FUEL SUPPLY SHORTAGE RISK: A CASE STUDY OF HUMANITARIAN ORGANIZATION "MEDICAL AID MYANMAR"

Htet Htet Win* and Chainarong Rungruengarporn**
Assumption University of Thailand

ABSTRACT

This study, which is a case of supply chain risks faced by Medical Aid Myanmar (MAM) within its fuel supply operations, aims to identify the risks, assess their impact, and propose strategies to mitigate these risks, to enhance MAM's operational stability. Data from 2022 to 2023 was collected through qualitative interviews and risk assessments, classifying 25 risks into high-priority (Zone A), moderate-priority (Zone B), and low-priority (Zone C) categories. Key findings include high-priority risks such as political instability and supply disruptions, which pose significant threats to MAM's fuel supply chain. Mitigation strategies were developed, focusing on increasing resilience and managing identified risks. The study emphasizes that systematic risk identification and effective mitigation measures improve risk management practices. Recommendations include adopting comprehensive risk management strategies and ongoing monitoring to be in line with Myanmar's current operational challenges.

***Keywords**: Supply chain risk management, fuel supply chain, risk mitigation, operational resilience*

บทคัดย่อ

การศึกษานี้เป็นกรณีศึกษาความเสี่ยงในโซ่อุปทานที่องค์กร Medical Aid Myanmar (MAM) เผชิญอยู่ในการดำเนินงานด้านการจัดหาน้ำมันเชื้อเพลิง โดยมุ่งหวังที่จะระบุความเสี่ยง ประเมินผลกระทบ และเสนอแนวทางในการลดความเสี่ยงเหล่านี้ เพื่อเสริมสร้างเสถียรภาพในการดำเนินงานของ MAM ข้อมูลจากปี ค.ศ. 2022 ถึง 2023 ถูกรวบรวมผ่านการสัมภาษณ์เชิงคุณภาพและการประเมินความเสี่ยง ซึ่งแบ่งความเสี่ยง 25 รายการออกเป็น 3 กลุ่ม คือ กลุ่มความเสี่ยงสูงสุด (Zone A) กลุ่มความเสี่ยงปานกลาง (Zone B) และกลุ่มความเสี่ยงต่ำ (Zone C) ผลการศึกษาพบว่า ความเสี่ยงที่มีความสำคัญสูงสุด เช่น ความไม่แน่นอนทางการเมืองและการหยุดชะงักของโซ่อุปทาน ถือเป็นภัยคุกคามสำคัญต่อโซ่อุปทานน้ำมันเชื้อเพลิงของ MAM โดยได้พัฒนาแนวทางการลด ความเสี่ยง ซึ่งเน้นการเพิ่มความยืดหยุ่นและการจัดการความเสี่ยงที่ระบุไว้ การศึกษายังเน้นย้ำว่าการระบุความเสี่ยงอย่างเป็นระบบและมาตรการการลดความเสี่ยงอย่างมีประสิทธิภาพช่วยให้การจัดการความเสี่ยงมีประสิทธิผลมากขึ้น ข้อเสนอแนะ ประกอบด้วยการใช้กลยุทธ์การจัดการความเสี่ยงที่ครอบคลุมและการติดตามสถานการณ์อย่างต่อเนื่อง เพื่อให้สอดคล้องกับความท้าทายในปัจจุบันของเมียนมา

***คำสำคัญ:** การจัดการความเสี่ยงในโซ่อุปทาน โซ่อุปทานน้ำมันเชื้อเพลิง การลดความเสี่ยง ความยืดหยุ่นในการดำเนินงาน*

Received September 8, 2024; Revised September 28, 2024; Accepted September 30, 2024

* Ms. Htet Htet Win is an MSc Supply Chain Management student at the Martin de Tours School of Management and Economics, Assumption University. Email: htethtetwinn82@gmail.com

** Dr. Channarong Rungruengarporn is the chairperson of the Department of Marketing at Assumption University.

INTRODUCTION

Medical Aid Myanmar (MAM) is a non-profit humanitarian organization in Myanmar which established in 2009 and provides essential healthcare services across the country. MAM operates clinics and project locations, treating diseases such as HIV, TB, and Hepatitis and Covid 19, etc. Due to the ongoing political and economic challenges in Myanmar, it seriously impacts in the areas including energy sector. The unstable fuel supply in Myanmar has caused shortages, affecting the local fuel stations to meet demand and limiting the fuel available to the industries and organizations including MAM. These fuel shortages force organizations to use their emergency reserves and reduce their daily activities. As reported by the World Bank in 2023, along with the Country's declining power generation, businesses and organizations face significant challenges in maintaining their daily operations.

