

STRENGTHENING LOGISTICS DEFENSE AND DIGITAL TECHNOLOGY TO OPTIMIZE HUMANITARIAN OPERATION SUPPORT IN INDONESIA

Shoraya Lolyta Octaviana ^{a*)}, Zainal Abidin Sahabuddin ^{a)}, Totok Imam Santoso ^{a)},
Guntur Eko Saputro ^{a*)}

^{a*)} Universitas Pertahanan Jakarta, Indonesia

^{*)}Corresponding Author: Octaviana181089@gmail.com

Article history: received 11 December 2025; revised 22 December 2025; accepted 17 Januari 2026

DOI: <https://doi.org/10.33751/jhss.v10i1.14>

Abstract: This research discusses the strategy of strengthening defense logistics through the use of digital technology in supporting humanitarian operations by the Indonesian Military. Background departs from the fact that defense logistics so far is often understood to be limited to technical functions, even though it has a strategic role in maintaining national resilience. The focus of research is directed at multidimensional barriers, which include overlapping regulations, separatist threats, limited resources, low public participation, weak information literacy, and infrastructure constraints and geographical conditions of the island. The research method uses a qualitative approach with PMESII frame combined with data analysis through NVIVO 12. The results show the need for defense logistics transformation into a strategic system based on digital technology with a risk management approach that emphasizes aspects of planning, distribution, transportation, efficiency, and effectiveness through the support of information systems, satellite technology and UAVs, and geographical mapping. This finding confirms that the transformation of digital technology can improve efficiency, transparency, and responsiveness while strengthening legitimacy and public trust. Further research is advised to test the effectiveness of the Digital Technology Based Defense Logistics Model through empirical case studies and disaster scenario simulations and conflicts in Indonesia.

Keywords: Defense Logistics, Digital Technology, Humanitarian Operations, Risk Management, PMESII-NVIVO.

I. INTRODUCTION

Logistics has long been recognized as a fundamental element in military operations and humanitarian support[1]. The Council of Supply Chain Management Professionals (2013) defines logistics as a process of managing the flow of goods, services, and information efficiently and effectively from the origin to the point of consumption[1]. According to Ballou (2004), logistics management is a strategic process that includes procurement, inventory, transportation, and distribution activities to achieve organizational goals[2]. In the context of Indonesia, according to Law Number 34 of 2004 concerning the Indonesian military (TNI), it stressed that logistics is part of the fostering of Indonesian military (TNI) forces to ensure the readiness of Indonesian military combat while supporting military operations other than war (OMP), including humanitarian operations[3].

Literature studies that exist so far are generally still focused on two large domains. First, the defense logistics highlighted Contented Logistics in military operations[4]. Second, humanitarian logistics that emphasize speed, accuracy, and just distribution in the midst of crisis[5]. Meanwhile, research on digital transformation highlights the role of the Geographic Information System (GIS), digital technology, logistics information systems, and monitoring dashboards in increasing transparency and decision making[6].

The main question to be answered in this study is how digital transformation in defense logistics can answer multidimensional barriers to political, military, economic, social, information, and

infrastructural issues in the Indonesian context[7]. This question is important because the geographical conditions of the island, vulnerability to natural disasters, and the potential for conflict make logistics not only a technical function but also a strategic need[8]. By answering this question, research is expected not only to contribute to the development of defense and humanitarian logistics theory but also to provide practical recommendations for strengthening the role of the Indonesian military in supporting humanitarian operations in Indonesia and globally[9].

Literature Gap Research on defense logistics emphasizes the vulnerability of supply chains in military operations[10]. Humanitarian logistics research is more focused on aspects of speed, accuracy, and just distribution of assistance[11]. Digital transformation studies highlight the role of technology such as GIS[12], logistics information systems[13], dashboard monitoring[14], satellites[15], and UAVs to increase transparency and decision making[16]. In this study the gap in the research is that there is no comprehensive integration that combines defense logistics, humanitarian logistics, and digital technology transformation in a conceptual model based on risk management, especially for the context of Indonesia as an archipelago that is prone to disaster, islands, inland, and potential conflict[17].

The problem statement is that defense logistics in Indonesia still face multidimensional barriers, which include in the political dimension (overlapping regulations and policy politicization); in the military dimension (separatist threats and cyber attacks); in the

economic dimension (budget constraints, scarcity of food, and price increases); in the social dimension (low public participation and vulnerability of unable groups); and in the dimension of information (low literacy, network disorders, and disinformation). In the infrastructure dimension (limited transportation access, geographical conditions of the island). These obstacles weaken the effectiveness of humanitarian operations by the Indonesian military [18].

The research question is "How can digital transformation in defense logistics with a risk management approach strengthen the role of the Indonesian military in supporting humanitarian operations in Indonesia?" [19]

Significance This study lies in its contribution in three main aspects. Theoretically, this study enriches academic treasures by integrating the risk management framework (ISO 31000)[20], the concept of defense logistics, humanitarian logistics, and the use of digital technology into a comprehensive conceptual model[21]. Practically, the findings of this research provide relevant recommendations for the Indonesian military [22], Ministry of Defense, and other policy makers in designing and implementing a more adaptive, efficient, transparent, and resilient defense logistics system to deal with various crisis situations[23]. Meanwhile, socially, this research has implications for strengthening the legitimacy of the state and increasing public confidence through the provision of human support that is faster, more appropriate, and accountable so as to be able to answer the expectations of the community towards the role of the state in protecting and prospering the people[24].

This study lies in the integration of three main aspects, namely defense logistics, humanitarian logistics, and digital transformation, into a comprehensive model that is contextualized with Indonesia's conditions[25]. During this time, the study of defense logistics tends to focus on combat readiness, humanitarian logistics emphasize the distribution of fast and equitable assistance, and digital transformation research highlights the use of information technology without linking it to the overall defense logistics system[26]. Therefore, this research offers a new approach that connects the three domains in an integrated risk management framework so as to be able to answer the multidimensional challenges faced by Indonesia as an archipelago that is prone to disaster as well as potentially conflict[27].

II. RESEARCH METHODS

In this section, the researcher will systematically describe the types of research used, the source of data that forms the empirical foundation, the analysis framework that guides thinking flow, data analysis techniques selected in accordance with variable characteristics, and data validation procedures to ensure the reliability and credibility of findings, as well as the formulation of conceptual propositions that function as a basis for the development of the technology based defense logistics[28]. The preparation of this methodological component not only provides epistemological and methodological clarity but also emphasizes the logical consistency between the research objectives, the analysis instrument, and the expected output so that the results of the study can be accounted for academically and make a significant contribution to the strengthening of defense logistics systems in the digital era[29].

2.1 Types of Research. This study uses a descriptive analytical qualitative approach with a PMESII framework (politics, military, economic, social, information, and infrastructure)[30]. The PMESII framework is used to group various potential obstacles and obstacles that arise in defense logistics risk management in Indonesia so that the analysis is carried out more directly and comprehensively and is able to provide a comprehensive picture of challenges that affect the effectiveness of the national defense logistics system[31].

2.2 Data Sources. Research with sources from primary data and secondary data[32]. Primary data was obtained through in-depth interviews with 12 people as experts in the field of knowledge, which includes 2 participant from Universitas Pertahanan Indonesia, 2 participant from strategi logistic defense from Kementerian Pertahanan RI, 2 participant from military, 2 participant from management from Universitas Pasundan Bandung, 1 participant from technology and communication, 1 participant from BNPB, 1 participant from BASARNAS, and 2 participant from Local Government from Bogor West Java Indonesia[33]. Secondary data from article scopus[34].

2.3 Data Analysis Techniques. The data analysis in this study was conducted using NVivo 12 software, which provides a structured approach to managing and interpreting qualitative data. The process began with the input of data derived from interviews and article reviews, allowing both empirical and theoretical perspectives to be integrated into the analysis. These sources were then organized through coding, where key themes and categories were systematically labeled, followed by the creation of cases and case classifications to capture specific attributes of respondents or documents, thus enabling meaningful comparisons across different groups. To identify patterns and relationships, the run query feature was employed, which facilitated the examination of frequently occurring words, thematic connections, and cross-case variations that would be difficult to detect through manual reading. The findings were further strengthened through visualization tools provided by NVivo 12, including search query text results, word clouds to highlight dominant keywords, hierarchy charts to illustrate thematic structures, and coding proportion coverage to present the distribution of themes within the data. This combination of coding, query analysis, and visualization ensured that the research findings were not only systematically derived but also transparent and easy to interpret, thereby enhancing the credibility and rigor of the study[35].

