

The Impacts of Transportation System towards the Military Logistics Support in Sabah

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Abstract— Military logistics are ranked among the critical components contributing to the military operation's success. The efficiency of military logistics support relies on its rapid response when a favorable choice of route and a high-performance vehicle is utilized. This study was conducted in Sabah to explore the logistics support's effectiveness, with the military establishment scattered around Sabah while the central depot is remotely located from Kota Kinabalu to support the logistics required for the whole military. Further, a qualitative inquiry methodology was utilized in exploring the nature of issues. The interview protocol was prepared as a guideline. This study used purposeful snowball sampling and resulted in 17 key informants, comprised of military transport drivers and officers. A semi-structured interview was conducted with these key informants. This study found that the main challenges were the military troop transporting logistics on mountainous and poor road conditions. Moreover, the vehicle used to transport logistics is old, aging, and inefficient to perform logistics support. Hence, it is imperative was found that the transportation system consisting of Drivers, Roads, and Vehicles has a direct impact on inefficient military logistics support. In light of these challenges, a framework of transportation system impacts on military logistics in Sabah was developed. This study contributes to gaining more insight into the transportation system's influence on Sabah's military logistics efficiency. Finally, this paper offers a solution that is the right time to replace the military vehicles since most of the vehicles were already beyond their economic life.

Keywords— Military logistics support; poor road conditions; road network; long-distance driving; transportation system.

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I. INTRODUCTION

A Road network is a framework of road patterns in a territory comprising highways, trunk roads, and principal roads, which serve as the communities and the country's strategic transportation necessities. A major road network development that the government effectuates is needed to ensure that all regions are interconnected efficiently, especially in rural areas [1]. Road infrastructure is essential for developing the quality of life and improving the vulnerable communities' economy in rural areas [2]. Moreover, to connect the society, this road network provides access to major ports, airports, and intermodal rail terminals, which is critical for economic and social well-being [3].

Road infrastructure is necessary for a country; thus, the government must ensure that the road network's safety standards are not compromised [4]. Road safety in this context refers to the standards set and the reduction of accidents and

losses [5]. However, budgets earmarked for road maintenance are always insufficient. Given that these road networks are under government accountability, the pressures between the national and local needs on road priorities are unavoidable [4], [6]. Generally, the major road network's geographical coverage, which connects regional cities, is inadequate in rural areas [7]. Hence, the road network's main issues relate to the capacity and coverage [8], especially in rural areas [9]. In Malaysia, road construction has begun before the independence. There are 61,420 kilometers of state roads and municipality roads, 18,904 kilometers of Federal roads, and 1,820 kilometers of highways [10].

Sabah is a state located in the East of Malaysia and has the second-highest population in Malaysia [11]. Sabah is partly mountainous with about 208 km of the mountainous road [12] and is separated by the South China Sea from the west peninsular. There are 21,934 kilometers of major roads, and the other roads comprise streets connecting small

communities and isolated towns. These routes and towns are presented in Table 1. Besides, the Sabahan communities have expressed their concerns that numerous parts of the state were not adequately linked with the existing critical road network [13].

TABLE I
ROUTES AND TOWN SERVED (SOURCE PUBLIC WORKS DEPARTMENT
SABAH) [10]

| Trunk Road | Routes/ Destination | Town Served |
|------------|---------------------------|---|
| A1 | Kota Kinabalu to Kudat | Kota Kinabalu - Tuaran - Tamparuli - Kota Belud - Kota Marudu - Pitas - Kudat |
| A2 | Kota Kinabalu to Sindumin | Kota Kinabalu - Penampang - (Putatan - Lok Kawi) Papar - Beaufort - Sipitang - Sindumin |
| A3 | Kota Kinabalu to Nabawan | Kota Kinabalu - Penampang - Tambunan - Keningau - Tenom - Nabawan |
| A4 | Kota Kinabalu to Sandakan | Kota Kinabalu - Tuaran - Tamparuli - Kundasang - Ranau - Telupid - Sandakan |
| A5 | Sandakan to Tawau | Sandakan - Lahad Datu - Kunak - Semporna - Tawau |
| A6 | Beaufort to Menumbok | Beaufort - Menumbok |

There is a considerable amount of army camps and naval bases scattered around Sabah, which are positioned there for the surveillance of international borders, either on land or the sea. Furthermore, the Royal Army and the Royal Malaysian Navy operate in these areas and acquire their logistics supplies from the suppliers directly to the camps and bases. However, some logistics supplies are obtained from the central depot in Kota Kinabalu, Sabah. This main logistics depot is the highest regional military logistics network structure in East Malaysia.

