. However, normality is not only and always tested by skewness but also by kurtosis. In this context kurtosis is posed as a measure of whether the data are flat relative to a normal distribution. Similarly, the acceptance range for normality is between -1 to 1, this is also according to Kline, (2011). It should also be noted that in some other studies acceptable kurtosis and skewness is between -2 and +2 (Kline, 2011) and as for kurtosis is between -3 and +3 (Balanda & MacGillivray, 1988).

Table 5: Descriptive Statistics - Skewness and Kurtosis.

Item	Mean	SD	Variance	Skewness	Kurtosis
RSD1	4.25	0.80	0.640	-1.12	1.58
RSD2	4.00	0.85	0.723	-1.06	1.42
RSD3	3.89	0.89	0.792	-0.98	1.27
RSD4	4.12	0.83	0.689	-1.08	1.36
RSD5	4.09	0.91	0.829	-0.94	1.19
RSD6	3.95	0.96	0.922	-0.88	1.05

Source: Table by the authors

The study's descriptive findings reveal favorable perceptions of Relief Supplies Distribution (RSD) processes among respondents, with mean ratings between 3.89 and 4.25, suggesting generally effective logistics systems. RSD1 received the highest mean (4.25), indicating strong confidence in supply condition upon arrival, while RSD3 (3.89) and RSD6 (mean not shown but implied lower) signaled areas for improvement, particularly in distribution reach and transport efficiency. Negative skewness and high kurtosis across items confirm that most ratings clustered at the positive end, highlighting widespread agreement on the effectiveness of current practices.

Table 6: Descriptive Statistics on level of agreement of respondents (N=192)

Variable	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Ensuring the condition of supplies on arrival is essential to maintain the quality and usability of relief items (RSD1)	0 (0%)	0 (0%)	59 (29.1%)	90 (44.4%)	43 (21.3%)
Proper handling and transportation protocols help preserve the integrity of supplies during transit (RSD2)	0 (0%)	0 (0%)	50 (24.0%)	97 (46.6%)	45 (21.6%)
Expanding distribution network coverage increases the reach of humanitarian aid (RSD3)	0 (0%)	0 (0%)	37 (18.3%)	107 (52.9%)	48 (23.7%)
Strategically located distribution centers and routes improve access to critical supplies (RSD4)	0 (0%)	0 (0%)	29 (14.4%)	116 (57.4%)	47 (23.3%)
Minimizing delivery lead time is crucial for timely aid in emergency situations (RSD5)	0 (0%)	0 (0%)	40 (19.8%)	113 (56.0%)	39 (19.3%)
Streamlined logistics and efficient transport management reduce delivery lead time (RSD6)	0 (0%)	0 (0%)	35 (17.3%)	116 (57.4%)	41 (20.3%)

Source: Table by the authors

Across six key dimensions—supply condition, handling protocols, network coverage, strategic center placement, lead time, and logistics efficiency—agreement levels ranged from 65% to 81%. For instance, 65.7% of respondents either agreed or strongly agreed that ensuring supply condition upon arrival is vital (RSD1), while 80.7% agreed that efficient logistics reduce lead time (RSD6). Most neutral responses (14–29%) may reflect differences in implementation capacity, awareness, or experience across organizations.

These findings underscore the strategic importance of maintaining supply integrity, expanding distribution coverage, optimizing logistics routes, and reducing lead time to improve humanitarian aid delivery. The data advocate for continuous improvements in logistics coordination, training, infrastructure, and technology adoption. While organizations appear to have strong foundational systems, gaps in consistency—particularly in RSD3 and RSD6—point to the need for further investment in last-mile delivery and standardized transport protocols. Strategically, humanitarian organizations must align logistics operations with operational demands, focusing on equitable access and responsiveness. The results confirm that efficient, well-coordinated supply chain systems are central to successful humanitarian interventions, and future research should examine barriers to logistics optimization in low-resource contexts.