The objectives of this study are to identify the supply chain risks faced by Medical Aid Myanmar (MAM), to assess the severity of these risks, and to propose techniques that can be used to mitigate or reduce them. This research examines the upstream and downstream fuel supply chain of MAM, starting from tier 2 gas stations to vehicles and generators. By using a qualitative approach and in-depth interview with MAM's Logistics Personnel, this study will provide insights into risk management within the fuel supply chain. The study will analyze data from 2022 to 2023, identifying risks and proposing mitigation strategies.

REVIEW OF RELATED LITERATURE

Supply Chain Risk

Supply chain risk refers to the potential disruptions or uncertainties that can adversely affect the smooth flow of goods, services, or information within a supply chain network. These risks can arise from various sources, including external factors such as geopolitical events, natural disasters, economic fluctuations, regulatory changes, and supplier dependencies, as well as internal factors like operational inefficiencies, quality issues, financial instability, and technological failures (Christopher, 2016; Monczka, 2015).

Supply Chain Risk Management

Supply Chain Risk Management (SCRM) is a coordinated activity among all supply chain actors that focuses on identifying, assessing, and managing risks that could potentially disrupt the entire set of production processes. These risks may arise from various areas such as supply management, demand management, production management, information management, and safety management (Christopher & Peck, 2004). Pettit, Fiksel, & Croxton (2010) explained that the key to effective Supply Chain Risk Management lies not only in identifying potential risks but also in managing those that have been identified. This management involves a systematic approach to assess the likelihood and impact of risks, prioritize them, and develop tailored mitigation strategies.

Supply Chain Risk Management Process

Effective supply chain risk management (SCRM) is essential for modern organizations to mitigate disruptions and enhance resilience in their operations. The SCRM process involves a systematic approach to identifying, evaluating, and managing risks across supply chains. Initially,

organizations must identify potential risks stemming from internal operations or external factors within their enterprise boundaries as explained by Christopher and Peck (2004).

Qualitative Analysis

According to Gordon and Langmaid (1988), qualitative research is best used for problems where the results will increase understanding, expand knowledge, clarify the real issues, generate hypotheses, and provide input for future research or development. Shao and Wang (2010) stated that the qualitative research collect data through observations and interviews and it focuses on experience, opinions and knowledge.

ABC Analysis or Pareto Analysis

Waters (2007) explained that ABC analysis, also known as Pareto analysis or the 80/20 rule, provides a method for categorizing risks based on the principle that 20% of the risks account for 80% of the concerns, while the remaining 80% of the risks only contribute to 20% of the concerns. This analysis identifies three main categories of risk: A risks, which are the most severe and require special attention; B risks, which are moderate and need regular attention; and C risks, which are low and need minimal attention.

Responses and Resilience for Supply Risk Management

In supply chain management, responding to risks involves selecting strategies to address potential problems and ensure minimal disruption. Effective responses aim to reduce risks, comply with regulations, and use resources efficiently. Strategies include accepting minor risks, reducing their likelihood or impact, transferring risks, making contingency plans, adapting operations, or relocating. Schlegel and Trent (2012) noted that these approaches help maintain supply chain stability. Resilience, the ability to recover from disruptions, is key to smooth operations. Schlegel and Trent (2012) described resilience as having strong systems, backups, resourcefulness, and quick responses. Pettit et al. (2013) highlighted that multiple resilience strategies enhance an organization's ability to handle disruptions and maintain competitiveness.

RESEARCH METHODLOGY

This section aims to explore and understand the fuel supply chain risks (SCRs) faced by Medical Aid Myanmar (MAM) and to evaluate these identified risks using qualitative methods. The focus is on the supply chain risk management process, specifically risk identification and risk evaluation, conducted through interviews with Logistics Supervisors from MAM.

Data Collection

There are four main data collection methods which are surveys, interviews, observations, and document analysis. According to Yin (2003), no single method has a complete advantage over all others but interviews allow for open-ended questions to gather facts, opinions, and insights. In this study, data is gathered from credible sources and interviews are conducted with experienced personnel from Medical Aid Myanmar’s logistics and supply chain sector.

Identification of Supply Chain Risks

The following risks were identified during interview with MAM’s Logistics team based on their experience in the current operational context, and these are classified as mentioned in Table 1.

