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Sustainable Military Fresh Ration Supply: Exploring Key Factors and Camp Farming Potential

Kelestarian Bekalan Rangsum Segar Tentera: Penyelidikan terhadap Faktor Utama dan Potensi Pertanian dalam Kem

HANI KALSOM HASHIM*, MUHAMMAD IZZAT SALLEHUDIN , NOR FYADZILLAH MOHD TAHA, ROSHAMIDA ABD JAMIL & MOHD NORSYARIZAD RAZALI

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ABSTRACT

The quality and sustainability of military fresh meals are critical for operational readiness and crew well-being. This study examines the principal elements affecting military food supply chains, emphasising quality control, delivery management, storage conditions, and contract management, with camp farming serving as a moderating variable. To gather operational insights, a mixed-methods approach was used, integrating qualitative thematic analysis with survey responses from 395 members of the Malaysian Armed Forces. The results indicate that contract management and storage conditions are the primary determinants of military ration quality. Simultaneously, camp farming operates as a partial intermediary, enhancing logistical efficiency without supplanting existing quality control protocols. Pearson correlation analysis reveals robust interrelationships between independent factors and ration quality, with contract management demonstrating the most significant correlation. Nevertheless, quality control and delivery management did not substantially forecast ration quality, indicating a necessity for improved enforcement measures. In order to maximise military food supply chains, our findings highlight the significance of localised food production, enhanced storage facilities, and supplier accountability. Strengthening contract enforcement, modernising cold storage facilities, and including camp farming as a sustainable supply chain approach are some of the policy ideas. There is a need for future research to investigate the long-term effects of camp agricultural initiatives and conduct comparative analyses across various military organisations. The empirical evidence presented in this study contributes to the expanding discourse on military food logistics, thereby improving the quality and sustainability of rations.

Keywords: Military food supply chains; quality control; contract management; storage conditions; camp farming; military logistics

ABSTRAK

Kualiti dan kelestarian makanan segar untuk angkatan tentera merupakan aspek penting dalam menjamin kesiapsiagaan operasi dan kesejahteraan anggota. Kajian ini meneliti elemen-elemen utama yang mempengaruhi rantaian bekalan makanan tentera, dengan tumpuan kepada kawalan kualiti, pengurusan penghantaran, keadaan penyimpanan dan pengurusan kontrak. Aktiviti pertanian dalam kem turut dikaji sebagai pemboleh ubah penyederhana dalam hubungan tersebut. Pendekatan kaedah campuran digunakan bagi memperoleh maklumat menyeluruh, menggabungkan analisis tematik kualitatif dan soal selidik yang melibatkan 395 anggota Angkatan Tentera Malaysia. Dapatan kajian menunjukkan bahawa pengurusan kontrak dan keadaan penyimpanan merupakan penentu utama kualiti rangsum tentera. Pertanian dalam kem berperanan sebagai moderator separa yang membantu meningkatkan kecekapan logistik tanpa menggantikan protokol kawalan kualiti sedia ada. Analisis korelasi Pearson menunjukkan hubungan yang signifikan antara faktor bebas dan kualiti rangsum, dengan pengurusan kontrak menunjukkan kekuatan korelasi tertinggi. Sebaliknya, kawalan kualiti dan pengurusan penghantaran tidak meramalkan kualiti rangsum secara signifikan, menandakan keperluan kepada mekanisme penguatkuasaan yang lebih berkesan. Kajian ini mencadangkan agar pengeluaran makanan secara setempat diperkasa melalui aktiviti pertanian dalam kem, di samping penaiktarafan kemudahan penyimpanan sejuk dan pengukuhan akauntabiliti pembekal menerusi penguatkuasaan kontrak. Kajian lanjutan dicadangkan untuk menilai kesan jangka panjang inisiatif pertanian dalam kem serta membuat perbandingan rentas organisasi bagi memperkukuh dapatan sedia ada.

Kata kunci: Rantaian bekalan makanan tentera, kawalan kualiti, pengurusan kontrak, keadaan penyimpanan, pertanian dalam kem, logistik ketenteraan

INTRODUCTION

Securing a high-quality, nutritious, and balanced supply of fresh rations is essential for the welfare and operational preparedness of military forces. Although considerable study has been undertaken on food supply chains in civilian settings, there is a paucity of studies addressing military rations and their distinct logistical, contractual, and sustainability challenges. Quality control, effective storage, delivery handling, and contract management all affect how well military food supply chains work, but current research frequently ignores how these elements interact in military environments.

The manufacture and distribution of military food depend heavily on quality control, which guarantees the stringent safety and nutritional requirements necessary for the wellbeing of soldiers, the military's image, and operational preparedness. Nonetheless, the Malaysian Armed Forces (MAF) encounter significant obstacles in sustaining high-quality fresh meals. Among these obstacles are contractors' failure to fulfil their obligations, inefficiencies in the fragmented supply chain, and inconsistent quality control measures. Poor contract management (contract management in this study means handling contracts from start to finish to ensure suppliers meet military needs efficiently and follow agreements) restricts responsibility and compliance, and poor storage and transportation conditions jeopardise the freshness and safety of food. Efficient management of the food supply chain is essential for assuring prompt delivery, minimising waste, and maintaining the nutritional quality of military rations (Burgess et al., 2022; Sube Singh et al., 2021). However, maintaining product quality and preventing spoiling are challenging due to the significant financial and operational costs associated with traditional quality control procedures (Goisser et al., 2020).

Given the logistical challenges, long-distance transportation, and potential supply chain disruptions that armed forces face, the sustainability of military fresh ration supplies is critical. Urban farming, also known as camp farming, offers a novel way to increase food security, lessen reliance on outside vendors, and guarantee a consistent supply of food that is grown locally and fresh. Nevertheless, its functionality in enhancing contract management and reducing logistical inefficiencies in military settings is still unexplored.

