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Enhancing HADR Effectiveness in the Philippines: A Critical Analysis of the Philippine Air Force's Capabilities and Challenges

June 2024

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Prepared for the Naval Postgraduate School, Monterey, CA 93943.

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ABSTRACT

This thesis provides an in-depth analysis of the Philippine Air Force's (PAF) Humanitarian Assistance and Disaster Relief (HADR) capabilities, set against the backdrop of the Philippines' vulnerability to natural disasters. The study evaluates the PAF's strengths and challenges in HADR operations, highlighting the impact of asset condition, logistical coordination, and the need for technological modernization. Considering the COVID-19 pandemic's economic effects, which have strained modernization efforts, the research offers strategic recommendations to enhance rapid response through fleet upgrades, improved logistics, procedural standardization, and the integration of advanced technologies like unmanned aerial vehicles (UAVs) and artificial intelligence (AI). These strategies aim to bolster the PAF's HADR readiness and efficacy, with implications for both national preparedness and the broader field of military disaster response. Through this analysis, the thesis contributes to shaping informed military and policy decisions, with the potential to transform disaster response practices in the Philippines and similar high-risk regions.

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ACKNOWLEDGMENTS

I am extremely grateful to my family and friends for their unwavering support and encouragement during my education. Their confidence in my ability has been a constant source of motivation. I have a special place in my heart for my mother, Luisa, who is in heaven, and her memory continues to inspire me. My father, Francisco, Auntie Merl, Uncle Paul, Benetoinnoju, my siblings, and my good friends Yulika, Almira, and General Angels have all provided invaluable support and love during my journey.

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LIST OF ACRONYMS AND ABBREVIATIONS

AHA Centre	Centre for Humanitarian Assistance on Disaster Management
AI	Artificial Intelligence
AMTI	Asia Maritime Transparency Initiative
ASEAN	Association of Southeast Asian Nations
CAS	Close-Air Support
DRR	Disaster Risk Reduction
FEMA	Federal Emergency Management Agency
HADR	Humanitarian Assistance and Disaster Relief
IAF	Indonesian Air Force
MNCC	Multinational Organizing Council
NASA	National Aeronautics and Space Administration
NGO	Non-Governmental Organization
NIST	National Institute of Standards and Technology
PACAF	Pacific Air Forces
PAF	Philippine Air Force
PAGASA	Philippine Atmospheric Geophysical and Astronomical Services Administration
PSA	Philippine Statistics Authority
SOP	Standard Operating Procedure
UAV	Unmanned Aerial Vehicle
UN	United Nations
USAID	United States Agency for International Development
USCG	United States Coast Guard
USD	United States Dollar
WRI	World Risk Index

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I. INTRODUCTION

A. BACKGROUND

The Philippines, according to the United States Agency for International Development (USAID; 2023), is in an area prone to tropical storms and volcanic activity, making it one of the most disaster-prone countries globally. On average, 20 cyclones impact the country a year, leading to floods, landslides, and storm surges that often cause damage to residences and infrastructure and result in the loss of lives and livelihoods. The Philippines is situated between two significant fault lines and has more than 20 active volcanoes, resulting in frequent seismic and volcanic events (USAID, 2023). Two recent catastrophic events in the Philippines that have caused immense loss of life and property are Typhoon Haiyan, also known as Yolanda, in November 2013 and the eruption of Mount Pinatubo in June 1991.

Typhoon Haiyan is remembered as one of the most powerful tropical cyclones to ever hit land. On November 8, 2013, it struck the Visayas region, causing widespread destruction. The storm led to more than 6,300 deaths and left thousands injured or missing. More than 3 million people were displaced. Damage to infrastructure, homes, and agriculture was substantial, amounting to approximately $89 million. The overall damage totaled approximately $2.86 billion USD (Government of the Philippines, 2014). The city of Tacloban and other areas were particularly hard hit, facing severe humanitarian challenges and a decade long recovery process.

Reflecting on the events documented by the National Aeronautics and Space Administration (NASA) Applied Sciences in 2021, the eruption of Mount Pinatubo on June 15, 1991, stands as the second-largest volcanic eruption of the 20th century and was the most substantial eruption to occur in a densely populated region within the last century. The features of the eruption were a vast cloud of ash that covered a wide area and rapidly moving pyroclastic flows—hot mixtures of volcanic matter that can destroy nearly everything in their path. Additionally, Typhoon Yunya came within 75 kilometers of the volcano at the peak of the storm, which made the situation worse by bringing deadly lahar

(volcanic mudflows) and floods. The region suffered devastating destruction that affected approximately 2 million people. Following the eruption, significant ash deposits, agricultural damage, and an estimated $700 million in losses were noted. Of these losses, $100 million resulted from damage to nearby airplanes during the eruption, with the remainder primarily originating from the property, forestry, and agriculture sectors (Allen, 2021).

A recent report by Kabagani (2024) highlighted that Mindanao experienced severe flooding and landslides due to heavy rainfall, resulting in substantial damage to infrastructure valued at approximately $13 million. The report detailed that the Caraga region bore the brunt of the damage, with 32 infrastructure facilities incurring costs of around $8.3 million. Additionally, the Davao Region saw 134 infrastructure facilities affected, with total damage amounting to $4.7 million. Between January 28 and February 3, 2024, the adverse weather conditions, attributed to the Northeast Monsoon (Amihan) and a dissipated low-pressure area's trough, led to the damage of 1,344 houses across Northern Mindanao, the Davao Region, and Caraga. Out of these, 558 houses were destroyed and 786 suffered partial damage. Furthermore, the report indicated that 1,389,073 individuals or 415,494 families across 818 barangays in Northern Mindanao, the Davao Region, Socsargen, Caraga, and the Bangsamoro Region were impacted by the heavy flooding and landslides. Nearly 50,000 of these individuals were taking refuge in evacuation centers, while over 300,000 found temporary shelter with relatives or friends (Kabagani, 2024).

Figure 1 shows the Risk Index Score for the Philippines for the many different kinds of natural disasters, earthquakes, tsunamis, tropical cyclones, and coastal floods that pose the greatest risk to the region. Figure 2 charts the number of deaths in the Philippines attributed to natural disasters each year from 2010 to 2023. The spike in 2012 corresponds with Typhoon Hiayan.

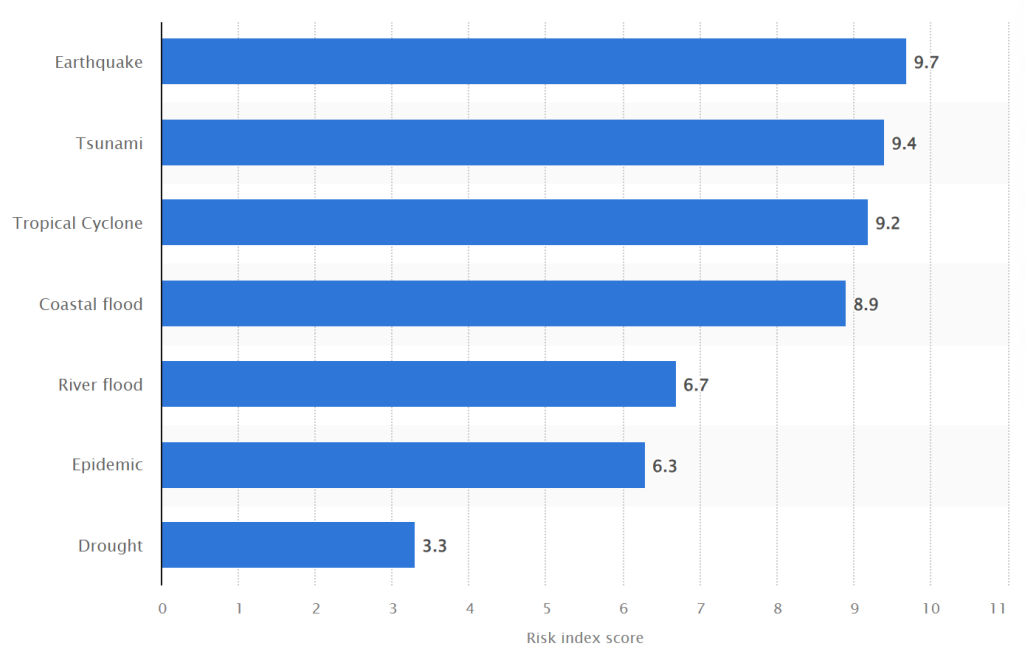


Figure 1. Philippines 2023 Natural Disaster Risk Index by Type.
Source: Statistica (2023).

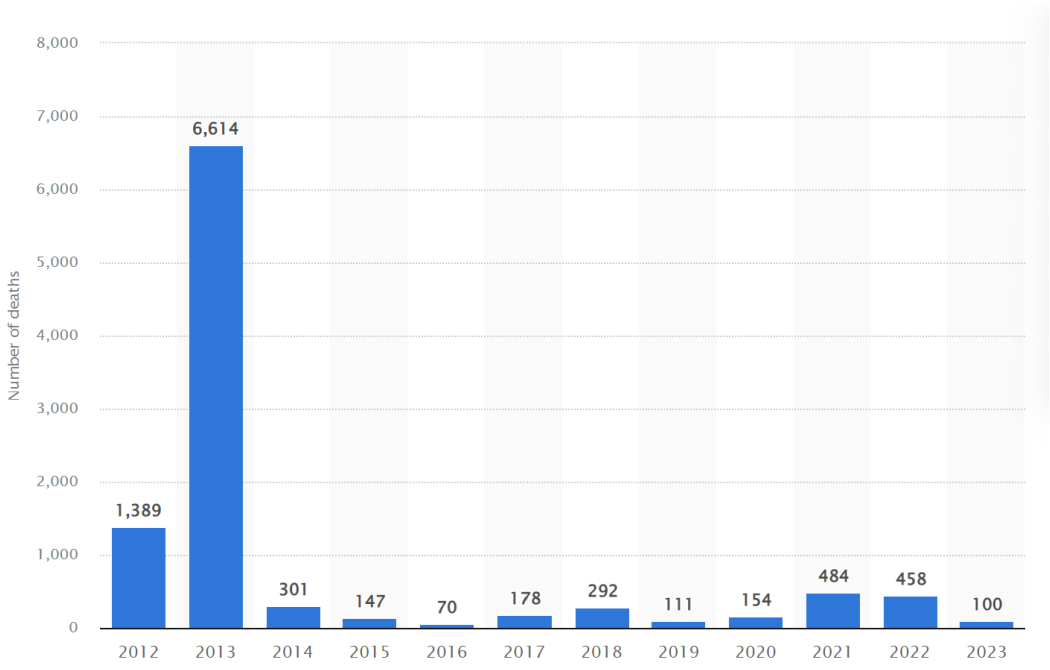


Figure 2. Number of Deaths Caused by Natural Events and Disasters, Philippines 2012–2023.
Source: Statistica (2023).

Collectively, these events underscore the significant need for a robust Humanitarian Assistance and Disaster Relief (HADR) framework. Such a framework is essential not only for addressing the immediate impacts of these disasters but also for supporting the long-term recovery and resilience of the affected communities. The detailed damages and the extensive number of people affected highlight the critical challenges that lie ahead in the disaster management and recovery process.

B. PROBLEM STATEMENT

The Philippine Air Force (PAF) plays a critical role in the country's disaster response efforts. However, persistent operational, technological, and coordination capacity challenges exist in fully optimizing disaster preparedness and response (Asia Maritime Transparency Initiative [AMTI], 2023; Nepomuceno, 2022). These issues are compounded by inefficiencies in organizing air missions, slow asset deployment, maintenance issues with an aging fleet, and difficulties in inter-agency coordination, which are exacerbated by the Philippines' archipelagic layout spanning over 7,100 islands. These geographic complexities create unique logistical hurdles in terms of access and relief distribution (Amador, 2023; Trajano, 2016a).

The restrictions are partly attributed to the slow pace of defense modernization programs, insufficient financing of capability upgrades to augment traditional security centric expenditures, regional airport limitations in vulnerable provinces, and inadequate contingency planning (Apte, 2010; Apte et al., 2013; Dy & Stephens, 2016). The compounded effect of these limitations is a diminished ability to mitigate disaster impacts, leading to increased casualties and economic losses. Addressing these critical gaps through strategic reforms is imperative to enhance the PAF's disaster response capabilities and improve overall disaster resilience in the Philippines.

Despite the known challenges posed by the Philippines' geography, detailed research into how these specific conditions affect the PAF's operational effectiveness in HADR has been limited. This oversight is critical given the PAF's pivotal role in national and regional disaster response frameworks. Official military directives and international assistance groups, such as the Association of Southeast Asian Nations (ASEAN)

Coordinating Centre for Humanitarian Assistance on Disaster Management (AHA Centre), have highlighted the need for comprehensive assessments of the PAF's HADR capabilities (Coe & Spandler, 2022). The absence of focused research on these operational challenges hinders efforts to streamline and enhance the PAF's disaster response mechanisms. This study aims to fill this gap by providing a detailed analysis of the PAF's operational hurdles within the context of the Philippines' unique geographic and logistical landscape.