Table 1: Identification of Fuel Supply Chain Risks faced by MAM

No.	Type of Risk	Sources
1	Supply Risk	Fuel shortages at the supplier's stations, temporary suspension of selling fuel due to limited reserves, suppliers' inability to meet the requested fuel quantities, and insufficient supply quantities.
2	Demand Risk	Frequent electricity blackouts impacting demand uncertainty at operation sites, and inaccurate forecasts due to unpredictable electricity conditions, leading to higher fuel consumption for generators.
3	Political Risk	Sudden changes in regulations by the government, disruptions in fuel supply chains due to political instability, and the imposition of new policies affecting fuel importation and distribution.
4	Operational Risk	Reduced activities and movement plan due to fuel shortage concerns, which disrupt normal operations and lead to inefficient resource allocation.
5	Policy or Regulation Risk	Uncertain government policies on fuel importation, complex procedures, and restrictions on fuel distribution with a new quota system, creating compliance challenges.
6	Inventory Risk	Low inventory levels due to delayed fuel deliveries by suppliers, potential fuel shortages leading to operational delays, and inadequate storage facilities to maintain buffer stocks.
7	Transport Risk	Restrictions on fuel transportation to operation sites by the government, logistical challenges, and increased transportation costs due to regulatory constraints.
8	Information Risk	Limited information flow on fuel situation updates and potential shortages from suppliers, impacting overall management and strategic planning, resulting in reactive rather than proactive measures.
9	Price Risk	Inflation and dollar exchange rate increase impacting fuel selling prices, with black market prices doubling during shortages, causing financial strain on the organization.
10	Storage Risk	Limited storage capacity at MAM's operation sites, fuel quality concerns for long-term storage, and the risk of fuel degradation over time, affecting its usability.
11	Financial Risk	Exchange rate discrepancies between the Central Bank and the market, limitations on cash withdrawals, and financial instability affecting the organization's ability to procure fuel.
12	Environmental Risk	Negative environmental impact due to increased fuel usage.
13	Theft Risk	Risk of fuel theft during shortages at operation sites, potential misuse of fuel due to local market scarcity, and the lack of effective security measures to protect fuel assets
14	Machines Risk	Frequent generator use leading to increased maintenance costs and low machine capacity, risks of equipment damage due to unstable power production, and the potential for operational failures.
15	Procurement Risk	Fuel scarcity at vendors and wholesalers during shortages, high purchasing competition due to demand-supply gaps, price instability, and limited cash withdrawals affecting standardized purchasing procedures, leading to procurement delays.

Table 1: Identification of Fuel Supply Chain Risks faced by MAM (Cont.)

No.	Type of Risk	Sources
16	Management Risk	Need for immediate approval of fuel purchasing procedures by the management team during challenging shortage periods to avoid operational breakdowns, and the strain on management resources to continuously adapt to the changing supply landscape
17	Quality Risk	Fuel quality safety concerns, lack of transparent procedures affecting generators and vehicles' engines, and the risk of receiving substandard fuel that could damage equipment.
18	Human Resource Risk	Drivers queuing for fuel for extended periods, affecting operational efficiency, increased stress on staff due to fuel shortages, and potential burnout from managing crisis situations.
19	Process Risk	Frequent updates to the Fuel Supply Chain Process flow within the organization are required to align with the current market situation to minimize disruptions.
20	Control Risk	Fuel shortages in the market affect the control of safety stock levels and reorder quantities, leading to potential stockout situations.
21	Forecast Risk	Errors in forecasting fuel needs can lead to shortages, causing operational disruptions and increased costs due to emergency procurement.
22	Strategic Risk	Long-term strategic decisions are impacted by unpredictable fuel market conditions, potentially leading to misaligned strategies and resource allocation.
23	Delay Risk	Delays in the arrival of ordered fuel quantities beyond the expected delivery date disrupt operational schedules and may require costly temporary solutions.
24	Planning Risk	Receiving less fuel than ordered quantities necessitates adjustments to operational plans, potentially leading to minor disruptions, but these are manageable.
25	Sanction Risk	Fuel suppliers sanctioned by funding donors, UN, US, and EU, restricting fuel purchases from the sanctioned listed suppliers.