The majority of current research on food logistics and supply chain management pertains to civilian food distribution, with military operations receiving limited attention (Lawrence & Suddaby, 2006). Although urban farming has been extensively researched, its contribution to enhancing the resilience of military food supply chains has not been properly investigated (Bisht et al., 2020). These gaps are filled in this study by introducing camp farming as a mediator and applying structured theoretical frameworks to analyse its effect on ration quality.

Moreover, the majority of food logistics research concentrates on North America, Europe, and China, resulting in the under-representation of Southeast Asia (Mustafa et al., 2024). This research addresses this gap by analysing the Malaysian Armed Forces (MAF) and evaluating the impact of contract management, storage conditions, and food safety on ration quality within a Southeast Asian military context. Furthermore, previous research has predominantly utilised either quantitative or qualitative methodologies, often combining the two (Peinado-Guerrero & Villalobos, 2022). A mixed-methods strategy is used in this work to give both statistical validation and explanatory insights, mixing open-ended replies with structured questionnaires.

This study fills this gap by utilising Pearson correlation, multiple regression, and the Sobel test to assess the effects of camp farming. Research on urban agriculture also frequently lacks empirical validation utilising statistical mediation tests (Singh Saharan & Choudhary, 2022). In addition, numerous urban agriculture studies are descriptive in nature, lacking hypothesis-driven statistical testing (Orsini et al., 2013). This study provides a more comprehensive comprehension

of the inefficiencies in the supply chain, contract issues, and food quality control in military logistics through the use of mixed-methods analysis and hypothesis testing.

RESEARCH OBJECTIVES

The purpose of this study is to investigate how quality control, delivery handling, storage conditions, and contract management affect the quality of military fresh rations, as well as to determine whether camp farming can operate as a mediating factor in enhancing food supply efficiency. In particular, the study will:

a. Examine how quality control, delivery handling, storage, and contract management affect the quality of military fresh rations
b. Examine the mediating capabilities of camp farming in the reduction of supply chain inefficiencies.
c. Provide useful suggestions for incorporating methods for sourcing sustainable food into military logistics.

This study contributes to the overall discussion on sustainable military food supply chains by resolving these research gaps and offers empirical evidence regarding the effectiveness of camp farming in optimising military ration systems.

THEORETICAL FRAMEWORK

This study develops a conceptual framework for comprehending the factors that influence the quality of military fresh provisions and the role of camp farming in mediating these relationships by incorporating several influential theories. The combination of these theories not only supports the study's variables, but also explains the mechanisms that govern their interactions.

According to the Resource-Based View (RBV), firms can gain a competitive edge by utilising resources that are rare, valuable, unique, and non-replaceable (VRIN) (Barney, 1991). In the context of this study, quality control processes, delivery handling procedures, and storage conditions might be viewed as critical organisational resources. The quality of fresh rations can be improved by military operations through the optimisation of these resources, which will increase personnel well-being and operational readiness.

The Institutional Theory highlights how standards, norms, and regulatory frameworks influence organisational behaviour (Scott, 1995). The study's focus on contract management is supported by this theory, which emphasises how responsibility, quality assurance, and compliance are ensured by following explicit, enforceable contractual agreements. The emphasis on quality control and supplier accountability in the study is consistent with institutional pressure to maintain high standards.

The Urban Agriculture Framework offers a prism through which to view how logistical issues might be resolved by localised food production methods like camp farming. By decentralising food production, urban agriculture guarantees the sustainability of food supply systems, reduces logistical complexities, and improves accessibility (Orsini et al., 2013). This study conceptualises camp farming as a mediator that enhances the connection between ration quality and operational parameters (such as quality control).

A key component of making sure that temperature-sensitive products are managed effectively is the Cold Chain Logistics Framework. From manufacturing and storage to delivery and transportation, this framework emphasises how crucial it is to maintain ideal temperature conditions throughout the supply chain. In the context of military supply chains, this framework is consistent with the operational requirements of maintaining the nutritional integrity, freshness, and safety of rations in a variety of remote locations. Temperature monitoring, transportation coordination, and sustainability practices are key components that directly impact the quality and safety of military rations (Chermala et al., 2024; Turan & Ozturkoglu, 2022).

CONCEPTUAL FRAMEWORK AND HYPOTHESES

Based on these theories, the conceptual framework for this study demonstrates the connections between the quality of military fresh rations, delivery handling, storage conditions, contract management, and quality control. To be precise, the framework asserts:

a. Quality control has a direct impact on ration quality by guaranteeing that the rations fulfil predetermined requirements for freshness, safety, and nutrition.
b. Storage and Delivery Management Maintaining the appropriate environmental conditions for perishable items throughout the supply chain has a favourable impact on ration quality. Storage and handling that are effective prevent temperature excursions and decomposition, thereby guaranteeing that rations are safe for consumption.
c. Contract Management guarantees that the cold chain process is consistent and that risks associated with food safety are mitigated by adhering to strict logistical and quality standards.
d. Camp farming acts as a mediator to improve the connection between ration quality and quality control. Camp farming guarantees that military soldiers receive wholesome and fresh rations even in remote operational zones by tackling logistical inefficiencies like supply chain interruptions or problems with food accessibility.

By integrating the theoretical perspectives discussed in the Theoretical Framework section namely the Resource-Based View, Institutional Theory, Urban Agriculture Framework, and Cold Chain Logistics Framework along with the proposed conceptual framework, this study aims to highlight the operational factors that influence the quality and safety of military rations, ultimately supporting mission success and personnel well-being. The relationships among these factors are illustrated in Figure 1, which presents the conceptual framework guiding this study.