Besides working on fulfilling logistics demands, the military personnel also perform tasks related to transporting the logistics required, such as:

- Load the military vehicle with associated supplies.
- Receive delivery of consignment, equipment, and materials.
- Forward movement equipment and materials.

Defense logistics plays a crucial role and is the center of gravity for the military [14]. This military transportation is highly used not only for delivering logistics supplies but also plays a key role in the movement of troops [15], [16]. With the changes in threats and new security outlook, the military is becoming more mobile with a lesser requirement to shift the soldiers to the field to resupply from the central depot [17]. However, the fundamental problem is to acquire the most efficient route to resupply from the central depot. The military supply chain has become more complicated since the central depot's location is greater than the army camps and naval bases.

The success of military logistics support is due to their rapid response and long-term goal to achieve sustainability to move forward [18]. Defense logistics is the science of planning and carrying out the movement of forces [19], which involves transporting material and redeploying personnel [20]. Hence, defense logistics should have the capabilities to

provide support during force generation, deployment, and peacetime.

The military operation is often planned, albeit the outcome is frequently unpredictable. Thus, it is imperative to acquire substantial logistics support to ensure success in a military operation; therefore, logistics support should respond rapidly. In the logistical planning process, extensive variables have to be considered to provide logistics support at the exact quantity, time, and the right place [21]. However, in the supplies' delivery or receipt, the demands and the location are crucial factors in fulfilling this operation.

Military transportation is the lifeline for operations, which plays a vital role in delivering logistics supplies such as the supplies and equipment to fulfill the operational requirement and transport personnel to the theatre [22]. This operation is a part of the military organization that provides mobility to move at any moment in any required direction [23]. Meanwhile, the transport service is one of the essential utilities that acts as an indicator of a successful military troop. Moreover, military operations are impossible without proper transport to place forces in the field [24]. In the context of historical military transport, military transportation was indicated crucial and had to comply with essential conditions, such as:

- It should be sufficient to fulfill force deployment.
- It should be in the best possible condition at all times.
- It should always be ready for movement.

II. MATERIALS AND METHOD

A. Study Area

The importance of military transportation has long been forgotten and has not been implemented in the military forces worldwide due to being uninvolved in conventional wars. Nevertheless, military transportation is an essential requirement; thus, this study aimed to understand Sabah's military land transport status. Therefore, this study identified the challenges in military logistics support in Sabah. The army camps and naval bases were scattered around Sabah, and the essential supplies must be collected from the central depot in Kota Kinabalu. Furthermore, for each trip, this study reported the routes and distance from the army camp and the naval bases to the central depot as in Table II, whereas the road conditions and the impact on the military vehicles were analyzed.

TABLE II
LOCATION AND DISTANCE

| Location | Distance (Kilometres) |
|------------|-----------------------|
| Sandakan | 335 |
| Lahad Datu | 404 |
| Tawau | 555 |
| Semporna | 565 |

B. Methodology

A qualitative inquiry method was used, which provided firsthand information. Inductive strategies used in conducting this study were first exploring the nature of issues and problems faced by Sabah's military logistics. After understanding the issues, the researcher reviews previous literature extensively to identify the research gap. Based on the preliminary issues identified, the researcher found that the

military troop is transporting logistics on mountainous and poor road conditions to perform logistics support in Sabah. This issue has become the main gap in this study. Based on the archival of the asset database and maintenance record, the vehicle used for transporting the logistics is old and aging. This has motivated the researcher to explore further how these issues impact the logistics support in Sabah.

