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Presenting a Crisis-Oriented Pharmaceutical Cold Logistics Management Model in Encountering with Maritime Crises: A Mixed-Method Design

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Abstract

Background and Theoretical Foundations: During natural and man-made crises and hazards, global pharmaceutical supply chains have experienced fluctuations in demand, production capacity issues, and distribution problems. The prevention and management of these challenges are crucial for maintaining public health, as the scarcity of essential medicines, vaccines, and blood products can pose severe health risks and hinder medical care. The present research aimed to develop a model of pharmaceutical cold logistics management during and facing maritime crises. Following a practical objective, this study is exploratory-descriptive in nature and benefits from a mixed methods design.

Methodology: The statistical population of the research includes academic and military experts in the field of Supply Chain Management and Maritime Crisis Management. They involve 20 in the qualitative phase using purposive sampling and

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120 constitute samples in the quantitative phase using convenience sampling. The qualitative phase was run through conducting semi-structured interviews, and a questionnaire was administered in the quantitative part. Data were qualitatively analyzed through thematic analysis, and a partial least squares (PLS) structural equation was run to quantitatively analyze the questionnaire.

Findings and conclusion: Results showed that the drug cold logistics management during the crisis includes the main themes of the application of emerging technologies, information and communication management, pharmaceutical supply and distribution management, quality and trust management, and pharmaceutical supply chain audit. Based on the quantitative findings, the structural model of the research was approved, possessing sufficient validity according to the quality indices. Finally, the results of ranking the dimensions of the research based on the Friedman test showed that the application of emerging technologies in the management of maritime crises had the highest importance, and the pharmaceutical supply chain audit was found to be the lowest priority in the management of maritime crises.

Keywords: pharmaceutical cold logistics management, maritime crises, crisis management, mixed-method design.

1. Introduction

During both natural and man-made crises and hazards, global pharmaceutical supply chains have experienced fluctuations in demand, production capacity issues, and distribution problems. The prevention and management of these challenges are crucial for maintaining public health, as the scarcity of essential medicines, vaccines, and blood products can pose severe health risks and hinder medical care (Latonen et al., 2023). Crises like the Covid-19 pandemic or those resulting from natural hazards necessitate coordinated responses from government agencies, the pharmaceutical industry, wholesalers, private pharmacies, hospitals, and advocacy organizations (Latonen et al., 2023).

Despite the uncertainty and urgency associated with such crises, research on crisis management emphasizes the benefits of interdisciplinary collaboration in navigating complex situations. Sharing resources, developing skills, and engaging in interactive training can enhance future crisis preparedness (Hermansson, 2016).

Currently, the pharmaceutical supply chain faces numerous challenges due to rapid market changes, technological advancements, and societal pressures. The integration of sustainability into supply chain design and planning decisions adds complexity to these operations. The United Nations' 2030 Agenda for Sustainable Development outlines 17 goals aimed at creating a more sustainable and resilient world for present and future generations, as well as the planet. These goals emphasize the importance of ensuring healthy lives, reducing inequalities within and between countries, and promoting responsible consumption and production patterns (United Nations, 2015). The pharmaceutical sector has significant economic, environmental, and social impacts, necessitating improvements in the supply chain network and global access to medicines (Duarte et al., 2023). Social goals, particularly those related to access to medicine, are crucial in this sector. The Access to Medicine Index (ATMI) highlights the importance of equitable availability and affordability of medicinal products in all countries (Menou et al., 2021), with a focus on improving access in countries with higher disease burden and limited capacity to acquire these products (Duarte et al., 2022).

Pharmaceutical companies comprise a subset of healthcare organizations that have encountered heightened regulatory scrutiny concerning economic, environmental, and social matters, prompting them to pursue more sustainable supply chains. Moreover, pharmaceutical firms involved in vaccine production must contend with product-specific attributes, such as storage temperature and

shelf life, which impact resource allocation across facilities (Lemens et al., 2016). This sector assumes a critical role within any nation's healthcare framework by furnishing medicines and vaccines that directly influence individuals' quality of life. Unquestionably, medications are responsible for disease prevention and treatment, bolstering or preserving health while averting the exacerbation of existing ailments. Consequently, in addition to directly benefiting populations, drugs and vaccines also contribute to substantial reductions in a country's overall healthcare expenditures by mitigating the need for long-term care services and/or costly surgeries. Thus, addressing equitable access considerations during the design and planning of pharmaceutical supply chains assumes paramount importance and propels the sector toward enhanced social sustainability (Duarte et al., 2022).

Supply chain disruptions resulting from conflicts, extreme weather events, cybercrime, trade policy uncertainties, and other risks pose significant challenges to global value chains in various industries. As a result, there is increasing interest among researchers and practitioners in effectively managing these disruptions (Handfield et al., 2020). However, traditional supply chain management practices that prioritize cost and efficiency have proven inadequate in addressing these disruptions (Huo et al., 2023).

One crucial aspect of crisis management is the handling of maritime crises and the management of pharmaceutical logistics during such crises. The occurrence of global maritime crises, such as sea storms, tsunamis, theft, piracy, and climate change, necessitates the provision of logistics facilities and equipment in areas prone to accidents. Timely response to maritime crises is essential to provide relief to personnel and affected individuals. Therefore, this study aims to propose a cold drug logistics model for maritime crises. The primary focus of this research is to determine an appropriate logistics response

model in the pharmaceutical field during maritime crises and identify the factors influencing this process. The findings of this study can assist managers and organizations operating in the maritime industry, particularly armed forces, in responding effectively and promptly when necessary. Additionally, this research contributes to the existing literature in this field, considering the limited available sources on the management of cold drug logistics during maritime crises.

