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Spare Parts Acquisition in the Sri Lanka Navy: An Analysis of Root Causes in Supply Chain Bottlenecks

December 2025

LCDR Kathriarachchige D. Kathriarachchi, Sir Lanka Navy

Thesis Advisors: Dr. Robert F. Mortlock, Professor
Bryan J. Hudgens, Senior Lecturer

Department of Defense Management

Naval Postgraduate School

Prepared for the Naval Postgraduate School, Monterey, CA 93943

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ABSTRACT

The operational availability and the readiness of Sri Lanka Navy Fleet is essential towards sustaining maritime defense capability of Sri Lanka and spare parts plays a critical role in continuing consistent operational availability. However, most of the time, it is very challenging to obtain spare parts on time due to the delays in the spare parts acquisition process. This study aims to identify the major bottlenecks of spare parts acquisition and analyze the root causes of the acquisition bottlenecks within the spare parts acquisition framework focusing on the acquisitions under the Staff Officer Procurement, Spare Parts Distribution Center (SOP[SPDC]). The study applies pareto analysis to prioritize major bottlenecks in spare parts acquisition and employs a modified Ishikawa (Fishbone) and Five-Whys framework to determine underlying root causes for such bottlenecks. Pareto analysis revealed that awaiting fulfillments, supplier evaluation and selection, quality control and technical acceptance, budget constraints and request for quotations were the major bottlenecks of spare parts acquisitions in SOP(SPDC) and each bottleneck consists of root causes that are inherent at each stage. The analysis indicated that the root causes are multidimensional, encompassing human-related factors, inefficiencies within internal processes, and external constraints stemming from supplier dynamics.

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ABOUT THE AUTHOR

Lieutenant Commander (S) KDPM Kathriarachchi is a distinguished officer of the Sri Lanka Navy. She joined the Sri Lanka Navy as a Lady Officer Cadet on 20th September 2009 and completed her initial military training at the General Sir John Kotelawala Defense University, Ratmalana, and the Naval and Maritime Academy, Trincomalee. She also holds a Bachelor of Science Degree in Management and Technical Sciences with First Class Honors.

Throughout her 16 years of service, LCdr (S) Kathriarachchi has held a range of key appointments within the Logistics Branch of the Sri Lanka Navy, making notable contributions to operational logistics, personnel training, and administrative efficiency. She has also served with distinction as Aide and Personal Secretary II to the Commander of the Navy on two occasions and has been commended four times by the Commander of the Navy for her exceptional dedication and professionalism.

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LIST OF ACRONYMS AND ABBREVIATIONS

CPC	Coastal Patrol Craft
FAC	Fast Attack Craft
FGB	Fast Gun Boat
GOSL	Government of Sri Lanka
GPS	Global Positioning System
ILMS	Integrated Logistics Management System
IPC	Inshore Patrol Craft
MMSIS	Marine Management and Ship Information System
MSIS	Maritime Safety Information System
OBM	Out Board Motors
OPV	Offshore Patrol Vessel
PABX	Private Automatic Branch Exchange
PE	Procurement Entity
RO	Reverse Osmosis
SLN	Sri Lanka Navy
SPDC	Spare Parts Distribution Center
UMSIS	Underwater Mine Surveillance Information System
ZF	Zahnrad Fabrik

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I. INTRODUCTION

This chapter provides an overview of the thesis topic including problem statement, research questions and objectives, methodology, scope and limitations.

A. PROBLEM STATEMENT

A small island in the Indian Ocean, known as Sri Lanka, is located very close to the southern tip of the Indian peninsula. Its naval force, the Sri Lanka Navy (SLN), as the first line of defense of the island nation, plays a critical role in safeguarding national security, countering maritime threats, and supporting disaster response operations (Sri Lanka Navy, n.d.). The SLN strategically deploys a diverse fleet of ships and crafts across the island to fulfill these responsibilities effectively and efficiently. Moreover, as depicted in Figure 1, the country is responsible for a comparably vast sea area (1,778,062.24 km^2) as the Search and Rescue Region (SAR) in the Indian Ocean, which is 27 times the land mass of Sri Lanka (Maritime Rescue Coordination Center–Colombo [MRCC-Colombo], 2022).