2.4 Data Validation. Data validation in this study was carried out to secure the accuracy, reliability, and credibility of the findings. Several steps were taken as part of this process. First, triangulation was applied by integrating data from interviews and article reviews, allowing empirical evidence to be cross-checked with theoretical sources. Second, coding consistency was maintained through repeated reviews of nodes and categories to minimize researcher bias and ensure that each theme genuinely reflected the original data. Third, case classifications and attributes were carefully verified to confirm that respondents and documents were properly categorized for comparative analysis. Finally, visualization tools in NVivo 12, such as word clouds and hierarchy charts, were used not only for analysis but also as a means of validation to test whether the coded data truly represented the dominant themes and relationships.

II.RESULTS AND DISCUSSION

This section summarizes the major findings and analysis of research according to primary and secondary data that have been examined using NVIVO 12 software and processed using the PMESII framework (politics, military, economic, social, information, and infrastructure). To provide more organized and thorough results, data can be methodically coded and shown as a

word cloud or hierarchy using NVIVO 12. Because each discovery is closely related to the empirical environment and the underlying theory, this analysis method offers a solid basis for the development of conceptual models that are both academically justified and pertinent to the field's practical requirements.

Risk Grouping Analysis Based on PMSEII Framework

Table 1. Risk identification based on the PMESII framework

Dimensions	Constraints and Obstacles	Impact
Political	The regulation is still overlapping and So the politicization arena	Inhibiting fast decision making, and inhibiting coordination between related institutions (Indonesian military, Regional Government, BNPB, National SAR Agency, and Public).
Military	Threat from the Papuan separatist group and Cyber war	Logistics distribution is hampered and Cause public unrest
Economic	Limited sources of food logistics in the region, Limits of Operational Budget Support, and food Prices Increase	Food breathing, reducing operational effectiveness, and decreased purchasing power
Social	Communities There are poor community groups and community participation is still low	Community displaced and legitimacy and slow down humanitarian responses.
Information	Literacy Literacy Limited, the internet network is cut off, disinformation/Hoax; and Social communication from the Indonesian military is limited	Creating negligence, Communication is hampered, Creating distrust to the government, and Reducing the quality of information
Infrastructure	Access to the road is cut off, the airport is not normal and the port is still limited and Extreme weather, geographical islands, and inland	Stagnant logistics distribution and humanitarian support becomes inefficient and effective.

In the political dimension, the existence of various regulations governing humanitarian operations, starting from Law Number 3 of 2002 concerning National Defense, Law Number 34 of 2004 concerning Indonesian military, Law Number 24 of 2007 concerning Disaster Management, Law Number 25 of 2025, Law Number 23 of 2019 concerning National Resource Management for National Defense, and Presidential Regulation Number 83 of 2016 concerning National Search and Relief, This regulatory fragmentation hinders rapid decision making because each institution often holds on to a different legal basis, so the plot is unclear[36]. In addition, coordination between agencies such as the Indonesian military, regional governments, BNPB, Basarnas, and public elements is hampered because overlapping authority raises doubts in the implementation of tasks. As a result, the process of distribution of assistance loses effectiveness, responses in the field become slow, and the affected community is increasingly disadvantaged due to late handling[37].

Politicization in handling disasters often makes the process of channeling logistics and humanitarian assistance not run optimally. Political interests can hamper rapid decision-making because every actor is more concerned with the image and political advantage than the urgent needs of the affected community. In addition, politicization also complicates coordination between related institutions, such as the Indonesian military, regional government, BNPB, Basarnas, and public elements, because each party tends to maintain its own authority and interests. As a result, the command mechanism and the flow of responsibility become blurred and overlapping, even causing inefficiency that has a direct impact on the late distribution of assistance[38].

Defense logistics distribution in rural areas, borders, outer islands, disaster affected areas, and conflict areas face heavy challenges sourced from physical and non-physical threats. For example, separatist group action in Papua, such as ambush and sabotage, often disrupts the distribution channels so that logistics movements become unstable and difficult to predict[39]. Meanwhile, cyberattacks have the potential to damage data, disrupt communication, and even cut off logistics information system networks that are vital in emergency situations. This dual obstacle slows the distribution of assistance to vulnerable areas, increasing public unrest due to delays in meeting urgent needs, as well as weakening the operational effectiveness of the Indonesian military. The impact and the potential for social and security instability are even greater, so a more adaptive, safe, and tough defense logistics system is needed to answer the complexity of threats in various operating fields[40].

In the economic dimension, limited local food sources, the lack of budget support, and the increase in prices of basic needs are real obstacles for smooth defense logistics. This condition triggers the scarcity of food, which directly decreases the effectiveness of humanitarian operations, because the distribution of assistance is limited and uneven. The lack of funds also makes the Indonesian military less flexible in carrying out mobilization and logistics procurement, while the price increase worsens the purchasing power of the people, so that dependence on assistance is higher. As a result, economic factors not only slow down humanitarian responses but also increase the vulnerability of defense logistics systems in dealing with emergency situations[41].

In the social dimension, the existence of poor people who are very vulnerable to disasters and conflicts adds to the burden in handling defense logistics. The low community participation in supporting logistics distribution increases the risk of absence, because some groups do not immediately receive the assistance needed. This situation also reduces the legitimacy of the government and the Indonesian military in carrying out humanitarian operations, because the lack of involvement of citizens creates a gap between policies and real needs in the field. Weak social support also slows down the response, even though the active involvement of local communities can be a determining factor in accelerating the distribution of assistance and strengthening the security of post disaster and conflict communities[8].

In aspects of information, the main obstacles arise from low public literacy, internet network disruption, the rise of disinformation, and the lack of social communication from the Indonesian military to the public[42]. This condition gives rise to the public in responding to an emergency situation, slows down the flow of communication, and triggers distrust of the government. As a result, the quality of information circulating decreases because it is inaccurate or not timely, thus disrupting decision-making and

inhibiting the effectiveness of defense logistics distribution. The wider impact is that humanitarian operations are not optimal because the path of information that should support coordination actually weakens the rapid response needed in the field[43].

In the infrastructure dimension, limited access to roads, airports, and ports that is exacerbated by the geographical conditions of the islands and inland areas makes the distribution of defense logistics face serious obstacles, especially when extreme weather can close the transportation path suddenly[44]. This situation often causes distribution stagnation so that humanitarian assistance does not arrive on time, reduces the efficiency of resource use, and reduces the effectiveness of operations in the field. As a result, the needs of the affected community are not immediately met, the level of social vulnerability is higher, and public trust in the government and the Indonesian military can weaken. This condition confirms that the availability of reliable and adaptive infrastructure is a crucial factor in determining the success of defense logistics operations, so that the construction of alternative pathways, utilization of nonconventional modes of transportation, and technological integration to overcome geographical obstacles are urgent strategic steps[45].

Analysis Using NVIVO

Analysis using the NVIVO 12 search query text is carried out to trace certain words or phrases in qualitative data so that it can be known patterns, frequencies, and context of its appearance. This step is important because it provides a more objective basis in

finding the main themes that are relevant to the focus of research, not just depending on the subjective assessment of researchers. Thus, the results of the analysis become more systematic, measurable, and can be accounted for academically.

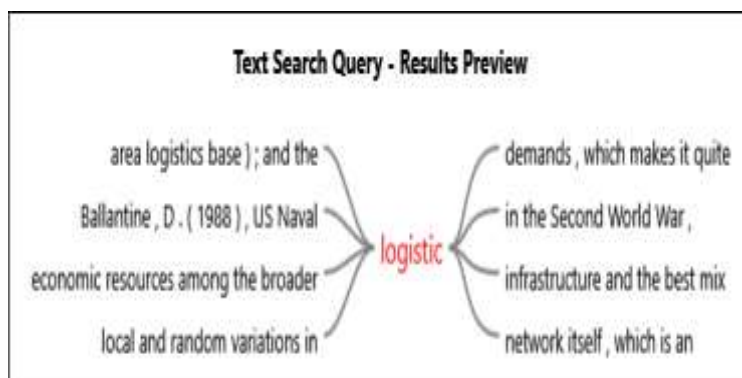


Figure 1: Teks Search query NVivo 12.