C. RESEARCH QUESTION AND OBJECTIVES

The primary research question is: How can the PAF enhance its HADR capabilities to respond more effectively to natural disasters? The research objectives are as follows:

- To assess the current state of the PAF's HADR capabilities.
- To identify the operational challenges faced by the PAF in disaster response.
- To explore strategies for improving the PAF's HADR effectiveness.

D. SIGNIFICANCE OF THE STUDY

The importance of this research extends well beyond the goal of enhancing the PAF's response to natural disasters. It is fundamentally about protecting lives, conserving resources, and building the resilience of the Philippines against the severe effects of disasters. Through an analysis of recent HADR missions, evaluating key variables such as response time, resource allocation efficiency, and coordination with other agencies, the study outlines strategies for improvement and delves into the complexities of military involvement in disaster management.

E. METHODOLOGICAL OVERVIEW

This thesis employs a qualitative research approach to analyze the operational intricacies of the PAF's engagement in HADR operations. Specifically, it focuses on comparative case studies of recent natural disaster responses by the PAF and the Indonesian Air Force (IAF). The selected cases are Typhoon Haiyan for the Philippines and the Sulawesi earthquake/tsunami for Indonesia. These events were chosen due to their

significance and the distinct challenges they presented, offering insights into the strategic responses, inter-agency coordination, and decision-making processes during disaster scenarios. This focused examination allows for a detailed analysis of each air force's strategies, successes, and areas for improvement in HADR missions.

The variables analyzed in these case studies include asset deployment efficiency, inter-agency coordination, and modernization efforts, focusing on the responses of both the PAF and the IAF to major disasters. This analysis assesses the PAF's resource mobilization and utility in disaster scenarios, its collaborative efforts with governmental and non-governmental organizations, and the impact of its technological advancements on HADR capabilities. Additionally, by examining the IAF, the study provides comparative insights, highlighting both forces' operational strengths and weaknesses. This comprehensive approach not only pinpoints areas needing enhancement but also aims to bolster the overall effectiveness and efficiency of military involvement in disaster relief operations.

F. THESIS OUTLINE

The structure of this thesis is carefully designed to cover various dimensions of the PAF's involvement in HADR operations without recapitulating the introduction. The remaining chapters in the thesis are as follows:

- Chapter II examines theoretical frameworks and prior research in HADR, identifying the gaps this study aims to address.
- Chapter III details the qualitative research design, data collection methods, and analytical approach to assess the PAF's operations in HADR.
- Chapter IV presents the analysis of the collected data, focusing on the operational capabilities and challenges of the PAF in HADR missions.
- Chapter V summarizes the main findings and provides recommendations to improve the PAF's effectiveness in HADR.

II. LITERATURE REVIEW

A. INTRODUCTION

Disasters induced by natural hazards and accelerating climate change impacts are increasing in frequency and intensity across the globe, with vulnerable communities facing amplified risk of loss of lives and livelihoods. According to Lindsey (2022), the global average sea level has experienced a significant increase since 1880, rising by approximately 8–9 inches (21–24 cm). This rapid increase is detailed in Figure 3. Lindsey further reports that in 2022, the worldwide average sea level reached a new peak, standing 4 inches (101.2 mm) above the levels recorded in 1993. The report draws attention to an alarming quickening of the rate of sea level rise worldwide. In particular, it states that between 2006 and 2015, the pace of sea level rise more than doubled, going from 0.06 inches (1.4 mm) per year throughout the majority of the 20th century to 0.14 inches (3.6 mm) annually (Lindsey, 2022).

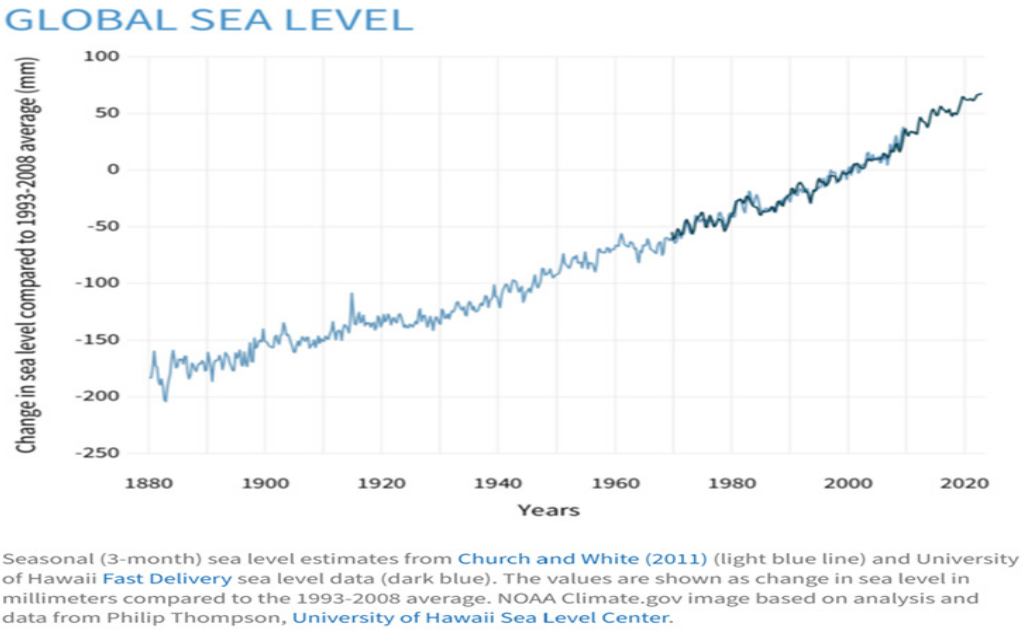
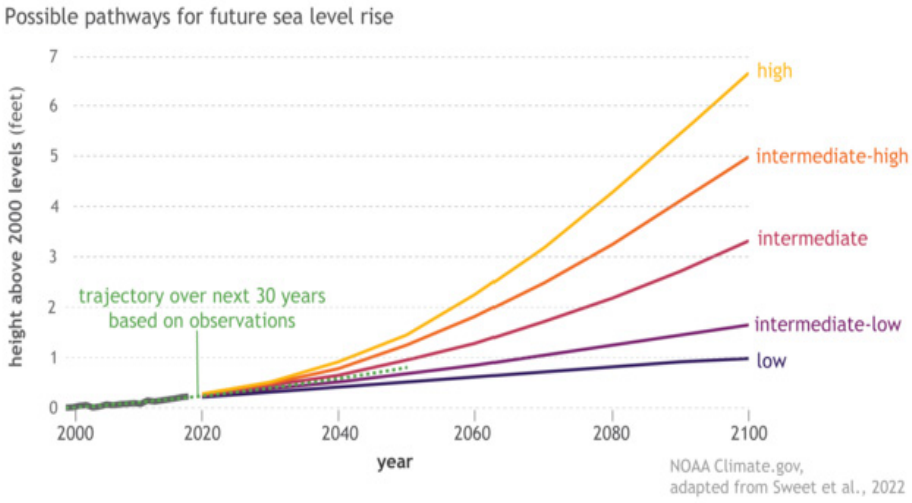


Figure 3. Rising Global Sea Levels Over Time.
Source: Lindsey (2022).

A climate scientist from the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), Rosalina de Guzman, has reported that the sea level in the Philippines is rising at a rate three times faster than the global average, endangering many coastal villages. As the representative of PAGASA's climate data section, de Guzman highlighted the vulnerability of the country given that 70% of its municipalities are adjacent to large bodies of water, including the Pacific Ocean. This situation poses a significant risk to those communities. De Guzman, drawing on a PAGASA report, indicated that such a rapid increase in sea level could lead to the inundation of low-lying areas, particularly affecting residents living along the coasts. This is of considerable concern for the Philippines, which boasts one of the world's longest coastlines, extending over 36,000 kilometers (Corrales, 2022). Figure 4 graphically illustrates these concerns, showing predicted levels of sea rise in various scenarios, underscoring the urgent need for adaptive strategies (Lindsey, 2022).



Observed sea level from 2000-2018, with future sea level through 2100 for six future pathways (colored lines) The pathways differ based on future rates of greenhouse gas emissions and global warming and differences in the plausible rates of glacier and ice sheet loss. NOAA Climate.gov graph, adapted from Sweet et al., 2022.

Figure 4. Potential Trajectories for Future Sea Level Rise.
Source: Lindsey (2022).

The Philippines' unique geographic context as an archipelagic nation of more than 7,000 islands exacerbates climate risks while exposing substantial portions of its population to intensifying typhoons, monsoon rains, and drought risks. The World Risk Index (WRI) 2022 ranks the Philippines as the highest globally in terms of disaster risk levels (WRI 46.82), with India (WRI 42.31) and Indonesia (WRI 41.46) close behind (Atwii et al., 2022). Coupled with the projection by the Philippine Statistics Authority (PSA) in 2023 that 22.4% of the population, or approximately 25.24 million Filipinos, would be living below the poverty line by the first quarter of 2023, this highlights the critical need for robust emergency response capabilities and humanitarian aid procedures in the Philippines. This need is further underscored by the additional PSA finding that about 22% of Filipino families have limited adaptive capacities, indicating a significant portion of the population lacks the resources or mechanisms to effectively respond to and recover from disasters and emergencies (PSA, 2023).

Limited investments in bolstering disaster preparedness and response over the past few decades have led to sub-optimal reactions to recurring small and mega-disaster events. Hence, a renewed policy focusing on strengthening capabilities of frontline agencies such as the armed forces through necessary organizational, technological, and coordination capacity advancements to save lives is an urgent national priority. This literature review examines such policy related issues for the PAF's emergency response landscape.

B. CONCEPTUAL MODELS IN DISASTER MANAGEMENT RESEARCH

Several key theoretical frameworks provide foundational lenses for examining disaster preparedness and response domains (Najafi et al., 2017). The disaster management cycle views emergency management processes through four interconnected phases: mitigation, preparedness, response, and recovery (Cutter & Gall, 2014; Francoeur, 2023). Figure 5 illustrates that these phases capture the sequencing from risk reduction efforts before a disaster event to responsive capabilities activated during an emergency and post-event mechanisms to rebuild communities in a resilient manner.

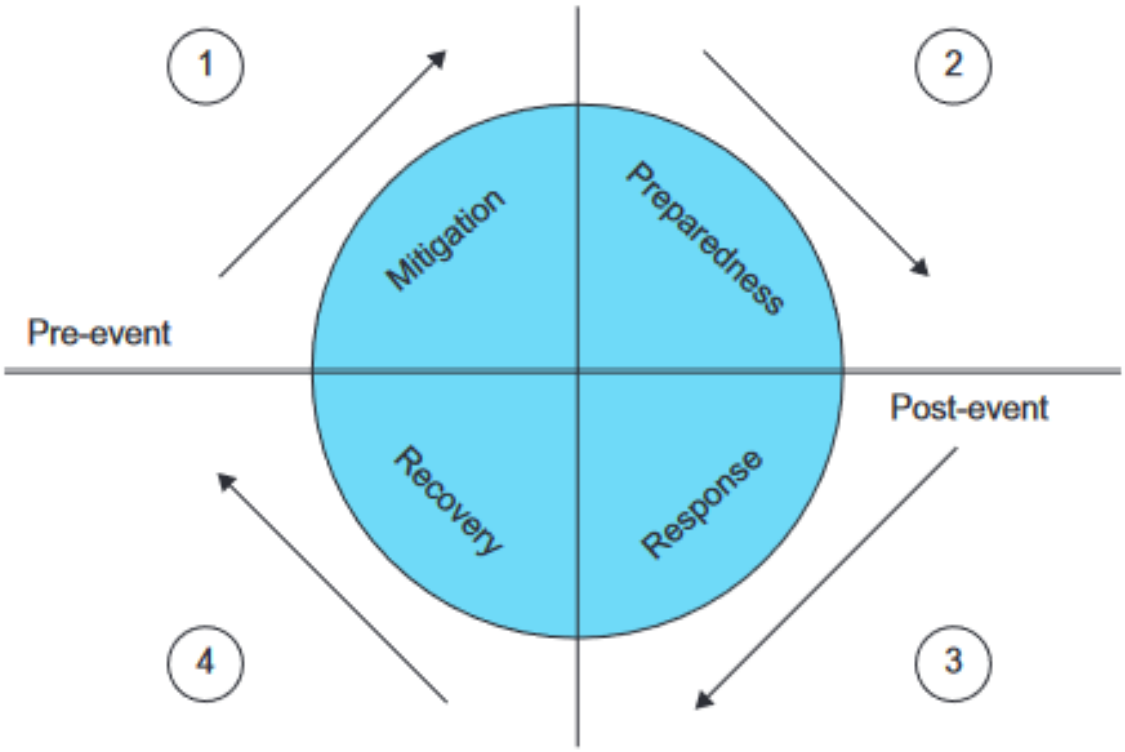


Figure 5. Four Phases of Disaster Management Cycle.
Source: Bullock et al. (2012, p. 436).

Specifically, mitigation requires implementation of structural and nonstructural measures to reduce risks from potential hazards. Structural measures include hazard-resistant infrastructure like flood embankments, earthquake-proof buildings, and wind-resistant shelter designs. Nonstructural mitigation measures span building code enforcement, land use planning such as creating buffer flood zones, and environmental impact assessments for development projects. The goal is to minimize damage when disasters inevitably strike (Bullock et al., 2012).