2. Theoretical Framework

2.1. Maritime crises

Marine accidents are one of the causes of the waste of countries' capital in all parts of the world and cause the death of many people. becomes; Therefore, in addition to trying to prevent these accidents in various ways, all countries are equipping themselves with marine facilities to reach the accident site in the shortest possible time and rescue and assist the injured and the injured (Siyareh and Haghi). Chaubar, 2015). According to the definitions, any event or incident that causes damage (including loss of life and property) or injury to people, or seriously threatens them, is called an accident. Risk is a process or event that has the potential to cause damage in the future, that is, a conventional source of risk. Most environmental hazards have an atmospheric origin. Most people are exposed to natural climate change. Although all severe storms have common characteristics, each type of storm creates its own harmful conditions (Mohammadi, 2019). The definition of a marine accident based on the resolution of the International Maritime Organization (IMO) on November 27, 1997 is:

- Death or severe injury to people (caused by the operation of the ship or related to the ship's activities)

- Disappearance of the ship's crew (caused by the ship's operation or related to the ship's activities)
- Material damage to the ship
- Grounding or disqualification of a ship or getting caught in a collision
- Physical (material) damage resulting from operations or activities related to shipping
- Damage to the environment caused by routine activities or accidents.

In order for an incident to be registered as a crisis, it must have at least one or a combination of the following criteria (Jehangiri, 2013):

- At least 10 deaths have been reported in the target population.
- At least 100 people of Balazdeh region have been affected.
- Declaration of a state of emergency by the government authorities where this incident happened.
- Asking for help from the international community

In a crisis, infrastructures are damaged and sometimes completely destroyed. This can be considered as the distinguishing feature of crises from catastrophic events. Many accidents or casualties also cause death or injury to a significant number of people, but the society's infrastructure remains intact to respond to such incidents, although in this case, the need is beyond the available resources in the processes. Every day is the functioning of the system (Asadi, 1401).

2-2. Pharmaceutical cold logistics management

One of the most vulnerable parts of healthcare systems is its distribution network, which relies on third parties to do the work. Pharmaceutical distribution in healthcare is done through traditional supply chain and cold chain. Cold chain is a state that maintains perishable products through the entire production process for consumption within a certain temperature range (Badia-

Melis, 2018). In this regard, the healthcare and pharmaceutical supply chain is a special type of supply chain where drugs and vaccines are produced, transported and consumed (Dixit et al., 2019). There are many drugs that are classified as perishable and need to be stored within a certain temperature range. Insulin, some eye drops, some ear drops, vaccines, biologics, and most AIDS test kits are examples of temperature-sensitive drugs (Kochek Kashani et al., 2023). Temperature-sensitive drugs are an integral part of the contemporary supply chain. Therefore, the proper design and control of the cold chain is necessary to reduce waste in terms of money and product (Kuchek Kashani et al., 2023).

A wide range of studies on various aspects such as equipment maintenance management (Yosefli et al., 2017), strategic issues (Singh et al., 2016), pharmaceutical and health supply chain implementation (Adebanjo et al., 2016), supply chain Sard (Sharma and Pali, 2015), supply chain operations (Albarron et al., 2015) and decision-making (Malek et al., 2018) exist in healthcare and pharmaceutical supply chains. A review of research literature shows that studies related to healthcare supply chain and cold supply chain have increased significantly in recent years. Figure (1) shows the number of studies published in this field, which clearly shows the increase in the number of studies in this field (Kochek Kashani et al., 2023).

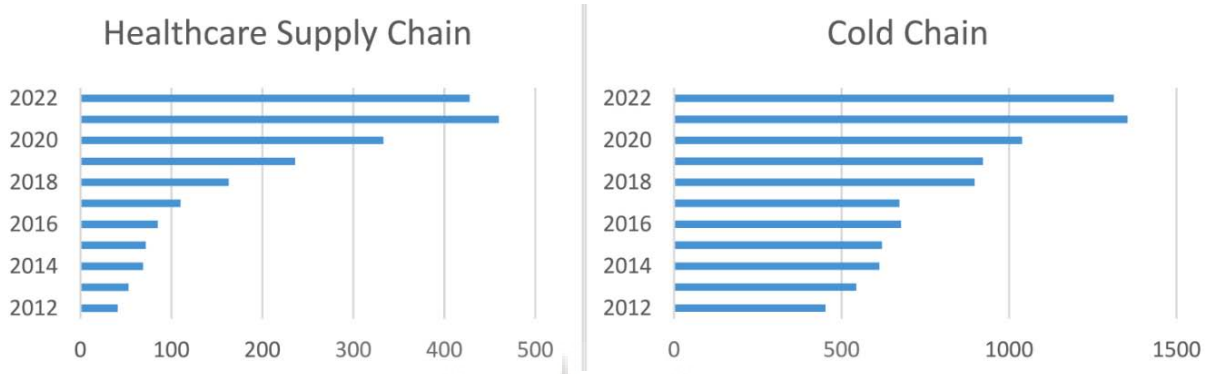

Figure 1: Published studies of cold supply chain and healthcare supply chain in Web of Science.

Also, Figure (2) shows the size of the cold logistics industry, which shows the continued growth of this field and is expected to continue its upward trend until 2028. This growth pattern emphasizes the importance of the cold supply chain and its growing need (Kochek Kashani et al., 2023).

Figure 2: Growth trends of the cold logistics industry (in millions of dollars).