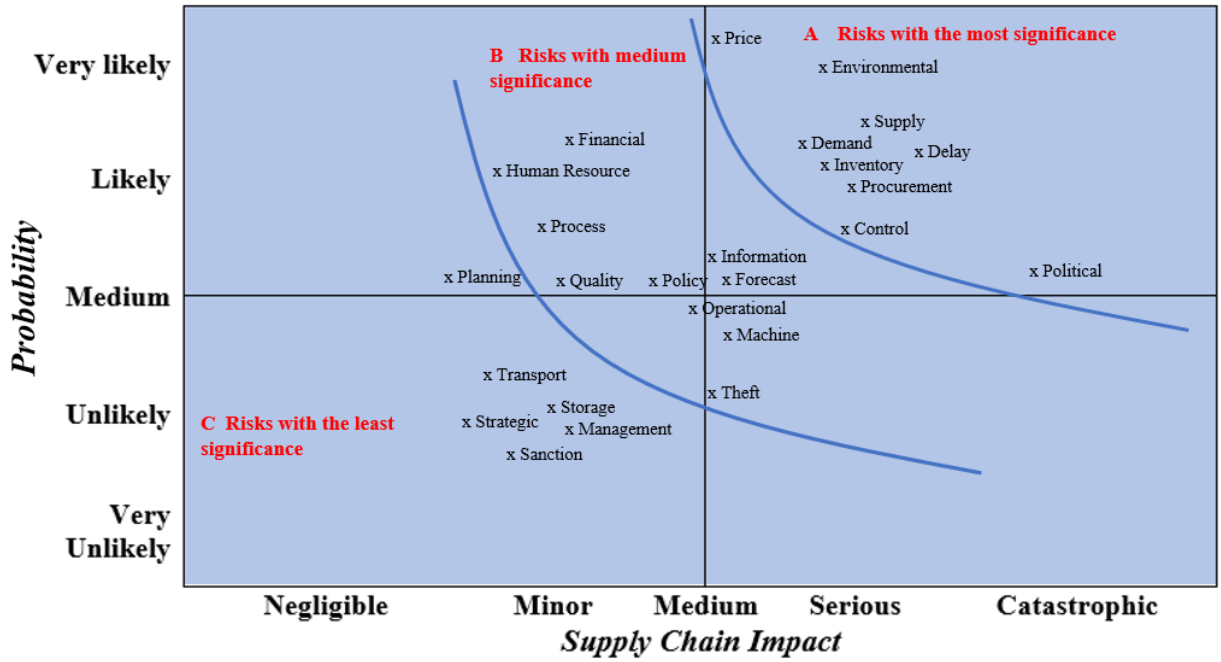
Evaluation of Supply Chain Risks

To evaluate and prioritize the identified risks, likelihood and impact of each risk were rated by using a five-tier scale which assessed probability from "Very Unlikely" indicating no prior occurrences to "Very Likely" denoting frequent events. The consequences were also similarly rated, ranging from "Negligible," with no impact on operations, to "Catastrophic," representing complete and irrecoverable failure. This approach provided a structured way to assess both the probability and potential impact of risks based on historical data and severity. The risks were then plotted on a risk matrix, as illustrated in Figure 1, using the insights and expertise of the interviewees.

The risk matrix in Figure 1 highlights the need to focus on risks in Zones A and B. Zone A includes high-impact risks such as pricing, supply, demand, and political factors, which require immediate and strong mitigation. Zone B involves risks such as human resources and finance that need ongoing monitoring and contingency planning. Zone C covers less significant risks related to planning and management, which should still be reviewed periodically to prevent escalation. The

Pareto principle (80/20 rule) underscores the importance of not ignoring less probable risks, as they can still lead to major disruptions.

Figure 1: MAM's Fuel Supply Chain Risk Matrix



PRESENTATION AND CRITICAL DISCUSSION OF RESULTS

Selection of Appropriate Techniques for Supply Chain Risks

For effective risk management, appropriate responses and resilience measures are tailored to the identified risks. These include contingency planning to prepare for disruptions, redundancy to provide backup resources, and flexibility to adapt operations by considering MAM's organization capacity, current market and political situation. Table 2 details about the application of risk management responses and resilience strategies, ensuring that MAM's fuel supply chain is well-prepared for both immediate and future challenges.

Implementation of the Risk Management Program

MAM Management team and Logistics Personnel developed a detailed strategy for implementing the risk management program, defining clear roles and procedures for handling unexpected issues. They also established Fuel Procurement Policies to regulate regular and emergency purchasing practices. MAM has contracted with multiple suppliers, including "Gold Link Terminal Co., Ltd." for diesel and additional suppliers for gasoline. This approach ensures a steady supply even during emergencies. Supplier performance is reviewed annually to maintain reliability.

To manage fuel demand accurately, MAM improved its fuel consumption tracking. A new system was implemented for recording vehicle and generator fuel usage, with periodic reviews to ensure fuel consumption data reliability.