The book titled *Introduction to International Disaster Management* (Coppola, 2015a) describes that mitigation techniques aim to diminish the impact of risks by lowering the probability of their occurrence or the intensity of their consequences (Coppola, 2015b). These techniques are customized for each hazard and differ in terms of cost, feasibility,

and effectiveness. The objective of mitigation might vary from completely avoiding risk to transferring, dispersing, or distributing it. Opting not to implement any mitigation measures is equivalent to acknowledging and embracing the associated risk. Structural mitigation refers to making physical alterations to the environment. This can involve improving the ability of buildings to withstand damage, enforcing building codes, moving structures to safer locations, adapting existing structures for increased protection, building community shelters, and creating systems for detecting, deflecting, and retaining potential threats. It also involves ensuring redundancy in critical safety infrastructure. Conversely, Coppola emphasizes that nonstructural mitigation involves changing human behavior or managing natural processes without using construction. This is achieved through methods such as implementing regulations, increasing community awareness, setting up warning systems, making nonstructural physical changes, controlling the environment, and encouraging behavioral changes (Coppola, 2015b).

The preparedness phase focuses on creating, testing, and upgrading disaster response capabilities through activities like contingency planning, simulations and drills, stockpiling relief inventories, investing in early warning systems, and bolstering detection-warning communication mechanisms. The efficacy of preparedness efforts directly impacts post-disaster rescue, relief, and rehabilitation outcomes, underscoring preparedness investments for communities (United Nations Office for Disaster Risk Reduction [UNDRR], 2021). Disaster preparedness emphasizes readiness over last-minute preparations for effective response and recovery. Coppola (2015a) states that emergency response agencies, government officials, corporations, and citizens participate in catastrophe preparedness to reduce the impact of disasters. The success of disaster response depends on these steps, which include preparation, training, equipment acquisition, and statutory authority. Coppola also emphasizes the wide range of preparedness activities in the emergency management cycle, including emergency operations plans, exercises, equipment readiness, and public education and warning systems. The media's involvement in disaster management is also explored, emphasizing its importance in crisis communication and information distribution (Coppola, 2015d).

In his work, Coppola (2015a) outlines the distinct phases of emergency management, namely the response and recovery phases. He emphasizes the complex nature of response activities that occur prior to, during, and following a hazardous occurrence. In this phase, which is marked by intense stress and a lack of information, the focus is on taking life-saving measures and ensuring the stability of crucial communal resources such as food, water, and shelter. The level of complexity rises when the requirement for coordination across several agencies during international catastrophe responses develops, typically resulting in a declaration of a disaster when local capacities are surpassed (Coppola, 2015f). Recovery involves the actions taken to fix, reconstruct, and hopefully improve the ability to withstand future disasters. The process includes both immediate measures to stabilize impacted communities and long-term strategies for reconstruction, necessitating substantial resources, meticulous planning, and effective coordination. The scope of recovery goes beyond simple restoration, with the goal of reducing the risk of future catastrophes. This highlights the extensive and expensive process of recovering from the repercussions of a disaster (Coppola, 2015e).

The integrated sequencing from risk mitigation to preparedness strengthens the response and recovery capabilities across socio-economic systems when faced with multifaceted emergencies. The disaster cycle offers key principles for managing risks systematically by understanding interlinkages across pre- and post-disaster phases.

C. MILITARY ROLES IN DISASTER RESPONSE

In 2015, Coppola pointed out that governments set up and run systems to handle tragedies, focusing on response actions because they save lives right away. It has been noticed that outside of industrialized areas, there has not been much progress in hazard risk management, even though risk management tools and methods can be used anywhere. Many different types of government reaction groups are ready to help with disasters all over the world. These groups include fire departments, police, civil protection agencies, emergency medical services, and the military (Coppola, 2015c). The fact that emergency management models can be changed to fit local, regional, or national organizational structures shows how important it is to use customized methods when responding to

disasters. It is interesting that not all countries have a formal national government structure committed to emergency management. This shows that disaster readiness around the world is not the same for everyone. Furthermore, Coppola highlights the important role that development aid plays in improving emergency management. Donor countries help disaster-stricken countries in many ways, from giving financial aid to using their military to help. This all-around support system shows how committed people around the world are to making emergency management and recovery efforts better (Coppola, 2015c).

Gassert et al. (2020) emphasize the indispensable role of militaries in enhancing Humanitarian Assistance and Disaster Relief (HADR) capabilities, leveraging their comprehensive resources for mobility, transport, logistics, and communication, crucial for swift large-scale aid delivery during disasters (Gassert et al., 2020). Meanwhile, Amador (2023) argues for a robust national defense strategy in the Philippines, recognizing not only the importance of addressing external threats and internal security but also the critical role of HADR amid emerging challenges such as cybersecurity and the integration of advanced technologies. Together, these perspectives underline the essential function of the military in both national defense and disaster response, advocating for a forward-looking defense strategy that encompasses a wide array of security and humanitarian considerations (Amador, 2023).

Chopra (2020) analyzes the strategic use of military assets in disaster management, focusing on airpower's adaptability and accuracy. The research examines how airpower is crucial in early catastrophe response. Aircraft using high-tech surveillance instruments can quickly acquire data and examine the affected area day or night. These overhead views are essential for mobilizing rescuers and lifesaving supplies. In a disaster, air transport is critical for delivering heavy machinery, food, water, and medical supplies. Airpower is crucial for rapid relief distribution to prevent starvation and disease outbreaks when the situation moves from quick response to longer-term recovery. Chopra's research shows that airpower may greatly improve disaster response and recovery, highlighting its importance in a military disaster management strategy (Chopra, 2020).

Additionally, the *Philippine Disaster Management Reference Handbook* (Center for Excellence in Disaster Management & Humanitarian Assistance [CFE-DM], 2021)

outlines the multifaceted role of military teams in disaster response, detailing how their engineering expertise is crucial for rebuilding damaged logistical infrastructure, including roads, bridges, and airfields, which is key to accelerating the delivery of relief to the most affected areas. The report further highlights the importance of soldiers trained in aquatic search and rescue operations, noting their ability to save lives during emergencies such as flash floods or storms.

According to the same source, the armed forces play a vital role in providing immediate humanitarian assistance through the establishment of field hospitals, inflatable shelters, and water purification plants near disaster sites, especially when local health systems are unable to respond effectively. The handbook also points out the significance of dedicated military communication units in ensuring the flow of vital information during crises. These units create temporary cell towers and deployable internet connectivity in rugged environments facilitating critical communications.

This comprehensive approach illustrates how various military battalions spearhead a range of humanitarian logistics and emergency support services. Their efforts create an interdependent ecosystem with civilian agencies and communities, forming the backbone of a comprehensive disaster response strategy. This ecosystem underscores the indispensable role of the military in bridging the gap between immediate disaster relief needs and long-term recovery efforts (CFE-DM, 2021).

D. DOMESTIC PHILIPPINE AIR FORCE RESPONSE ACROSS RECENT DISASTERS

The Philippine Air Force (PAF) has played a leading role in addressing significant calamities in the Philippines, showcasing its crucial contribution to national emergency response endeavors. The participation of the PAF during these occasions showcases its capacity to adjust, its strategic prowess, and the difficulties it faces due to limited resources.

The PAF's rapid deployment from Northern Luzon to Western Mindanao after Tropical Storm Paeng in late October 2022 showed its commitment and adaptability in responding to disasters. This encompassed the transportation of provisions to inundated regions and the retrieval of marooned households. The prompt response of the PAF was

highlighted by the dual role of Tactical Operations Group 12 in conducting aerial inspections and delivering supplies to Cotabato City and Sultan Kudarat, as well as the nocturnal rescues carried out by the 15th Strike Wing in Cavite. The PAF's crucial role in disaster management was highlighted by the Tactical Operations Wing Western Mindanao's commendable actions in evacuating civilians and conducting damage assessments in Zamboanga City (PAF, 2022).

These examples demonstrate the PAF's vital role in disaster management and its preparedness to support communities during severe weather events. Although the PAF has encountered resource-related difficulties, its capacity to rapidly deploy, coordinate logistics, and cooperate with global allies, particularly through projects such as the Multinational Organizing Council (MNCC), has proven to be extremely valuable. The occurrences of Super Typhoon Haiyan and Tropical Storm Paeng have offered valuable chances for learning, emphasizing the crucial importance of airpower in disaster response situations and pointing out areas that need improvement in disaster preparedness and response capabilities.

E. COMMUNITY RESILIENCE PARADIGMS

To prevent harm to people, property, vital infrastructure, and ecosystems, communities that are considered resilient must be able to withstand, absorb, adapt to, and recover from disaster occurrences in a timely and effective manner. This requires concerted work at all levels (Alcayna et al., 2016).

Catastrophes possess the capacity to severely incapacitate any country and nullify the progress achieved by diligent development efforts. Uppal (2018) highlights the importance of implementing a proactive recovery strategy to prevent such consequences, emphasizing resilience as the foundation of disaster preparedness. This notion centers on the capacity of individuals and communities to foresee, plan for, endure, and bounce back from diverse obstacles without compromising their future. According to Uppal, technology is essential in strengthening resilience by providing access to important information, healthcare, social support networks, and economic opportunities. This helps communities become less vulnerable and more adaptable during disasters (Uppal, 2018).

In today's world, characterized by growing uncertainties and a greater occurrence of both man-made and natural disasters, the importance of community resilience has never been more significant. UrbanFootprint (2024) highlights the unequal allocation of hazards linked to calamities, underscoring the importance of geographical position, infrastructure, and accessible resources in defining a community's readiness for unexpected occurrences. Communities can improve their readiness by taking inspiration from the resilient traits observed in different areas. They can use appropriate tools to successfully reduce and adjust to future changes (National Institute of Standards and Technology [NIST], 2016; UrbanFootprint, 2024).

The National Institute of Standards and Technology (NIST, 2016) further clarifies community resilience as the capacity to efficiently strategize, adjust to, bounce back from, and endure disruptions. This involves a thorough strategy for being ready for disasters, which includes measures to prevent, safeguard against, lessen the impact of, respond to, and recover from such events. Through participation in these activities, communities can establish a trajectory towards resilience, equipping themselves to confront difficulties with enhanced adaptability and strength. Collectively, these viewpoints provide a course of action for communities around the world to enhance their ability to withstand and recover from challenges, guaranteeing a more stable and environmentally friendly future in light of growing threats (NIST, 2016).

Communities are pivotal in reducing the impact of disasters, leveraging their deep understanding of local environments and resources for effective disaster management. Aggarwal and Dwivedi (2022) emphasize the significance of involving communities from the onset, bolstered by initiatives that enhance their capabilities and connections, to enable them to effectively mitigate and respond. As first responders, communities' contributions are vital, underscoring the need to support and empower their efforts (Aggarwal & Dwived, 2022).

Furthermore, building resilient communities necessitates a multifaceted strategy, focusing on enhancing health and social services access, integrating health within disaster preparedness, fostering community-wide communication and cooperation, engaging vulnerable groups, and cultivating social bonds. According to UrbanFootprint (2024), these

measures are designed to fortify communities against disasters, considering each community's specific circumstances and requirements.

Table 1 outlines the sequential activities that constitute a holistic disaster management approach. It details specific actions within the phases of mitigation, preparedness, response, and recovery. For instance, mitigation encompasses hazard identification and structural improvements, while preparedness focuses on community readiness and early warning systems. The response phase activates emergency plans and aid distribution, and recovery entails rebuilding efforts and the restoration of infrastructure. This visualization serves as a guide for stakeholders to understand and execute their roles across the disaster management spectrum.

Table 1. Community-Driven Disaster Management Phases and Activities. Source: Aggarwal and Dwived (2022).

Phases of Disaster Management	Activities
Disaster Mitigation & Prevention	• Identification of hazards in their locality • Risk analysis • Establishing prevention measures to control hazardous situations • Application of building codes and methods for rebuilding and Infrastructure strengthening • Use of indigenous knowledge for disaster-resistant construction practices • Structural and non-structural measures • Risk insurance • DM planning (unit level to state-level)
Preparedness	• Awareness generation • Emergency response and logistics planning • Early warning systems and communications emergency operation centers • Constitution of community/volunteer teams and their training • SoPs for various teams to support local govt. • Mass casualty management, acquiring the necessary equipment, kits and vehicles etc.
Response	• Activation of emergency plan and emergency operation center • Search and rescue, evacuation and first-aid • Relief distribution, shelter management • Relief camp management
Recovery & Build Back Better (BBB)	• Assessment of damages • Loss calculation • Reconstruction and rehabilitation • Restoration of damaged infrastructure • Socio-economic rehabilitation

F. SYNTHESIZING GLOBAL AIRPOWER APPLICATION IN DISASTER MANAGEMENT

Coppola (2015a) asserts that as global disaster frequency intensifies, the international disaster management sector faces escalating challenges. Despite efforts to mitigate these recurring events, the persistence of disasters signals enduring global concerns. The complexity of coordination among responders, the influence of media, enhancement of institutional capacities for emergency management, political resolve for risk reduction, and the multifaceted nature of compound emergencies are pivotal issues that necessitate resolution. Moreover, the ramifications of terrorism amplify the intricacies of disaster management. The projection suggests a future where disasters not only become more commonplace but also impact nations universally (Coppola, 2015f).