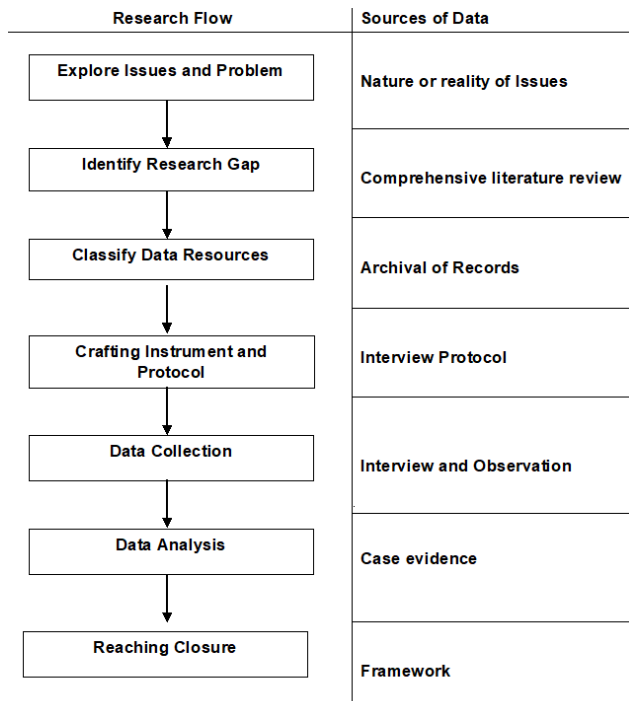


Fig. 1 Research Flow Chart

The interview protocol was prepared as a guideline during the interview session. In finding the research participants for the interview, this study used purposeful snowball sampling and resulted in 17 key informants, which comprised military transport drivers and officers. According to Heaton [25], using the snowball method in purposeful sampling will help gather rich information in learning about an issue. With the assistance given by military headquarters, the semi-structured interview was conducted. Moreover, these experienced personnel were identified and selected due to their capability for long-distance driving, especially from the army camps and naval bases to the central depot.

Six trained Sabahan research assistants were recruited to collect military vehicle transportation status data that impacted Sabah's logistics support. The interviews were voice recorded. The recordings were transcribed verbatim and translated into the Malay language. Notably, most of these drivers were Sabahan; thus, their pronunciation and phrases were unique and dissimilar to the peninsular or West Malaysia citizens. Next, the transcript was reviewed using a thematic analysis that generated codes to describe the theme categories: distance, road condition, and military vehicle status. Moreover, the observations took place on the routes used by the military personnel to travel from their camps or bases to the central depot in Kota Kinabalu. The data collected was then analyzed into case evidence and used in developing a conceptual framework

III. RESULTS AND DISCUSSION

The military personnel responsible for collecting logistics supplies from the central depot in Kota Kinabalu involve males, while the tasks are based on rotations. Additionally, the personnel possessed more than three years of experience in long-distance driving. During the interview, it was found that there were other findings, such as fatigue management, which did not directly impact the logistics support. However, this support was crucial and needed to be taken into consideration.

A. Distance and Road Condition

The time duration to traverse between two nodes was used to measure the road conditions and distance. Reliability of travel time is considered successful when a trip from origin to destination is achieved within a specific time [26]. However, most of the time, the journey takes a longer duration. The variations in time duration are usually caused by the network uncertainties, potentially due to traffic demand, accidents, weather conditions, or road construction. Time duration varies due to certain factors such as poor road conditions and long-distance travel. However, in the context of roads in Sabah, it was rarely related to uncertainties.

In fulfilling the logistics needs, the military personnel in charge of the army camps and naval bases must travel for a long-distance journey to Kota Kinabalu, the central depot, for logistics supply in Sabah. The movement is usually in a single-vehicle and sometimes in a group known as platooning. Hence, Table II illustrates the locations of the army camps and naval bases in Kota Kinabalu.

“Before this, to travel from Kota Kinabalu to Tawau, we have to travel a further distance which is through Kota Kinabalu – Ranau – Telupid – Kinabatangan -Lahad Datu finally reaching Tawau, which is 555 kilometres takes about 10 to 11 hours. But now we have another option with a new route where to Tawau from Kota Kinabalu through Keningau is about 476 kilometers. However, the duration of time is more or less the same as the old route, which takes about nine to ten hours. We have to be on the road for a long time because many lorries carrying timber have slowed down our journey [sic].” Research Participant 3

The journey traveled for 565 kilometers one way, which took more than ten hours because of the poor road conditions, which may cause punctured tires and vehicle break-down. Additionally, the road was bumpy [13], full of potholes [27], across mountainous areas, and prone to landslides, which were due to poor road design and the lack of maintenance [28]. The journey also did not have places to stop mid-journey, leaving the vehicles in bad conditions.

“...the challenge we faced every time travel to Kota Kinabalu is that we have to travel on a bumpy road. Every time I travel, I will see many roads patching works here and there. I think the district office has done their job to patch the pothole; however, it is just a temporary measure. I think they should do proper road maintenance [sic].” Research Participant 7

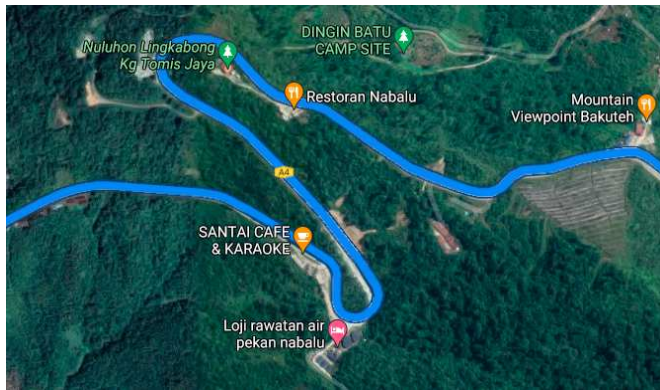


Fig. 2 Mountainous Road Tamparuli to Kota Kinabalu

“...the most challenging route is the mountainous road from Tamaparuli to Kota Kinabalu. Almost every time we climb up the hill, there will be an accident or landslide when it is raining season[sic].” Research Participant 5.