Results Text Search A query in NVIVO 12 shows that the term "logistics" appears in various important contexts that enrich the understanding of this research. The discovery of the word "area logistics base" confirms the strategic meaning of logistics base as a center for operating support that determines the success of distribution, both in the military and humanitarian context. The "US Naval Ballantine (1988)" reference shows that logistics has long been studied as an important element of military power, so this research has a strong historical basis for placing logistics as a determining factor for defense readiness. Meanwhile, the phrase "Economic Resources Among The Broader" shows that logistics is not only related to the distribution of goods but also closely related to the management of extensive economic resources. The emergence of the words "demands" and "infrastructure" underlines real challenges in Indonesia, where high logistics demand is often not balanced with the limitations of transportation and storage infrastructure. The context of "The Second World War" confirms

that historically logistics is proven to be a determining factor for the victory of war and, in a modern context, relevant for humanitarian operations that require the speed and accuracy of distribution. Finally, the term "Network Ition" shows that logistics must be understood as a complex network system, which not only regulates the flow of goods but also information integration, acting coordination, and digital support. Thus, the results of this query strengthen the research argument that defense logistics needs to be strengthened through digital transformation and integrated management to be able to answer the needs of humanitarian operations in Indonesia effectively[46].

According to the Council of Supply Chain Management Professionals (CSCMP, 2013), logistics is the management of the flow of goods, services, and information efficiently, which in the results of this analysis is reflected in the emergence of the words "demand," "infrastructure," and "network." This shows that logistics efficiency is always related to the ability to meet demand (demand),

availability of supporting infrastructure, and connectedness in an integrated network. Meanwhile, as confirmed by Ballou (2004), logistics management is a strategic process that includes procurement, inventory, transportation, and distribution. The findings of the words "economic resources" and "logistics base area" strengthen the view because they show that logistics does not only function as a technical activity but also as a strategy regarding the management of economic resources and the importance of the logistics base as a center for operational support. As for the context of defense, Law No. 34 of 2004 asserted that logistics is an integral part of fostering Indonesian military forces directly related to combat readiness and military operations other than war (OMSP). The emergence of the term "Second World War" is a historical reminder that logistics has long been proven to be a critical factor in the success of military operations, and in the context of contemporary relevance, it remains high to support humanitarian operations in Indonesia[47].

Text search results indicate that the term "logistics" is not understood narrowly but in a very broad spectrum. In the historical aspect of war, the referral in World War II confirmed that logistics has long been a determining factor for the success of military operations. In the military dimension, the term "naval base" shows the role of logistics as a center for control and support of combat operations. In economic terms, findings regarding resource management show that logistics also function as a strategic distribution and utilization of national resources. Meanwhile, in a modern context, the emergence of network words and infrastructure confirms that logistics is no longer understood as limited only to the movement of goods but as a complex system that integrates the flow of information, technology, and cross sector coordination[48].

In the defense military logistics framework in Indonesia, the results of this visualization confirm the importance of building a logistics system that is no longer conventional but based on digital technology and is seen as an adaptive network. That is, defense logistics must be able to respond to urgent needs during disaster or crisis, not only with distribution speed, but also with sturdy infrastructure support, extensive accessibility, and the use of technology to ensure transparency and accuracy of information. With this approach, defense logistics is not only a matter of providing goods or materials but also strategic instruments that integrate data, communication, transportation, and coordination across institutions. This means that the readiness of the Indonesian military in supporting humanitarian operations will be far more effective if supported by a digital system that is able to adjust to emergency conditions while strengthening public trust in the ability of the state to protect its people[49].

Word Cloud Nvivo 12 results show that the word "logistics" is the center and dominant, confirming that the logistics issue is the core of the overall research analysis. Other words such as "defense," "military," "management," and "supply" show that defense logistics does not stand alone but is closely related to military functions, governance, and supply availability. The appearance of humanitarian operations, response, and coordination confirms the relevance of this research to the context of humanitarian operations that always involve cross-actors, both the Indonesian military (TNI) and BNPB and the civilian parties. Furthermore, Technology, Infrastructure, Security, and Information give the meaning that the success of defense logistics is largely determined by the support of digital technology, infrastructure readiness, system security, and

accurate information flow[50]. Meanwhile, the terms "national," "strategic," and "tactical" in the system indicate that logistics is not only a technical distribution issue but also a strategic instrument that determines the readiness of national defense[51].



Figure 2: Word Cloud NVivo 12 text analysis

Additional words, such as planning, analysis, authorities, distribution, crisis, total defense, and actors, and international expand the meaning that defense logistics must be understood thoroughly, ranging from planning and cross-sectoral authority involvement to readiness to face crises in national and international contexts. This finding means that research on Strengthening Logistics Defense and Digital Technology to Optimize Humanitarian Operation Support in Indonesia emphasizes the importance of building a modern, digital, and adaptive defense logistics system, with the support of multi-actor coordination, so as to be able to answer emergency needs effectively while strengthening national resilience[52].

Based on the results of the analysis, the findings of keywords in the word cloud show close links between the theory and empirical reality of defense logistics in Indonesia. According to CSCMP (2013), logistics emphasizes the efficiency and effectiveness of the flow of goods, services, and information, which is reflected in the dominance of the words "logistics," "supply," "information," and "distribution." This proves that the core of defense and humanitarian logistics lies in the ability to maintain the smooth supply of the supply chain in a timely manner and on target. Meanwhile, as explained by Ballou (2004), logistics management does not only concern the technical aspects of distribution but also includes planning, operating management, and coordination between actors. The findings of the word management, planning, operations, and coordination strengthen the view that in the Indonesian context, the success of defense logistics is largely determined by the synergy across institutions, including the Indonesian military (TNI), BNPB, regional government, and non governmental organizations[53]. Furthermore, Law No. 34 of 2004 confirms defense logistics as part of the fostering of Indonesian military forces directly related to combat readiness and military operations other than war (OMSP). This is reflected in the emergence of the words "defense," "military," "national," "tactical," and "response," which shows that the practice of Indonesian defense logistics remains based on the legal mandate to ensure readiness to face military threats and provide support for

humanitarian operations. Thus, the results of this analysis underline that defense logistics in Indonesia is not just a technical function but is a strategic instrument based on theory, cross-actors, and national regulation coordination[54].

Thus, defense logistics in Indonesia cannot be understood only as a technical matter for providing and distributing material but has become a strategic instrument that determines the success of defense missions and humanitarian operations. The analysis shows that logistics includes theoretical dimensions, such as the efficiency of the flow of goods and information as confirmed by CSCMP, and managerial aspects that demand planning, management, and coordination across institutions as described by Ballou. Furthermore, defense logistics is also rooted in national regulations, namely Law No. 34 of 2004, which placed logistics as part of fostering Indonesian military forces for combat readiness and military operations other than war (OMSP). That is, defense logistics not only supports the availability of equipment or supply but also plays a role in maintaining the legitimacy and effectiveness of the country in dealing with threats, disasters, and humanitarian crises. This confirms that the strengthening of digital, integrated, and adaptive defense logistics is a strategic need to ensure the readiness of the country in various emergency conditions[55].

This cloud shows that defense logistics has a much broader meaning than just a material distribution process[56]. The visualization confirms that logistics includes strategic dimensions related to planning and decision making, cross level coordination between the Indonesian military, BNPB, local governments, and non governmental actors, as well as digital technology support that enables transparency and speed of information flow[57]. The dominance of the word "logistics" at the center shows that all key concepts ranging from defense and military to supply and humanitarian are bound to one main axis, namely how logistics is used as a key instrument in sustaining national defense while ensuring the effectiveness of humanitarian operations[58]. These findings interpret that defense logistics research in Indonesia must be seen as a strategic study, not merely technical, because its role is crucial in answering emergency needs, strengthening national resilience, and building public trust in the ability of the state to protect its citizens[59].



Figure 3: Hierarchy Chart

Domination theme Efficiency and effectiveness show that the core of defense logistics strengthening in Indonesia lies in the ability to manage the flow of goods, services, and information in a timely manner, on target, and save resources. This is in line with the definition of CSCMP (2013), which confirms efficiency and effectiveness as the main goal of logistics, where the success of the system is not only measured by the availability of supply but also by speed, accuracy, and costs incurred. In the context of this research, the meaning is that efforts to strengthen defense logistics,

both to support combat and humanitarian operations, must place efficiency and effectiveness as a strategic priority. That is, the digitalization of the logistics system, infrastructure improvement, and multi-actor coordination not only function as technical instruments but also as mechanisms to ensure that logistics is truly able to sustain national defense while providing a quick response in the situation of the humanitarian crisis[60].