With the increasing complexity of healthcare supply chains and the increasing demand for pharmaceutical products due to the spread of contagious viruses, more practical approaches are needed. In addition, hospitals need to achieve a supply chain that is responsive during disruptions and can manage drugs as a whole, taking into account their various characteristics (eg, storage conditions, shelf life, volume, and priority) in comment (Kochek Kashani et al., 2023). . Strategies for success in managing supply chain risk include diversifying suppliers, building strong supplier relationships, monitoring supplier performance, and investing in technology to develop supply chain visibility and flexibility. Supply chain risk management is a critical aspect of modern business operations. Companies face a wide range of risks as global supply chains become more complex, threatening their capacity to provide products and services to customers (Abassi et al., 2022). From natural disasters and geopolitical instability to cyberattacks and supplier bankruptcies, risks are many and varied. To effectively manage these risks, companies should comprehensively understand the key issues and emerging trends in supply chain risk management (Amrozenjad et al., 2023).

Research shows that only 21% of supply chain organizations believe they have a highly flexible network (Gartner, 2022). Organizations are increasingly looking to restructure their supply chain networks to support their risk tolerance by developing upstream and downstream network design strategies. On the one hand, resilient supply chains require the coordination of internal and external partners to respond to disruptions or even rebuild the supply chain network to achieve full recovery (Bettacharya et al., 2013). On the other hand, balanced flexibility to maintain dynamic supply chain continuity requires a trade-off between developing sufficient capabilities to compensate for excessive vulnerability to risks (Petit et al., 2013). In general, supply chain resilience can

be defined as the ability of a supply chain to prepare for, respond to, and recover from supply chain disruptions and maintain the continuity of materials, information, and material flows (Guo et al., 2021). In terms of dimensions of supply chain resilience, previous researches have mainly divided supply chain resilience into flexibility, speed, agility, adaptability, visibility and resource redundancy (Wiland & Wallenberg, 2013). These dimensions generally focus on a supply chain as a whole. However, they fail to examine the locations where the supply chain is disrupted and the ripple effect of supply chain disruptions (Ivanov et al., 2019). Disruption at one supply chain node can spread throughout the entire supply chain (Zhang et al., 2018). Some studies define supply chain resilience as the ability to react and recover from severe disasters that disrupt the supply chain (Yurcioli et al., 2014), others specify adaptation to environmental uncertainties or changes (Disjardin et al., 2021). Recent research shows that there is no universal definition of supply chain resilience (Chi et al., 2023).

Production risks, storage and transportation risks, financial risks, legal risks, quality risks, shipping delays, theft, natural disasters, weather related issues and cybercrimes are some of the important risks associated with supply chain management. are supply (Abassi et al., 2022). Regardless of the type of disruption risks or operational uncertainties, some studies focus on the capability perspective. They define supply chain resilience as the ability of a supply chain to anticipate and overcome possible disruptions or as the characteristic of a network to resist disruptions (Alikhani et al., 2021). Other studies adopt a performance-outcome perspective, focusing on the recovery time of the supply chain to return to the initial operational state and the performance lost during recovery periods (Shen and Sun, 2023).). Furthermore, most of the supply chain resilience literature considers both proactive

identification and reactive response to a supply chain disruption, which combines "pre" and "post-disruption" processes (Chaudri and Kvados, 2017; Pournader et al. et al., 2016; Zhao et al., 2019).

Supply chain management refers to the ability of a supply chain (including the focal company, its suppliers, and its customers) to maintain the continuity of materials, information, and flows by preparing for, responding to, and recovering from supply chain disruptions (Guo et al., 2021; Weiland and Durack, 2021). This definition of resilient supply chain management integrates and expands the perspectives of previous studies; It identifies the upstream and downstream structure of a supply chain network with the focal firm and breaks the limitation of measuring its total unit. Supply chain resilience includes the cyclical processes of preparation, response, and recovery (Brandon-Jones et al., 2014):

- The preparation process in supply chain resilience refers to maintaining high situational awareness and preparing alternative plans for supply chain disruptions such as stockpiling excess resources, inventory, or convertible production lines (Van Hook, 2020). For example, in cases where supply chain disruptions are caused by delays in the delivery of raw materials, a firm may decide to maintain production for a while or establish a relationship with a new supplier (Torabi et al., 2015).
- The response process in supply chain resilience includes quick response and dealing with changes caused by supply chain disruptions (Goldbek et al., 2020).
- The recovery process in supply chain resilience refers to adjusting the company's operational activities and adapting to the changed environment after a disruption (Yu et al., 2019). Regulatory activities involve changing processes, tactics, and even strategies that were adopted in the previously undisturbed state. Through these processes and activities, firms reach a new steady state and

continue to respond in subsequent cyclical processes when another supply chain disruption occurs (Hugh et al., 2023).

This study focuses on the response part in the maritime supply chain and considers the issues and actions and challenges in crisis response with an emphasis on pharmaceutical logistics management in maritime crises. In this direction and in order to provide a suitable response from the aspect of cold medicine logistics to marine risks and crises, efforts are being made to provide suitable solutions by identifying the effective and influencing factors on this process.

2-3. Research background

I. Hao et al. (2023) conducted a study titled the impact of supply chain flexibility on customer satisfaction and financial performance: a combination of contingency and configuration approaches. This study uses a combination of contingency and configurational approaches to examine direct and probabilistic relationships between dimensions of supply chain flexibility (including internal, supplier, and customer flexibility) and performance. Survey data collected from 206 Chinese manufacturers show that the three dimensions of supply chain flexibility are positively related to customer satisfaction, while customer flexibility has no direct contribution to financial performance. Internal resilience moderates the relationship between supplier resilience and performance (negative for customer satisfaction and positive for financial performance). In this study, a classification for supply chain flexibility was established based on internal, supplier, and customer flexibility, which provides a comprehensive perspective to examine performance differences among four different models of supply chain flexibility, including high external

orientation, high uniformity, moderate uniformity, and There is little uniformity. This review highlights the importance of effective supply chain risk management in ensuring business continuity and resilience and emphasizes the need for organizations to adopt a proactive approach to risk management. Finally, the paper identifies areas for future research, including the development of new risk management frameworks and the integration of emerging technologies into supply chain risk management practices.