Table 7: Influence of Relief Supplies Distribution on Resilient Disaster Relief Operation

Resilient Disaster Relief Operation	Coef.	SE Coef.	T	P
RSD1	0.386	0.048	8.04	0.000
RSD2	0.314	0.052	6.04	0.000
RSD3	0.269	0.050	5.38	0.000
RSD4	0.332	0.055	6.05	0.000
RSD5	0.279	0.057	4.91	0.000
RSD6	0.310	0.054	5.74	0.000

R-Sq = 0.71 Adjusted R-squared (R^2 adj) is 0.69

Source: Table by the authors

The analysis indicates that relief supplies distribution significantly and positively influences resilient disaster relief operations. All six variables (RSD1–RSD6) showed statistically significant coefficients ($p = 0.000$), with an Adjusted R^2 of 0.69, indicating that 69% of the variation in disaster relief resilience is explained by the model. This confirms that efficient relief distribution is a key driver of resilience, although slightly less explanatory than factors like information flow or collaboration. Among the predictors, RSD1 ($\beta = 0.386$) had the strongest impact, followed by RSD4 ($\beta = 0.332$) and RSD2 ($\beta = 0.314$), emphasizing the strategic importance of supply condition upon arrival, location of distribution centers, and transportation protocols. Although RSD3 ($\beta = 0.269$) and RSD5 ($\beta = 0.279$) had slightly lower coefficients, all T-values (≥ 4.91) were strong, confirming the robustness of the model. The findings highlight the need to invest in optimized distribution systems, improved inventory tracking, and enhanced logistics coordination to ensure timely aid. As emphasized in prior research, strategic facility location, efficient networks, and inventory control are vital for resilience (Manopiniwes & Irohara, 2014). Government support and strategic planning also drive resilient supply chains (Singh et al., 2018), while decision-support tools enhance operational performance (Smilowitz & Dolinskaya, 2011). Challenges in IDP camps reveal the importance of third-party logistics (Adewale et al., 2020).

Other scholars underline similar priorities: effective distribution safeguards supply quality, supports timely delivery, and enhances access through network expansion and optimized logistics (Costa et al., 2014; Ghiasvand & Ejlaly, 2014). Effective systems improve post-disaster efficiency and quality, boosting survivor resilience (Shehadeh & Tucker, 2020; Xu et al., 2021; Gan et al., 2016; Qezelbash-Chamak et al., 2023; Abe & Ye, 2013). Collectively, the literature reinforces that efficient relief supply distribution is critical, crucial and vital to building resilient disaster response operations. As for RSD1, Wang et al., (2023) illustrated that the novel period rotation mechanism improves the quality of relief supplies by gradually rotating items based on shelf life, thus ensuring better condition upon arrival and reducing the financial burden on relief organizations. Rivera-Royero et al., (2020) on this aspect found out that assembling relief items into kits before distribution is crucial for maintaining their quality and usability, as it allows for better organization and handling, ensuring that supplies arrive in optimal condition for the affected population. Löffel et al., (2024) portrayed this as a part of risk management and narrated that: adequate supply chain risk management is crucial for effective humanitarian aid delivery, which includes ensuring the condition of supplies upon arrival to maintain the quality and usability of relief items in diverse contexts.

And for RSD2, Hamdi et al., (2024) for the case of pharmaceutical supplies the authors pointed out logistics assessment as a critical component of pharmaceutical supply operations management during disaster response, emphasizing the need for effective handling and transportation protocols to preserve supply integrity and ensure efficient delivery in disaster relief operations. Also, Rivera-Royero et al., (2020) emphasized on the importance of assembling standard relief kits and arranging them into pallets, which aids

in preserving the integrity of supplies during transit and enhances the efficiency of distribution operations in disaster relief settings. On other aspect as such Negi, (2022) illustrated that proper handling and transportation protocols are crucial in disaster relief operations, as they ensure the integrity of supplies during transit. Effective logistical operations, including adherence to established protocols, facilitate timely resource mobilization and minimize the impact of disasters. This was also supported by Ye & Yan, (2020), stating that proper handling and transportation protocols are crucial in disaster relief operations to ensure the timely delivery of the Right relief supplies with the Right quality and quantity, thereby preserving their integrity and minimizing waste during transit (Fredin, 2022; Baporikar & Atshipara, 2019; Modgil et al., 2020; Baidya & Bera, 2019).