Table 2: Response and Resilient Technique for Each Risk

Sr.	Risk	Probability	Consequences	Degree of Risk	Responses	Resilience in Supply Chain
1	Political Risk	Medium	Catastrophic	A	Adapt to it by adjusting the operations to comply with new laws and regulations by updating the practices to align with new governmental policies.	Flexibility by aligning with the changes in policies set by the government.
2	Supply Risk	Likely	Serious	A	Make contingency plans and develop strategies to order supplies before stock levels reaches to the minimum stock and implement quality control measures before shipment to prevent potential disruptions.	Redundancy by having multiple suppliers and maintain relationships to ensure continuous supply in case of disruptions.
3	Demand Risk	Likely	Serious	A	Reduce the probability by analyzing historical data and set a real-time monitoring system to forecast demand more accurately and adjust procurement strategies accordingly.	Flexibility by implementing advanced demand forecasting strategies and adjust procurement process based on the real time fuel consumption data.
4	Inventory Risk	Likely	Serious	A	Reduce the probability by implementing an inventory management system to track and manage stock levels efficiently, thereby reducing the risk of overstocking or running out of stock.	Redundancy by utilizing multiple storage locations to mitigate risks of stockouts and manage of overstocking.
5	Procurement Risk	Likely	Serious	A	Make contingency plans by having long-term agreements with multiple suppliers to reduce relying on any single supplier and reduce procurement risk.	Redundancy by developing long-term relationships with several suppliers and have backup options to ensure consistent procurement.
6	Price Risk	Very Likely	Medium	A	Adapt to it by aligning with the current market price and manage the inventory and reorder level.	Flexibility by negotiating payment terms twice a month or once a month with the contracted suppliers to manage price volatility.
7	Environmental Risk	Very Likely	Serious	A	Reduce the consequences of environmental impact by developing a new solar system for long term effect and reduce the relying on the fuel system.	Redundancy by implementing solar installation sites plans.
8	Delay Risk	Likely	Serious	A	Reduce the consequences by creating a buffer stock and having alternative suppliers to reduce the impact of delivery delays.	Redundancy by having a buffer stock and having agreements with multiple suppliers to ensure continuous supply.

Table 2: Response and Resilient Technique for Each Risk (Cont.)

Sr.	Risk	Probability	Consequences	Degree of Risk	Responses	Resilience in Supply Chain
9	Control Risk	Likely	Serious	A	Reduce the probability by having reliable inventory control systems and regular review to maintain appropriate stock levels and prevent stockouts.	Redundancy by using fuel stock monitoring system to review the stock levels in real-time.
10	Information Risk	Medium	Medium	B	Reduce the probability by having good communication flow system with the Suppliers and create the information sharing group to keep updated of fuel situation in the market	Flexibility by having good communication and information flow system with the Suppliers and among the team.
11	Policy/Regulation Risk	Medium	Medium	B	Reduce the probability by staying informed about changes in policies and regulations, and adapt organizational practices accordingly to ensure ongoing compliance.	Flexibility by continuously monitoring regulatory changes and adjust organization practices to maintain compliance.
12	Operational Risk	Medium	Medium	B	Make contingency plans by developing backup plan to prepare for potential operational disruptions and maintain main functions.	Redundancy by developing backup plan to ensure operations continue smoothly during disruptions.
13	Machine Risk	Medium	Medium	B	Reduce the probability by having preventive maintenance for the generators with the Service Providers and having regular service contract to prevent breakdown and ensure service availability	Redundancy by implementing preventive maintenance schedules and regular service maintenance of the machines and ensure emergency repair service availability in case of breakdown.
14	Theft Risk	Medium	Medium	B	Reduce the consequences by having safe storage of fuel tanks and inventory control, to prevent theft and unauthorized access.	Redundancy by having safe storage facilities and access control to safeguard against theft.
15	Quality Risk	Medium	Minor	B	Reduce the probability by purchasing fuel from the reliable and contracted supplier and ensure the suppliers supply the fuel with quality standard.	Flexibility by having reliable and contracted suppliers that ensure providing fuel with quality standards.
16	Human Resource Risk	Unlikely	Minor	B	Reduce the consequences by managing daily work schedule and having communication with the Suppliers to avoid long-queue at the fuel stations.	Flexibility by having daily work schedule and vehicle movement plan and having good communication with the Suppliers for fuel available stations.

Table 2: Response and Resilient Technique for Each Risk (Cont.)

Sr.	Risk	Probability	Consequences	Degree of Risk	Responses	Resilience in Supply Chain
17	Financial Risk	Medium	Minor	B	Adapt to it by adjusting with current fuel market prices and consistent monitoring of financial budget.	Flexibility by managing financial budget.
18	Process Risk	Medium	Minor	B	Reduce the probability by regularly review and updating the fuel supply chain processes to align with the current market conditions.	Flexibility by conducting periodic reviews and improvements of the supply chain processes to enhance efficiency and reduce disruptions.
19	Forecast Risk	Medium	Minor	B	Reduce the probability by improving forecasting techniques and incorporating real-time data to enhance accuracy.	Flexibility by using advanced forecasting tools and methods to adjust procurement strategies based on real-time data.
20	Transport Risk	Unlikely	Minor	C	Reduce the consequences by having alternative transportation routes and partnerships with reliable logistics providers to ensure timely and effective delivery.	Flexibility by having alternative transportation routes and partner with logistics service providers to ensure timely delivery.
21	Storage Risk	Unlikely	Minor	C	Reduce the consequences by having backup fuel storage facilities and managing inventory.	Redundancy by having backup storage facilities and additional storage options to protect against disruptions.
22	Management Risk	Unlikely	Minor	C	Make contingency plan by developing policies and guidelines which is in line with the situation and ensure to keep update of the policies about the fuel purchasing and management system.	Flexibility by updating organization's fuel management policies to adapt with the changes and challenges.
23	Planning Risk	Medium	Minor	C	Make contingency plans by stock sharing among the clinics and emergency outsourcing of fuel for continuing operation.	Flexibility by developing emergency plans to handle unexpected changes and challenges.
24	Strategic Risk	Unlikely	Minor	C	Reduce the probability by aligning strategic decisions with thorough market analysis and risk assessments.	Flexibility by conducting regular strategic reviews and adjustments based on market conditions and risk evaluations.
25	Sanction Risk	Unlikely	Minor	C	Reduce the consequences by having alternative fuel suppliers and keeping up to date information on sanction list not to happen any interruption with the fuel supply chain process.	Flexibility by having alternative contracted suppliers and not depending on single fuel supplier and getting up to date information of international sanction list websites.