II. Latonen et al. (2023) developed a new conceptual model to describe the organization of collaborative crisis management in a study titled Organization of intersectoral collaboration and its impact on the effectiveness of crisis management among pharmaceutical supply chain stakeholders during the COVID-19 pandemic. Without a pre-defined crisis management organization, intersectoral cooperation was organized based on previous structures, channels and relationships and through the creation of subject-related groups by government agencies according to legal mandates. Guided crisis dynamics and issues related to group formation and meeting frequency. Advocacy organizations and government agencies acted as a bridge between stakeholders. Shared knowledge among pharmaceutical supply chain stakeholders enabled anticipation and crisis preparedness, and shared resources strengthened core functions.

III. Yang (2023) in a study titled A Strategic Environmental, Social and Governance Model for Managing Pharmaceutical Supply Chains with Financial Barriers, found that integrating a pharmaceutical supply chain and environmental, social and governance strategy can effectively improve pharmaceutical supply chain innovation. to promote The supply chain matching strategy is more effective than the mismatching strategy in

pharmaceutical supply chain management and can improve the financing efficiency of manufacturers with limited capital. In matching strategy, centralized matching can attract customers who prefer green products better than decentralized matching. At the lower level of green investment, a focused environmental, social and governance management strategy can better contribute to the development of the pharmaceutical supply chain.

IV. Dorit et al. (2022) in a study titled Supply Chains of the Pharmaceutical Industry: How to Improve Sustainable Access to Vaccines?, presented several scenarios to provide a multi-objective linear planning model for strategic and tactical decisions of the meningitis vaccine supply chain and They analyzed the effects of these scenarios on supply chain objectives. Among the things examined in this model are the identification of environmental, economic and social critical points, access to the product, and the identification of strategies for sustainable design and planning of the pharmaceutical supply chain, which is used to improve access to products.

V. Panjeh Kobi and Firozi Jahantigh (2019) in a study titled identifying and evaluating risk factors in the supply chain of the pharmaceutical industry using artificial intelligence, concluded that changes in interest and inflation, changes in exchange rates, inflexibility in production and disruption in services Customers are respectively the most important in drug supply chain risks.

VI. Shah Bahrami et al. (2019) in a study titled prioritization of factors affecting the management of sustainable drug supply chain in pharmacies of selected teaching hospitals finally concluded that 23 factors in 5 dimensions of reliability, responsiveness, flexibility, costs and asset management were identified, the most important factors identified were

from the asset management dimension and the largest number of factors were from the accountability dimension.

VII. Azar et al. (2019) conducted a study titled Designing the Resilience Model of the Supply Chain of the Pharmaceutical Industry in Crisis Conditions with the Interpretive Structural Modeling (ISM) Approach. The purpose of this article is to provide a model for interactions and mutual influence of supply chain resilience factors in the pharmaceutical industry. In order to stratify the resilience components of the supply chain, interpretive structural modeling was used, and after going through its steps, a model with 8 levels and 13 indicators was presented. The results showed that the indicators of agility and information sharing/knowledge sharing are at the lowest level, respectively, which indicates a high impact on other indicators. The indicators of agility and participation and cooperation are the most penetrating and the indicators of trust and stability in the supply chain are the most dependent elements in the supply chain of the pharmaceutical industry.

VIII. Amin Tahmasabi and Hami (2018) in a study titled analysis of resilience and sustainability criteria of the supply chain in the pharmaceutical industry using the interpretive structural analysis method, after identifying resilience and sustainability criteria from available sources and receiving the opinions of pharmaceutical industry experts, Determining relationships and leveling of criteria was done using interpretive structural analysis method. The results of the research indicate that factors such as learning, stakeholder management, field of vision, organization, position in the market, economic power, external pressures, internal pressures are powerful factors for the resilience of the supply chain and should be considered more than other factors.

IX. Heshmati (2017) in a study entitled the application of the healthcare supply chain during a crisis and natural disasters, identified the issues in this field, which include the disruption of the transportation system of the supply chain in crisis conditions, the appropriate inventory model of the involved medical centers. In the supply chain in crisis conditions, the integration of different parts of the supply chain in crisis conditions and finally the expansion of the use of information technology in the supply chain in crisis conditions.

X. Esmail Lu et al. (2016) in a study entitled "Evaluation of the impact of customer relationship management on the supply chain with regard to the mediating role of information technology (case study: drug supply in military hospitals)" concluded that not only relationship management With the customer, it has a direct effect on the supply chain, but the complete mediating effect of information technology is also confirmed. Also, there is a positive and significant relationship between customer relationship management and supply chain, and customer relationship management and information technology, information technology and supply chain.

XI. Fadzi Poursain and Torabipour (2012) in a study titled investigating the role and identification of effective factors in improving the performance of cold chain management for competitive organizations with the factor analysis approach, concluded that the structures of equipment, planning and time respectively have the highest coefficient are important in this chain.

3. Research methodology

This research has been done with the aim of presenting a cold medical logistics model during a crisis in dealing with maritime crises. Therefore, in terms of the

purpose of this research, it is practical. In terms of the method of data collection, it is mixed and in terms of its nature and method, it is exploratory-descriptive. The statistical population of this research is academic experts, commanders and high-ranking assistants of the Armed Forces Health Department. The sampling method in the qualitative part is targeted and the number of 20 people and in the quantitative part is 120 people and available. In this research, in order to collect data in the qualitative part, semi-structured interviews were used, and in the quantitative part, the questionnaire obtained from the results of the qualitative part was used. Thematic analysis method was used to analyze the data in the qualitative section.