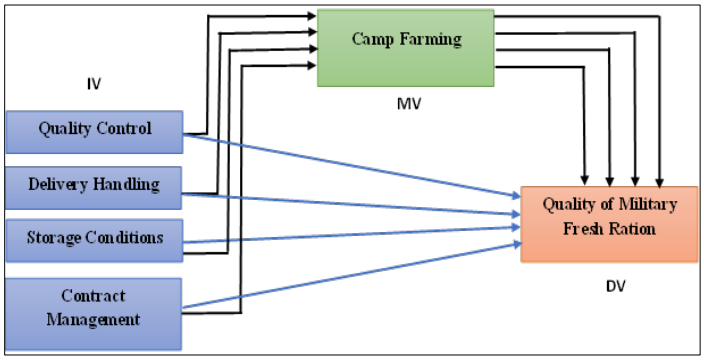

FIGURE 1. Conceprual Framework

Based on the research objectives and variables, the following hypotheses were tested:

a. H1: There is a positive relationship between quality control and the quality of military fresh rations.
b. H2: Delivery handling is positively related to the quality of military fresh rations.
c. H3: Storage conditions are positively related to the quality of military fresh rations.
d. H4: Contract management is positively related to the quality of military fresh rations.
e. H5: Quality control, delivery handling, storage conditions, and contract management significantly predict the quality of military fresh rations.
f. H6: Camp farming mediates the relationship between quality control and the quality of military fresh rations.
i. H7: Camp farming mediates the relationship between delivery handling and the quality of military fresh rations.

LITERITURE REVIEW

OVERVIEW OF MILITARY FOOD SUPPLY CHALLENGES

Health depends on having access to fresh, wholesome food, yet limiting supply might harm vulnerable populations, such as low-income people and minorities (Wang & Li, 2022). Due to changes in temperature, extreme weather, and the spread of contaminants, climate change further compromises food safety, which is made worse by socioeconomic inequality (Guerin, 2022). Sustainable cold supply systems are essential for reducing these hazards and guaranteeing consistent access to fresh food (Liao et al., 2023). The imperative for structural adjustments was highlighted by the COVID-19 pandemic, which revealed flaws in global food security by upsetting supply systems and widening disparities (Zurayk, 2020). In order to improve food security, foster resilience, and guarantee fair access, these issues call for integrated approaches.

Due to logistical limitations, stringent nutritional requirements, and the requirement for dependable food supplies in isolated or conflict-prone places, military food supply chains involve significant challenges (Görçün et al., 2023). Military logistics, in contrast to civilian food supply systems, have to strike a compromise between long-term sustainability, food safety compliance, and operational preparedness (Peinado-Guerrero & Villalobos, 2022). Reliable storage options, effective contract administration, and delivery optimisation are necessary to guarantee military personnel's access to food (Wincewicz-Bosy et al., 2022). Stronger supervision procedures are required because relying on various suppliers frequently results in contractual inefficiencies, food shortages, and inconsistent quality (Mandal et al., 2023). The durability of military rations and the reduction of food loss depend heavily on temperature-controlled storage and cold chain operations (Liao et al., 2023). Additionally, port governance, infrastructure, and logistics play a crucial role in influencing military supply chain efficiency and ration quality, highlighting the need for robust management practices in these areas (Idris, 2022). Similarly, just as port governance and logistics impact overall supply chain effectiveness, military supply chains require equally structured and resilient management frameworks to ensure operational readiness and food security in diverse operational contexts.

KEY VARIABLES AND EXISTING RESEARCH

Food shelf life, or the amount of time it keeps its acceptable quality, is determined by a variety of physical, chemical, enzymatic, and microbiological processes (Hoffmann et al., 2023). Appropriate preservation preserves sensory characteristics and guarantees safety. Household refrigeration initiatives demonstrate how important it is to optimise storage conditions in order to preserve food quality and reduce waste. Deterioration can be slowed by controlling temperature, humidity, and air movement (Wincewicz-Bosy et al., 2022). Military storage, however, has the same problems as smallholder farmers, with inadequate infrastructure making postharvest losses worse (Onwude et al., 2023). Although energy limits provide substantial obstacles, ration shelf life is extended through chilled transit and cold storage (Pal & Kant, 2022). Although accurate preservation may be ensured by customising storage to various ration kinds (Vilas-Boas et al., 2023), there is still a question about how to balance prices with specific storage requirements (Ortiz-Guillén et al., 2022). Low-GWP refrigerants and energy-efficient technology are examples of sustainable solutions that promote environmental objectives and ration longevity (Aprea et al., 2022).

To improve the quality of military fresh rations, distribution handling issues that are comparable to those that smallholder farmers confront must be addressed. Onwude et al. (2023) point out that poor storage and transportation practices might result in postharvest losses of above 40%. Although cold storage and refrigerated transportation prolong shelf life and preserve food quality, access problems and energy constraints are similar to those in military environments. Similar to agricultural supply chains, poor road conditions and lengthy travel times can cause food to deteriorate, and insufficient storage space and haphazard distribution can result in spoiling and foodborne infections (Pal & Kant, 2022). Defraeye et al. (2022) stress that refrigerated containers are vital for consistent cooling and temperature management, which is necessary for cutting waste and ensuring food quality (Liao et al., 2023). Efficient cold chain logistics reduce carbon footprints and help prevent food losses by striking a compromise between sustainability and temperature control (Liu et al., 2022; Zhang & Kim, 2022).

Preventing deterioration and guaranteeing customer satisfaction depend on maintaining product quality (Vilas-Boas et al., 2023). Food safety is improved across the supply chain by effective quality control systems and conformity to industry standards (Burgess et al., 2022). Systems based on blockchain technology present viable ways to increase food supply networks' dependability and transparency (Yuchen, 2020). In addition to protecting against contamination and health hazards, quality control guarantees that food maintains its important qualities, including freshness, texture, colour, and nutritional value ((Singh et al., 2020; Singh Saharan & Choudhary, 2022). By extending shelf life and preventing spoiling, proper preservation techniques preserve the integrity of food.