The appearance of distribution as an important dimension emphasizes that the availability of logistics will not have a real impact without a reliable, timely, exact number of distribution systems that are on target. In humanitarian operations, distribution is a determining factor because it involves a direct meeting of the needs of the affected community or conflict, while in the military context, the distribution ensures the readiness of troops in dealing with threats. This is in line with Law No. 34 of 2004, which places material distribution as an integral part of fostering the power of the Indonesian military so that the distribution is not only a technical function but also a strategic aspect that affects the effectiveness of the country's defense and legitimacy. In this study, the meaning is that logistics distribution becomes a bridge between the availability of resources and meeting real needs in the field, so that the strengthening of the distribution system, both through infrastructure, digital technology, and multi actor coordination, is an absolute requirement to realize strong and responsive defense logistics[61].

The appearance of transportation as one of the significant dimensions confirms that the mobility factor is the main determinant of the success of defense logistics in Indonesia. With the geographical characteristics of the islands, land, sea, and air transportation are not only means of connecting but also strategic instruments that ensure that logistics distribution can reach remote areas, borders, and disaster-affected areas. This is in line with the view of Ballou (2004), which emphasizes that transportation is a vital element in logistics management because it determines the speed, cost, and accuracy of the flow of goods. In the context of this research, the meaning is that strengthening defense logistics in Indonesia cannot be separated from increasing integrated multimodal transportation capacity, both through infrastructure development and the use of digital technology for route planning, cross-mode coordination, and operational supervision. Thus, transportation is the key that connects the national defense strategy with the effectiveness of humanitarian responses[62].

The appearance of planning flow with a large portion emphasizes that planning is an important foundation in defense logistics management, especially to deal with the dynamics and uncertainty of humanitarian operations. In practice, logistics planning not only includes determining material needs but also anticipating risks and adjustments to geographical conditions, as well as reserve strategies if the main distribution channels are disrupted. This is in line with CSCMP (2013), which places planning and implementation as a core part of the logistics process so that the flow of goods, services, and information can run efficiently and effectively. In the context of this research, the meaning is that strengthening digital based defense logistics must focus on planning integrated with information systems so that decisions can be taken faster, transparently, and data based. Thus, planning flow is not just an administrative function but a strategic instrument that determines logistics readiness in answering emergency needs in a timely and on target manner[63].

The emergence of other indicators such as organizational objectives, inventory management, implementation flow, and goods, services and information flow, although with a smaller portion, still shows its important role in the whole defense logistics system. Organizational objectives emphasized that every logistics activity must be in harmony with the strategic objectives of the organization, namely supporting the readiness of national defense. Inventory management in accordance with the view of Ballou (2004) is the key in maintaining a balance between availability and needs so that supply does not experience weaknesses or overloading strengths. Implementation Flow shows the importance of the structured implementation process so that the logistics plan can be realized in the field. Whereas Goods, Services & Information Flow shows that logistics is not only related to material but also to services and information that support the smooth operation. In the context of Law No. 34/2004, all of these aspects are directly related to meeting the operational needs of the Indonesian military, both for combat readiness and humanitarian operations, so that even though the portions are smaller in analysis, its role remains crucial to ensure the defense logistics system runs as a whole and sustainably[64].

Visually, the diagram confirms that the main pillar of defense logistics strengthening to support humanitarian operations lies in the

efficiency, distribution, transportation, and careful planning. These four aspects are foundations that ensure logistics is not only available but also reaches parties who need it on time and on target and saves resources. On the other hand, elements such as inventory management and organizational objectives, even though the portions are smaller, remain important as a buffer for the sustainability of the system, because without good inventory management and harmony with organizational goals, the logistics system will lose its strategic direction. Thus, the success of Strengthening Logistics Defense and Digital Technology to Optimize Humanitarian Operation Support in Indonesia is largely determined by the ability of the Indonesian military and the government to optimize distribution and transportation, guarantee the efficiency and effectiveness of the entire process, and support it through digital technology based planning such as logistics information systems, Geographic Information System (GIS), and Dashboard Monitoring that is able to provide vision and effectiveness, and support it through digital technology based planning such as logistical information systems, Geographic Information System (GIS), and Dashboard Monitoring is able accuracy, and transparency in making operational decisions[64].

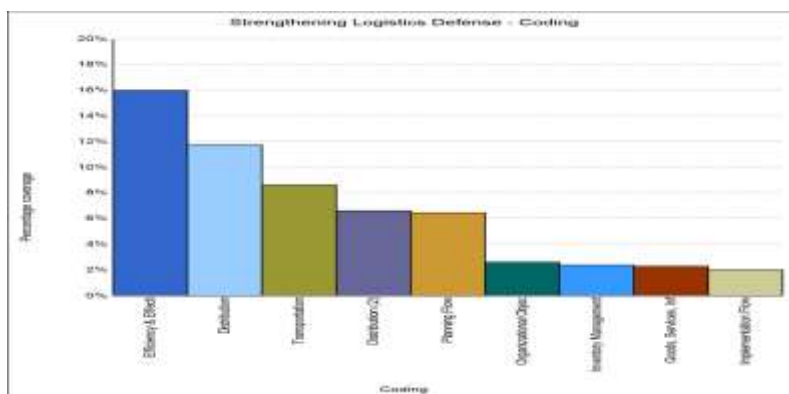


Figure 4: Coding Proportion of Percentage Coverage

Finds that efficiency & effectiveness occupies a portion of around 16% and asserts that this dimension is a dominant factor in the success of defense logistics, especially when supporting humanitarian operations. Efficiency is needed so that the flow of goods, services, and information can be managed quickly and precisely and save resources, while effectiveness ensures that all logistics activities actually achieve the goal, namely meeting the needs of the affected community and optimal support for Indonesian military operations[65]. This is in line with the definition of CSCMP (2013), which places efficiency and effectiveness as the core of logistics, so the meaning in this study is that the strategy of strengthening defense logistics must focus on system digitalization efforts, distribution transparency, and integration of coordination between actors so that humanitarian operations in Indonesia can run more resiliently, responsively, and reliably[66].

Distributions that occupy a portion of about 12% show that the success of defense logistics is not enough only with the availability of supply but is largely determined by the ability to channel logistics in a timely manner, exactly, and on target. In practice, distribution is a key in both the context of War Military

Operations (OMP) and Military Operations Besides War (OMSP), because it directly involves the readiness of troops and meeting the needs of disaster-affected communities. This is in line with the mandate of Law No. 34 of 2004, which emphasized the distribution of material as part of the fostering of Indonesian military strength, so that its meaning in this study was that the strengthening of distribution, both through infrastructure improvement and utilization of multimodal transportation paths, as well as digital technology integration, is a strategic necessity to ensure defense logistics is truly able to sustain the effectiveness of humanitarian operations in Indonesia[67].

Transportation, which occupies a portion of about 9%, shows that the mobility factor is a strategic element in defense logistics, especially with the geographical conditions of Indonesia as an archipelago that demands land, sea, and air. The success of humanitarian and defense operations is largely determined by the ability to move supplies to remote areas, borders, and areas affected by disasters quickly and safely[68]. This is in line with the view of Ballou (2004), which emphasizes that transportation is a vital component of logistics management because it affects the speed of

distribution as well as cost efficiency. In the context of this research, the meaning is that the strengthening of defense logistics cannot be separated from the development strategy and integration of multimodal transportation, as well as the use of digital technology for route planning, operational supervision, and cost control, so that the Indonesian military logistics system is able to answer Indonesia's geographical challenges more adaptively and effectively[69].

Planning flow, which occupies a portion of about 7%, confirms that the success of defense logistics is greatly influenced by the quality of planning as well as controlling distribution. Without careful planning, risk distribution is not on target, late, or not as needed, especially in disaster emergency situations and conflicts that are full of uncertainty. With a systematic planning flow, logistics can be regulated from the needs identification stage, allocating resources, to the selection of alternative transportation paths[70]. This allows the defense logistics system to be more adaptive, both in supporting military operations and humanitarian operations, because every obstacle in the field can be anticipated with a reserve scenario. In the context of this research, the meaning is that digital technology-based distribution planning, such as system logistic information, GIS, and Dashboard Monitoring, becomes a strategic instrument so that the TNI and the government are able to respond to the crisis more quickly, accurately, and transparently[71].