Thematic analysis is a process for analyzing textual data and transforms scattered and diverse data into rich and detailed data (Brown and Clark, 2006). In the quantitative part, structural equations using the partial least squares (PLS) method were used to validate the research model and the relationship between the research dimensions and indicators. In the qualitative part, various methods were used to check the validity and reliability of the research. In order to validate the interview, Wall's (1996) method was used, according to which the researcher must carefully and accurately perform seven stages of the interview process, including determining the topic, design, interview situation, transcription, analysis, confirmation and reporting.

Do it in a scientific way. In order to calculate the reliability of the interview with the intra-subject agreement method, an expert was asked to code the number of 3 interviews with the researcher and the percentage of intra-subject agreement using the formula ((2 x number of agreements)/(total number of codes) 100% × 100%) was calculated, the results of which are shown in Table (1), which revealed that there is an intra-subject agreement up to the level of

82.35%. Therefore, the reliability of the research was confirmed in the qualitative part.

No	Interview code	The number of codes	The number of agreements	Reliability between two coders (percentage)
1	4	64	26	% 81.25
2	8	58	24	% 82.75
3	12	48	20	% 83.34
-	All	170	70	% 82.35

Table 1: Reliability between two coders (qualitative part)

In the quantitative part of the research, combined reliability and Cronbach's alpha were used to confirm the reliability, and the results in table (2) show that the values of combined reliability and Cronbach's alpha were greater than 0.7, so the reliability of the quantitative part was confirmed. To check the validity of the research, construct validity was used in the quantitative part, which includes convergent validity and divergent validity. For convergent validity, the Average Variance Extracted Index (AVE) was used, according to which all the obtained values are greater than 0.5, which indicates the confirmation of convergent validity. For divergent validity, HTMT index was used, according to table (2), all its values are smaller than 0.9, which indicates the confirmation of the divergent validity of the research in the quantitative part.

Structure	Cronbach's alpha	Combined reliability	(AVE) Convergent validity	HTMT divergent validity				
				(1)	(2)	(3)	(4)	(5)
Information and communication management	0/905	0/955	0/713	1				
Management of quality and trust	0/745	0/877	0/797	0/507	1			
Application of emerging technologies	0/723	0/877	0/782	0/834	0/633	1		
Pharmaceutical supply and distribution	0/783	0/874	0/699	0/364	0/776	0/592	1	
Pharmaceutical supply chain audit	0/801	0/863	0/558	0/571	0/862	0/704	0/552	1

Table 2: reliability and validity of the research (quantitative part)

4. Research findings

Due to the fact that this research was conducted in two stages, qualitative and quantitative. Therefore, first the qualitative findings and then the quantitative findings are presented:

4-1. Findings of the qualitative section

Table (3) shows the demographic information of the studied sample. As can be seen, the majority of the studied sample are men, people aged 31 to 40 years, with a doctorate degree, with a service history between 11 and 20 years, and with the organizational position of commanders and deputies of the armed forces.

Property	Status	Frequency	Frequency percentage
Gender	Male	16	80
	Female	4	20
Age	20-30	4	20
	31-40	9	45
	41-50	5	25
	More than 50	2	10
Education	BA	3	15
	MA	6	30
	PhD	11	55
Years of service	1-5	2	10
	6-10	2	10
	11-15	6	30
	16-20	6	30
	More than 20	4	20
Field of activity	Academic experts	7	35
	Commanders and deputies of the armed forces	13	65

Table 3: Profiles and characteristics of the interviewees

After conducting a semi-structured interview with the participants in the research, the thematic analysis method with the six-step technique of Brown and Clark (2006) was used to analyze the qualitative data. This method includes six stages of getting to know the data, creating primary codes, searching for selective codes, creating sub-themes, defining and naming themes, and preparing a report. After performing the above steps and analyzing the coding of data in three levels of basic themes, organizing themes (main and secondary) and comprehensive themes, the results of which are shown in table (4). As can be seen in this research, the main research theme is pharmaceutical cold logistics management during the crisis, which includes 5 themes organizing the

use of emerging technologies, information and communication management, pharmaceutical supply and distribution management, quality and trust management, and pharmaceutical supply chain audit. Each of these organizing themes has sub-organizing themes and basic themes. In total, in this research, there are 70 basic themes, 14 sub-organizing themes, 5 main organizing themes and one overarching theme.

Comprehensive themes	Main-organizer themes	Sub-organizer themes	Basic themes
Management of cold pharmaceutical logistics during a crisis	Application of emerging technologies	Emerging communication technologies	Two-way radios, satellite phones, mobile applications, social networks, emergency communication systems
		Types of emerging technologies	ERP systems (Enterprise Resource Planning), wireless technologies, geographic information systems, block chain technology, Data Management Systems (DMS), Internet of Things technology, artificial intelligence, drones
	Information and communication management	Expansion of communication	Use of communication technologies, standardization of communication protocols, cooperation with academic and research institutions, cooperation with the local community, communication and coordination with other organizations, investment in communication technologies, communication and cooperation of key stakeholders.
		Information quality	Creating electronic health records, determining data analysis tools, data and information sharing agreements, data standardization, data integration