Global humanitarian situations have shown the crucial function air forces provide in assisting people impacted by calamities. Their distinctive capabilities facilitate efficient assistance in many ways. These tasks involve wide-area surveillance to evaluate infrastructure damage, rapid transportation of emergency teams and critical relief supplies to remote crisis-affected areas, organizing large-scale evacuations to relocate distressed individuals to safe places, sending engineering units to repair crucial access routes, and setting up supply chains with partner organizations for the aerial delivery of essential goods (Williamson, 2015).

For instance, in the wake of Typhoon Haiyan in 2013, Operation Damayan illustrated a profound display of airpower and coordination, as recounted by Williamson (2015). The Pacific Air Forces (PACAF) played a pivotal role utilizing crisis-action planning teams and employed RQ-4 high-altitude sensors to evaluate the damage, which was instrumental in coordinating the delivery of aid and assessing the evolving needs on the ground (Williamson, 2015). The devastating impact of Haiyan, or Yolanda as it was locally named, resonates through the report by Parker et al. (2016), which details the storm's unprecedented strength and the subsequent U.S. military response. With sustained winds reaching 200 mph, Haiyan ravaged nine Filipino regions, leading to a concerted U.S. aid effort involving more than 13,400 personnel and an array of aircraft and vessels, culminating in the delivery of 2,495 tons of aid to some 450 sites and the evacuation of

more than 21,000 individuals, a testament to the synergistic efforts of the civil, military, and private sectors. This humanitarian mission, backed by $86 million in U.S. assistance, also underscored the indispensable role of airpower in disaster response (Parker et al., 2016).

The large-scale airlift enabled United Nations (UN) agencies and humanitarian clusters to overcome bottlenecks in relief distribution to devastated regions where maritime/land transport were disrupted. Airpower's unique capabilities in reconnaissance, transporting response crews with equipment over vast disaster landscapes, and enabling temporary infrastructure are amplifying global humanitarian agencies' capacity for assistance in disasters (Williamson, 2015).

G. SUMMARY

This literature review investigates the rising frequency and intensity of global disasters driven by natural hazards and climate change, emphasizing the heightened risk to vulnerable communities, particularly in the Philippines where sea levels are rising at three times the global average (Corrales, 2022; Lindsey, 2022). It discusses foundational disaster management frameworks that include the phases of mitigation, preparedness, response, and recovery, advocating a systematic approach to minimize and recover from disasters (Cutter & Gall, 2014; Francoeur, 2023; Najafi et al., 2017). The critical role of the PAF is highlighted, detailing its essential contributions to logistical, mobility, and communication support necessary for effective large-scale aid delivery (Amador, 2023; Chopra, 2020; Gassert et al., 2020). Furthermore, it identifies significant research gaps in enhancing the PAF's operational capabilities and integrating disaster resilience frameworks focused on community resilience through disaster risk reduction (DRR) practices, which are critical for reducing economic losses and safeguarding lives, especially given the increasing impact of climate change in the Philippines (Oxfam International, 2024; Smith, 2023). This review sets a solid foundation for a focused HADR research program aimed at evaluating and improving the PAF's response roles and capabilities within established disaster management frameworks.

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III. METHODOLOGY

A. RESEARCH APPROACH

This study adopts a qualitative, exploratory research approach using comparative case study analysis. It focuses on examining the operational dynamics of the Philippine Air Force's (PAF's) response to Typhoon Haiyan in 2013 and the Indonesian Air Force's (IAF's) response to the 2018 Sulawesi earthquake/tsunami. The methodology aims to identify differences and similarities in asset deployment efficiency, inter-agency coordination, and modernization efforts within these two distinct humanitarian emergencies in archipelagic regions.

The comparative analysis will allow for a detailed examination of each air force's strategies and the effectiveness of their disaster response mechanisms. This approach is structured around three main variables: asset deployment efficiency, inter-agency coordination, and the impact of modernization on Humanitarian Assistance and Disaster Relief (HADR) operations. These variables were chosen to provide a focused evaluation of the key aspects of military engagement in disaster management.

By analyzing these elements, the study seeks to offer insights into optimizing disaster response strategies in multifaceted environments and enhancing overall HADR operational efficiency. The findings are expected to contribute to a deeper understanding of effective disaster preparedness and response mechanisms across similar contexts.

B. ASSET DEPLOYMENT EFFICIENCY

Asset deployment efficiency refers to the timely mobilization, force allocation, and utilization of available response capabilities including aircraft, vessels, personnel, and equipment when disasters occur (Smith, 2023). It is a key metric of operational effectiveness in time-critical humanitarian interventions during the initial response phase (Federal Emergency Management Agency [FEMA], n.d.-a).

Efficient asset deployment is defined in this analysis across three core aspects:

1. Assembly Time: The timeframe from disaster onset or warning to when mobilization orders are issued and assigned HADR assets are mission-ready at their home stations.

2. Transit Time: The duration required for mobilized relief assets like aircraft and naval vessels to deploy from their home bases to designated staging areas near disaster zones.

3. Employment Time: The timeframe from arrival at a response staging area to when mobilized assets are actively employed delivering relief personnel and critical supplies during field operations.

Together, these phases provide a quantifiable picture of how rapidly the PAF can translate operational disaster response directives into physical HADR mission outcomes. Asset deployment efficiency data includes timeline reporting in after-action reviews and hourly utilization rates of mobilized relief platforms during various disaster case responses.

C. INTER-AGENCY COORDINATION

Inter-agency coordination refers to the ability of involved response stakeholders, including military branches, government bodies, and humanitarian organizations, to collaborate effectively towards synchronized disaster relief goals and objectives (FEMA, n.d.-b).

In the context of HADR operations, inter-organizational coordination necessitates that the PAF can seamlessly integrate with national agencies like the Office of Civil Defense, Departments of Social Welfare, Health, and Transportation, as well as international relief entities like the United Nations (UN), Red Cross, and foreign militaries (Trajano, 2016b).

Key aspects include:

1. Operational coordination is critical for successful catastrophe recovery, as outlined by FEMA in 2020. It involves developing a cohesive structure that incorporates all essential parties to promote coordinated planning and reaction. This capability enables leaders to assess community concerns,

establish recovery priorities, and effectively use available resources and partnerships to guide recovery initiatives. By combining diverse resources such as information, technical support, expertise, and funding, operational coordination ensures that recovery actions are comprehensive and inclusive. Effective disaster management requires a collaborative strategy that involves the entire community in addition to government involvement (FEMA, 2020).

2. Communication alignment, introduced by the U.S. Coast Guard in 2013, is a strategy designed to improve communication efficiency during emergency management. This approach encompasses establishing a Common Operating Picture and achieving interoperability. The Common Operating Picture enables all emergency management partners to access and share consistent information about an incident, facilitating effective coordination. This comprehensive perspective is bolstered by traffic conditions, weather updates, and resource availability data, which support informed decision-making across agencies. Interoperability is also crucial, as it allows emergency responders to communicate across different agencies and jurisdictions effectively. It involves having adequate resources for regular communications and the capability for real-time information transmission during emergencies. By ensuring that personnel can engage and coordinate seamlessly, communication alignment helps emergency response teams act quickly and effectively (United States Coast Guard [USCG], 2013).

3. Collaborative behavior in HADR, as explored by Canyon in 2017 using insights from Ferris, encompasses extensive cooperation between civilian and military organizations to enhance disaster response efficacy. This necessity for integration is acknowledged by prominent institutions like the International Federation of the Red Cross/Red Crescent and the UN, which advocate for the proactive incorporation of military assets in disaster relief efforts. They emphasize the benefits of leveraging complementary capabilities across these groups. Additionally, this collaboration is underpinned by ongoing enhancements to strategies and protocols, especially

by forward-thinking militaries like those in the United States, which continuously evaluate and improve their civil-military coordination efforts. This iterative process is supported by appropriate legislative frameworks and clear lines of authority, ensuring that resources are mobilized effectively. On a regional level, the Association of Southeast Asian Nations (ASEAN) serves as a prime example of this collaborative ethos, with various agreements and mechanisms that lay the groundwork for legal and operational coordination, thereby fostering a unified approach to disaster response. Such initiatives not only consolidate efforts within ASEAN but also elevate its status as a global frontrunner in coordinated HADR operations (Canyon, 2017).

D. MODERNIZATION IMPACT

Modernization impact can be measured by analyzing

1. Capability Gains: Documenting new operational capacity added to the PAF's HADR toolkit based on specifications of new platforms and technologies post-acquisition.

2. Disaster Readiness Improvements: Identifying positive impacts of modern equipment, networks, and systems on reducing PAF aircraft downtimes and enhancing reliability rates, sortie rates, and maintenance agility crucial for HADR missions.

3. Operational Utilization: Tracking the extent to which newly added aircraft, satellites, radars, and other modernized assets are utilized as key enablers during case study disaster response activities.

This data will quantify modernization outcomes against HADR necessities like speed, reach, visibility, and flexibility amidst typhoons, earthquakes, and other humanitarian crises.

E. DATA COLLECTION

Data is compiled from the following sources to enable a comparative analysis.

Philippine Sources:

- After-action reports from the PAF and Office of Civil Defense detailing HADR assets mobilized, operational timelines, and coordination challenges during Typhoon Haiyan relief efforts.
- Government and non-governmental organization (NGO) analyses evaluating the agility, adequacy, and limitations of the typhoon response across various domains.
- Academic literature assessing Philippines disaster management mechanisms and organizational coordination complexities impeding air mobility operations.

Indonesian Sources:

- IAF data on aircraft and resource deployment for the 2018 Sulawesi earthquake/tsunami, including operational utilization rates, staging areas, and assessed gaps.
- Government and humanitarian agency report on inter-organizational coordination, key challenges, and documented areas needing improvement during the Sulawesi response.
- Academic studies of disaster management strategies in different Indonesian archipelagic environments, highlighting best practices. This multi-sourced data underpins both within-case and comparative analysis focused on illuminating contrasts and commonalities in archipelagic HADR responses between the two countries.

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IV. COMPARATIVE CASE STUDIES AND ANALYSIS

A. INTRODUCTION

In this examination of Humanitarian Assistance and Disaster Relief (HADR) operations, a qualitative comparative case study approach is meticulously applied to dissect and understand the operational dynamics of the Philippine Air Force (PAF) and the Indonesian Air Force (IAF). This analytical process is particularly focused on their respective responses to two catastrophic natural disasters: Typhoon Haiyan and the Sulawesi earthquake/tsunami. The methodological underpinnings of this chapter are deeply rooted in the insightful frameworks and scholarly perspectives established in the initial chapters. Through this lens, the study emphasizes the vital importance of effective and rapid HADR actions within the challenging and varied geographical contexts that define the Philippines and Indonesia as archipelagic nations. The integration of these insights aims to draw out the nuanced differences and shared experiences between the PAF and IAF, offering a reflective exploration of each air force's strategic approach to disaster management and response within their complex maritime territories (Jain & Chetty, 2022). This detailed comparative analysis not only highlights areas of operational strength and agility but also pinpoints opportunities for significant improvements in the domain of HADR within the Association of Southeast Asian Nations (ASEAN) region.

B. PHILIPPINE HADR CHALLENGES AND THE PAF'S ROLE

Being an archipelagic country prone to mega-disasters such as super typhoons, flooding, storm surges, and volcanic eruptions, HADR efficacy is a national security priority in the Philippines (CFE-DM, 2021). However, ongoing operational, technological, and coordinating capacity issues prevent the Philippines from completely optimizing catastrophe preparedness and response. The PAF contributes significantly to HADR missions by providing airlift support, air surveillance, dedicated rescue teams, key equipment, and supply mobilization, as well as larger armed forces relief operations (Nepomuceno, 2022).

Yeo (2022) outlines how budget constraints and the economic impact of the COVID-19 pandemic have exacerbated the Philippines' challenges in modernizing its air force. Collin Koh of Singapore's Nanyang Technological University notes that the nation's debt has sharply increased during the pandemic, hindering efforts to replace aging defense assets and impacting the military's ability to swiftly respond to calamities (Yeo, 2022).

Tabaco et al. (2023) identify that the Philippines is making efforts to enhance collaboration with civilian agencies during HADR missions. These efforts include establishing clear protocols and contacts, conducting regular meetings and drills, implementing a shared information system, standard procedures, regular training and familiarization, community engagement and awareness, and conducting post-mission evaluation. Furthermore, limited interoperability with civilian agency information systems, delays in post-disaster needs analysis, inadequate prepositioning of relief inventories in vulnerable areas, and a lack of night operating capabilities for certain helicopter fleets all limit effective HADR mobilization and deployment from air bases across the Philippines' three major island groups (Tabaco et al., 2023).