On the other side for RSD3, Khairuddin et al., (2022) emphasized that effective humanitarian aid relies on logistics and communication among actors. Expanding distribution network coverage enhances coordination, ensuring timely delivery of aid, thus improving the overall effectiveness of disaster relief operations in affected localities. According to Vaithiyanathan & Shalini, (2025), the author narrated that increase in distribution network coverage facilitates more effective resource allocation and coordination during crisis scenarios, particularly in high-risk regions. These narrations also supported by Arifin et al., (2024), demonstrating that expanding distribution network coverage enhances the reach and effectiveness of humanitarian aid and disaster relief operations. Hrydziushka et al., (2021) on the other side emphasized on maximizing aid distribution through a dynamic flow model, which can be adapted to expand network coverage. This approach enhances the reach of humanitarian aid, ensuring effective disaster relief operations by addressing multiple objectives and constraints. According to Clemente et al., (2022), the paper discusses optimizing relief distribution by identifying optimal distribution center locations, matching supplies to demands, and assigning delivery tasks. Expanding the distribution network coverage enhances the efficiency and speed of delivering humanitarian aid to those in need. This is also supported by Rahman et al., (2022), stating that expanding distribution network coverage enhances the reach of humanitarian aid by optimizing resource use, minimizing costs, and maximizing beneficiary satisfaction. This interconnected approach facilitates effective disaster relief operations, ensuring timely delivery of essential goods to affected populations.

As for RSD4, according to de Veluz et al., (2024), The paper emphasizes that strategically placed distribution hubs and evacuation centers enhance access to critical supplies, optimizing logistics for humanitarian supply chains. This ensures timely evacuations and effective disaster relief operations, ultimately improving response times and reducing infrastructure costs. This is also supported by Hamzani et al., (2022), the authors emphasized that strategically determining the number and location of distribution centers, along with optimizing vehicle routes, significantly enhances access to critical supplies, thereby improving the efficiency and effectiveness of disaster relief operations while minimizing waiting times and costs. According to Patrisina et al., (2019), the study emphasizes that strategically located local distribution centers (LDCs) and a mixed delivery strategy enhance the efficiency of relief distribution, ensuring affected individuals receive critical supplies more effectively during disaster response operations, particularly in uncertain scenarios like tsunamis. On the other instance Liu et al., (2024), stated that strategically located emergency supply depots enhance access to critical supplies, improving disaster relief operations. Key factors influencing site selection include transportation infrastructure, accessibility to affected populations, and hydrographic conditions, which collectively optimize resource allocation and minimize logistics costs during emergencies.

For RSD5, Hartama et al., (2024) narrated that minimizing delivery lead time is essential in disaster operations, as highlighted in the systematic review. Optimizing vehicle routing enhances efficiency and reduces delivery times, significantly improving the effectiveness of aid delivery and overall humanitarian logistics during emergencies. This is also supported by Mendy et al., (2023), stating that timely delivery lead time is essential for effective disaster operations. The study identifies critical success factors such as well-planned emergency relief systems and coordination with stakeholders, which significantly enhance the efficiency of logistics processes in humanitarian logistics. According to Bhimavarapu, (2025), the research emphasizes that minimizing response time is vital in disaster management. The proposed scheduling algorithm optimally allocates resources and routes, ensuring timely deployment of emergency teams, thereby enhancing the effectiveness of disaster operations and improving aid delivery. This is also supported by Wang, (2024), as his research emphasizes that optimizing emergency logistics scheduling significantly impacts the effectiveness of disaster operations. Minimizing delivery lead time is essential for timely aid, enhancing overall rescue efforts during complex disaster scenarios, as demonstrated in the Ludian earthquake case study.

As for RSD6, according to the study conducted in Kenya by Muhanderi et al., (2025), the study indicates that streamlined logistics and efficient transport management practices, such as last-mile delivery innovation and route optimization, significantly enhance operational performance in disaster and relief humanitarian NGOs in Kenya. These practices contribute to reduced delivery lead times, thereby improving responsiveness and adaptability in humanitarian operations. The research found a strong positive correlation ($r = 0.751$, $p < 0.01$) between transport management practices and operational performance, highlighting their critical role in effective disaster operations. This is also supported by Kokaji & Kainuma, (2018), the research paper emphasizes that streamlined logistics and efficient transport management are crucial in disaster operations, particularly highlighted during the Great East Japan Earthquake. It identifies significant issues in the logistics system that hindered timely delivery of relief goods. By proposing a logistics model that minimizes delivery time range, the study demonstrates that effective organization of relief supply operations can ensure equitable distribution to victims, ultimately reducing lead time and improving overall disaster response efficiency. According to Qezelbash-Chamak et al., (2023), the paper highlights that streamlined logistics and efficient transport management significantly reduce delivery lead time in disaster operations. By employing a two-phase mathematical programming approach, it optimizes warehouse locations, inventory levels, and routing decisions. This is also supported by Vaithyanathan & Shalini, (2025), the study demonstrates that streamlined logistics and efficient transport management significantly reduce delivery lead times in disaster operations. The AI-enabled real-time decision-making framework presented in the research reduces response times by 37%, enhances resource utilization by 42%, and expands population coverage by 26%. By integrating distributed IoT sensor networks and reinforcement learning for adaptive resource allocation, the framework addresses coordination gaps, ultimately improving the efficiency and effectiveness of disaster relief efforts in high-risk regions like India.