Organizational objectives and inventory management with a portion of about 3% emphasized that defense logistics management is not only regulating the movement of goods but must also be in harmony with the strategic objectives of the organization and ensure appropriate inventory management so that there are no shortcomings or advantages that can interfere with operations. Meanwhile, Goods, Services & Information Flow, as well as implementation flows that occupy a portion of about 2%, even though it looks small, still has an important meaning because it involves the integration of data, the smooth implementation of logistics policies, and the support of valid information flow for decision-making. In the context of this research, the meaning is that although these aspects arise with a smaller portion than other dominant dimensions such as efficiency, distribution, and transportation, their existence is a supporting factor that ensures the defense logistics system runs consistently, transparently, and adaptively so that the main objectives of supporting the readiness of Indonesian military combat as well as humanitarian operations can be achieved sustainably[72].

Visually, the priority pyramid shows that the success of defense logistics in supporting humanitarian operations in Indonesia is largely determined by the ability of the Indonesian military and the government to manage a number of key aspects in an integrated manner. First, the efficiency and effectiveness of the flow of goods, services, and information must be a top priority so that logistics distribution takes place quickly and precisely and saves resources. Second, distribution needs to be optimized as the heart of the logistics system so that the supply actually reaches the parties that need it according to time, amount, and target. Third, land, sea, and air multimodal transportation must be strengthened to answer Indonesia's geographical challenges as an archipelago, including reaching remote and border areas. Fourth, logistics planning is demanded to be adaptive with digital technology support such as satellites, Unmanned Aerial Vehicles (UAV), system logistic information, GIS, and Dashboard Monitoring to anticipate risks and

uncertainty in the field[73]. Fifth, inventory management and policy implementation become the support of the system so that stock is always maintained and logistics policies can be operationalized consistently in various emergency situations[74].

Integration of PMESII Framework Findings and NVIVO Analysis Findings

Based on the manufacturing of problems based on the PMESII framework with the findings of NVIVO 12 software show that defense logistics in Indonesia face political barriers in the form of overlapping regulations and politicization that weaken coordination; Military barriers in the form of separatist threats and cyber attacks that interfere with the distribution and information system; Economic barriers in the form of food limitations, lack of budget, and price increases that increase vulnerability[75]; Social barriers in the form of vulnerability to the poor and low community participation that reduces the legitimacy of the government and the Indonesian military; Information resistance in the form of low literacy, tissue disorders, and disinformations that slow down the response; as well as infrastructure barriers in the form of limited access to transportation and the geographical conditions of the islands that cause distribution stagnation[76].

This meeting confirms that defense logistics can no longer be understood only as a technical function but must be seen as a strategic system based on digital technology that demands the efficiency of the flow of goods, services, and information as confirmed by CSCMP (2013); planning, inventory management, transportation, and distribution as explained by Ballou (2004); and the legal mandate in Law No. 34 of 2004 concerning the Indonesian military[77]. With technological integration such as satellites, Unmanned Aerial Vehicles (UAV), system logistic information, GIS, and Dashboard Monitoring, defense logistics systems can be more effective, efficient, adaptive, transparent, and tough in supporting the readiness of combat and humanitarian operations, as well as strengthening public trust in the TNI as a defense tool for national defense in protecting the safety of the people and nationality of the nation[78].

IV. DISCUSSION

Meaning of the findings of this research is that defense logistics in Indonesia can no longer be understood only as a technical function of providing and distributing material but must be seen as a complex strategic system and based on digital technology. Multidimensional barriers identified through the framework of PMESII (Politics, Military, Economy, Social, Information, and Infrastructure) show that the problem of defense logistics does not stand alone but is interrelated with regulatory governance, security aspects, availability of resources, community participation, information literacy, and geographical conditions of the island. Therefore, the findings of this research confirm that the success of defense logistics in supporting humanitarian operations can only be achieved through the integration between the efficiency of the flow of goods and information and logistics management that includes planning, inventory, transportation, and distribution that

Important The results of this study lie in the affirmation that the weaknesses of logistics distribution in Indonesia are mostly sourced from the absence of an integrated, transparent, and real-time information system. Barriers to the distribution of assistance are not only triggered by physical limitations such as infrastructure or transportation but also by inaccuracies in information, delays in

data, and weak coordination between actors. Therefore, the development of integrated information systems becomes crucial because it allows the flow of goods, services, and information to be managed more efficiently and accountably and can be monitored directly by all stakeholders to ensure fast and appropriate responses.

The contribution of this study in the field of informatics lies in the provision of empirical evidence that the application of an integrated information system in defense logistics does not only function to improve operational technical efficiency but also becomes a strategic instrument in strengthening the country's legitimacy. Transparency and speed of distribution of assistance that can be verified by the public will encourage the growth of public confidence in the government and the TNI, especially in the crisis situation. Thus, this research expands the perspective of informatics study by placing information technology not only as a managerial tool but also as a strategic element that supports the stability of the country and strengthens social trust in the context of defense and humanitarian operations.

The contribution of this research in the field of technology lies in the empirical proof that the use of digital technology such as satellites, Unmanned Aerial Vehicles (UAV), Silogs (Logistics Information Systems), GIS (Geographic Information System), and Dashboard Monitoring can be a strategic solution in strengthening the Indonesian defense logistics system. Technology is no longer positioned as an administrative device but rather as the main instrument that is able to increase the efficiency of the flow of goods, ensure information transparency, strengthen the accuracy of decision-making, and accelerate responses in disaster emergency situations and conflicts. Thus, this study made a real contribution to the development of technology by showing how digital innovation can be adapted in the context of defense and humanitarian operations so that technology plays a role not only as a supporting factor but also as a core element in building modern, tough, and responsive defense logistics.

The contribution of this research in the field of education confirms that the success of digital technology transformation in defense logistics is very dependent on increasing the capacity of human resources through appropriate education and training. This finding reinforces the relevance of experiential learning theory, which emphasizes the importance of learning processes through direct experience, reflection, conceptualization, and application of digital technology in real situations of humanitarian operations. Thus, this research expands the contribution to the field of education by showing that the mastery of logistics technology cannot stop at theoretical aspects but must be integrated with integrated practical learning in the military curriculum and cross-agency training programs. This approach will form the competence of Indonesian military soldiers and supporting actors who are adaptive, professional, and ready to face the dynamics of disasters and conflicts in Indonesia.

The contribution of this research in the field of management is to emphasize that defense logistics must be understood as a strategic system that demands cross-actor coordination, adaptive planning, and measurable management of resources. The results showed that the success of humanitarian operations was not only determined by the availability of logistics but also by how planning, distribution, transportation, and inventory were managed in an integrated manner by competent human resources. Referring to the view of Ballou (2004), this research enriches management studies

by emphasizing the importance of integration of risk management, multi level coordination between the Indonesian military, BNPB, local governments, and NGOs, as well as the use of digital technology to increase operational effectiveness. Thus, this study presents a real contribution to management literature through the adaptive, transparent, and efficient defense logistics management model in dealing with crises in an archipelago such as Indonesia, as well as interpreting defense logistics not as a mere technical function, but as a strategic instrument that determines the resilience and legitimacy of the state.

The contribution of this research in the field of informatics confirms that the quality of data and information systems is the core success of defense logistics. Findings show that information barriers such as low digital literacy, network disorders, and the rise of disinformation have the potential to weaken the effectiveness of distribution and reduce the level of public trust. By offering satellite-based solutions, Unmanned Aerial Vehicle (UAV), Silogs, GIS, and Dashboard Monitoring, this study emphasizes the importance of data integration in real time, information validation, and logistics flow transparency to support strategic decision making. The contribution to the field of information lies in the expansion of the application of the concept of integrated information systems into the realm of defense and humanity, where information technology not only functions to improve technical efficiency but also becomes the main pillar in building accountability, public trust, and state legitimacy.

This research emphasizes that defense logistics in Indonesia still face serious multidimensional barriers as mapped through the framework of PMESII, starting from the political aspects in the form of overlapping regulations; military aspects such as separatist threats and cyber attacks; economic aspects related to the limited sources of food and budget; social aspects in the form of vulnerability of the poor and low participation; and limited transportation access in the islands. This overall obstacle shows that defense logistics can no longer be understood as a technical function of supply and distribution but must be placed as a strategic system based on digital, efficient, adaptive, and integrated technologies so as to be able to answer emergency needs, strengthen the readiness of the Indonesian military, and increase the legitimacy of the state in humanitarian and defense operations.