The PAF has made significant strides in recent years, as demonstrated by the 505th Search and Rescue Group (505SRG), which has expanded its role from rescuing downed pilots to providing comprehensive HADR services. This includes conducting rapid damage assessments and needs analyses, participating in fire suppression, and supporting vaccination drives across the archipelago. The group's ongoing advancements in personnel training, equipment upgrades, and operational strategies have notably enhanced their readiness and effectiveness in disaster response scenarios (PAF, 2023).

The PAF is vigorously pursuing its modernization agenda through the Flight Plan 2040, which aims to reshape the force into a credible and agile entity equipped for modern warfare and responsive to regional and national security needs (PAF, 2023). The Air Force Symposium 2023 played a pivotal role, emphasizing the enhancement of international relations and interoperability to tackle future threats, with contributions from the Royal Australian Air Force and Pacific Air Forces. Key modernization efforts include the anticipated Philippines-Japan Reciprocal Access Agreement and Japan's Official Security Assistance program, which promise to bolster joint exercises and foster technological

advancements in cyber warfare and artificial intelligence (Nepomuceno & Barcelonia, 2023). Moreover, the PAF is strategically leveraging alliances and fostering ASEAN cooperation to enhance its disaster response capabilities and regional stability. The creation of the PAF International Military Affairs Office underscores these initiatives, aiming to maximize the benefits of international collaborations and align with the broader goals of Philippine foreign policy, thus strengthening the PAF's role in ensuring regional peace (Philippine Air Force OA-5, 2022)

Figure 6, as detailed in the World Directory of Modern Military Aircraft (WDMMA, 2024b), provides an insightful breakdown of the PAF fleet, mapping out its composition and readiness for both defense and humanitarian missions. The PAF operates 169 aircraft, strategically diversified into 26 close-air support aircraft and 98 multi-role helicopters, which are pivotal for transport, specialty missions, and direct combat operations. In addition to these, the fleet includes 18 transport planes that serve multiple roles, from transporting military and government personnel to delivering essential supplies during disaster relief efforts. Supporting the fleet's operational capabilities, 24 specialized trainers are tasked with enhancing the PAF's training programs, providing extensive instruction across various flight disciplines. The fleet is further strengthened by three specialized mission aircraft, each designed for specific operational roles.

In this context, the utility of each aircraft type within HADR missions is critically evaluated. While the close-air support and multi-role helicopters are directly applicable to HADR operations, providing essential services such as rapid transport and aerial support, the role of transport planes becomes equally vital in mobilizing large-scale relief efforts. However, specialized mission aircraft, although fewer in number, play a strategic role in surveillance and coordination, enhancing the overall effectiveness of disaster management operations.

Therefore, to bolster its HADR capabilities effectively, the PAF might consider a strategic review of its fleet composition to possibly increase the number of multi-role and transport aircraft. Such adjustments would ensure a more flexible and robust response to the frequent natural disasters that impact the archipelago, not only securing national defense but also enhancing the nation's resilience against catastrophic events. This analysis

underscores the importance of a well-balanced fleet that aligns with both national security requirements and humanitarian needs.

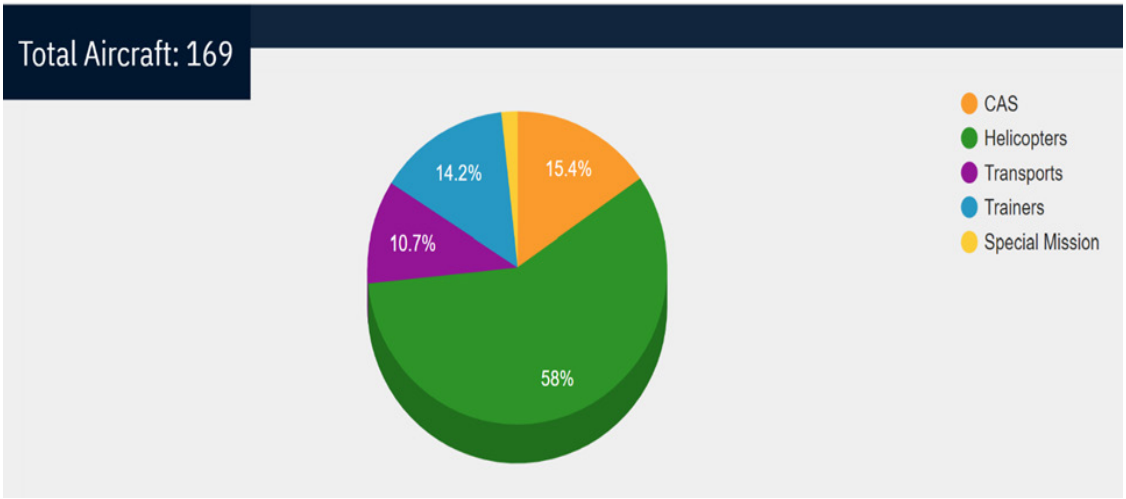

Figure 6. PAF FleetMix Composition.
Source: WDMMA (2024b).

Figure 7 displays a fleet of close-air support aircraft, emphasizing their role in direct-attack missions and their capacity for sustained, maneuverable flight patterns suited to combat scenarios to support HADR missions in contested environments. It includes a numerical and percentage breakdown of aircraft types, reflecting the operational composition of the fleet.

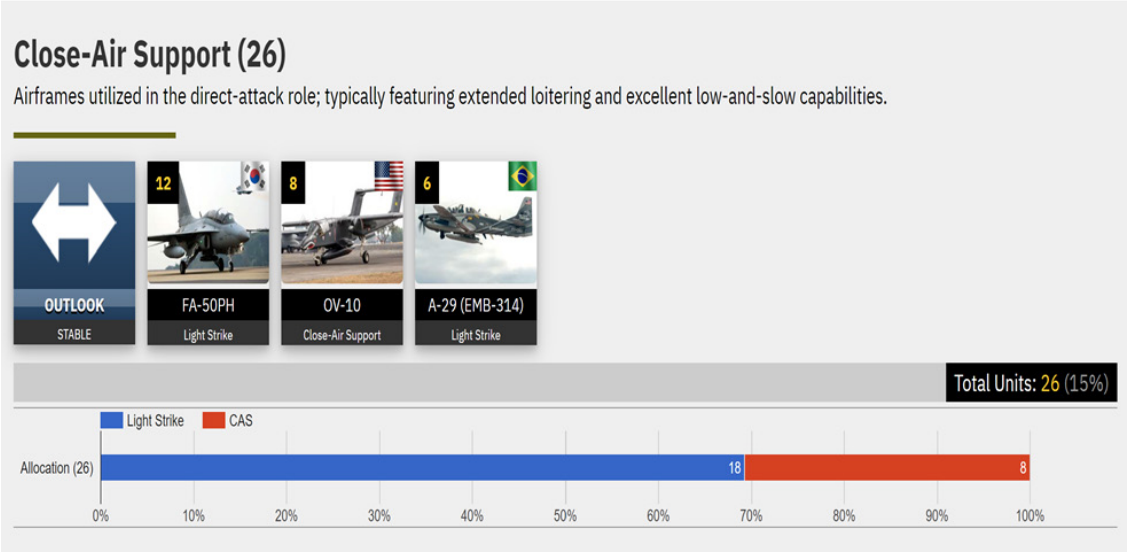

Figure 7. Close-Air Support Fleet Overview.
Source: WDMMA (2024b).

Figure 8 provides an at-a-glance summary of the various types of helicopters within the PAF, showcasing their distribution across different roles such as transport, special mission, and direct attack. It visually breaks down the total count and allocation percentage of each helicopter type, reflecting their readiness for various operational duties and highlighting some limitations like negative night flying capability (Tabaco et al., 2023).

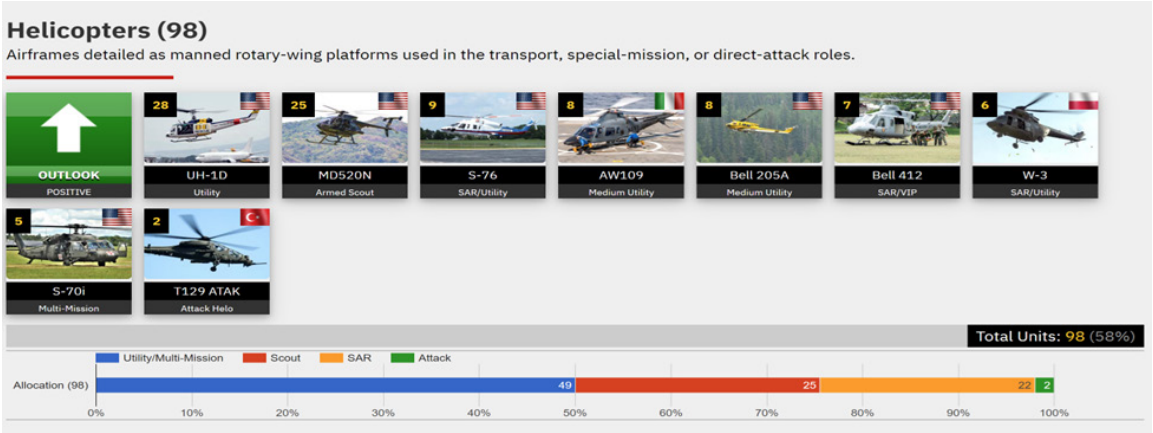

Figure 8. Rotary-Wing Air Assets Overview.
Source: WDMMA (2024b).

Figure 9 highlights the transport aircraft fleet of the PAF, focusing on airframes specifically dedicated to hauling tasks for military and high-government personnel or cargo delivery (WDMMA, 2024b). This illustration reflects a positive forecast for fleet utilization and diversification within the PAF. The accompanying bar graph provides a visual breakdown of the aircraft types, showcasing a strategic balance between tactical and utility air transport capabilities, crucial for varied operational demands.

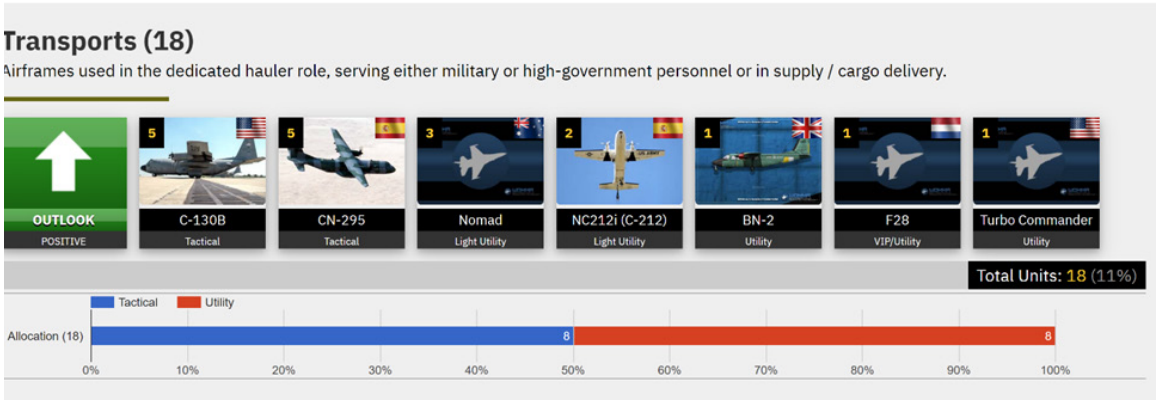

Figure 9. Multi-Role Transport Aircraft Allocation.
Source: WDMMA (2024b).

Figure 10 displays the three specialized mission aircraft in the PAF, specifically tailored for reconnaissance and maritime patrol, reflecting their strategic importance in surveillance and security operations (WDMMA, 2024b).

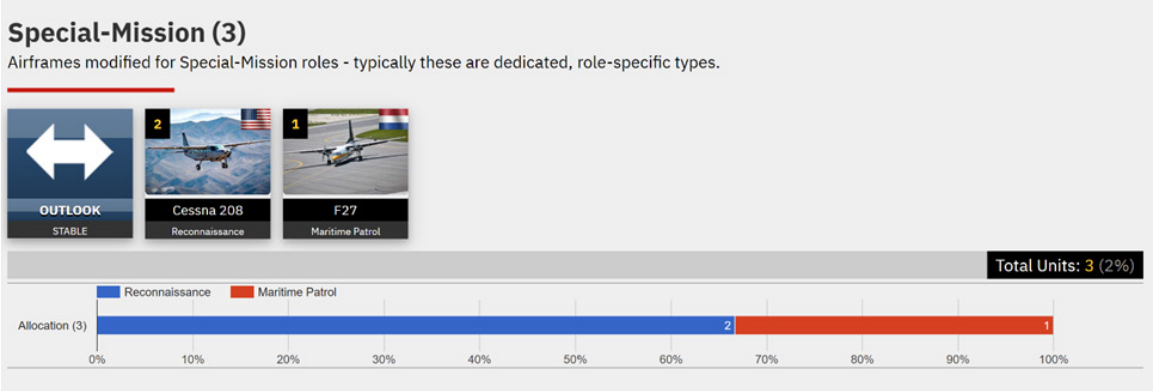

Figure 10. Special-Mission Aircraft Overview.
Source: WDMMA (2024b).