Food quality and safety are largely dependent on contract management transparency, especially when it comes to government procurement. Transparency is crucial for lowering corruption, boosting accountability, and fostering public trust, according to (Androniceanu, 2021). Transparency is crucial for ethical contract governance since it can boost trust in supply chain choices. Well-drafted contracts guarantee that producers fulfil safety, freshness, and quality standards by precisely defining quality requirements (Lees et al., 2020; Lyu et al., 2023). Additionally, contracts hold suppliers accountable by enforcing fair pricing and imposing penalties for non-compliance (Sahni & Khanduja, 2023).

Establishing quality standards, assessing vendor skills, and ensuring compliance through testing, audits, and inspections are all part of an all-encompassing approach to contract

management. Structured performance monitoring and efficient quality control procedures assist guarantee that providers fulfil requirements. Reducing risk, increasing customer satisfaction, and improving contract outcomes are all achieved by swiftly addressing deviations (Hassan & Omwenga, 2023). The significance of upholding strict standards for food quality is shown by the harmony between open government procedures and private sector responsibility.

CAMP FARMING AS A SUSTAINABLE SOLUTION FOR MILITARY FOOD SUPPLY CHAINS

The potential of camp farming to improve sustainability, decrease supply chain vulnerabilities, and increase food security has been extensively researched (Orsini et al., 2013). However, there is still a lack of research on its use in military logistics (Bisht et al., 2020). Camp farming is a localised form of urban agriculture that military facilities can implement to increase contract efficiency, decrease dependency on outside suppliers, and improve food resilience (Dan J. Donoghue et al., 2014). There are various benefits to camp farming, such as:

a. Improving food availability in isolated areas by decreasing dependency on centralised vendors (Singh Saharan & Choudhary, 2022).
b. Reducing food transportation distances to improve ration freshness and nutritional value (Link A et al., 2018).
c. Improving logistics management, decreasing contract delays, and boosting supply chain efficiency through localised production (Rendon, 2005).
d. Improving food security in military environments to guarantee operational sustainability and sufficient nutrition (Mustafa et al., 2024).

Even with these advantages, the majority of research on urban farming concentrates on civilian food systems, and its effects on military logistics have not been empirically validated (Singh Saharan & Choudhary, 2022). This study fills this gap by employing statistical analysis to examine the mediating role of camp farming on food quality and supply chain effectiveness.

METHODOLOGY

This study employs a mixed-methods approach to examine the influence of quality control, delivery handling, storage conditions, and contract management on the quality of military fresh rations, with camp farming as a moderating variable. This approach enables both quantitative validation through statistical analysis and qualitative insights from open-ended responses to strengthen the findings.

SAMPLE SELECTION AND DEMOGRAPHIC CONSIDERATIONS

Using camp farming as a moderating variable, this study uses a mixed-methods approach to investigate how quality control, delivery handling, storage conditions, and contract management affect the quality of military fresh rations. This method allows for both qualitative insights from open-ended responses and quantitative validation through statistical analysis to support the conclusions.

SAMPLE SELECTION AND DEMOGRAPHIC FACTORS

The Armed Forces of Malaysia (MAF), which include the Army, Navy, Air Force, and civilian employees of the Ministry of Defence (MINDEF), are the subject of the study. To ensure representation across various service branches and grades, a total of 395 respondents were chosen through the use of stratified random sampling. The sample size was chosen using (Krejcie & Morgan, 1970) recommendations, which state that for populations larger than 100,000, there should be at least 384 participants.

Potential sampling biases were evaluated. Although equal involvement from all service branches was the study's goal, practical limitations led to a somewhat higher representation from Navy personnel. Furthermore, because they participate in daily ration consumption more than senior officers, the study admits that lower-ranked staff members might have higher involvement rates.

RESEARCH VARIABLES AND HYPOTHESES

Four independent variables (IVs), one moderating variable (MV), and one dependent variable (DV) are all examined in this study. The independent variables are: Quality Control (QC), which gauges adherence to food safety, nutritional, and freshness standards; Delivery Handling (DH), which evaluates the efficiency of logistical and transportation procedures; Storage Conditions (ST), which assesses the infrastructure and environmental conditions of food storage; and Contract Management (CM), which looks at accountability mechanisms, supplier compliance, and procurement efficiency. Camp Farming (CF), the moderating variable (MV), evaluates its contribution to improving supply chain resilience and ration quality. Quality of Military Fresh Rations (QMFR), the dependent variable (DV), is a representation of the general food quality, safety, and sustainability of the military food supply system.

Several hypotheses were evaluated in the study based on these variables. H1 asserts a positive correlation between quality control and the quality of military fresh rations, whereas H2 indicates that delivery handling favourably influences ration quality. Likewise, H3 asserts that storage conditions favourably influence the quality of military fresh rations, whereas H4 posits that contract management is positively correlated with ration quality. H5 investigates the extent to which quality control, delivery handling, storage conditions, and contract management jointly forecast the quality of military fresh rations. Furthermore, H6 investigates the mediating function of camp farming in the association between quality control and ration quality, whereas H7 evaluates whether camp farming mediates the connection between delivery handling and the quality of military fresh rations.

Using camp farming as a moderating factor, a conceptual framework (Figure 1) shows how quality control, delivery handling, storage conditions, and contract management affect QMFR.