Comprehensive themes	Main-organizer themes	Sub-organizer themes	Basic themes
	Pharmaceutical supply and distribution	Cold pharmaceutical supply	supply of required medical items (vaccine, medicine, blood products, etc.), emergency stock of drugs, drug storage, use of technology in drug supply
		Cold pharmaceutical transport	Use of appropriate transport equipment, maintenance and repair of transport equipment, temperature and humidity monitoring during transport, use of experienced transport team, adherence to pharmaceutical transport standards, existence of alternative routes, variety of pharmaceutical transport. (sea, air)
		Cold pharmaceutical distribution	Managing drug distribution operations, managing the life cycle of drugs, ensuring the quality and safety of drugs, recycling and disposing of excess drugs, interaction and cooperation with other institutions in distribution, support and information in distribution.
	Management of quality and trust	Specialized management	Coordination and management of activities, information management, quality management, personnel management, safety management
		The quality of the logistics process	The quality of infrastructure and equipment, the flexibility of the pharmaceutical cold supply chain, the agility of the pharmaceutical cold supply chain, maintaining the quality of pharmaceutical products
	Pharmaceutical supply chain audit	Ethical considerations	Ensuring equitable access to medicines, prioritizing vulnerable populations, ensuring transparent and accountable distribution, need-based distribution programs, ensuring supply chain integrity

Comprehensive themes	Main-organizer themes	Sub-organizer themes	Basic themes
		Security considerations	Preventing misuse of scarce resources, protection against theft and counterfeiting, ensuring that medicine is not diverted to illegal purposes, cyber security
		Privacy	Ensuring safe collection of personal information, use of personal information for drug distribution purposes, safe storage of personal health information
		Cultural considerations	respect for local beliefs and cultures, distribution of medicine with cultural considerations, collaboration with local community leaders, collaboration with local health care providers,
		Legal considerations	Compliance with regulations, adherence to legal manufacturing and distribution practices, quality control standards

Table 4: Basic, organizing and overarching themes

Based on the findings and coding done by thematic analysis method, the final research model is designed. Figure (3) shows the final research model. As can be seen, the management model of cold pharmaceutical logistics of the Armed Forces J.A. During the occurrence of marine crises and disasters, Iran is in 5 areas of application of emerging technologies, information and communication management, pharmaceutical supply and distribution management, quality and trust management, and pharmaceutical supply chain audit.

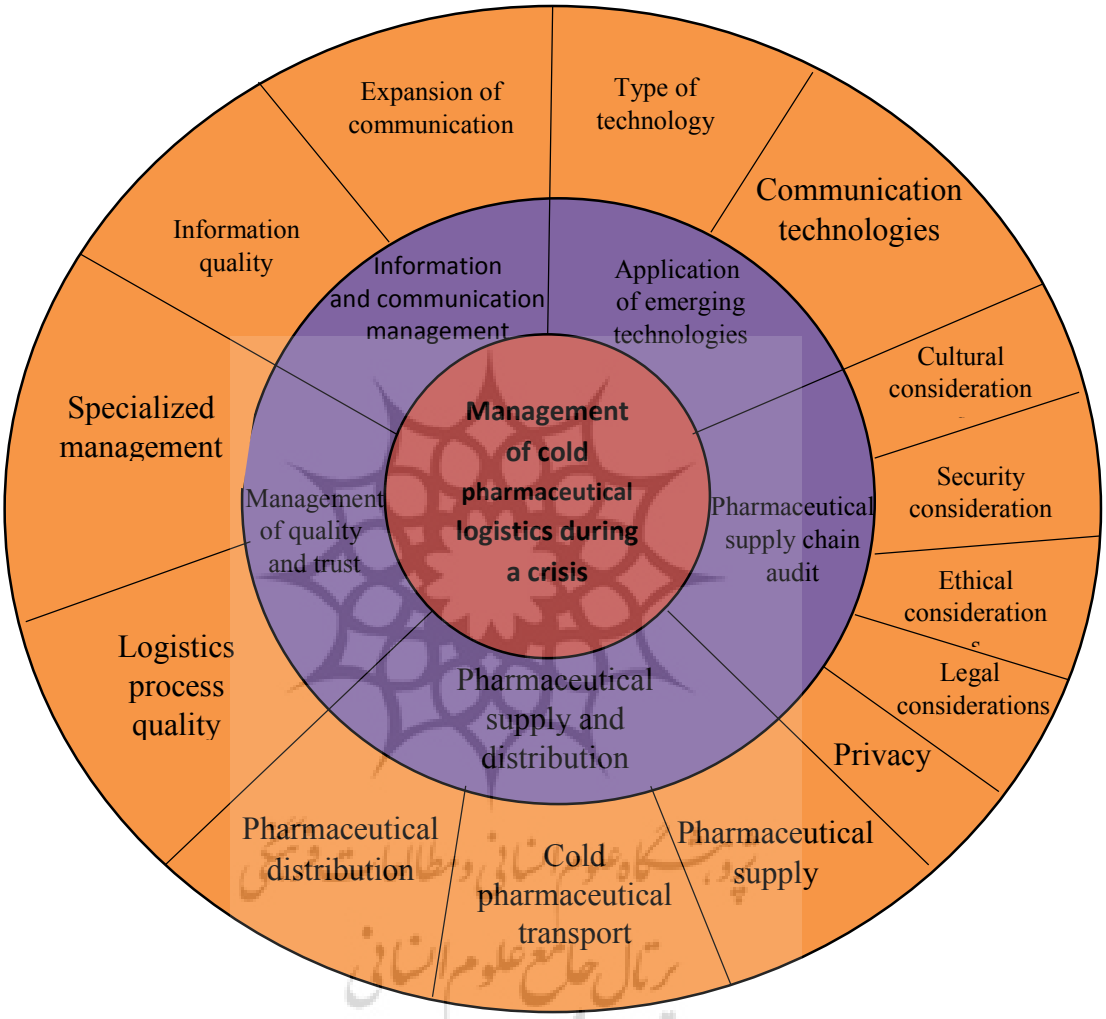

Figure 3: Research model in the qualitative section

4.2. Findings of the quantitative section

After identifying the research indicators through the qualitative process, in the next step and in the quantitative part, the indicators were formulated in the form of a questionnaire and were given to 120 experts, graduates and commanders of

the armed forces with academic or work records related to pharmaceutical logistics management and maritime crisis management. First, the demographic information of the statistical sample is shown in table (5). As can be seen, 73.3% of the statistical sample are men and 26.7% are women. In terms of age, 31.7% of people were between 20 and 30 years old, 37.5% were between 31 and 40 years old, 20% were between 41 and 50 years old, and 10.8% were over 50 years old. In terms of educational status, 28.3% had a high school diploma, 43.3% had a master's degree, and 28.3% had a doctorate. Finally, in terms of field of activity, 41.7% were educated, 37.5% were military commanders, and 20.8% were experts.