A regular maintenance schedule was also established for the Generators to prevent breakdowns and ensure longevity. As show in Table 3, the schedule includes following tasks and inspections, with checklists for maintenance documentation.

Table 3: Regular Service Schedule Checklist of Generators

Engines no _____ Running hours_____ Date_____ Mechanic _____ Signature_____ W/shop Station _____ Signature_____ Check By _____ Signature_____ Before any service or repair, wash body, chassis and engine	
Each 200 Hours (or) six month	**Checked?**
Check all fuel lines and pipes, exhaust pipe and mountings	
Check all bolts and nuts on chassis and body	
Check engine mounting and clean the engines and any leakage	
Check the condition of the fan belts	
Check the cooling system, radiator, hoses, level, antifreeze	
Check battery mounting and clamp, battery level, clean and grease terminals	
Check all electrical system, all check light on dashboard	
Check the functions of all the indicator, alternator in/out power	
Change engine oil, oil filter, fuel filter	
Check the condition of the air cleaner element (replace it if necessary)	
Final test running	
Each 1000 Hours or every 2 years	**Checked?**
Same as 150 Hours service and	
Check fuel pump (replace it if necessary)	
Change spark plugs, cooling liquid water and antifreeze (replace it if necessary)	
Check and adjust valve clearance	
Change fan belt, air cleaner element (replace it if necessary)	
Check engine compression, injector nozzle, tuning carburetor, pump timing	
Final test running	

Additionally, MAM Management team decided to install the solar systems at clinics to reduce fuel dependency and environmental impact. This decision was made as the renewable energy will lower operational costs and ensure a reliable power supply.

Monitor and Modification of the Risk Management Program

MAM Management team decided to have supply chain risk mitigation strategies as illustrated in Table 4, which outlines specific monitoring and modification strategies for the identified risks in MAM's fuel supply chain.

MAM Management team implemented a system to regularly monitor fuel consumption data and trends, allowing for better evaluation of fuel usage. This helps in planning fuel inventory and procurement for uninterrupted operations. The consumption analysis system, depicted in figures 2 and 3 for vehicles and generators, enables logistics staff to effectively analyze and manage the fuel consumption data.

Table 4: Risk Monitoring and Modification Strategies

Sr.	Risk	Monitoring and Modification Strategies
1	Political Risk	Monitor political situation and regulatory changes and adapt operations to comply with new laws and regulations.
2	Supply Risk	Regularly evaluate supplier reliability. Maintain relationships with multiple suppliers and develop contingency plans.
3	Demand Risk	Developed fuel consumption follow up recording system and monitor real-time fuel consumption data to adjust procurement strategies.
4	Inventory Risk	Use an inventory management system to track and manage stock levels and have multiple storage locations to reduce the risks of stockouts.
5	Procurement Risk	Establish long-term agreements with multiple suppliers and regularly evaluate supplier performance to ensure consistent supply of fuel to MAM.
6	Price Risk	Align procurement strategies with market prices and negotiate payment terms with suppliers and monitor financial budgets to adapt to market changes.
7	Environmental Risk	Decided to install solar systems at clinics to reduce environmental impact and fuel dependency and monitor the effectiveness of solar installations in reducing fuel consumption.
8	Delay Risk	Improved communication flow with the Suppliers to track the delivery timeline and monitor the delays happened periods to reduce such similar delays in the future. Develop contingency plans of purchasing fuel from the alternative suppliers not to happen stock out and operational delays.
9	Control Risk	Monitor inventory levels and safety stock and regularly review and adjust safety stock level to ensure enough inventory levels.
10	Information Risk	Have a good communication flow with suppliers and created a information-sharing group to keep all related Logistics staff informed about the fuel situation in the market.
11	Policy/Regulation Risk	Stay informed about changes in policies and regulations and adapt organizational practices to ensure ongoing compliance.
12	Operational Risk	Develop and have backup plans for potential operational disruptions.
13	Machine Risk	Implement preventive maintenance schedules and regular servicing of equipment. Ensure service contracts with reliable providers for timely maintenance and repairs.
14	Theft Risk	Have a safe fuel storage facility with access to authorized person only and regular recording of fuel inventory and stock checks.
15	Quality Risk	Ensure fuel is purchased only from the reliable and contracted suppliers who meet quality standards and conduct regular quality checks.
16	Human Resource Risk	Manage daily work schedules and maintain good communication with suppliers to avoid long queues.
17	Financial Risk	Keep inform Finance team to manage financial budget to align with market prices. Continuously monitor and negotiate payment terms with suppliers.
18	Process Risk	Regularly update the fuel supply chain process flow to align with the current market situation. Implement continuous process improvement and regular staff meeting to share information of update process flow.
19	Forecast Risk	Developed fuel consumption monitoring system and regularly review forecast accuracy and adjust procurement plan based on updated forecast data.