In the field of technology, the findings of this research confirm that defense logistics modernization can only be achieved through satellite system integration, unmanned aerial vehicles (UAV), system information logistic, GIS, and dashboard monitoring as the main instruments supporting efficiency, transparency, and response speed. In terms of informatics, this research shows the urgency of the development of logistics information systems that are real-time, transparent, and integrated so as to be able to support strategic decision-making in crisis situations. From the management perspective, the results of research expanding the literature show that the success of defense logistics is largely determined by the coordination of actors, adaptive planning, and measurable inventory management to deal with disaster dynamics and conflict. Meanwhile, in the realm of education, this research emphasizes that the mastery of logistics technology is not sufficiently based on theory but must be developed through the experiential learning approach that emphasizes practical training, simulation, and field experience in the humanitarian operation scenario.

The main benefit of this study lies in the affirmation that defense logistics is not only a technical function but also a strategic instrument that strengthens the role of the Indonesian military in humanitarian operations. Through digital technology-based conceptual models, this research shows how distribution efficiency can be improved, emergency responses are accelerated, and legitimacy and public trust in the country are strengthened. In addition, this research contributes a conceptual contribution that is relevant to defense policy makers and practitioners, especially in integrating logistics management theories with practical needs in the field, so that defense logistics strategies can be more adaptive, transparent, and responsive to the dynamics of crisis in Indonesia.

The limitations of this study lie in the dominance of the use of secondary data sourced from documents, regulations, and online media, so the results of the analysis have not fully represented empirical conditions in the field. In addition, the focus of research emphasizes the conceptual aspects of technological integration without being accompanied by quantitative testing on the effectiveness of the application of digital logistics systems in Indonesian military units in real operations. These limitations indicate that the research findings are still initial and require further testing through primary data, such as in-depth interviews, observation, and direct case studies on the implementation of humanitarian operations, so that the validity and relevance of conceptual models can be strengthened.

The next research is to test digital-based defense logistics models with a mixed-methods approach so that conceptual validity can be strengthened through empirical data support. Further research is also important to involve key actors such as the Indonesian military, BNPB, regional government, and NGOs to evaluate the implementation of collaborative logistics information systems in the field. In addition, the direction of future research can be focused on the development of disaster scenarios and conflicts by utilizing the latest technology, such as Digital Twin and Unmanned Aerial Vehicle (UAV), to test the effectiveness of defense logistics models in situations that are close to real conditions.

REFERENCES

- [1] I. Antai and R. Hellberg, "Identifying total defense logistics concepts: a comparative study of the Swedish pandemic response," *J. Humanit. Logist. Supply Chain Manag.*, vol. 14, no. 2, pp. 208–222, 2024, doi: 10.1108/JHLSCM-07-2022-0084.
- [2] A. H. M. H. Al-Aidrous *et al.*, "Critical Factors Influencing Inventory and Procurement System of Infrastructure Projects," *J. Civ. Eng. Manag.*, vol. 28, no. 8, pp. 634–645, 2022, doi: 10.3846/jcem.2022.16681.
- [3] K. S. Madutharanga, F. G. C. Timur, and S. Surjaatmadia, "Strategic Imperatives of National Defense System: The Ideal Indonesian Defence Posture Development Program in the Natuna Islands," *J. Kewarganegaraan*, vol. 7, no. 2, pp. 2380–2388, 2023, [Online]. Available: <https://journal.upy.ac.id/index.php/pkn/article/view/5733>
- [4] M. I. Bădilă, G. Bârsan, and L. I. Cioca, "Model for the Prediction of Performance With Eco-Innovation Capability Development Criteria: a Military Logistic Regression Analysis," *Polish J. Manag. Stud.*, vol. 29, no. 2, pp. 87–120, 2024, doi: 10.17512/pjms.2024.29.2.05.
- [5] G. Kovács and I. Falagara Sigala, "Lessons learned from humanitarian logistics to manage supply chain disruptions," *J. Supply Chain Manag.*, vol. 57, no. 1, pp. 41–49, 2021, doi: 10.1111/jscm.12253.
- [6] Á. Lloret, J. Peral, A. Ferrández, M. Auladell, and R. Muñoz, "A Data-Driven Framework for Digital Transformation in Smart Cities: Integrating AI, Dashboards, and IoT Readiness," *Sensors*, vol. 25, no. 16, pp. 1–30, 2025, doi: 10.3390/s25165179.
- [7] A. Skopeliti, A. Stratigea, V. Krassanakis, and A. Lagarias, "Geographic Information Systems and Cartography for a Sustainable World," *ISPRS Int. J. Geo-Information*, vol. 14, no. 7, pp. 1–9, 2025, doi: 10.3390/ijgi14070254.
- [8] H. M. Hashim, Y. G. Ng, O. Talib, and S. B. M. Tamrin, "International Journal of Disaster Risk Reduction," *Int. J. Disaster Risk Reduct.*, vol. 60, no. 102, pp. 1–8, 2021.
- [9] A. P. L. Trias and A. D. B. Cook, "Military humanitarian and disaster governance networks in Southeast Asia: framework and analysis," *Disasters*, vol. 47, no. 1, pp. 205–241, 2023, doi: 10.1111/disa.12542.
- [10] D. Loska, B. Hazen, N. Rich, S. Genchev, and T. Malik, "Military Supply Chain Logistics and Dynamic Capabilities: A Literature Review and Synthesis," *Transp. J.*, vol. 64, no. 2, 2025, doi: 10.1002/tjo3.70002.
- [11] C. A. Rojas Trejos, J. D. Meisel, and W. Adarme Jaimes, "Humanitarian aid distribution logistics with accessibility constraints: a systematic literature review," *J. Humanit. Logist. Supply Chain Manag.*, vol. 13, no. 1, pp. 26–41, 2023, doi: 10.1108/JHLSCM-05-2021-0041.
- [12] M. Yasir *et al.*, "Automatic Coastline Extraction and Changes Analysis Using Remote Sensing and GIS Technology," *IEEE Access*, vol. 8, pp. 180156–180170, 2020, doi: 10.1109/ACCESS.2020.3027881.
- [13] Q. Li and G. Wu, "ERP System in the Logistics Information Management System of Supply Chain Enterprises," *Mob. Inf. Syst.*, vol. 2021, 2021, doi: 10.1155/2021/7423717.
- [14] E. Dong, H. Du, and L. Gardner, "An interactive web-based dashboard to track COVID-19 in real time," *Lancet Infect. Dis.*, vol. 20, no. 5, pp. 533–534, 2020, doi: 10.1016/S1473-3099(20)30120-1.
- [15] O. Kodheli *et al.*, "Satellite Communications in the New Space Era: A Survey and Future Challenges," *IEEE Commun. Surv. Tutorials*, vol. 23, no. 1, pp. 70–109, 2021, doi: 10.1109/COMST.2020.3028247.
- [16] M. Quamar, B. Al-ramadan, and K. Khan, "Quamar, M. M., Al-Ramadan, B., Khan, K., Shafiullah, M., & El Ferik, S. 2023. Advancements and Applications of Drone-Integrated Geographic Information System Technology—A Review.pdf," pp. 1–35, 2023.
- [17] D. Edwards, N. Subramanian, A. Chaudhuri, P. Morlacchi, and W. Zeng, "Use of delivery drones for humanitarian operations: analysis of adoption barriers among logistics service providers from the technology acceptance model perspective," *Ann. Oper. Res.*, vol. 335, no. 3, pp. 1645–1667, 2024, doi: 10.1007/s10479-023-05307-4.
- [18] Y. Malhouni and C. Mabrouki, "Mitigating risks and overcoming logistics challenges in humanitarian deployment to conflict zones: evidence from the DRC and CAR," *J. Humanit. Logist. Supply Chain Manag.*, vol. 14, no. 3, pp. 225–246, 2024, doi: 10.1108/JHLSCM-04-2023-