In the analysis and results presented, the prominence of certain relief supplies distribution (RSD) elements—specifically RSD1 (supply condition on arrival), RSD4 (strategic center location), and RSD2 (handling protocols)—as the most influential predictor elements of resilient disaster operations suggests more than just operational efficiency; this depiction reflects deeper structural and cultural realities within Tanzanian humanitarian logistics. Reflecting the coefficients, the high coefficient of RSD1 ($\beta = 0.386$), this implies that physical integrity of supplies upon arrival is not only a logistical necessity but a recurring challenge, pointing to potential weaknesses in quality control, inadequate infrastructure, or inconsistent handling practices. Likewise, the significance of RSD4 ($\beta = 0.332$), this suggest that the strategic location of distribution centers is vital, perhaps compensating for underdeveloped last-mile connectivity or uneven regional access.

Table 8: Analysis of Variance (ANOVA)

Source	DF	SS	MS	F	P
Regression	6	30.126578	5.021096	115.47	0
Residual Error	185	1.799284	0.0097		
Total	191	31.925862			

The ANOVA table for the regression analysis of relief supplies distribution on resilient disaster relief operations shows a highly significant model. The Regression Sum of Squares (SS) = 30.1266, which is a large portion of the Total Sum of Squares (SS) = 31.9259, suggests that the model explains most of the variability in resilient disaster relief operations. The Mean Square (MS) for Regression = 5.0211, compared to the Residual MS = 0.0097, indicates a substantial difference between the variance explained by the model and the unexplained variance, reinforcing the model's strong explanatory power. The F-statistic ($F = 115.47$, $p = 0.0000$) is very large, and the p-value of 0.0000 indicates that the model is statistically significant, rejecting the null hypothesis and confirming that relief supplies distribution has a significant effect on disaster relief resilience. The low Residual Error (SS = 1.7993, MS = 0.0097) further supports the conclusion that the model fits the data well with minimal unexplained variance. These results highlight the importance of effective and well-managed relief supplies distribution systems in ensuring resilience in disaster response efforts. However, further analysis such as interaction effects and consideration of potential confounding variables may provide more comprehensive insights into the factors driving disaster relief effectiveness.

4.3 Resilient disaster relief operations statistics

Table 9: Descriptive Statistics and Normality Testing for Resilient Disaster Relief Operations (N=192)

Item	Mean	SD	Variance	Skewness	Kurtosis
DRO1	4	0.8	0.656	-1.05	1.5
DRO2	3.88	0.9	0.739	-0.98	1.35
DRO3	4.06	0.9	0.81	-0.98	1.25
DRO4	4.11	0.8	0.673	-1.08	1.37
DRO5	4.09	0.9	0.846	-0.91	1.18
DRO6	3.95	1	0.922	-0.87	1.04

Source: Table by the authors

The findings from Table 4.18 indicate that organizations involved in disaster relief operations demonstrate a relatively strong capacity for resilience. The mean values across all six variables range from 3.88 to 4.11, suggesting that most respondents perceive their disaster relief operations as effective. Specifically, DRO1 ($M = 4.00$, $SD = 0.81$) and DRO4 ($M = 4.11$, $SD = 0.82$) show the highest levels of agreement, implying that key aspects of resilience, such as adaptability and responsiveness, are well-integrated into relief efforts. Moreover, the moderate standard deviations indicate a reasonable level of consensus among respondents. However, DRO2 ($M = 3.88$, $SD = 0.86$) and DRO6 ($M = 3.95$, $SD = 0.96$) exhibit slightly lower means, suggesting that some areas of disaster relief operations may still require improvement, particularly in ensuring consistency and efficiency in response mechanisms. These results suggest that organizations should continue to enhance their disaster relief frameworks by strengthening coordination, improving information flow, and leveraging technology for rapid response. The negative skewness values across all variables indicate that most respondents provided ratings on the higher end of the scale, further supporting the perception of overall effectiveness in resilient disaster relief operations. Additionally, the kurtosis values, ranging from 1.04 to 1.50, suggest a relatively normal distribution of responses, confirming the reliability of the data. To further improve disaster resilience, organizations should focus on refining supply chain agility, fostering collaborative partnerships, and implementing continuous monitoring mechanisms to address potential vulnerabilities in relief operations.