A systematic questionnaire with four sections was used to collect the data. The characteristics of the respondents, such as years of experience, service branch, and rank, were recorded in the Demographic Information section. Important operational aspects such quality control, supply handling, storage conditions, and contract management techniques were evaluated in the section on Observed Procedures in Military Food Supply. The Overall Ration Quality portion examined how these factors affected the quality of military fresh rations (QMFR), while the Efficiency of Camp Farming section assessed the perceived advantages of localised food production within military facilities.

A five-point Likert scale was used to score each item (1 being strongly disagree and 5 being strongly agree). To evaluate the questionnaire's clarity and dependability, thirty military members participated in a pre-test; their input was integrated into the final draft. Collection and analysis of qualitative data open-ended qualitative questions were incorporated into the survey along with structured replies to get details on the implementation of camp farming, quality control efficacy, and military food supply issues. Thematic analysis was used to examine the responses in accordance with the framework developed by Braun and Clarke (2006):

a. Data familiarisation: Reading the responses in order to find important themes.
b. Creating initial codes: Important patterns are coded systematically.
c. Theme searching: Classifying codes into broad themes like supply chain issues and food quality.
d. Examining themes: Improving and confirming important findings.
e. Identifying and characterising themes: Concluding the results and analysing them in light of the goals of the study.

Thematic analysis revealed in-depth viewpoints from military personnel on logistical inefficiencies, contract management problems, and storage conditions, which served to supplement the quantitative findings. Statistical Examination The following statistical methods are used in this study:

a. Descriptive Statistics: Summarises essential variables (mean, standard deviation, frequency distributions).
b. Pearson Correlation Analysis: Analyses the relationships between independent variables and QMFR.
c. Multiple Linear Regression: Assesses the predictive influence of quality control, delivery handling, storage conditions, and contract management on QMFR.
d. Sobel Test for Mediation: Evaluates the degree to which camp farming mediates the association between the independent variables and QMFR.

The study complies with ethical research guidelines, guaranteeing confidentiality and voluntary involvement. The goal of the study was explained to the respondents, and their agreement was acquired prior to their involvement.

RESULTS AND DISCUSSION

In this study, quality control, delivery handling, storage conditions, and contract management were the main factors affecting the quality of military fresh rations (QMFR), with camp farming acting as a mediating variable. The results show that improving the sustainability and efficiency of the military food supply chain is supported by both qualitative and empirical evidence. The survey included 395 military individuals from various service branches. Navy personnel made up 82.0 percent of the respondents, followed by Air Force personnel (13.9 percent), Army personnel (11.1 percent), and Ministry of Defence civilian employees (4.1%). The majority of participants were men (77.2%), with the largest group consisting of sergeants and lower (52.4%). The variation in years of service, with 36.7% of individuals possessing less than five years of experience, facilitated the inclusion of a diverse array of perspectives. Figure 2 presents a breakdown of their attributes.

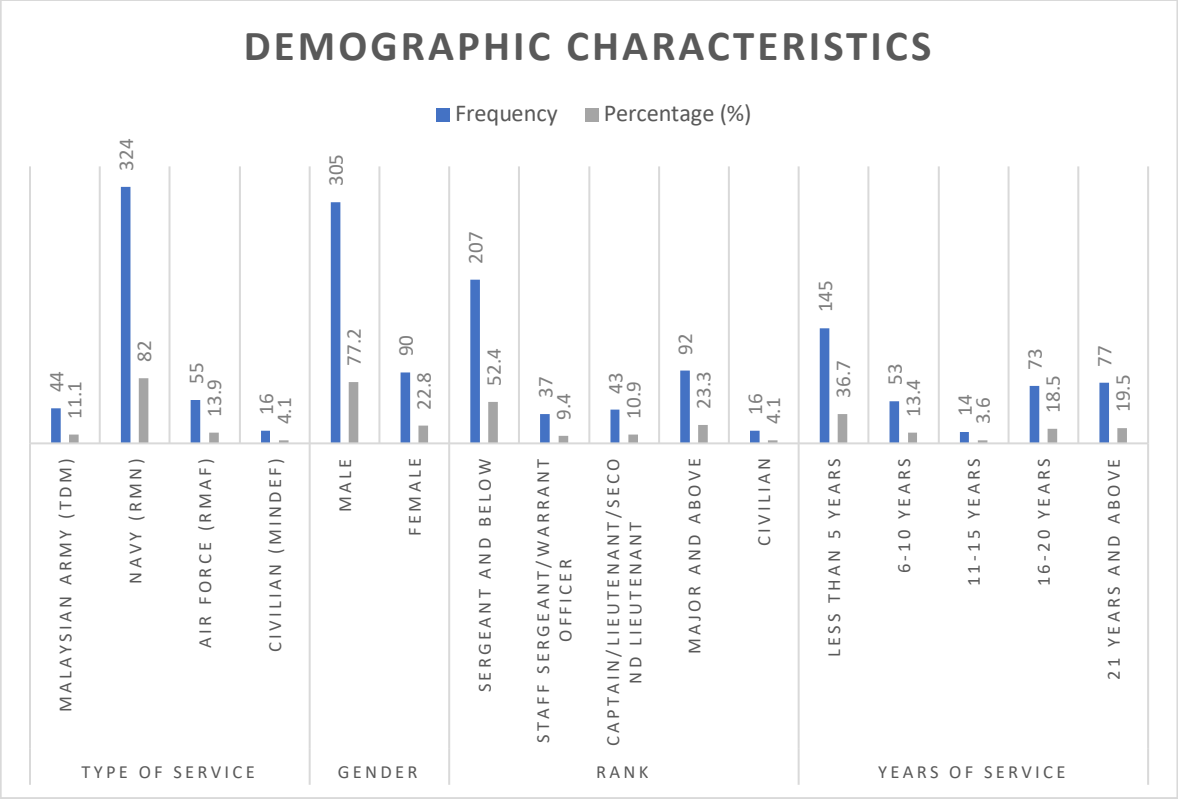

FIGURE 2. Demographic Characteristics

TABLE 1. Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
QC_mean	395	1.00	5.00	4.1595	.71728
DH_mean	395	1.00	5.00	4.0228	.72573
ST_mean	395	1.00	5.00	3.8815	.84164
CM_mean	395	1.00	5.00	4.1858	.69165
CF_MV_mean	395	1.00	5.00	3.7286	.91456
QMFR1_DV_mean	395	1.00	5.00	4.0830	.67017
Valid N (listwise)	395				