Table 4: Risk Monitoring and Modification Strategies (Cont.)

Sr.	Risk	Monitoring and Modification Strategies
20	Transport Risk	Establish alternative transportation routes and partner with multiple logistics providers. Regularly monitor the transportation plan.
21	Storage Risk	Decided to have a backup fuel storage facilities and fuel tanks at the warehouse with safe precautions. Conduct regular checking of storage facilities to ensure they are stored safely and monitor the backup fuel quality.
22	Management Risk	Develop and regularly update policies and guidelines to align with current situations. Conduct regular meeting with the respective Logistics Personnel and Management Team to ensure development of effective management decisions.
23	Planning Risk	Implement a contingency planning process that includes adjustments for receiving less fuel than ordered. Regularly review and update operational plans in line with the current market situation.
24	Strategic Risk	Regularly review long-term strategic decisions and adjust based on current market conditions. Conduct continuous strategic planning and scenario analysis.
25	Sanction Risk	Regularly monitor the updated suppliers list to avoid sanctioned entities by Funding donors, UN, US and EU websites. Establish relationships and explore alternative suppliers in the market.

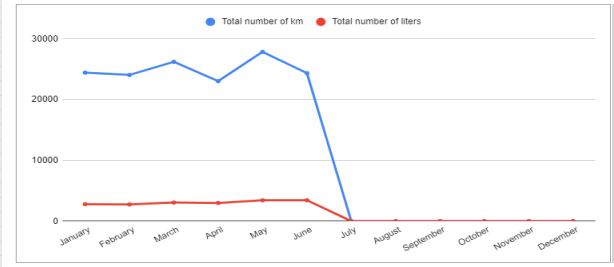
CONCLUSIONS AND RECOMMENDATIONS

The research paper focuses on improving the fuel supply chain for Medical Aid Myanmar (MAM) to enhance operational stability during Myanmar's political crisis and ongoing fuel shortages. It employs risk management techniques to explore key issues, including fuel procurement challenges, supply disruptions, and inventory control. The study identifies risks through a structured process, categorizing them based on priority to allocate resources more effectively. The analysis revealed high-priority risks, such as political instability and price fluctuations, which significantly affect MAM's operations.

Figure 2: Monitoring of Monthly Fuel Consumption Data of Vehicles

Total for vehicles

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Total number of km	24,429	24,051	26,209	23,027	27,836	24,340	0	0	0	0	0	0	149,893
Total number of liters	2794	2747.696	3055.0683	2991.748	3426.844	3442.973	0	0	0	0	0	0	18,459
Total cost of fuel in MMK	7208982.0	7666227.0	8306361.0	15615932.0	9203184.0	9037537.0	0.0	0.0	0.0	0.0	0.0	0.0	57,038,223
Total cost of Maintenance in MMK	954790	850255	1331299	2575611	2703200	2485600	0	0	0	0	0	0	10,900,755



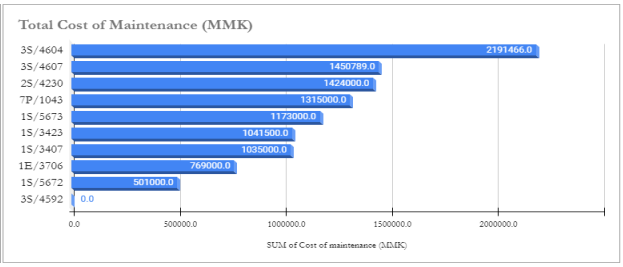
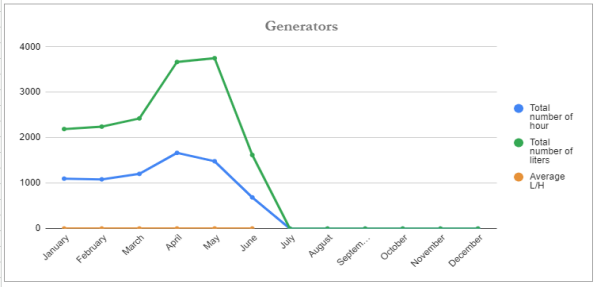
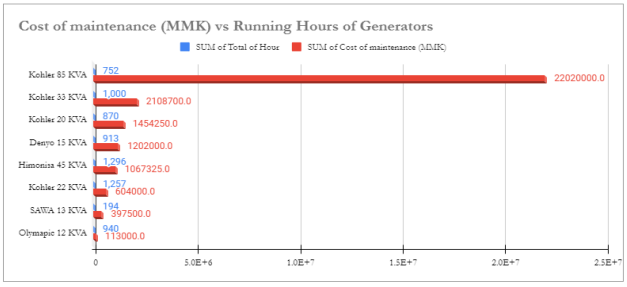