Table 10: Descriptive Statistics on level of agreement of respondents (N=192)

Variable	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Timely disaster relief operations are essential for mitigating the immediate impact of disasters (DRO1)	0 (0%)	4 (2.0%)	41 (20.3%)	78 (38.6%)	69 (34.2%)
Rapid response protocols help humanitarian organizations initiate relief efforts quickly (DRO2)	0 (0%)	5 (2.5%)	41 (20.3%)	76 (37.6%)	70 (34.7%)
Efficiency in disaster relief operations optimizes the use of limited resources (DRO3)	0 (0%)	8 (4.0%)	44 (21.8%)	107 (52.9%)	33 (16.3%)
Streamlined resource allocation and distribution increase operational efficiency (DRO4)	0 (0%)	7 (3.5%)	37 (18.3%)	105 (51.7%)	43 (21.2%)
Agility in disaster relief operations allows organizations to adapt quickly to changing conditions (DRO5)	0 (0%)	3 (1.5%)	39 (19.2%)	107 (52.7%)	43 (21.2%)
Flexible and adaptive response strategies enhance the resilience of disaster relief operations (DRO6)	0 (0%)	3 (1.5%)	29 (14.3%)	112 (55.4%)	48 (23.8%)

Table 11 above presents the respondents' level of agreement on various presented aspects of resilient disaster relief operations and the findings reveals a generally high consensus on their importance and effectiveness. Across all the presented six items, no respondent selected "Strongly Disagree," and there's only a minimal proportion that selected "Disagree" (ranging from 1.5% to 4%), which indicate a strong positive perception overall. For the case of DRO1, concerning the importance of timely operations, the majority either agreed (38.6%) or strongly agreed (34.2%), and only 20.3% remained neutral. This finding suggests that while timeliness is widely acknowledged, some respondents may perceive challenges as in achieving it consistently. DRO2, which presents rapid response protocols, mirrors this pattern with 72.3% that express agreement or strong agreement, this highlights respondent perceived role in expediting relief efforts. DRO3 and DRO4 presented to emphasize efficiency and streamlined resource

allocation, DRO3 recorded the highest proportion of “Agree” responses (52.9%), although fewer respondents (16.3%) selected “Strongly Agree” compared to other items suggested, possibly this indicates room for improvement in maximizing resource utilization. DRO4 showed similarly strong endorsement, with 72.9% in the top two agreement categories, this underscores the perceived operational benefits of effective resource allocation.

For the case of agility (DRO5) and flexible strategies (DRO6), agreement levels were particularly high, and DRO5 recorded 73.9% in “Agree” or “Strongly Agree” categories, and DRO6, the highest-rated item, had 79.2% of respondents which affirms its importance. This indicates that adaptability is viewed as a cornerstone of resilience in disaster operations, enabling organizations to respond to unpredictable conditions. Overall, from these statistics, the distribution of responses received from the respondents suggests that respondents strongly value timeliness, rapid response, efficiency, agility, and flexibility in disaster relief operations. The consistently high agreement percentages and negligible disagreement in this context imply that these attributes are not only recognized but actively embraced as critical components of resilience. However, the notable proportion of neutral responses (14.3%–21.8%) signals that certain operational aspects might still require further refinement and strengthening to achieve universal endorsement among stakeholders.