- 0031.
- [19] Y. Can Saglam, S. Yildiz Çankaya, and B. Sezen, "Proactive risk mitigation strategies and supply chain risk management performance: an empirical analysis for manufacturing firms in Turkey," *J. Manuf. Technol. Manag.*, vol. 32, no. 6, pp. 1224–1244, 2020, doi: 10.1108/JMTM-08-2019-0299.
 - [20] L. Zhao and A. Huchzermeier, "Supply Chain Risk Management," *EURO Adv. Tutorials Oper. Res.*, pp. 39–55, 2018, doi: 10.1007/978-3-319-76663-8_3.
 - [21] M. Hilbert, "Digital technology and social change: The digital transformation of society from a historical perspective," *Dialogues Clin. Neurosci.*, vol. 22, no. 2, pp. 189–194, 2020, doi: 10.31887/dcn.2020.22.2/mhilbert.
 - [22] M. T. Valdez, "Factors That Affect US Military Access in Indonesia," 2022, [Online]. Available: <https://apps.dtic.mil/sti/citations/trecms/AD1184648>
 - [23] D. Smiljanić, D. Ćorić, and M. Paljević, "Rethinking defence industry policy: A conceptual framework for strategic adaptation," *Def. Secur. Conf.*, vol. 1, no. 1, pp. 251–282, 2025, [Online]. Available: <https://www.croris.hr/crosbi/publikacija/prilog-skup/879662>
 - [24] H. J. Jiang, T. C. Underwood, J. G. Bell, S. Ranjan, D. Sassellov, and G. M. Whitesides, "Mimicking Lighting-Induced Electrochemistry on the Early Earth," *Proc. Natl. Acad. Sci.*, vol. 120, p. 2017, 2017, doi: 10.1073/pnas.
 - [25] M. Plevnik and R. Gumzej, "Open Source as the Foundation of Safety and Security in Logistics Digital Transformation," *Systems*, vol. 13, no. 6, pp. 1–23, 2025, doi: 10.3390/systems13060424.
 - [26] F. Maurer, "Business Intelligence and Innovation: A Digital Innovation Hub as Intermediate for Service Interaction and System Innovation for Small and Medium-Sized Enterprises," *IFIP Adv. Inf. Commun. Technol.*, vol. 629 IFIPAI, pp. 449–459, 2021, doi: 10.1007/978-3-030-85969-5_42.
 - [27] O. M. Araz, T. M. Choi, D. L. Olson, and F. S. Salman, "Data Analytics for Operational Risk Management," *Decis. Sci.*, vol. 51, no. 6, pp. 1316–1319, 2020, doi: 10.1111/deci.12443.
 - [28] Á. Rocha, M. Paredes-Calderón, and T. Guarda, *Developments and Advances in Defense and Security Proceedings of MICRADS 2020*, vol. 181. 2020. [Online]. Available: <https://link.springer.com/book/10.1007/978-981-15-4875-8>
 - [29] M. Pekarčíková, P. Trebuňa, M. Kliment, M. Edl, and L. Rosocha, "Transformation the logistics to digital logistics: Theoretical approach," *Acta Logist.*, vol. 7, no. 4, pp. 217–223, 2020, doi: 10.22306/al.v7i4.174.
 - [30] J. E. M. Sale, "The role of analytic direction in qualitative research," *BMC Med. Res. Methodol.*, vol. 22, no. 1, pp. 1–12, 2022, doi: 10.1186/s12874-022-01546-4.
 - [31] M. Halizahari, M. F. Daud, and A. A. Sarkawi, "The Impacts of Transportation System towards the Military Logistics Support in Sabah," *Int. J. Adv. Sci. Eng. Inf. Technol.*, vol. 12, no. 3, pp. 1092–1097, 2022, doi: 10.18517/ijaseit.12.3.14516.
 - [32] N. M. Deterding and M. C. Waters, "Flexible Coding of In-depth Interviews: A Twenty-first-century Approach," *Sociol. Methods Res.*, vol. 50, no. 2, pp. 708–739, 2021, doi: 10.1177/0049124118799377.
 - [33] R. Rutakumwa *et al.*, "Conducting in-depth interviews with and without voice recorders: a comparative analysis," *Qual. Res.*, vol. 20, no. 5, pp. 565–581, 2020, doi: 10.1177/1468794119884806.
 - [34] J. Zhu and W. Liu, "A tale of two databases: the use of Web of Science and Scopus in academic papers Historia de dos bases de datos: el uso de Web of Science y Scopus en artículos académicos," *Scientometrics*, vol. 123, no. 1, pp. 321–335, 2020.
 - [35] K. Dhakal, "NVivo," *J. Med. Libr. Assoc.*, vol. 110, no. 2, pp. 270–272, 2022, doi: 10.5195/jmla.2022.1271.
 - [36] H. J. Schünemann *et al.*, "The ecosystem of health decision making: from fragmentation to synergy," *Lancet Public Heal.*, vol. 7, no. 4, pp. e378–e390, 2022, doi: 10.1016/S2468-2667(22)00057-3.
 - [37] J. Kalmenovitz, M. Lowry, and E. Volkova, "Regulatory Fragmentation," *J. Finance*, vol. 80, no. 2, pp. 1081–1126, 2025, doi: 10.1111/jofi.13423.
 - [38] C. Bellini and M. Sauter, "Humanitarian Nationalism During Autocratic Disaster Governance: The Politicization of the Earthquake Response in Türkiye," *Stud. Comp. Int. Dev.*, no. 0123456789, 2025, doi: 10.1007/s12116-024-09454-y.
 - [39] G. Lele, "Asymmetric decentralization, accommodation and separatist conflict: lessons from Aceh and Papua, Indonesia," *Territ. Polit. Gov.*, vol. 11, no. 5, pp. 972–990, 2023, doi: 10.1080/21622671.2021.1875036.
 - [40] R. Agnesica, H. Sihalo, M. Hanita, and C. Pamungkas, "Papua Conflict Resolution Challenges : The Linkage Of Relative Deprivation With The Spirit Of Separatism Of Indigenous Papuans," vol. 34, pp. 4429–4453, 2023.
 - [41] R. S. Barino, V. C. P. Lira, L. R. A. Cunha, and I. de B. Junior, "Logistical challenges faced by Civil Defense in the 2023 São Sebastião disaster," *Production*, vol. 34, pp. 1–19, 2024, doi: 10.1590/0103-6513.20240007.
 - [42] D. Surjatmodjo, A. A. Unde, H. Cangara, and A. F. Sonni, "Information Pandemic: A Critical Review of Disinformation Spread on Social Media and Its Implications for State Resilience," *Soc. Sci.*, vol. 13, no. 8, 2024, doi: 10.3390/socsci13080418.
 - [43] M. Hafel, "Digital Transformation in Politics and Governance in Indonesia: Opportunities and Challenges in the Era of Technological Disruption," *Society*, vol. 11, no. 2, pp. 742–757, 2023, doi: 10.33019/society.v11i2.577.
 - [44] S. Shen, R. H. Chang, K. Kim, and M. Julian, "Challenges to maintaining disaster relief supply chains in island communities: disaster preparedness and response in Honolulu, Hawai'i," *Nat. Hazards*, vol. 114, no. 2, pp. 1829–1855, 2022, doi: 10.1007/s11069-022-05449-x.
 - [45] P. Hou, X. Yi, and H. Dong, "Identifying critical regions in industry infrastructure: A case study of a pipeline network in Kansas, USA," *IEEE Access*, vol. 8, pp. 71093–71105, 2020, doi: 10.1109/ACCESS.2020.2985595.
 - [46] A. Ghadge, "ICT-enabled approach for humanitarian disaster management: a systems perspective," *Int. J. Logist. Manag.*, vol. 34, no. 6, pp. 1543–1565, 2023, doi:

- 10.1108/IJLM-11-2021-0532.
- [47] R. Grange, G. Heaslip, and C. McMullan, "Coordination to choreography: the evolution of humanitarian supply chains," *J. Humanit. Logist. Supply Chain Manag.*, vol. 10, no. 1, pp. 21–44, 2020, doi: 10.1108/IJLSCM-12-2018-0077.
- [48] A. Ahmed Eid, matevz obrecht, "an ag em en t J ou rn a me nt Jo ur," *Rausp*, pp. 1–28, 2022.
- [49] S. E. Bibri, "Data-Driven Smart Eco-Cities of the Future: An Empirically Informed Integrated Model for Strategic Sustainable Urban Development," *World Futures*, vol. 79, no. 7–8, pp. 703–746, 2023, doi: 10.1080/02604027.2021.1969877.
- [50] K. Huter, T. Krick, D. Domhoff, K. Seibert, K. Wolf-Ostermann, and H. Rothgang, "Effectiveness of digital technologies to support nursing care: Results of a scoping review," *J. Multidiscip. Healthc.*, vol. 13, pp. 1905–1926, 2020, doi: 10.2147/JMDH.S286193.
- [51] V. Astarita, G. Guido, S. S. Haghshenas, and S. S. Haghshenas, "Risk Reduction in Transportation Systems: The Role of Digital Twins According to a Bibliometric-Based Literature Review," *Sustain.*, vol. 16, no. 8, 2024, doi: 10.3390/su16083212.
- [52] P. Cui, S. Cao, R. Qin, and F. Zhang, "Development of a data-driven urban immunity assessment model: providing a new benchmark for urban governance under public health emergencies," *Front. Public Heal.*, vol. 13, no. May, 2025, doi: 10.3389/fpubh.2025.1609641.
- [53] Y. Xing, "Optimization of Management Structure and Resource Coordination Management Method of Construction Enterprises under Urban Environmental Pollution," *J. Environ. Public Health*, vol. 2022, 2022, doi: 10.1155/2022/3823835.
- [54] K. Gooding, M. P. Bertone, G. Loffreda, and S. Witter, "How can we strengthen partnership and coordination for health system emergency preparedness and response? Findings from a synthesis of experience across countries facing shocks," *BMC Health Serv. Res.*, vol. 22, no. 1, pp. 1–19, 2022, doi: 10.1186/s12913-022-08859-6.
- [55] E. Kaneberg *et al.*, "Defence organizations in emergency networks: the early response to COVID-19 in Europe," *J. Humanit. Logist. Supply Chain Manag.*, vol. 13, no. 1, pp. 91–105, 2023, doi: 10.1108/IJLSCM-11-2021-0114.
- [56] M. Pinto and C. Leite, "Digital technologies in support of students learning in higher education: Literature review," *Digit. Educ. Rev.*, no. 37, pp. 343–360, 2020, doi: 10.1344/DER.2020.37.343-360.
- [57] F. D. Cifone, K. Hoberg, M. Holweg, and A. P. Staudacher, "'Lean 4.0': How can digital technologies support lean practices?," *Int. J. Prod. Econ.*, vol. 241, no. August, 2021, doi: 10.1016/j.ijpe.2021.108258.
- [58] L. Bitto Urbanova *et al.*, "Technology supports me: Perceptions of the benefits of digital technology in adolescents," *Front. Psychol.*, vol. 13, no. January, pp. 1–11, 2023, doi: 10.3389/fpsyg.2022.970395.
- [59] M. Khan, G. S. Parvaiz, A. Ali, M. Jehangir, N. Hassan, and J. Bae, "A Model for Understanding the Mediating Association of Transparency between Emerging Technologies and Humanitarian Logistics Sustainability," *Sustain.*, vol. 14, no. 11, 2022, doi: 10.3390/su14116917.
- [60] R. Dmuchowski, "Methods of measuring the effectiveness of logistics activities," *Contemp. Econ.*, vol. 15, no. 3, pp. 309–320, 2021, doi: 10.5709/ce.1897-9254.451.
- [61] T. Sobb, B. Turnbull, and N. Moustafa, "Supply chain 4.0: A survey of cyber security challenges, solutions and future directions," *Electron.*, vol. 9, no. 11, pp. 1–31, 2020, doi: 10.3390/electronics9111864.
- [62] R. Ti and C. Kinsey, "Lessons from the Russo-Ukrainian conflict: the primacy of logistics over strategy," *Def. Stud.*, vol. 23, no. 3, pp. 381–398, 2023, doi: 10.1080/14702436.2023.2238613.
- [63] A. Khan, S. Gupta, and S. K. Gupta, "Emerging UAV technology for disaster detection, mitigation, response, and preparedness," *J. F. Robot.*, vol. 39, no. 6, pp. 905–955, 2022, doi: 10.1002/rob.22075.
- [64] V. W. B. Martins, R. Anholon, O. L. G. Quelhas, and W. Leal Filho, "Roadmap to enhance the insertion of social sustainability in logistics systems," *Int. J. Product. Perform. Manag.*, vol. 72, no. 10, pp. 2838–2858, 2023, doi: 10.1108/IJPPM-03-2022-0132.
- [65] A. A. Atieh Ali, A. A. A. Sharabati, M. Allahham, and A. Y. Nasereddin, "The Relationship between Supply Chain Resilience and Digital Supply Chain and the Impact on Sustainability: Supply Chain Dynamism as a Moderator," *Sustain.*, vol. 16, no. 7, pp. 1–20, 2024, doi: 10.3390/su16073082.
- [66] D. H. S. Keefe, H. Jang, and J. M. Sur, "Digitalization for agricultural supply chains resilience: Perspectives from Indonesia as an ASEAN member," *Asian J. Shipp. Logist.*, vol. 40, no. 4, pp. 180–186, 2024, doi: 10.1016/j.ajsl.2024.09.001.
- [67] I. Utama *et al.*, "From Farm to HORECA: Advancing Sustainable Value Chains for Tourism-Driven Agribusiness in Indonesia," *Front. Sustain. Food Syst.*, vol. 9, p. 1639384, 2025.
- [68] T. Binsfeld, S. Hamdan, O. Jouini, and J. Gast, "On the optimization of green multimodal transportation: a case study of the West German canal system," *Ann. Oper. Res.*, vol. 351, no. 1, pp. 667–726, 2025, doi: 10.1007/s10479-024-06075-5.
- [69] D. Dzemydienė, A. Burinskienė, and A. Miliauskas, "Integration of multi-criteria decision support with infrastructure of smart services for sustainable multi-modal transportation of freights," *Sustain.*, vol. 13, no. 9, 2021, doi: 10.3390/su13094675.
- [70] X. Xu, H. Wang, and P. Deng, "Exploring the Optimization of Synchronomodal Transportation Path under Uncertainties," *J. Mar. Sci. Eng.*, vol. 11, no. 3, 2023, doi: 10.3390/jmse11030577.
- [71] H. Yee, J. Gijsbrechts, and R. Boute, "Synchronomodal transportation planning using travel time information," *Comput. Ind.*, vol. 125, no. 2011, pp. 1–27, 2021, doi: 10.1016/j.compind.2020.103367.
- [72] M. H. Shah, Y. Ding, S. Zhu, Y. Gu, and M. Liu, "Optimal Design and Implementation of an Open-Source Emulation Platform for User-Centric Shared E-mobility Services," *Lect. Notes Comput. Sci.*, vol. 15508 LNCS, pp. 43–57, 2025, doi: 10.1007/978-3-031-82481-4_4.
- [73] S. A. H. Mohsan, M. A. Khan, F. Noor, I. Ullah, and M. H. Alsharif, "Towards the Unmanned Aerial Vehicles (UAVs):

- A Comprehensive Review,” *Drones*, vol. 6, no. 6, 2022, doi: 10.3390/drones6060147.
- [74] S. Seetharaman, S. Tekumalla, and M. Gupta, “Applications and challenges,” *Magnesium-Based Nanocomposites*, pp. 11-1-11-9, 2020, doi: 10.1088/978-0-7503-3535-5ch11.
- [75] C. Garau, G. Desogus, B. Barabino, and M. Coni, “Accessibility and Public Transport Mobility for a Smart(er) Island: Evidence from Sardinia (Italy),” *Sustain. Cities Soc.*, vol. 87, 2022, doi: 10.1016/j.scs.2022.104145.
- [76] R. A. Castanho, J. M. N. Gómez, A. Vulevic, A. Behradfar, and G. Couto, “Assessing transportation patterns in the azores archipelago,” *Infrastructures*, vol. 6, no. 1, pp. 1–16, 2021, doi: 10.3390/infrastructures6010010.
- [77] L. Criollo, C. Mena-Arciniega, and S. Xing, “Classification, Military Applications, and Opportunities of Unmanned Aerial Vehicles,” *Aviation*, vol. 28, no. 2, pp. 115–127, 2024, doi: 10.3846/aviation.2024.21672.
- [78] S. F. A. Shah *et al.*, “Applications, challenges, and solutions of unmanned aerial vehicles in smart city using blockchain,” *PeerJ Comput. Sci.*, vol. 10, pp. 1–35, 2024, doi: 10.7717/peerj-cs.1776.