Figure 11 outlines aircraft currently on order, scheduled for delivery in the upcoming procurement year or thereafter. It showcases the diversity of the new additions, which include multi-mission helicopters and attack helicopters, and their expected contribution to the existing fleet capabilities (WDMMA, 2024b). Based on what is upcoming, these additions are likely to enhance HADR missions. The inclusion of multi-mission helicopters, for example, can improve the fleet's versatility in delivering aid and executing rescue operations across diverse and challenging environments. Attack helicopters, while primarily for defense, can also provide aerial support to secure areas during large-scale disaster responses.

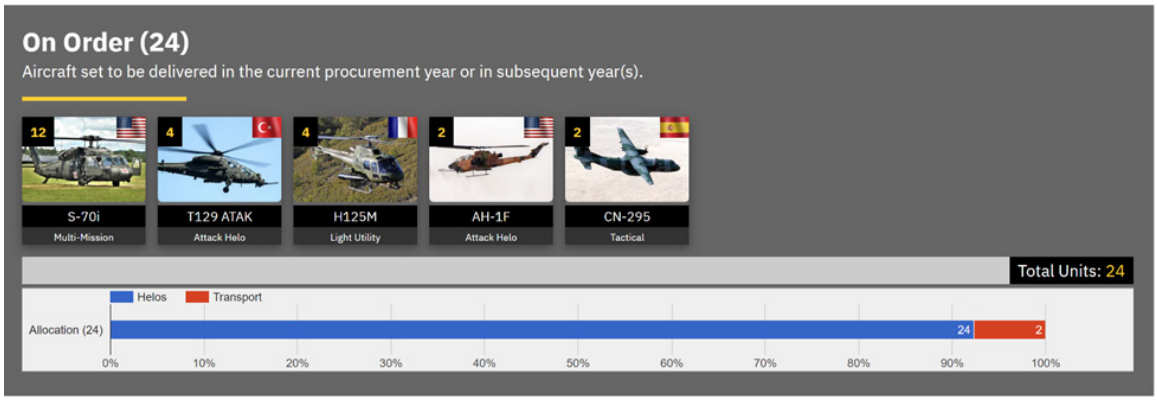

Figure 11. Upcoming Aircraft Procurements.
Source: WDMMA (2024b).

In conclusion, the PAF has established a robust foundation to support national HADR operations. However, ongoing challenges necessitate continued investment and strategic enhancements to optimize disaster response capabilities. Notably, budget constraints and economic pressures from the COVID-19 pandemic have hampered the modernization efforts necessary for replacing aging assets and maintaining rapid response capabilities. Collin Koh highlights that increased national debt during the pandemic has constrained military upgrades, impacting the PAF's effectiveness during disasters (Yeo, 2022).

Efforts to enhance collaboration with civilian agencies are underway, which include setting up protocols and regular training crucial for improving HADR missions. However, issues such as limited interoperability with civilian information systems and delays in disaster needs analysis significantly hinder effective deployment and mobilization (Tabaco et al., 2023).

The PAF's 505th Search and Rescue Group has expanded its role to offer more comprehensive HADR services, indicating an enhancement in readiness and effectiveness in disaster scenarios (PAF, 2023). The fleet, as documented by the World Directory of Modern Military Aircraft (WDMMA, 2024b), consists of a diverse array of aircraft that are strategically crucial for the nation's rapid and versatile disaster response capabilities.

Visual representations from the WDMMA (2024) in Figures 6 through 11 outline the current fleet and forthcoming additions, including multi-mission and attack helicopters, which are anticipated to significantly bolster the PAF's HADR efforts. These additions are expected to enhance fleet versatility and improve operational readiness across challenging environments, thereby strengthening the military's role in national security and contributing to the Philippines' resilience against natural disasters (PAF, 2023). To ensure the alignment of the fleet's structure and capabilities with the nation's HADR needs, a continuous review and addressing of these limitations are critical.

C. INDONESIAN HADR CHALLENGES AND THE IAF'S ROLE

Indonesia, an archipelago susceptible to numerous natural disasters such as earthquakes, tsunamis, volcanic eruptions, and floods, places high priority on the efficacy

of HADR for national security. Challenges in operational capabilities, technological advancements, and coordination efforts hinder Indonesia's disaster preparedness and response efficiency. The IAF plays a critical role in HADR missions by providing airlift support, air surveillance, dedicated rescue teams, essential equipment, and supply mobilization, as well as supporting larger armed forces relief operations (World Bank Group & Asian Development Bank, 2021).

Economic challenges exacerbated by the COVID-19 pandemic have significantly constrained Indonesia's capacity to modernize its air force. The pandemic led to a substantial increase in national debt, complicating the replacement of outdated military assets and impacting the military's ability to respond swiftly to disasters (Chavez, 2024b).

Collin Koh from the S. Rajaratnam School of International Studies observes that Indonesia's defense enhancements have been continuous since President Susilo Bambang Yudhoyono's tenure began in 2004 (Chavez, 2024b). Koh anticipates that Defense Minister Prabowo will vigorously pursue these military upgrades, although fiscal limitations may confine him to finishing existing projects rather than starting new ones (Chavez, 2024b).

In terms of military acquisitions, Indonesia has focused on enhancing its naval and air capabilities. Significant negotiations with Airbus in 2021 involved A330 Multi Role Tanker Transport aircraft, anti-submarine and transport helicopters, and A400M transport planes (Chavez, 2024b). The Defense Ministry finalized orders for two A400M aircraft in January, while discussions on the A330 continue. Additionally, the purchase of 42 Dassault Rafale fighter jets for $8.1 billion was confirmed, with the completion of the last 18 jets in January 2024 (Chavez, 2024b).

Enhancing collaboration with civilian agencies is crucial for effective HADR missions, underscored by the need for clear communication protocols, regular joint exercises, a unified information system, and standardized procedures (Samudro et al., 2022). Challenges such as limited interoperability with civilian systems, delayed disaster impact assessments, inadequate prepositioning of emergency supplies, and the absence of night operations capabilities for some aircraft fleets further complicate effective HADR efforts across Indonesia's extensive archipelago.

The IAF has made notable advancements in recent years, demonstrated by its enhanced role in both domestic and international HADR operations. This includes rapid damage assessments, participation in fire suppression, and supporting vaccination drives. Ongoing improvements in personnel training, equipment upgrades, and operational strategies have significantly boosted their readiness and effectiveness in disaster response scenarios (Chavez, 2024b), echoing the progress observed in other national forces such as the PAF.

Figure 12 provides a comprehensive overview of the IAF fleet, detailing its composition and projecting future capabilities through current assets and units on order. The fleet consists of 254 aircraft, categorized into fighters, close-air support, helicopters, transports, trainers, tankers, and special mission aircraft, each fulfilling a unique role in defense and operational tasks. This figure precedes the analysis of how these aircraft types contribute specifically to HADR missions.

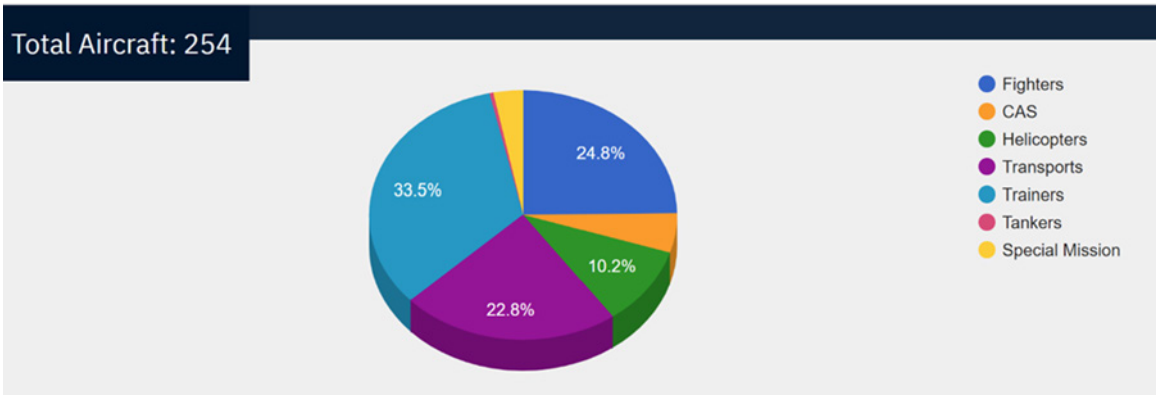

Figure 12. IAF's Composition.
Source: WDMMA (2024a).

In analyzing the fleet's structure and makeup considering HADR needs, it is essential to evaluate the utility of each aircraft type. For instance, while fighter jets are crucial for national defense, they offer limited direct utility in HADR operations, as they cannot be repurposed for rescue, relief, or recovery missions (Da Costa, 2024). This could represent a strategic limitation, given that one-quarter of Indonesia's fleet comprises fighter

jets, potentially diverting resources from more versatile aircraft that could better serve HADR purposes.

On the other hand, the fleet's helicopters, transports, and special mission aircraft are more directly valuable in HADR scenarios. Helicopters facilitate rapid response for search and rescue, medical evacuation, and aerial assessment of disaster-impacted areas. Transport aircraft are vital for moving large quantities of relief supplies and personnel quickly across the archipelago (Chavez, 2024a). Special mission aircraft, equipped for surveillance and communication roles, enhance the coordination and efficiency of disaster response efforts.

Therefore, for Indonesia to strengthen its HADR capabilities, a strategic review of fleet allocation and investment towards increasing the proportion of multi-role and transport aircraft would be beneficial (Da Costa, 2024). This shift would enable a more agile and effective response to natural disasters, which is critical for an archipelagic nation frequently facing catastrophic events. This analysis underlines the need for a balanced fleet that not only ensures national security but also enhances the country's resilience in managing humanitarian crises.

Figure 13 depicts that fighter aircraft represent 25% of the total assets, showcasing a range of aircraft designed for air superiority and multi-role missions (WDMMA, 2024a). Notably, the positive outlook suggests an anticipation of growth or modernization within this segment.

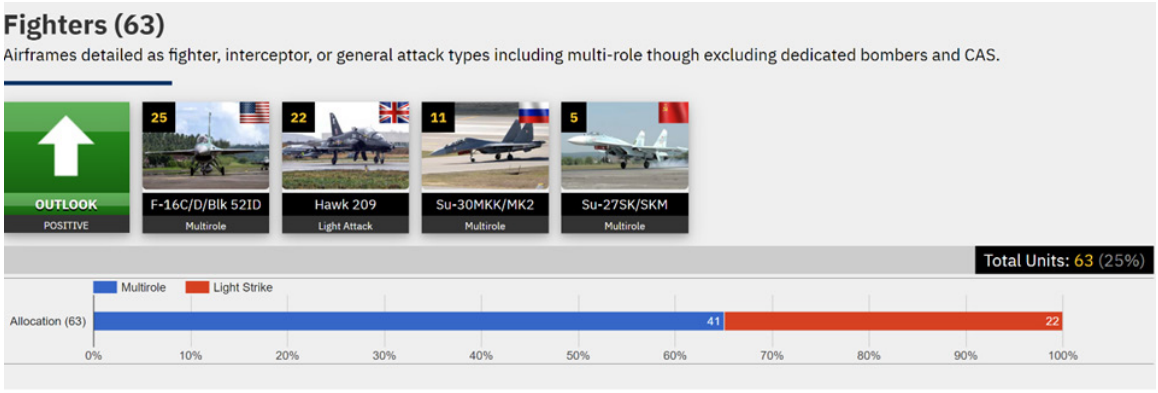

Figure 13. Fighter Aircraft Fleet Overview.
Source: WDMMA (2024a).

Figure 14 shows the close-air support (CAS) platform, which is a smaller yet vital component with stable prospects, indicating reliability in providing direct support to ground forces performing HADR missions in contested environments.

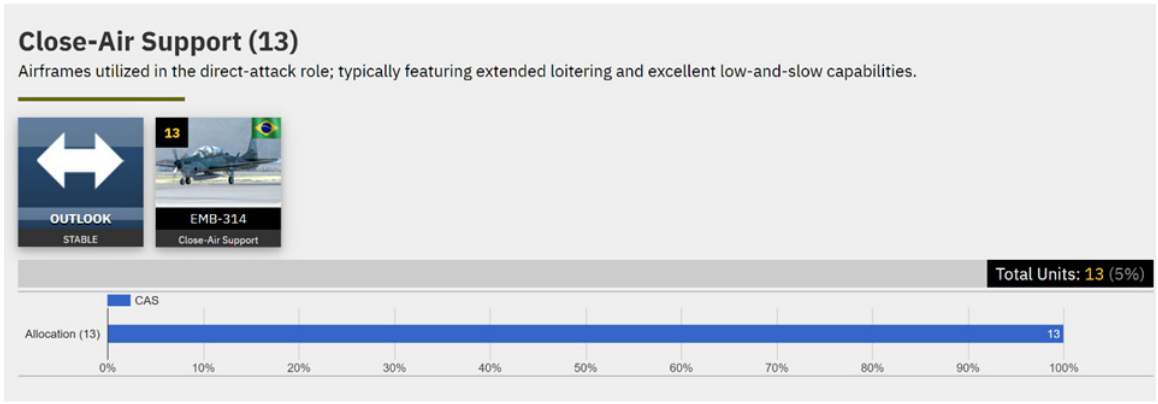

Figure 14. Close-Air Support Aircraft Fleet.
Source: WDMMA (2024a).