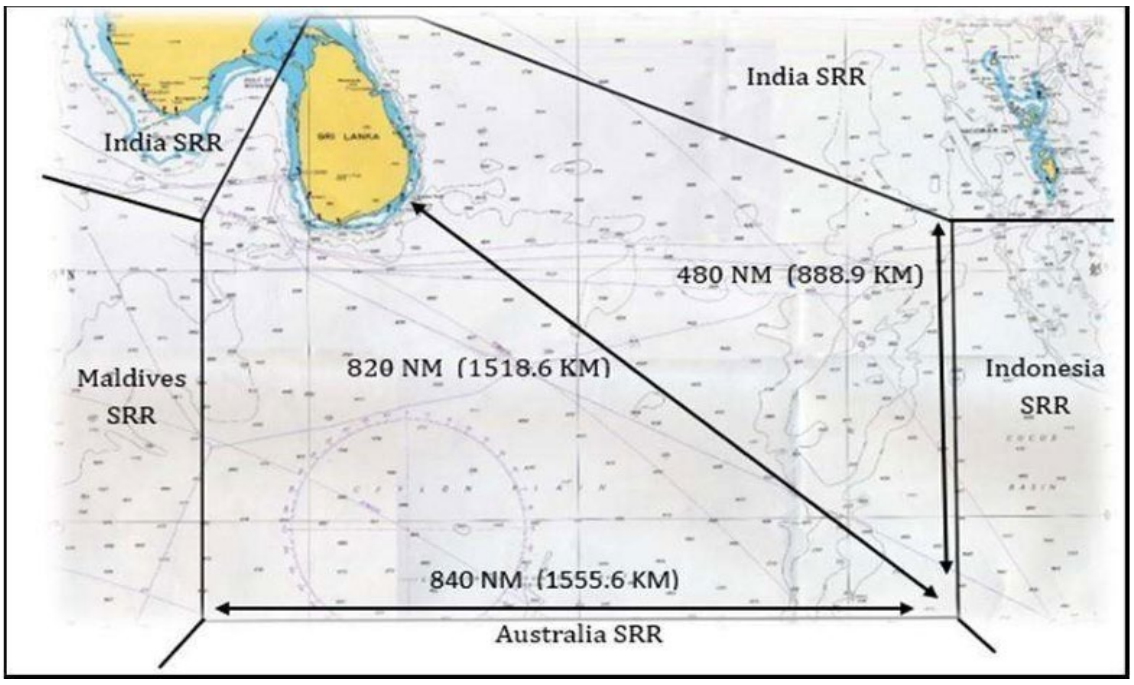


Figure 1. The SAR of Sri Lanka. Source: MRCC-Colombo (2022).

The area for SAR is designated by the International Maritime Organization, which has the responsibility and authority to conduct search and rescue operations for any ships and crafts whenever required (International Maritime Organization, n.d.). The SLN, with the assistance of other responsible entities, primarily shoulders this SAR responsibility (Perera, 2024). The obligation towards SAR further emphasizes the requirement for SLN to have a naval fleet with a high state of readiness and availability. Ensuring fleet readiness is obvious and essential to maintain mission capability of the fleet. The availability of spare parts required for critical equipment and machines of the ships plays a significant role in this regard. Readiness also relies heavily on the timely availability of critical spare parts. A study on optimal spare parts management for vessel maintenance scheduling highlights the significance of spare parts, considering its indispensable role towards maintaining operational availability and reducing maintenance turnaround time (Kian et al., 2019). SLN is required to maintain a sufficient fleet to accomplish entrusted duties. Table 1 shows the number of ships and crafts with their ship type that SLN possessed as of 2023.

In today's climate of increasing global uncertainty, disruptions or bottlenecks in supply chains, particularly those concerning spare parts, are liable to pose persistent challenges to overall readiness and naval operations. The supply chain related to spare parts encompasses several key stages, beginning with the forecasting of adequate requirement and ending with timely receipt of the same to the end user. The acquisition process, which lies in between these stages, is frequently identified as both critical and time-consuming since spares are often acquired from external parties (Wang et al., 2017). Delays in spare parts procurement can significantly prolong planned maintenance periods, resulting in extended nonoperational statuses for ships and crafts and ultimately reducing overall fleet readiness (Kian et al., 2019). For instance, operational logs from the SLN that record annual breakdown of SLN ships and crafts particular to 2024 indicated that a total of 29 ships and crafts in SLN were rendered nonoperational at various points throughout the year due to scheduled docking, major overhauls, major refits, and routine underwater maintenance (Staff Officer Operation, Personal communication, April 21, 2025). Notably, the duration of these nonoperational periods can be further extended with the delays in the availability of spare parts. In short, spare

parts are indispensable and critical for staying operative and maintaining the highest possible availability and the reliability of main equipment (Burman, 2016).