Property	Status	Frequency	Frequency percentage
Gender	Male	88	73/3
	Female	32	26/7
Age	20-30	38	31/7
	31-40	45	37/5
	41-50	24	20
	More than 50	13	10/8
Education	BA	34	28/3
	MA	52	43/3
	PhD	34	28/3
Field of activity	experts	25	20/8
	Commanders	45	37/5
	Graduates	50	41/7

Table 5: Demographic information of the statistical sample in the quantitative section

4.2.1. Determining the importance of pharmaceutical logistics management dimensions during a maritime crisis

Friedman's test has been used to check the importance of each of the dimensions and concepts obtained in maritime crises, the results of which are shown in table (6). According to the obtained results, the use of emerging technologies in maritime crises has the highest priority, followed by the aspects of pharmaceutical supply and distribution management, quality and trust management, information and communication management, and supply chain audit in the next ranks of importance. Management of pharmaceutical logistics during maritime crises.

Variable	Dimensions	Average	Rank	Chi-square	Degree of freedom	Significance
Pharmaceutical supply chain audit	Information and communication management	3/08	4	14/017	4	0/007
	Management of quality and trust	3/10	3			
	Application of emerging technologies	3/24	1			
	Pharmaceutical supply and distribution	3/12	2			
		2/58	5			

Table 6: The results of Friedman's test for ranking the main dimensions of the research.

4-2-2. Structural model

In order to validate and measure the quality of the research model, the structural model of the research was implemented in SmartPLS-3 software in two modes of coefficient estimation and coefficient significance, which are shown in figures (4) and (5). Since all the significant numbers (Figure 4) for each of the research dimensions and components are greater than 1.96 and the factor

loadings (Figure 5) are greater than 0.5, so the research model is structurally approved.

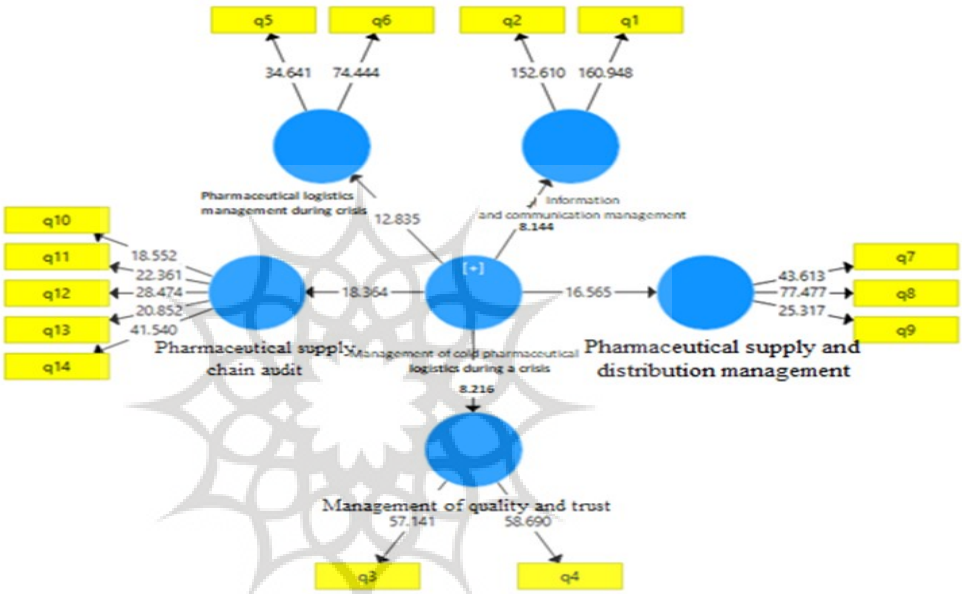

Figure 4: The structural model of the research in the significance mode of the coefficients