Figure 15 shows that helicopters account for 10% of the IAF's assets. They serve multiple functions, from transport to special missions, and a positive outlook reflects an expectation of enhanced versatility and increased operational use (WDMMA, 2024a).

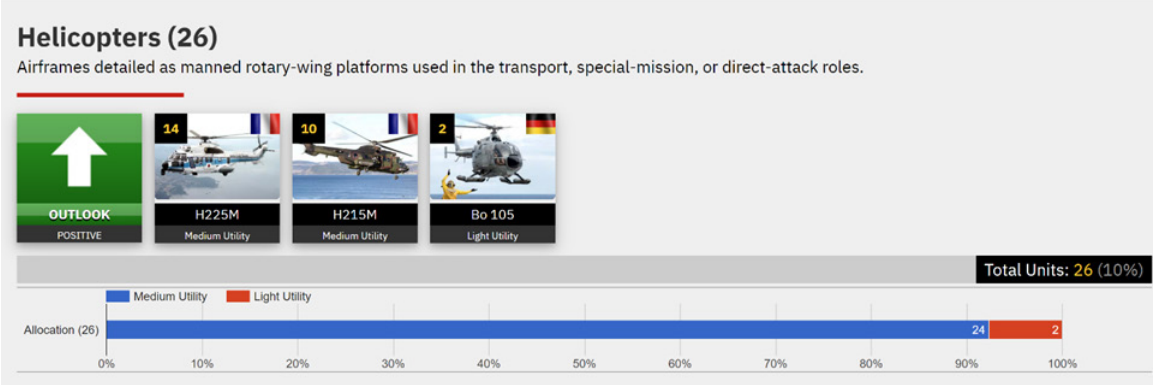

Figure 15. Helicopter Fleet Composition: Utility and Special Mission Capabilities. Source: WDMMA (2024a).

Figure 16 displays that IAF transport aircraft are a significant portion of the fleet at 23%. A positive outlook on their capability to move personnel and supplies indicates a robust logistic backbone in HADR (WDMMA, 2024a).

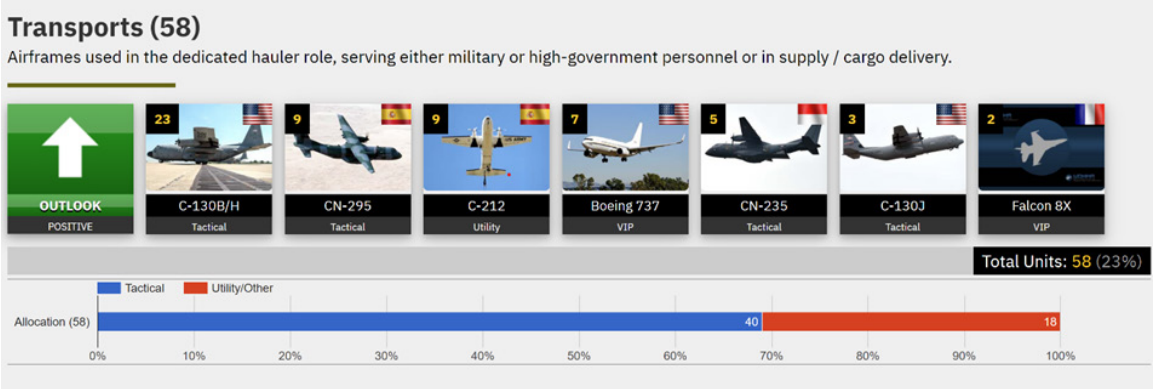

Figure 16. Transport Aircraft Fleet: Tactical and Utility Roles. Source: WDMMA (2024a).

Figure 17 accounts for trainers, the largest segment at 33%, which emphasizes the IAF's commitment to personnel development and readiness. The positive outlook hints at continuous improvement in training programs and resources.

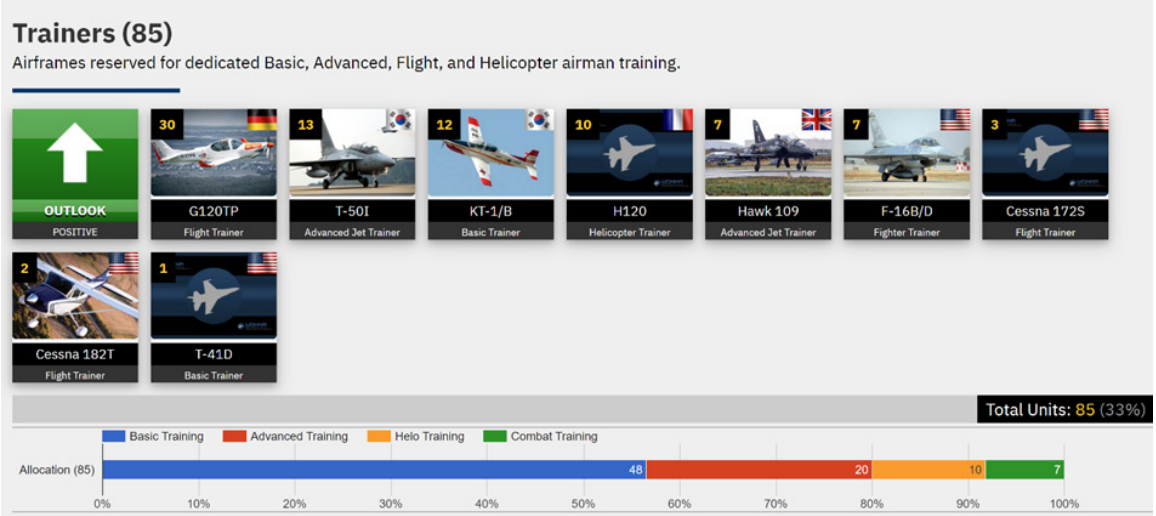

Figure 17. Training Aircraft Fleet Distribution: Specialization in Basic, Advanced, and Combat Roles. Source: WDMMA (2024a).

Figure 18 shows that the IAF has a single tanker for aerial refueling—a critical asset for extended HADR operations.

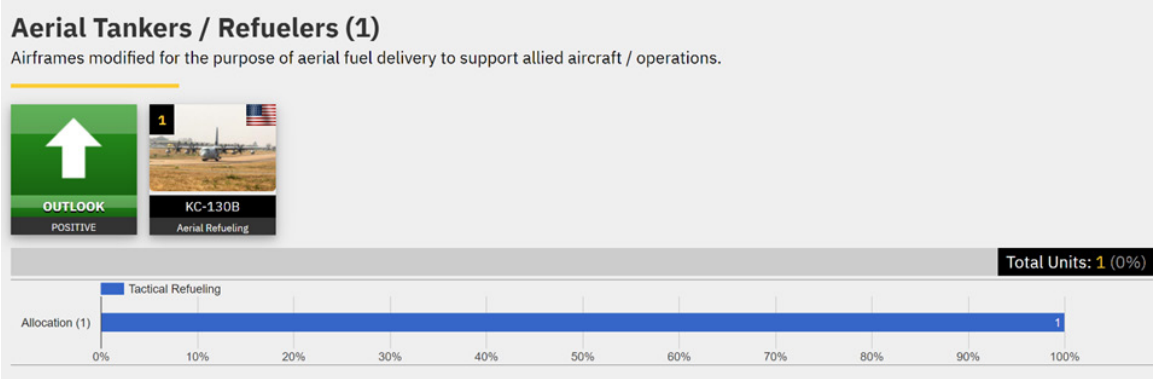

Figure 18. Aerial Tanker Fleet Status: Single Unit Allocation for Tactical Refueling. Source: WDMMA (2024a).

Figure 19 illustrates a fleet of eight special-mission aircraft primarily assigned to maritime patrol duties (WDMMA, 2024a). These aircraft are vital for the air force's HADR operations, providing critical capabilities in maritime surveillance and environmental tasks such as cloud seeding, which can be instrumental in disaster mitigation. The figure

underscores the positive outlook of this segment, highlighting its role in enhancing the air force's readiness for specialized HADR activities.

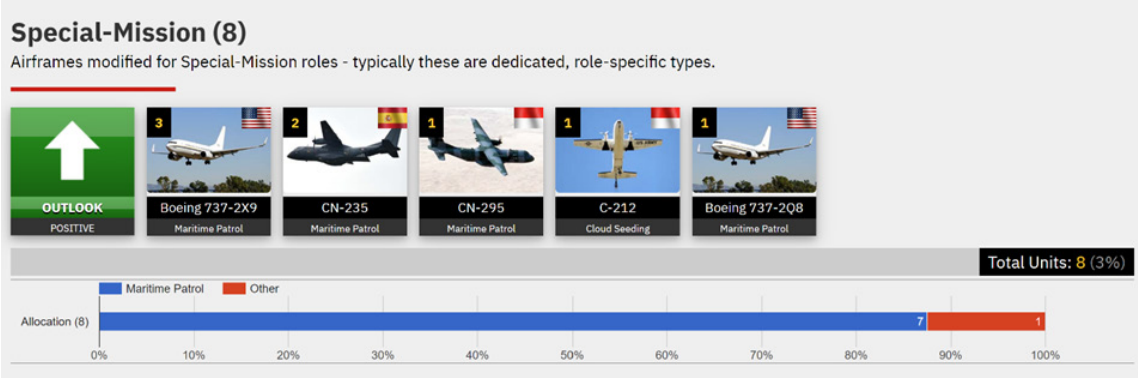

Figure 19. Special-Mission Aircraft Allocation: Diversity in Maritime Patrol and Other Specific Roles. Source: WDMMA (2024a).

Figure 20 outlines the aircraft currently on order, scheduled for delivery in the upcoming procurement year or thereafter. It highlights the strategic diversity of the new additions, totaling 60 units, which include multi-mission helicopters, attack helicopters, and advanced multi-role fighters like the Rafale F4. These planned acquisitions are set to significantly enhance the existing fleet's capabilities (Da Costa, 2024).

The inclusion of multi-mission helicopters will bolster the fleet's versatility (Chavez, 2024a), improving its capacity to deliver aid and execute rescue operations across diverse and challenging environments, which is crucial for HADR missions. Attack helicopters, while primarily designed for defense, will also provide vital aerial support to secure areas during large-scale disaster responses, ensuring safer conditions for relief operations.

Moreover, the addition of advanced multi-role fighters such as the Rafale F4 reflects a substantial investment in cutting-edge technology, aimed at maintaining a competitive edge and enhancing combat capabilities (Da Costa, 2024). These fighters will also support the fleet's training and transport capacity and expand its special and utility operations, further modernizing the fleet and preparing it to meet future challenges effectively. This strategic focus on modernizing and expanding the fleet's capabilities is

critical, ensuring that the air force remains well-equipped to handle both national defense and humanitarian crises (WDMMA, 2024a).

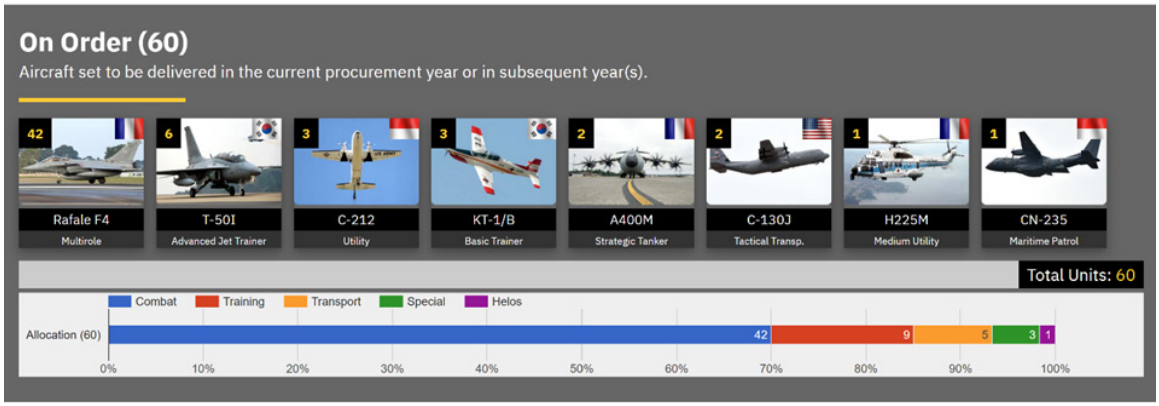

Figure 20. Upcoming Aircraft Deliveries by Type.
Source: WDMMA (2024a).

In conclusion, the IAF is integral to the nation's HADR operations, particularly due to Indonesia's susceptibility to a range of natural disasters. Nonetheless, the IAF faces ongoing challenges that require sustained investment and strategic development to enhance its disaster response capabilities (Chavez, 2024b). Economic constraints intensified by the COVID-19 pandemic have significantly restricted the ability of the IAF to modernize and replace outdated equipment, thus impacting its rapid response potential during emergencies (Chavez, 2024b).