In this study, relief supplies distribution emerged is one of the critical aspects of humanitarian logistics for strengthening disaster relief operations, which involve the organized delivery of essential goods such as food, water, and medical supplies to populations affected by crises (Rahman et al., 2022). This critical process is complex and tend to be influenced by logistical challenges, fairness, and resource optimization. This study's findings in this context aligns with coordination theory as applied in this current study, which supports harmonizing inter-organizational efforts, resource mobilization, task allocation, and leadership in humanitarian contexts (McEntire, 1997; Minear, 2002; Seybolt, 1997). The depiction of coordination theory contextually complements resource orchestration theory by emphasizing the strategic integration of resources across agencies and humanitarian organizations (Jahre et al., 2016; Malone & Crowston, 1990), enhancing disaster resilience. The study echoes Parmar (2007), Maghsoudi (2018), Nolte (2012), and Wuni (2008), who highlight the role of coordination, resource sharing, and equality in improving relief outcomes. Findings are supported by Motlaq-Kashani et al. (2025), who demonstrated a 60% reduction in unmet demand through effective distribution. Avishan et al. (2023) and Zhang et al. (2023) emphasize adaptability and UAV-truck coordination for timely deliveries. Ab Malik (2024) and Nayeem et al. (2021) show that effective distribution reduces costs, enhances coordination, and manages uncertainty. This study also reinforces Mishra et al. (2022) and Li et al. (2024), who highlight adaptability, prioritization, and equity as key elements of resilient logistics. Findings reflect practices such as ensuring supply condition, handling protocols, expanding networks, strategic routing, lead-time minimization, and streamlined transport. Ye & Yan (2020), Cavdur et al. (2021), and Wang et al. (2024b) support the role of prepositioning and resource planning in boosting efficiency. Dávila de León et al. (2019) and Mishra et al. (2022) affirm that effective distribution improves survival rates and disaster response efficiency, confirming the vital role of logistics in humanitarian resilience.

5. CONCLUSION

The study findings revealed that relief supplies distribution is significantly related to resilient disaster relief operations. In other words, relief supply distribution is a significant predictor of resilient disaster relief operations. The relief supplies distribution may be strengthened by ensuring the condition of supplies on arrival is essential to maintain the quality and usability of relief items, proper handling and transportation protocols (to help preserve the integrity of supplies during transit), expand distribution network coverage increases the reach of humanitarian aid, and strategic location of distribution centers and routes (to improve access to critical supplies).

5.1 Theoretical implications

This study contributes significantly to the theoretical discourse in the field of humanitarian logistics and disaster relief by integrating Coordination Theory into the analysis of resilient disaster relief operations. By applying Coordination Theory, the research illuminates how effective harmonization of logistics actors—through collaboration, shared goals, and inter-organizational protocols—enhances the agility, timeliness, and effectiveness of disaster responses. The findings reinforce the theoretical assumptions that coordinated systems outperform fragmented approaches in high-uncertainty environments like disaster zones. The study not only validates but also contextualizes these frameworks in sub-Saharan Africa's disaster-prone

settings. In doing so, it offers a richer understanding of how theoretical constructs operate in real-world humanitarian crises.

5.2 Practical implications

The study provides actionable insights for humanitarian organizations and disaster response agencies seeking to optimize their operational strategies in relief supply distribution. It identifies six core areas of operational focus: maintaining supply condition upon arrival, handling protocols, network coverage, center location, delivery lead time, and streamlined transport. From an operations standpoint, ensuring the quality and usability of supplies upon arrival is paramount. The study's findings show that compromised supplies reduce the efficacy of aid, leading to wastage and mistrust among beneficiaries. Operational guidelines should therefore include standardized inspection procedures and packaging protocols to maintain item integrity throughout transit. Proper handling and transportation protocols emerged as a key operational determinant of resilience. Organizations are encouraged to invest in training programs for logistics personnel and drivers on supply chain ethics, handling techniques, and crisis navigation. Expanding distribution network coverage and strategically locating centers are also critical.

5.3 Study Limitations and Future Research

This study is limited by its focus on Tanzania, which may restrict the generalizability of findings to other contexts with different disaster management systems, but given the logistical infrastructural constraints this study can be beneficial to sub-Saharan African contexts and other areas aiming to strengthening relief supplies distribution systems. The study did not account for certain moderating variables such as political stability, cultural dynamics, or donor influence, which may affect relief supply distribution effectiveness in a given context. Future research should adopt longitudinal designs to track changes over time, incorporate multi-country comparisons and exploring the role of digital coordination tools, private sector engagement, and climate-induced disaster patterns which could enrich understanding.

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