Furthermore, these unfavorable conditions had increased the traveling duration and extensively impacted the military vehicle's condition and performance, which increased the chance of road accidents.

B. Military Vehicle Performance

The units in Sabah have requested a replacement of vehicles; however, they were only allocated for vehicle maintenance due to the ministry's budget constraints. Based on the Asset Reports, 17 military vehicles consisted of three-tonne and 3^{3/4} tonne trucks aged between eight to 23 years, which were used for logistics support in delivering and receiving supplies from the central depot in Kota Kinabalu. According to the Asset Management Procedure, trucks' economic life was at a maximum of 8 years. Additionally, these trucks had to go through preventive and corrective maintenance, in which most of these trucks were beyond their economic life. This predicament will affect vehicle maintenance, where these defective trucks cannot be repaired, thus increasing the maintenance cost. This technical failure has caused poor performance, which brings unsafe driving and leads to accidents. Hence, the unit could not retire these trucks despite the poor vehicle performance due to unattainable trucks replacement.



Fig. 3 Military Vehicle Accident at Ranau to Tamparuli Road [29]

The vehicle issue in Sabah has become a secondary issue, where all the units in Sabah are focused on the operational issue instead. Furthermore, these units comprised the forward operating base for East Malaysia with their primary task of safeguarding the sovereignty in specific areas. Additionally, most commanders displayed less interest in vehicle issues, where most were related to vehicle performance. Based on the

report, the low vehicle performance was caused by over-usage, in which these vehicles were used beyond their economic life. Ultimately, with the poor road conditions and the long-distance journey, these vehicles will deteriorate over time.

“...with this condition, we have difficulties in delivering the supplies on time. We are unable to deliver the supplies on time. An unplanned stop on the roadside causes this delay. The engine overheated we could not carry on our journey [sic].” Research Participant 13

“Our 3-tonne trucks are maintained according to schedule; however, surprisingly, the truck's status is under maintenance and has to be sent for outside repair for replacing the component. This costs a lot, making us reschedule our resupply activities [sic].” Research Participant 16

Notably, the military vehicles used on numerous occasions were not limited to being utilized only for the personnel's movement and logistics support. Furthermore, with the heavy military-related operations in Sabah, these military vehicles were used maximally. However, most of these trucks have exceeded beyond economic life, which created unfavorable inefficiencies for Sabah's military logistics support.

C. Driving Fatigue

The military personnel drove to meet the work schedules, including delivering or receiving logistics supplies. Furthermore, military personnel were aware of the speed limits and safety regulations. However, they were required to drive regardless of fatigue to fulfill their essential duties.

“...sometimes I feel so tired, but I have no choice but to continue driving, and the road has no place to stop for me take a nap or rest for a while”. In order to ease this fatigue and tiredness, I usually listen to the music from the radio while opening the window. However, this couldn't stop me from feeling sleepy because the music I can hardly hear it because the noise from the lorry engine and the outside noise is louder than the music [sic].” Research Participant 11

“I realised that I likely to be fatigued in the afternoon. Usually, to travel from Tawau to KK, I will try to drive as early as 7 o'clock in the morning. However, after 3-4 hours on the road, I will start feeling sleepy and fatigued. I think a long hour makes me feel fatigued [sic].” Research Participant 9

This study found that the long hour driving will increase the tendency of fatigue. The military personnel must stay focused, not disturb by other road users, and always alert to the situation and the road environment. Moreover, given that there were no rest facilities for the military personnel on the roadside, they have no choice but to continue driving, which may increase the chance of accidents and casualties.

The military logistics support in Sabah faces a high risk of operating their transport to get Central Depot supplies in Kinabalu [30]. Based on the findings, a framework of transportation system impacts towards military logistics in Sabah was developed. As mentioned in Driver-Vehicle interaction simulation [31], the transportation system consists of drivers, vehicles, and roads. This transportation system issues faced by the military in Sabah greatly impact the inefficiency of military logistics support in Sabah.