Table 1. The SLN Fleet in 2023. Adapted from Perera (2024).

Type of Vessels / Crafts	**Quantity as of 2023**
Offshore Patrol Vessels	8
Fast Missile Vessels	2
Fast Gun Boats/Coastal Patrol vessels	11
Fast Patrol Crafts	2
Fast Attack Crafts	49
Passenger Auxiliary	1
Landing Ship Tanks	1
Landing Craft Mechanized	2
Landing Craft Utility	2
Inshore Patrol Crafts	63

The acquisition process is particularly vital in overall spare part management considering the susceptibility to a range of challenges both in internal and external environments. Timely procurement of spare parts is essential in sustaining operational capability and ensuring the functionality of naval assets in the long term. Delays in acquisition can hinder the SLN's ability to maintain its fleet as planned, contributing to an increasing number of ships/crafts being placed in nonoperational status due to spare part shortages, maintenance deferrals, and procurement-related inefficiencies. Procurement lead time is considered one of the key aspects of spare part management

because of its role in keeping machines and equipment in operational readiness by having the necessary parts available when needed (Kennedy et al., 2002).

Given these challenges, it is crucial to identify and understand supply chain bottlenecks related to the spare parts acquisition process. Of all the options available to understand supply chain bottlenecks in spare parts acquisitions, comprehensive root cause analysis offers the optimal approach (Robitaille, 2010) to identify the underlying issues critical for developing targeted strategies to minimize procurement delays. Addressing such delays with necessary precautions would enhance the overall efficiency and effectiveness of the acquisition process in the SLN. This capstone research project focuses specifically on the spare parts acquisition process in the SLN, with the objective of uncovering the underlying causes of these bottlenecks that prevent the timely receipt of spares, ultimately impacting the SLN's operational readiness.

B. RESEARCH QUESTIONS

1. **Primary**: What are the major supply chain bottlenecks affecting spare parts acquisitions in the Sri Lanka Navy?
2. **Secondary**: What are the root causes of these bottlenecks in acquisitions of spare parts?

C. RESEARCH OBJECTIVES

1. To identify the major supply chain bottlenecks affecting spare parts acquisition in the Sri Lanka Navy that contribute to overall process delays.
2. To identify and examine the root causes of bottlenecks in the spare parts acquisition process in the Sri Lanka Navy.

D. METHODOLOGY

Root cause analysis is the structured framework used by this research to identify the root causes of the supply chain bottlenecks in acquisition of spare parts in the SLN. Root cause analysis can be described as the organized problem-solving approach aimed at recognizing the actual causes of a problem in order to take actions that are appropriate to eliminate such causes (Andersen & Fagerhaug, 2006a).

Three techniques are used by the author to complete a root cause analysis in this research. They are the Pareto charts, the Ishikawa Diagram, and the "five whys" technique. At the outset, the research leverages previous year's procurement data and a

Pareto analysis accordingly to understand the significant stages that can cause delays or stagnations in the spare part acquisition process. Pareto charts, histograms, scatter charts, problem concentration diagrams, relation diagrams and affinity diagrams are some of useful tools for problem cause data analysis (Andersen & Fagerhaug, 2006a). Moreover, apart from historical data, due concern was given for other academic articles, including an SLN report that discusses the other possible bottlenecks in acquisition.

Subsequently, the Ishikawa diagram and the "five whys" technique were employed to facilitate further analysis. Modified versions of both tools were applied to better align with the specific causes identified in the study. This approach is consistent with the work of Cirone et al. (2023), who also utilized adapted forms of these tools in their thesis on root cause analysis, due to the absence of standardized frameworks for the particular subject area they investigated. A comprehensive explanation of the root cause analysis methodology and the tools employed is presented in Chapter IV.

The sources used to conduct the root cause analysis were primarily obtained from spare parts acquisition records at the Spare Parts Distribution Center (SPDC) established in the SLN Dockyard at Trincomalee, official reports, existing literature, anecdotal articles, and professional experience of the author as Staff Officer Procurement in the SPDC. Additionally, official reports from the Commodore Superintendent Logistics Department (East), including government procurement guidelines and manuals, were also taken into consideration.