Figure 3: Monitoring of Monthly Fuel Consumption Data of Generators

Total for Generators

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Total number of hour	1099.5	1083.8	1204	1666.3	1482.3	687.3	0	0	0	0	0	0	7223.2
Total number of liters	2191	2244	2425	3666	3750	1620	0	0	0	0	0	0	15896
Average L/H	**2**	**2.1**	**2.1**	**2.3**	**2.6**	**2.4**	**-**	**-**	**-**	**-**	**-**	**-**	**2.3**
Total cost of Maintenance in MMK	1,963,000	1,117,525	3,040,200	20,894,250	1,951,800	0	0	0	0	0	0	0	28,966,775





By using the ABC analysis method, the research evaluates these risks and develops appropriate risk mitigation strategies. Practical recommendations such as engaging multiple fuel suppliers and implementing a fuel consumption monitoring system were also offered to ensure better inventory and procurement management. Additionally, preventive maintenance schedules were introduced to extend machine life and reduce unexpected breakdowns.

In conclusion, the research focuses the importance of a structured risk management approach to maintain operational resilience. By focusing on high-priority risks and implementing practical mitigation strategies, MAM can reduce the impact of fuel shortages and improve overall supply chain performance.

The managerial implications highlight the need for MAM and similar organizations to adopt structured risk management frameworks. Managers should prioritize the implementation of the recommended strategies, regularly evaluate fuel supply operations, and continuously adapt to changing market conditions. Collaboration with suppliers and regular updates to procurement policies are important for maintaining resilience in challenging situations.

However, it is important to acknowledge the limitations in this research such as the focus in this study on high-priority risks means that some less critical problems may not have been thoroughly explored. In addition, the study is specific to MAM's operations and may not be fully applicable to other organizations. Future research should expand on these findings by considering broader locations and extending the analysis to other industries and supply chains facing similar challenges.

REFERENCES

Christopher, M. (2016). *Logistics and supply chain management* (5th ed.). Pearson. Retrieved from https://www.scirp.org/reference/referencespapers?referenceid=2455438

Christopher, M., & Peck, H. (2004). Building the resilient supply chain. *The International Journal of Logistics Management, 15*(2), 1–14. https://doi.org/10.1108/09574090410700275

Gordon, W., & Langmaid, R. (1988). *Qualitative market research: A practitioner's and buyer's guide*. Cambridge: Gower Publishing Company.
Khojasteh, Y., et al. (2022). *Supply chain risk mitigation*. Google Books. Retrieved from https://www.google.com.mm/books/edition/Supply_Chain_Risk_Mitigation/ws2REAAAQBAJ?hl=en&gbpv=1&printsec=frontcover
Monczka, R. M., Handfield, R. B., Giunipero, L. C., & Patterson, J. L. (2015). *Purchasing and Supply Chain Management* (6th ed.). Cengage Learning.
Pettit, T. J., Croxton, K. L., & Fiksel, J. (2013). Ensuring supply chain resilience: Development and implementation of an assessment tool. *Journal of Business Logistics, 34*(1), 46-76.
Pettit, T. J., Fiksel, J., & Croxton, K. L. (2010). Ensuring supply chain resilience: Development and implementation of an assessment tool. *Journal of Business Logistics, 31*(1), 1-21.
Schlegel, G. L., & Trent, R. J. (2012). Risk management: Welcome to the new normal. *Supply Chain Management Review*, January/February, 14.
Shao, C., & Wang, L. (2010). Quantitative and qualitative forecasting applied to supply chain management. *Journal of Forecasting, 29*(4), 310-323. https://doi.org/10.1002/for.1166
Waters, D. (2007). *Vulnerability and resilience in logistics supply chain risk management*. Kogan Page.
World Bank Group. (2023). *In the dark: Power sector challenges in Myanmar.* World Bank. Retrieved from https://www.worldbank.org/en/country/myanmar/publication/in-the-dark-power-sector-challenges-in-myanmar
Yin, R.K. (2003). *Case Study Research-design and Methods*. Thousand Oaks, California: Sage Publication.