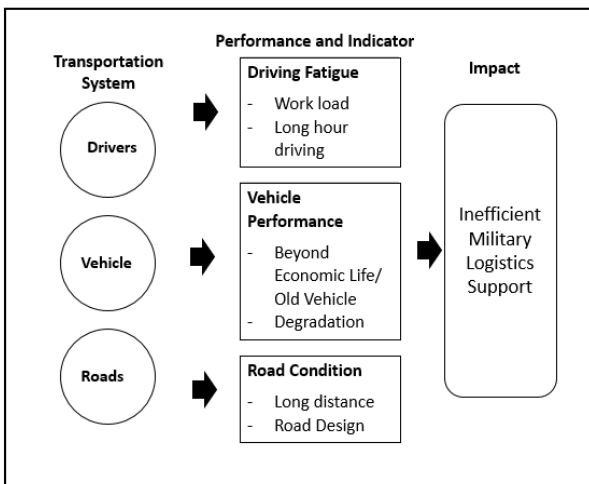


Fig. 4 Transportation system impacts in inefficient Military Logistics Support

As shown in Figure 4, the transportation system directly impacts inefficient military logistics support. Transportation systems can be classified in drivers, vehicles, and roads. It should be noted that the components under this view reflect the value contribution of driving fatigues, vehicle performance, and road condition.

Drivers' perception changes in many different conditions based on their psychological state. Long hours of driving can cause sleep deprivation and fatigue. Moreover, driving on monotonous highways and curves on mountainous roads requires speed and continuous land position control changes. These driving conditions require focusing on the eyes to watch, the hand to handle the vehicle, and the mind to stay alert. In this situation, the mind has to handle a more mental workload. Military drivers are more likely to drive to meet the work schedule and workload. Driving long distances for long hours will make the drivers exhausted and leave them with fatigue. Many people continue driving even though they feel fatigued, which may cause an accident.

Old vehicles are expensive to maintain, caused by charges for maintenance. Along with fuel inefficiency in fuel consumption, the absence of proper modern passenger safety, and the production of high levels of toxic exhaust emissions. At the same time, it could not meet the user or driver's expectations of deteriorating performance and inability to continue the task of transporting goods. The vehicles would finally stop on the roadside, thus delaying the delivery tasks as scheduled. This will, therefore, reduce the operating hours of the vehicle. The value of beyond economical repair vehicles usually decreases from 80% to 20%. Old vehicles are not only deteriorating their roadworthiness but also the safety element. Vehicle in the military transportation system is responsible for extended activities, including the movement of troops and materials. These activities involve service demand, identifying a destination, and calculating distance and duration. However, those activities will be hindered from accomplishing within the required time beyond economical repair vehicles. When driving this type of vehicle, the degradation issue becomes a serious matter and requires a solution to prevent the whole military logistics support system from jeopardizing.

The vulnerability of road networks created risks and threats to road users. Most of the roads in rural areas have poor road

designs, conditions, and lack of maintenance which cause unreliability of the network. Complement with long-distance location and failure to provide a good network will affect travel time, accidents, and road users' safety issues. In addition, long travel distances and frequent stops have caused stress to the drivers and the vehicles, and other parts such as shock absorbers and tires.

Hence, military logistics operation is crucial and acts as a lifeline, especially during war. The military's transport system depends on the drivers, vehicles, and roads to respond to logistics requirements. Failure of these three elements will impact the efficiency of military logistics support where supplies could not be delivered at the right time.

IV. CONCLUSIONS

The findings from this study showed that military logistics support's efficiency depends on several factors. These include the distances between the army camps and naval bases located remotely from the central depot. Furthermore, given this remote distance, the probability of accidents during the task of delivering and receiving supplies, which are performed by the military personnel, would also increase. Moreover, with poor road conditions, the routes to the mountainous central depot route became difficult for the drivers and had serious effects on access to the locations. This predicament was enhanced by the vehicles' low performance caused by the age factor, causing them to break down and ultimately delay the military logistics support's activities. Therefore, fulfilling the logistics requirement for those who urgently needed supplies with this condition was not an option. In particular, operating the trucks with maximum loads required the military personnel to drive cautiously, which caused tiredness, stress, and fatigue.

Nevertheless, the army camps and naval base personnel had no choice but to acquire their supplies remotely from the central depot. Thus, given these points, it is the right time to replace military vehicles since most vehicles are already beyond their economic life. Additionally, even though the vehicle maintenance was performed, it was found that the maintenance activities could not solve or increase the vehicle's performance, which is deteriorating over time. Therefore, this study is crucial for the military to revise the asset replacement policy to enhance and support efficient logistics, which becomes critical during a conflict. Nevertheless, to reduce the transportation cost and enhance road mobility as well as accessibility, the state government should consider new initiatives to improve, construct, and upgrade the roads in Sabah, besides reducing the rate of serious injuries and fatalities caused by road transport accidents, which should be of the highest priority.

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