E. RESEARCH SCOPE AND LIMITATIONS

There are numerous underlying factors that influence the spare parts supply chain, including acquisition, inventory management, distribution, transportation, and other logistical components. However, this study intentionally narrows its scope to focus exclusively on the acquisition process of spare parts, rather than addressing the broader spectrum of supply chain bottlenecks. Within this specific domain, the research further refines its focus to examine the root causes of such bottlenecks occurring during the acquisition phase. Specifically, the study concentrates on acquisitions initiated through the Staff Officer Procurement within the SPDC, operating under the Commodore Superintendent Logistics Department (East). Moreover, due to the limitations in

accessing personnel for interviews or surveys, this study relies on data sources including procurement records and purchasing summaries in SOP(SPDC) particularly in 2024, scholarly articles, official reports and SLN's book of reference - 4 (BR 4) which states about naval storekeeping system, supplemented by the researcher's professional experience to conduct root cause analysis.

F. SIGNIFICANCE OF THE STUDY

The significance of this research lies in its potential to offer valuable insights into identifying major supply chain bottlenecks related to spare parts acquisition in the SLN that contribute to overall process delay. Understanding these bottlenecks in the spare parts acquisition process will help logistics officers, technical officers, and executive officers in the SLN to plan ahead to mitigate such bottlenecks and ensure the smooth flow of spare parts to the SLN fleet. Since research on this subject matter appears to be largely unexplored within the SLN context, the findings of this qualitative study may provide valuable insights and serve as a foundational reference for future research and strategic decision-making within the SLN.

G. THESIS STRUCTURE

The structure of this research consists of five chapters; each chapter contributes constructively towards the overall study and has its own distinct purposes. Chapter I provides an introduction to the research, Chapter II organizes the background of the spare parts acquisition, Chapter III reviews relevant literature on acquisition bottlenecks, and Chapter IV outlines the root cause analysis process and how it was used to identify bottlenecks in the spare parts acquisition process. Finally, Chapter V offers conclusions and recommendations.

H. SUMMARY

This chapter serves as the foundation of the thesis by introducing the key elements that guide the research. It outlines the problem statement, research questions, objectives, methodology, scope, limitations, and overall significance of the study. The focus of this research is to identify and analyze the root causes of supply chain bottlenecks in the spare parts acquisition process within the Sri Lanka Navy.

II. BACKGROUND

This chapter outlines the spare parts acquisition framework of the SLN, emphasizing the departmental procedures, the system and the guidelines used by SLN for acquisitions of spare parts.

A. MANAGEMENT OF SPARE PARTS

Spare parts are interchangeable items that are kept in inventories for the purpose of replacing with breakdown components of equipment, machines, or any other system, and they are essential for the smooth and uninterrupted functioning of equipment across all industries (Hu et al., 2018). The definition of spare parts can vary by industry, but the core meaning remains the same. Unavailability of spare parts for the repair can incur significant losses financially, specifically the industries that have mass and continuous production and rely on advanced technologies. Hence, to assure optimal maintenance, repair, readiness, and availability performance requirements, it is crucial to have proper spare part management (Au-Yong et al., 2016).

In military operations, the importance of spare parts is even more pronounced, as the availability of critical spare parts directly affects the operational readiness of assets. Operational availability of ships and crafts is directly related to the maintenance down time of its systems, equipment, and machines; therefore, decreasing repair time and cycle time improves operational availability (Apte & Kang, 2007). This, in turn, plays a decisive role in determining the success of missions, where delays or failures due to equipment downtime can have significant consequences.

B. BOOK OF REFERENCE 4 OF SRI LANKA NAVY

Book of Reference 4 (BR 4) of the SLN outlines the Naval Storekeeping System, which must be strictly adhered to by all naval personnel involved in logistics and supply chain management. BR4 is intended solely for the internal reference of SLN personnel, therefore not publicly available. However, recognizing the critical importance of ship maintenance, repairs, and spare parts management, Chapters 33 and 34 are specifically dedicated to these areas. Chapter 33 addresses protocols related to ship maintenance and repairs, while Chapter 34 focuses on the operations and procedures of the SPDC.

1. Ship Maintenance and Repairs

This chapter highlights the type of maintenance programs needed to be carried out by the engineering branch with the assistance of the logistics branch in order to maintain the sustainability of the limited number of ships and crafts of the SLN. Periodic maintenance, programmed refit, major overhaul actions and replacement of machinery and equipment are the main programs carried out for SLN ships and crafts. Further emphasized in this chapter are the responsibilities of commanding officers and logistics officers of the ships in ensuring necessary spare parts are available on time for such periodic and routing maintenance.