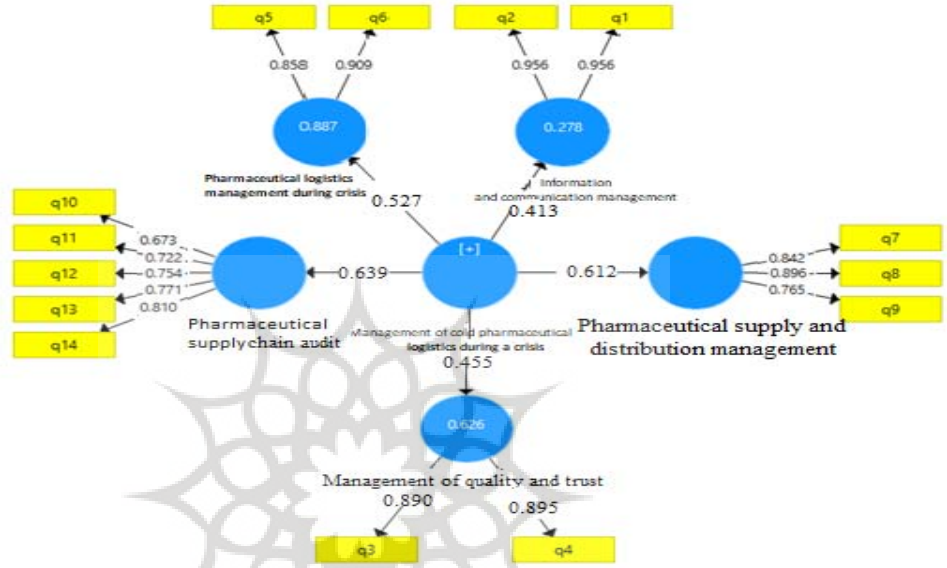

Figure 5: Measurement model in coefficient estimation mode

4-2-3. The quality of the research model

Finally, in order to evaluate the quality of the research model, various indicators have been used. Table (7) shows the results of various indicators for the quality of the research model, including determination coefficients (R2), redundancy cross validity index (Q2) and goodness of fit (GOF). The first index is the coefficient of determination, which shows the degree of prediction of the dependent variable by the independent variable, which is compared based on three values of 0.19 (weak), 0.33 (medium) and 0.67 (strong). According to the results, the determination coefficient values obtained for the research dimensions are moderate and strong. The second index is Q2, which examines the quality of prediction in the structural model and is compared with three values of 0.02 (weak), 0.15 (moderate) and 0.35 (strong). Based on the results

of the table, all Q2 values are at the upper average level. Finally, the third goodness-of-fit index (GOF) evaluates the quality of the overall research model and is evaluated with values of 0.02, 0.15, and 0.35. The relationship (GOF=√((AVE) □×(R^2) □)) is used to measure the goodness of fit. After calculating the GOF value of 0.604, it was found that the overall research model has a very strong fit. According to the results of the three mentioned indicators, it can be said that the research model has a high quality level.

Structure	R2	Q2	AVE	GOF
Information and communication management	0/278	0/156	0/713	
Management of quality and trust	0/626	0/173	0/793	
Application of emerging technologies	0/887	0/206	0/783	0/604
Pharmaceutical supply and distribution	0/375	0/249	0/699	
Pharmaceutical supply chain audit	0/408	0/209	0/558	

Table 7: Quality and fit of the research model

5. Discussion

This study was carried out with the aim of providing a model of cold pharmaceutical logistics management during a crisis in dealing with maritime crises. Using qualitative methodology and interviews with military experts, it was determined that different factors should be considered for logistics management during a crisis. so that it is necessary to use different technologies such as wireless technologies, satellite phones, emergency communication systems, blockchain, internet of things, etc. He had an appropriate and quick response to the crisis. On the other hand, having information and

communication management can be effective in managing pharmaceutical logistics in a crisis. Due to the fact that through various methods of communication with different stakeholders such as the local community, employees, influential groups, armed forces, etc., he established sufficient communication to establish the necessary coordination during the crisis in the operational and support teams. Having quality and trust management can also play a fundamental role in this field. The crisis management team must have sufficient expertise in the fields of coordination and management, quality management, safety management, human resource management, etc., and at the same time, the quality of logistics processes in the field of infrastructure and equipment, the flexibility of the logistics process, To guarantee the agility of pharmaceutical logistics and the quality of your products.

Another aspect of pharmaceutical cold logistics management is how to manage pharmaceutical supply and distribution, which emphasizes how to supply, transport and distribute pharmaceuticals and blood products. In order to respond appropriately and quickly to a maritime crisis, it is necessary to provide necessary preparations for any event in the logistics system by providing necessary medical items during a possible crisis, warehousing and creating strategic and emergency drug reserves.

Also, suitable transportation equipment for temperature and humidity sensitive drugs, experienced transportation team, maintenance and repair of transportation equipment, identification of alternative routes and use of transportation diversity such as sea and air can be used to deal with Crisis used. In the process of distribution of pharmaceutical items, it is necessary to take effective action in this field from the quality and safety of drugs, recycling and disposal of emergency drugs, cooperation with various institutions, etc. Finally, in order to ensure the correctness and efficiency of logistics management during

a crisis, various audits in the legal, ethical, security, cultural and privacy fields should be observed in order to avoid problems in these areas in the pharmaceutical logistics management process during a crisis.

After identifying the dimensions and components of pharmaceutical logistics management during a crisis, structural equations were used to confirm and validate the model in maritime crises, and the research model was approved in terms of quality indicators. Also, the results of the ranking of the research dimensions showed that from the perspective of the research participants, the dimension of the use of emerging technologies in the management of maritime crises is more important. This result shows that in maritime crises, emerging technologies play an essential role in the field of identification, quick action and even dealing with maritime crises and can reduce the amount of damages by creating the necessary conditions for a quick response to maritime crises. and prevent possible casualties.

The findings of this research can be used in the management of medical cold logistics in maritime crises. In this regard, the following suggestions are presented in order to use the research results in the rescue and logistics forces of the Navy:

- It is suggested that by summarizing and preparing new reviews of the use of emerging technologies in maritime organizations, with periodic visits and continuous planning at certain time intervals, in order to obtain the necessary preparations to deal with emerging crises and disasters and reduce the damages caused by them, from the collection of members of the crisis and pharmaceutical logistics; Especially the team of paramedics, nurses, doctors and pharmacists, cross-sectional and general evaluations and verifications should be done.

- It is suggested that in future researches, in addition to pharmaceutical supply chain management (DSCM), other dimensions such as green supply chain (GSCM), management of emerging technologies of pharmaceutical supply chain (DETSCM) and emerging technologies of food supply chain management (FETSCM) in disaster management and Maritime crises should also be addressed.
- It is suggested that in the next researches, new technologies used in other advanced crisis-prone countries such as Japan, China, Germany, etc., taking into account the geographical regions of Iran based on the probability of occurrence of types and severity of natural disasters with emphasis on crises Marine, statistics, planning, organization and execution.

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