With a sample size of 395 respondents, all variables were measured on a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree), as shown in Table 1. The highest average score was obtained by Contract Management (M = 4.19, SD = 0.69), indicating a high level of agreement that contract management plays a crucial role in military fresh ration quality. Similarly, Quality Control (M = 4.16, SD = 0.72) and Quality of Military Fresh Ration (M = 4.08, SD = 0.67) also received high agreement, suggesting that respondents perceive these factors as strongly influencing ration quality.

On the other hand, Storage Conditions (M = 3.88, SD = 0.84) and Camp Farming (M = 3.73, SD = 0.91) had moderate agreement, indicating that while these aspects contribute to ration quality, their effectiveness may vary depending on implementation and infrastructure. Delivery Handling (M = 4.02, SD = 0.73) also received a favorable rating, suggesting that respondents generally view transportation and handling practices as important but not as critical as contract management.

The highest degree of variability was observed in Camp Farming (SD = 0.91), implying diverse opinions on its effectiveness, possibly due to differing experiences across military units.

TABLE 2. Pearson Correlation Analysis

		QC mean	DH mean	ST mean	CM mean	CF MV mean	QMFR1 DV mean
QC_mean	Pearson Correlation	1	.810**	.695**	.668**	.434**	.635**
	Sig. (2-tailed)		.000	.000	.000	.000	.000
	N	395	395	395	395	395	395
DH_mean	Pearson Correlation	.810**	1	.790**	.725**	.533**	.680**
	Sig. (2-tailed)	.000		.000	.000	.000	.000
	N	395	395	395	395	395	395
ST_mean	Pearson Correlation	.695**	.790**	1	.567**	.525**	.617**
	Sig. (2-tailed)	.000	.000		.000	.000	.000
	N	395	395	395	395	395	395
CM_mean	Pearson Correlation	.668**	.725**	.567**	1	.456**	.765**
	Sig. (2-tailed)	.000	.000	.000		.000	.000
	N	395	395	395	395	395	395
CF_MV_mean	Pearson Correlation	.434**	.533**	.525**	.456**	1	.581**
	Sig. (2-tailed)	.000	.000	.000	.000		.000
	N	395	395	395	395	395	395
QMFR1_DV_mean	Pearson Correlation	.635**	.680**	.617**	.765**	.581**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	
	N	395	395	395	395	395	395

**. Correlation is significant at the 0.01 level (2-tailed).

Strong correlations between the independent factors and their impact on ration quality were established by the Pearson correlation analysis in Table 2. Contract management and QMFR had the strongest association ($r=0.765, \rho<0.01$), highlighting how important supplier accountability is to maintaining food quality. Delivery handling comes in second ($r=0.680, \rho<0.01$), suggesting that food freshness and preservation are directly impacted by transportation efficiency. Storage Conditions ($r=0.617, \rho<0.01$) showed a moderate association, supporting findings by Chermala et al. (2024)), which emphasize the critical role of temperature-controlled logistics and proper storage facilities in ensuring food safety and longevity in military supply chains. However, the overall impact could be affected by inconsistent infrastructure upkeep. Quality Control had a positive correlation with QMFR ($r=0.635, \rho<0.01$), but its lower predictive strength in regression analysis indicates that there may already be established food safety standards in place, which limits its flexibility in impacting food quality. Although positive, the moderating variable, camp farming, showed a modest connection with QMFR ($r=0.581, \rho<0.01$), indicating that additional policy integration may be necessary to optimize its impact. Supporting this, (Bisht et al., 2020; Li et al., 2022) highlight that localized food production systems, such as camp farming, can enhance supply chain resilience and reduce dependency on external vendors, but require proper integration with existing procurement frameworks to maximize efficiency in military logistics.

TABLE 3. Multiple Regression Analysis

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.558	.129		4.337	.000
	QC_mean	.091	.048	.097	1.901	.058
	DH_mean	-.013	.059	-.014	-.225	.822
	ST_mean	.113	.039	.142	2.909	.004
	CM_mean	.508	.042	.524	12.140	.000
	CF_MV_mean	.171	.026	.233	6.628	.000

Contract Management (B=0.508,t=12.140 ρ<0.001), Storage Conditions (B=0.113,t=2.909 ρ=0.004), and Camp Farming (B=0.171,t=6.628 ρ<0.001) were the three factors that substantially predicted QMFR, according to the multiple regression analysis shown in Table 3. Contract management showed the most pronounced positive standardised effect among these, emphasising its vital role in guaranteeing ration quality through transparent supplier agreements and compliance procedures. Supporting this Han et al. (2021) indicate that effective contract management enhances food quality by ensuring suppliers adhere to strict procurement standards, reducing inconsistencies and logistical inefficiencies in food supply chains. In contrast, there was no significant contribution to QMFR prediction from Quality Control (B=0.091,t=1.901 ρ=0.058) or Delivery Handling (B=-0.013,t=-0.225 ρ=0.822). These results indicate that although quality control and delivery handling are crucial operational components, their efficacy may vary depending on the supply chain's context and how supply chain procedures are enforced. Zhang & Kim (2022) further highlight that in decentralized supply chain models, variability in enforcement and monitoring of food quality standards can lead to discrepancies in food safety and freshness, which may explain the lack of significant impact in this study.