2. Function of Spare Parts Distribution Center

In SLN, generally stored items are classified into two categories: SPDC stores and non-SPDC stores. Accordingly, all the spares used for ships and crafts in SLN are considered as a SPDC store category. In Chapter 34, the function of the SPDC, procurement process of spare parts, classification of stores, demanding procedures, issuing and distribution, and disposal actions are systematically laid down.

C. SPARE PARTS DISTRIBUTION CENTER

The SPDC is considered the critical logistics facility of the SLN, located in SLN Dockyard, Trincomalee within the Eastern Naval Command. It is situated in the eastern part of Sri Lanka about 160 miles from Colombo, the commercial capital city of Sri Lanka. It operates under the Commodore Superintendent of Logistics (CSLOG) and is administered by Captain Superintendent, SPDC. Functionally, as a pivotal store complex, the SPDC is responsible for planning, ordering, maintaining, and distributing essential spares required for the repair and maintenance of SLN ships, craft, workshops, and machinery across the entire naval fleet.

The SPDC plays a vital role in sustaining the operational readiness of the SLN by ensuring the timely delivery of engineering and technical components to relevant ships, crafts, and workshops both within and beyond the Eastern Naval Command. The facility comprises 11 specialized SPDC stores, which are systematically organized to handle

spare parts related to engineering, electrical and electronic systems, filters, bearings, lubricants, generators, and reverse osmosis (RO) plants.

1. Management Structure

As per BR 4, key personnel under the SPDC are as follows (depicted in Figure 2):

- CS (SPDC) - Captain Superintendent SPDC
- SSO (SPDC) - Senior Staff Officer SPDC
- SOP (SPDC) - Staff Officer Procurement SPDC
- SO (SPDC) I - Staff Officer I SPDC
- SO (SPDC) II - Staff Officer II SPDC

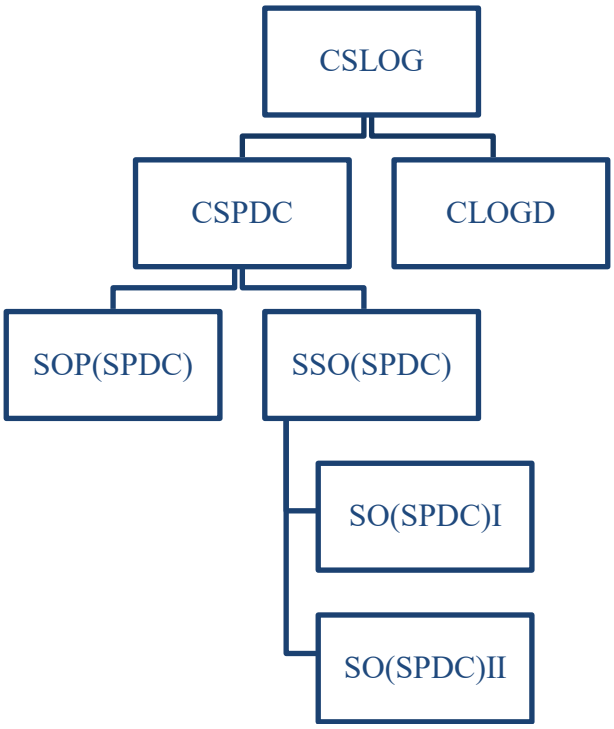


Figure 2. The structure of SPDC

2. Spare Parts Distribution Center Stores Classification

The spare parts stores in the SPDC complex are classified into different types for easy administration as depicted in Table 2.

Table 2. SPDC store classification as per BR 4

Store	Description
SPDC 1	Consisted with Out Board Motors (OBM) and generator spares
SPDC 2 (E)	Consisted with Fast Gun Boat (FGB) engine and FGB generators spares
SPDC 2 (L)	Consisted with FGB electrical spares
SPDC 3	Consisted with Inshore Patrol Crafts (IPCs)/water jet engineering and electrical spares, all shore-based generator spares, Landing Craft Mechanism (LCM)/passenger craft spares, compressor spares
SPDC 4	Consisted with running maintaining spares of Advances Offshore Patrol Vessels (AOPVs)
SPDC 5	Consisted with all Offshore Patrol Vessels (OPVs) and Reverse Osmosis (RO) plants spares
SPDC 6	Consisted with DEUTZ electrical and engineering spares, Fast Attack Crafts (FACs) generator spares, ranges gear box spares, lips control system, all FACs Air condition (AC) system spares
Dovra Stores	Consisted with MTU electrical and engineering spares, ZF gear box spares, FAC fuel injection pump
Central Electronic Stores (CES)	Consisted with communication equipment and spares, radar, echo sounder, GPS and spares, gun communication system spares, sonars and spares, typhoon, Marine Management and Ship Information System (MMSIS), Maritime Safety Information System (MSIS), Underwater Mine Surveillance Information System (UMSIS) [weaponry electrical] spares, PABX and intercoms spares
Central Filters and Bearing Stores (CFBS)	Consisted with all types of filters and bearing for ships/craft engine and generators, base generators
Central Oil and Lubricant Stores (COLS)	Consisted with all types of shell, servo, Coastal Patrol Craft (CPC), and Caltex products