The commitment to improving coordination with civilian agencies, as evidenced by initiatives to establish clear protocols and conduct regular training, is key to bolstering HADR missions. Still, limitations such as interoperability issues with civilian information systems and delayed disaster impact assessments pose substantial obstacles to effective HADR actions across the archipelago (Samudro et al., 2022).

Despite these challenges, the IAF has made commendable progress, as seen in the strategic negotiations for fleet augmentation, including multi-mission helicopters and advanced fighters like the Rafale, which are expected to significantly improve the IAF's HADR capabilities (Chavez, 2024b). Figures 12 to 20 from the WDMMA (2024a)

illustrate the IAF's current and prospective aircraft, indicating the potential for increased operational readiness in complex disaster scenarios. The acquisition of these diverse assets highlights the foresight of Indonesia's military leadership in preparing for future demands, mirroring the advancements observed in regional counterparts such as the PAF.

To ensure that the IAF remains a pivotal force in both national defense and international disaster response, a continual reassessment and realignment of the fleet's structure and capabilities with the nation's HADR needs are essential. This strategic approach will not only preserve the IAF's readiness for HADR operations but will also contribute significantly to Indonesia's resilience and stability in the face of natural catastrophes.

D. COMPARATIVE ANALYSIS OF AIR ASSETS IN HADR OPERATIONS

The comparative analysis of air assets between the PAF and the IAF reveals both similarities and differences in their strategic approach to HADR operations. In the face of Typhoon Haiyan, the PAF leveraged its C-130 aircraft and UH-1H helicopters as pivotal components of their relief efforts. Despite the logistical and maintenance challenges associated with the aging equipment, these assets proved crucial in the transportation and distribution of aid to affected areas. The utilization of these assets aligns with observations by Smith (2023) and the Federal Emergency Management Agency's (FEMA's) (2006) emergency management principles, which underscore the indispensable role of versatile and reliable air assets in disaster scenarios.

In a parallel vein, the IAF's response to the Sulawesi earthquake/tsunami also featured the C-130 Hercules, underscoring the shared reliance on this type of aircraft for its logistical capabilities in crisis situations. The IAF's reliance on this platform mirrors the PAF's strategy, indicating a regional preference for the C-130's proven reliability in rapid response and aid delivery across challenging geographic landscapes.

The post-disaster evaluations from both air forces highlight the critical need for modernization and readiness improvements. This insight dovetails with the PAF's Flight Plan 2040, which seeks to enhance the force's credibility and readiness through strategic modernization, as detailed in *Perspective 2023* (PAF, 2023). Similarly, the IAF's ongoing

modernization initiatives aim to address the identified fleet readiness challenges, as underscored by Chavez (2024b). Both forces recognize the evolving nature of airpower in HADR operations and the necessity of bolstering their fleets with modernized assets that can provide rapid, flexible, and efficient disaster response capabilities.

This comparative analysis sheds light on the need for robust, agile, and technologically advanced air assets in the ASEAN region's HADR efforts. It also points to a shared understanding of the strategic value of airpower in enhancing national and regional disaster response frameworks. Through continuous investment in modernization and readiness, both the PAF and IAF aim to reinforce their commitment to safeguarding communities and strengthening resilience in the face of natural calamities.

E. ASSET DEPLOYMENT EFFICIENCY: A COMPARATIVE ANALYSIS

Asset deployment efficiency is a crucial aspect of military operational capabilities during HADR missions. This comparative analysis examines how the PAF and the IAF have managed asset deployment in response to Typhoon Haiyan and the Sulawesi earthquake/tsunami, respectively. Focusing on assembly time, transit time, and employment time, this analysis draws on the operational experiences of both air forces to assess the efficiency of their disaster response operations.

1. Assembly Time

Smith (2023) reports that in the aftermath of Typhoon Haiyan, the PAF experienced delays in assembly time due to the scattered nature of its assets across the archipelago, which impeded rapid consolidation and deployment. In contrast, during the Sulawesi disaster, the IAF benefited from its centralized command structure and the effectiveness of pre-disaster drills, which contributed to a state of preparedness allowing for quicker assembly times (FEMA, n.d.-a). These observations suggest that strategic pre-positioning of assets and the adoption of a centralized control system are critical for improving response times in geographically dispersed settings.

2. Transit Time

Smith (2023) details how the PAF's response times to disasters are often lengthened by the complex archipelagic geography of the Philippines, coupled with the nation's less developed infrastructure and inadequate coordination among different transportation methods. Conversely, according to FEMA (n.d.-a), the IAF has effectively reduced transit times by investing in the resilience of critical infrastructure, such as airfields and ports, and by the strategic pre-positioning of resources in anticipation of potential disasters. These practices showcase the significant role that infrastructure preparedness and strategic positioning of assets play in enhancing the efficiency of air force responses in disaster-prone archipelagic regions.

3. Employment Time

According to Smith (2023), the PAF aspired to achieve rapid deployment of assets within 72 hours following disasters but faced significant delays due to runway obstructions from debris, which impeded the synchronization of air and ground relief operations. In contrast, the IAF capitalized on established disaster response protocols and the seamless coordination between their air assets and ground personnel, enabling a more efficient deployment of resources during the Sulawesi disaster response (FEMA, n.d.-a). This comparison highlights the critical role that thorough disaster preparedness, consistent maintenance of infrastructure, and strong inter-agency coordination play in minimizing the time to employ assets effectively during HADR efforts.

The comparative analysis of asset deployment efficiency between the PAF and the IAF underscores several areas needing enhancement to improve the rapid deployment of military assets during disaster responses. The findings suggest that integrating a centralized command structure, strategic pre-positioning of assets, robust investment in resilient infrastructure, and the establishment of clear disaster response protocols are crucial. Additionally, fostering interagency cooperation and coordination with other military forces and civilian agencies can significantly boost operational effectiveness. Such integrations are critical for ensuring that air forces in archipelagic nations can deliver timely and effective HADR support amid natural disasters. Continual investments in these strategic

areas, along with enhancing interagency collaboration, are essential for optimizing the readiness and response capabilities of air forces.

F. COMPARATIVE ANALYSIS OF INTER-AGENCY COORDINATION IN PAF AND IAF DISASTER RESPONSES

Effective inter-agency coordination is pivotal for the success of disaster response efforts, enabling various organizations to collaborate seamlessly and efficiently. This section assesses the coordination efforts of the PAF and the IAF during Typhoon Haiyan and the Sulawesi earthquake/tsunami, respectively. The PAF faced considerable challenges during Typhoon Haiyan due to significant communication gaps among different disaster response agencies compounded by the absence of a unified command system. These issues led to inefficiencies in role distribution and responsibilities, resulting in delayed decision-making and overall response time, which severely impacted the effectiveness of the relief operations (Damaševičius et al., 2023).

In contrast, the IAF's response to the Sulawesi earthquake/tsunami showcased an evolution in inter-agency coordination. There was a noticeable improvement in alignment and cooperation among various governmental and non-governmental organizations, though challenges persisted with some inconsistencies in operational procedures and priorities. These occasionally hindered a fully unified approach to the disaster response. Nevertheless, the IAF demonstrated a more structured coordination framework that facilitated quicker consensus-building and resource allocation among the involved entities. A notable example was during the immediate aftermath of the earthquake, where the IAF efficiently coordinated with local emergency services and international aid organizations to establish a centralized command for distributing aid and managing logistics, thus optimizing the response effort (FEMA, 2020).

These experiences highlight the critical role robust inter-agency coordination plays in enhancing the efficacy of disaster response efforts. While the PAF's coordination difficulties were rooted in systemic communication failures and a lack of cohesive operational command, the IAF's scenario displayed the potential benefits of having well-prepared coordination protocols, despite some procedural alignment issues. Both instances

underline the necessity for pre-established, clear, and practiced coordination mechanisms that can significantly streamline collective response efforts during emergencies, underscoring the importance of integrated planning and the need for continuous improvement in communication and procedural protocols among all disaster response stakeholders.

G. COMPARATIVE ANALYSIS OF MODERNIZATION IMPACTS ON PAF AND IAF DISASTER RESPONSE

The modernization of air force capabilities is a critical factor in enhancing the effectiveness of disaster response operations. This section examines the impact of modernization efforts within the PAF and the IAF in the context of their responses to significant natural disasters. The PAF's involvement in Typhoon Haiyan and the IAF's engagement in the Sulawesi earthquake/tsunami provide a basis for evaluating the role of modernization in operational efficacy.

The PAF's response to Typhoon Haiyan highlighted several challenges attributed to outdated equipment and technology. These deficiencies underscored the urgent need for modernization within the air force to improve its disaster response capabilities. In the wake of Haiyan, the PAF initiated comprehensive modernization plans under its Flight Plan 2040, aimed at enhancing operational readiness and technological advancement to better manage future natural calamities (PAF, 2023).

Conversely, the IAF's handling of the Sulawesi earthquake/tsunami showcased the positive outcomes of its recent modernization efforts. These included the procurement of new aircraft and enhancements in logistics and command and control systems, which collectively expedited the IAF's response times. However, while these upgrades have provided a robust platform for rapid deployment, the IAF's experiences during the earthquake underscored the need for ongoing updates to keep pace with the evolving demands of disaster response (Chavez, 2024b).

Both the PAF and IAF have recognized the importance of modern air assets and sophisticated command structures in improving the speed and efficiency of their disaster responses. The PAF's planned advancements under Flight Plan 2040 and the IAF's

ongoing modernization efforts reflect a shared understanding across the forces that upgrading military capabilities is imperative to address the complex challenges presented by natural disasters effectively. These initiatives not only aim to enhance the technical and operational capacities of the air forces but also ensure that they are better prepared to manage the logistics and coordination challenges that typically arise during large-scale humanitarian crises.

V. CONCLUSION AND RECOMMENDATIONS

A. CONCLUSION

This comparative study underscores the Philippine Air Force's (PAF) critical role in the nation's Humanitarian Assistance and Disaster Relief (HADR) efforts, using the Indonesian Air Force (IAF) as a benchmark to evaluate and enhance the PAF's operational strategies. The PAF's ongoing modernization, outlined in its Flight Plan 2040, aims to significantly improve its operational efficiency and readiness for HADR missions (PAF, 2023). By examining the IAF's response strategies and organizational reforms, which have bolstered its capabilities in disaster response (Chavez, 2024b), this analysis highlights key areas where the PAF could enhance its own effectiveness.

The comparison reveals that while the PAF has made substantial progress, there are still crucial opportunities for improvement, particularly in positioning, logistics, and inter-agency coordination. These elements are pivotal for maximizing the effectiveness of disaster response efforts. By focusing on these areas, the PAF can ensure that it not only matches but potentially exceeds the response capabilities demonstrated by the IAF. This focused improvement will enable the PAF to more effectively manage the complex challenges presented by natural disasters, thereby enhancing the overall efficacy of its HADR operations.

B. RECOMMENDATIONS

Building on insights from Chapters I and II, which highlighted the exacerbating impact of climate change on the frequency and intensity of natural disasters, this study makes several strategic recommendations to strengthen HADR responses.

1. Strengthen Asset Deployment Efficiency

- Accelerate fleet modernization efforts to replace aging assets with more reliable, versatile, and maintenance-friendly aircraft, focusing on acquisitions that offer quick response capabilities suitable for the Philippines' geographical context (PAF, 2023).

- Enhance logistical frameworks to support rapid mobilization and deployment of assets, including the establishment of forward-operating bases equipped with necessary maintenance facilities (Smith, 2023).

2. Improve Inter-Agency Coordination

- Develop and implement standardized operating procedures (SOPs) for HADR operations that outline roles, communication protocols, and information sharing mechanisms among all stakeholders, including government agencies, non-governmental organizations (NGOs), and international partners (FEMA, n.d.-b).

- Invest in integrated communication and information systems that provide a Common Operating Picture for all involved in disaster response, facilitating better coordination and decision-making (FEMA, 2020).

3. Accelerate Modernization Initiatives

- Formulate a comprehensive modernization plan that aligns with the operational demands of HADR missions. Prioritize investments in dual-use technologies that enhance both military and humanitarian response capabilities (Chavez, 2024b).

- Foster innovation and embrace new technologies such as unmanned aerial vehicle (UAV) drones, satellite communications, and artificial intelligence (AI)–based coordination tools that can significantly improve situational awareness, assessment capabilities, and decision-making processes in disaster scenarios (Jain & Chetty, 2022).

4. Build Capacity and Foster Collaboration

- Conduct regular training and joint exercises involving the PAF, other military branches, civilian agencies, and community organizations to build capacity, improve collaborative behaviors, and enhance overall disaster response readiness (Smith, 2023).

- Establish partnerships with academic and research institutions to explore innovative solutions and best practices in disaster management that can be adapted to the local context (Jain & Chetty, 2022).

C. SUMMARY

In conclusion, while the PAF and IAF are progressing in their capabilities for disaster response, the comparative analysis clearly indicates that additional efforts in modernization, coordination, training, and collaborative partnerships are essential. These areas are critical for ensuring that both air forces can meet the evolving challenges of disaster management effectively. The findings from the literature review and comparative case study support these conclusions and recommendations, emphasizing the need for an integrated and proactive approach to enhancing the operational efficacy of military involvement in disaster response and management.

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