TABLE 4. Sobel Test

Independent Variable	Sobel Test Statistic (z)	p-value	Significance
QC_mean	-1.05	0.294	Not Significant
DH_mean	2.5	0.012	Significant
ST_mean	3.56	0.0004	Significant
CM_mean	2.46	0.014	Significant

The findings of the Sobel test as per Table 4, showed that Contract Management (Z=2.46,ρ=0.014), Storage Conditions (Z=3.56,ρ=0.0004), and Delivery Handling (Z=2.5,ρ=0.012) were all significantly mediated by Camp Farming with QMFR. On the other hand, its mediation effect on the QMFR-QControl association was not statistically significant (Z=-1.05,ρ=0.294). Supporting this, Bisht et al., (2020) and Li et al. (2022)) emphasize that while localized food production methods, such as camp farming, can strengthen logistical efficiency, their impact on quality assurance is limited unless integrated with strict food safety protocols. This suggests that internal quality control mechanisms must function independently to maintain consistent standards, regardless of external food sourcing strategies.

TABLE 5. Hypothesis Results

Hypothesis	Test Type	Key Statistics	Result
H_1: There is a positive relationship between quality control and the quality of military fresh rations.	Pearson Correlation	r = 0.635, p < 0.001	Supported
H_2: Delivery handling is positively related to the quality of military fresh rations.	Pearson Correlation	r = 0.680, p < 0.001	Supported
H_3: Storage conditions are positively related to the quality of military fresh rations.	Pearson Correlation	r = 0.617, p < 0.001	Supported
H_4: Contract management is positively related to the quality of military fresh rations.	Pearson Correlation	r = 0.765, p < 0.001	Supported
H_5: Quality control, delivery handling, storage conditions, and contract management significantly predict the quality of military fresh rations.	Multiple Regression	Significant predictors: $B_{CM} = 0.524, \rho < 0.001$, $B_{ST} = 0.14, \rho = 0.004$ Non-significant predictors: $B_{QC}, \rho = 0.058$, $B_{DH}, \rho = 0.822$	Partially Supported
H_6: Camp farming mediates the relationship between quality control and ration quality.	Sobel Test	z = -1.05, p = 0.294	Not Supported
H_7: Camp farming mediates the relationship between delivery handling and ration quality.	Sobel Test	z = 2.50, p = 0.012	Supported

H_1: There is a positive relationship between quality control and the quality of military fresh rations.

The Pearson correlation analysis revealed a moderate positive relationship between quality control and ration quality ($r = 0.635, \rho < 0.001$). This indicates that effective quality control practices are significantly associated with improved perceived quality of military fresh rations. The result supports $\boldsymbol{H_1}$, highlighting the importance of robust quality control mechanisms in maintaining ration standards.

H_2: Delivery handling is positively related to the quality of military fresh rations.

The correlation between delivery handling and ration quality was positive and significant ($r = 0.680, \rho < 0.001$). This finding supports $\boldsymbol{H_2}$:, suggesting that proper handling during delivery positively influences the quality of military rations.

H_3: Storage conditions are positively related to the quality of military fresh rations.

A moderate positive correlation was observed between storage conditions and ration quality ($r = 0.617, \rho < 0.001$). This supports $\boldsymbol{H_3}$, emphasizing the importance of proper storage practices in preserving the quality of fresh rations. The findings suggest that well-maintained storage conditions significantly contribute to the overall quality.

H_4: Contract management is positively related to the quality of military fresh rations.

The correlation analysis showed a positive relationship between contract management and ration quality ($r = 0.765, \rho < 0.001$). This result supports $\boldsymbol{H_4}$, indicating that effective contract management plays a key role in ensuring the quality of rations. The relationship suggests that streamlined and disciplined contract practices directly impact ration quality.

H_5: Quality control, delivery handling, storage conditions, and contract management sinificantly predict the quality of military fresh rations.

The multiple regression analysis revealed that **Contract Management** had the most significant positive effect on ration quality quality ($\beta = 0.524, \rho < 0.001$), followed by **Storage**

Conditions ($\beta = 0.142, \rho = 0.004$) and the moderating variable **Camp Farming** ($\beta = 0.233, \rho < 0.001$). However, **Quality Control** ($\rho = 0.058$) and **Delivery Handling** ($\rho = 0.822$) were not significant predictors. These findings partially support $\boldsymbol{H_5}$, highlighting the critical role of contract management while suggesting that other predictors may have indirect or context-specific effects.

$\boldsymbol{H_6}$: Camp farming mediates the relationship between quality control and ration quality. The Sobel test confirmed that camp farming significantly mediates the relationship between quality control and ration quality ($z = -1.05, \rho = 0.294$). This result does **not support $\boldsymbol{H_6}$**, indicating that camp farming does not enhance the relationship between quality control and ration quality.

$\boldsymbol{H_7}$: Camp farming mediates the relationship between delivery handling and ration quality. The Sobel test revealed that the mediation effect of camp farming on the relationship between delivery handling and ration quality was significant ($z = 2.50, \rho = 0.012$). This supports $\boldsymbol{H_7}$, highlighting that camp farming facilitates the influence of delivery handling on ration quality.