3. Procurement of Spare Parts

Spare part acquisition begins with the Spare Part General Order Request Form (SPGORF), which is initiated when there is a requirement of initiating procurement. It can be due to the lead time required for restocking, the available stock being demarcated for another requirement, or the nonavailability of the spare part, as certain spares are not

stocked owing to risks of being non-moving, high cost, or obsolete. SPGORF is generated through the Integrated Logistics Management System (ILMS) by ships or workshops that have the spare part requirement. Once an SPGROF is received from ships or workshops within the Eastern Naval Command or any other naval command, it is directed to the respective SPDC stores. Upon receipt, the Procurement Request (PR) is created by the relevant store, where the spare part belongs to and is authorized by the designated staff officer. Based on financial limitations promulgated in financial regulations and other relevant memorandums, the request is either allocated for procurement through Naval Headquarters (NHQ) or processed through SOP(SPDC). Additionally, procurement may be carried out in accordance with special requirements projected by the respective technical directorates, such as Engineering or Electrical in the SLN.

The procurement process for spare parts is conducted in accordance with the provisions outlined in the Government Procurement Guideline. The focus of this thesis is limited only to acquisitions under SOP(SPDC). Once the PR is generated, the Office of SOP(SPDC) initiates subsequent actions, including the verification of specifications, preparation of a possible supplier list, and completion of other preliminary requirements necessary for the selected procurement method (see Figure 3).

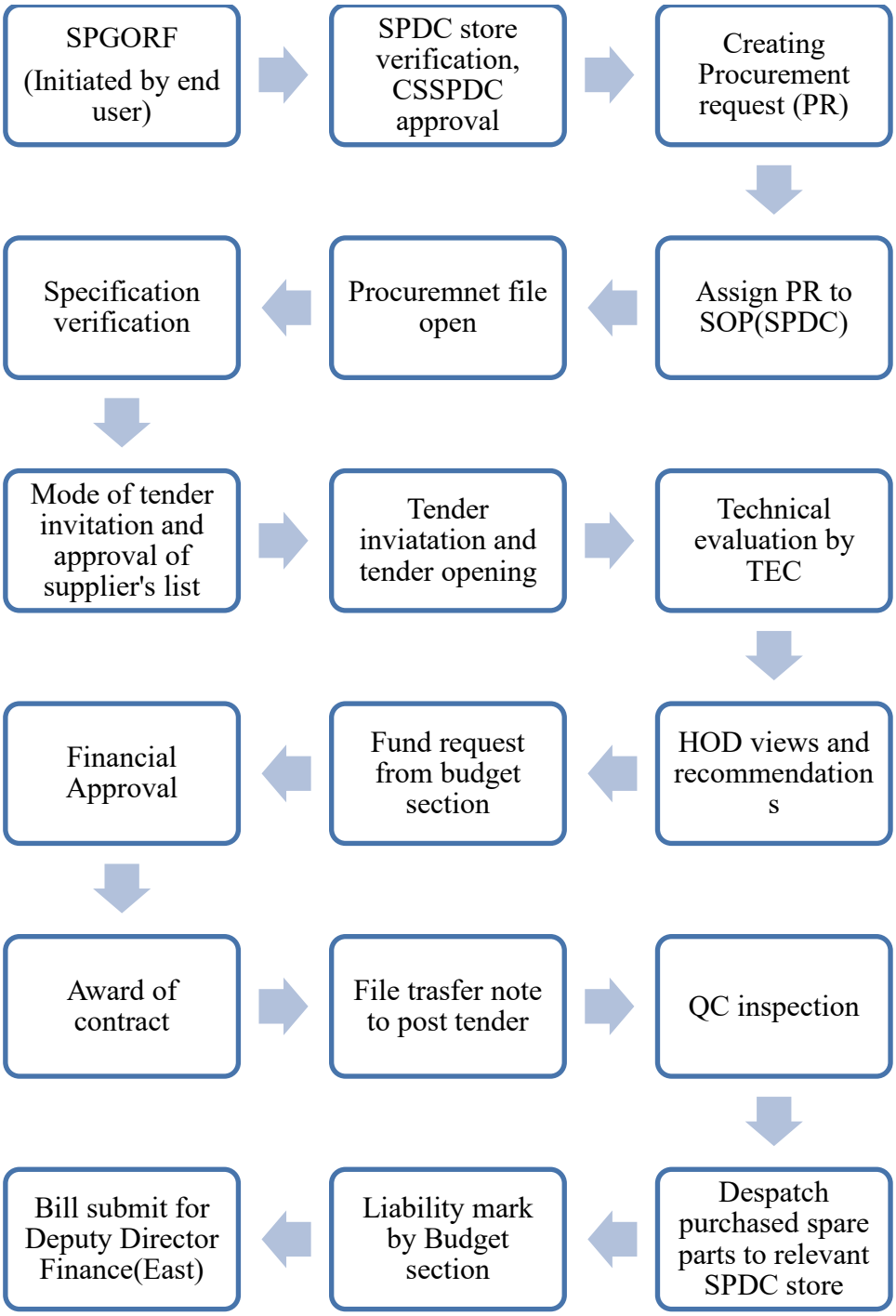


Figure 3. Flow chart with the basic steps of spare parts acquisition as per ILMS

D. INTEGRATED LOGISTICS MANAGEMENT SYSTEM (ILMS)

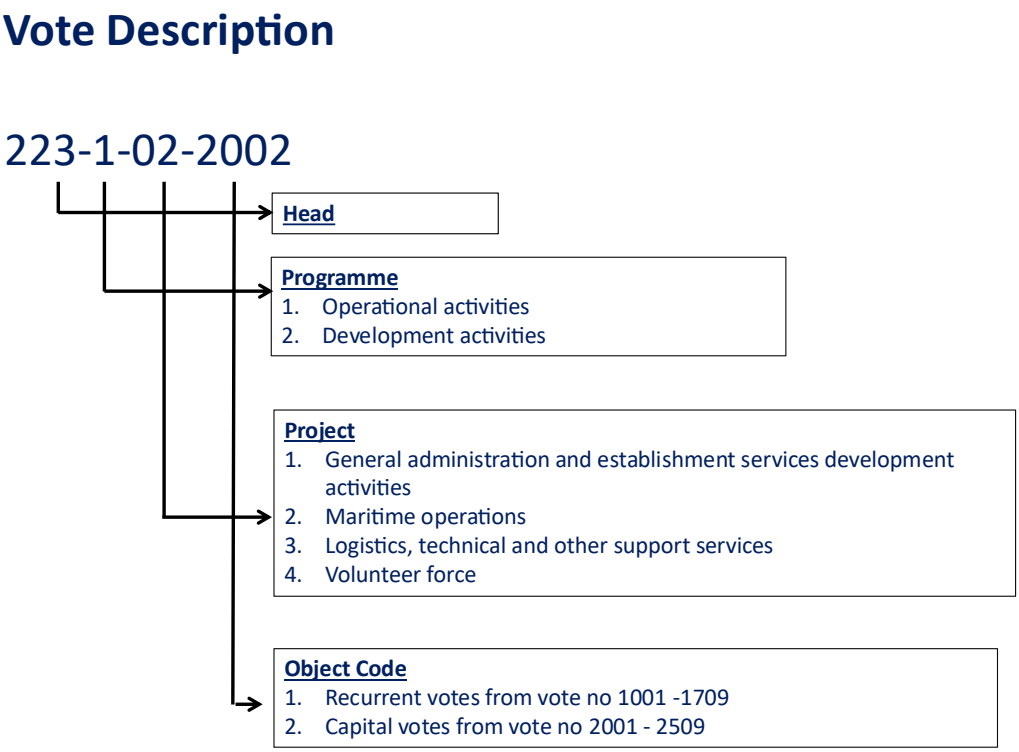
The SLN conducts most of its functions related to inventory management through the Integrated Logistics Management System (ILMS). ILMS represents the first and foremost step toward implementing a comprehensive enterprise resource planning (ERP)

system within the SLN. It is an integrated, computerized platform designed to replace manual processes, thereby streamlining logistics operations. At present, ILMS conducts diverse modules within the SLN such as the store management module, the purchase management module, and the budget module (Serasinghe, 2023). All stores within the SPDC Stores Complex have been integrated with ILMS, ensuring that all transactions are carried out electronically through ILMS. This integration significantly enhances the efficiency of normal operations carried out by the SPDC, quick traceability of previous as well as current processes, and accuracy of the data involved in procurement and inventory management activities. The spare part acquisition process mainly uses store management modules, purchase management modules, and the budget module.