TABLE 6. Thematic Analysis Table

Theme	Subtheme	Example Responses
Quality Control	Enforcement of Standards	Stricter enforcement of quality standards is needed.
	Regular Audits and Monitoring	Conduct regular inspections to ensure compliance with standards.
	Accountability Measures	Penalties for contractors not meeting benchmarks should be strictly enforced.
Delivery Handling	Comprehensive Guidelines	Develop clear guidelines to standardize delivery processes.
	Supplier Reliability	Screen suppliers thoroughly to ensure consistent quality.
	Training Programs	Train staff in handling and transporting fresh rations effectively.
Storage Conditions	Infrastructure Upgrades	Allocate budgets for upgrading storage facilities and chillers.
	Routine Maintenance	Ensure regular maintenance of storage equipment to maintain efficiency.
	Hygiene and Compliance	Improve cleanliness and ensure compliance with storage standards.
Contract Management	Monitoring Mechanisms	Enhance monitoring of contract compliance to ensure supplier accountability.
	Detailed Contract Clauses	Include specific quality standards in contracts with penalties for non-compliance.
	Timely Deliveries	Use refrigerated transport to ensure rations arrive fresh and on time.

Four major topics emerged from the thematic analysis: contract management, storage conditions, delivery handling, and quality control. The need for stricter implementation of the quality control standards was highlighted by the respondents, which is in line with the findings of Wincewicz-Bosy et al. (2022) that emphasize the crucial role of adherence to regulations and procedures within military logistics. Storage conditions emerged as a major concern, with investment in temperature-regulated facilities and regular maintenance suggested by participants, corroborating the findings of Onwude et al. (2023) on some of the infrastructure challenges along the food supply chain. Recommendations for effective contract management were also made, including reinforcing supplier accountability, putting penalties in place for non-compliance, and real-time monitoring, which Sahni & Khanduja (2023) do promote as a major step to improve procurement efficiency. Additionally, Mandal et al. (2023) underscored that supplier contracts must include explicit quality benchmarks to facilitate consistent food safety and delivery reliability. Finally, the use of camp farming and its potential for ameliorating logistical

inefficiencies was addressed, with Mustafa et al. (2024) in military settings, citing its ability to improve food security and supply chain resilience. These results highlight the need for local food production within military logistics in order to minimize reliance on external food suppliers and create more sustainable rations.

CONCLUSION

This study offers actual data on the major variables affecting the quality of military fresh rations, highlighting the importance of camp farming, contract management, and storage conditions in improving the effectiveness of the military food supply chain. The findings highlight the importance of supplier responsibility, compliance systems, and organised procurement procedures in military food logistics, since contract management had the most effect on ration quality. Furthermore, the quality of rations was greatly impacted by storage conditions, highlighting the need to invest in temperature-controlled infrastructure, maintain storage facilities, and coordinate logistics in order to keep food fresh and prevent spoiling. The association between storage conditions, contract management, and QMFR was significantly mediated by camp farming; however, its impact on quality control was not statistically significant. In order to maintain consistent food standards, internal quality control procedures must continue to be a top concern, even when localised food production can improve supply chain efficiency. Additionally, the study discovered that delivery handling and quality control did not significantly predict outcomes in the regression model. This suggests that current regulations and standard operating procedures may already be reducing the unpredictability of these factors in affecting food quality.

Implications for Policy and Recommendations The results offer politicians and military logistics decision-makers practical information. Military food supply systems can benefit from the following suggestions to improve food security and quality:

a. Reinforce Contract Management Policies: To increase accountability in procurement, implement automated compliance tracking, real-time supplier monitoring, and penalty enforcement for non-compliance.
b. Make an investment in storage infrastructure: To prevent spoiling and preserve food integrity, modernise military cold chain logistics, refrigeration facilities, and predictive maintenance systems.
c. Expand Camp Farming Initiatives: Establish localised food production on military installations to minimise reliance on outside vendors and improve operational sustainability.
d. Optimise delivery handling procedures: To reduce contamination and maintain food freshness, put in place quality checkpoints during transportation, sophisticated tracking systems, and training programs for food handlers.

Constraints and Prospective Research Avenues Even though this study offers insightful information, it should be noted that it has several limitations. The results may not apply to other military contexts with different supply chain arrangements because the sample was restricted to the Malaysian Armed Forces. Comparative studies between various military organisations should be the focus of future research in order to examine differences in the logistics of food. Secondly, self-reported survey data were used in the study, which could introduce respondent bias. To improve validity, future research could include supply chain tracking data and objective quality evaluations. Finally, to determine the long-term effects of camp farming projects on the

sustainability and cost-effectiveness of the food supply, longitudinal studies ought to be carried out.

Concluding Observations This study adds to the expanding body of research on sustainable military food supply chains by demonstrating the critical role that infrastructure investments and contract management play in ensuring food security. Military logistics may become more resilient and sustainable if camp gardening is incorporated as an additional food source. Utilising these insights, policymakers and military institutions may create strategic actions that enhance food security, cut waste, and guarantee military people receive wholesome nourishment.

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Hani Kalsom Hashim (Corresponding author)
Faculty of Defence Science and Technology,
National Defence University of Malaysia,
Kem Sungai Besi, 54200 Kuala Lumpur, Malaysia
Email: hanikalsom@upnm.edu.my

Muhammad Izzat Sallehudin
Faculty of Defence Science and Technology,
National Defence University of Malaysia,
Kem Sungai Besi, 54200 Kuala Lumpur, Malaysia
Email: 3221592@alfateh.upnm.edu.my

Mohd Norsyarizad Razali
Faculty of Defence Science and Technology,
National Defence University of Malaysia,
Kem Sungai Besi, 54200 Kuala Lumpur, Malaysia
Email: norsyarizad@upnm.edu.my

Nor Fyadzillah Mohd Taha
Faculty of Defence Science and Technology,
National Defence University of Malaysia,
Kem Sungai Besi,
54200 Kuala Lumpur, Malaysia
Email: norfyadzillah@upnm.edu.my

Roshamida Abd Jamil
Faculty of Defence Science and Technology,
National Defence University of Malaysia,
Kem Sungai Besi,
54200 Kuala Lumpur, Malaysia
Email: roshamida@upnm.edu.my