E. UNITS OF BUDGETARY CLASSIFICATION FOR SPARE PARTS ACQUISITION IN SLN

The Treasury of Sri Lanka is the government entity working on budget allocation for each financial year. The Treasury allocates the budget for each ministry or department using a detailed classification system. The classification system consists of several units: head, project, object code to ensure the line of authority, transparency, accuracy, and accountability. The "Head of expenditure," which is a unit of appropriation, represents the entity that receives funds, such as a ministry, department, or special spending unit under the government. Each "Head" has a unique identification number. The "Program of expenditure" is the functional unit of appropriation, which should be formulated in facilitating the departments to achieve its objectives. The "project" represents a cluster of homogeneous actions or an activity, which also facilitates the costing of each activity. The "Object code" is a reflection on the spending area, which is categorized into broader types. This object code can emphasize whether the allocation is either under capital expenditure or recurrent expenditure (Treasury, Government of Sri Lanka, 1992). Accordingly, the SLN's head number is 223 (Treasury, Government of Sri Lanka, 2024). The acquisition of spare parts for the SLN under SOP(SPDC) generally falls under Object Code 2002, which pertains to the rehabilitation and improvement of capital assets, including plant, machinery, and equipment (Parliament of Sri Lanka, 2023). For each financial year, the Directorate of Budget of the SLN allocates funds to the Eastern Naval

Area under this object code to facilitate the procurement of spare parts, among other related expenditures. The example of budget allocation is as follows in Figure 4.



* 2002: Rehabilitation and improvement of capital assets including plant, machinery, and equipment

Figure 4. Description of budgetary classifications. Adapted from Treasury, Government of Sri Lanka (1992).

F. PROCUREMENT GUIDELINE AND MANUAL

Procurement Guideline 2024 on Goods, Works, and Non-Consulting Services was published by the National Procurement Commission of Sri Lanka to standardize, streamline, and assure the accountability, efficiency and transparency in public sector procurement. This guideline superseded the previous guideline issued in 2006 by the National Procurement Agency and went into effect on January 1, 2025. *Procurement Guideline 2024* provides details and guidelines related to procedures, responsibilities on each level of authority, authority limits, explanations, threshold limits, and time schedules that need to be considered in public procurement, which the SLN also practices in spare parts acquisitions. The procurement entity is authorized to initiate procurement actions directly through the original manufacturer or an authorized local agent,

particularly when the authenticity and quality of spare parts are of critical concern. Additionally, it retains the discretion to procure from independent spare parts manufacturers or dealers, provided that all actions are conducted in accordance with the established acquisition procedures (National Procurement Commission of Sri Lanka, n.d.).

Spare part procurement under SOP(SPDC) is mainly conducted through three procurement methods laid down in the procurement guideline as follows:

1. Clause 3.1.2: National Competitive Bidding

National Competitive bidding (NCB) is the competitive procurement method that shall be generally applicable for most Government of Sri Lanka (GOSL) funded projects when the Goods, Works, and Non-consulting Services are available within Sri Lanka. Procurement entity (PE) may encourage local bidders as far as possible by using the NCB method when procurements are financed by GOSL funds. However, when local bidders do not have adequate technical or financial capacity, foreign entities may be allowed to submit bids/proposals for procurements under the NCB method. In such instances, foreign bidders may be allowed to bid, provided that the prices are quoted in Sri Lanka rupees. NCB method in foreign-funded projects shall be used with the concurrence of the Foreign Funding Agency as articulated in the respective financing agreement.

2. Clause 3.1.5 a: Shopping/ Request for Quotations (National)

Shopping/request for Quotations (RFQ) is a procurement method that can be used by the PE when purchasing off-the-shelf Goods, Works, and Non-consulting Services, as mentioned below by comparing price quotations received from reputed or registered bidders.

- Commercially available off-the-shelf Goods.
- Commodities for which specifications are standard; or
- Small-value Goods, Works, and Non-consulting Services.

3. Clause 3.1.6: Direct Contracting

Direct contracting is a contracting method with a single source without competition and may be an appropriate method under special circumstances. Direct contracts with government institutions may be considered when it is justifiable in special circumstances in accordance with government policies established with the concurrence of the NPC. (National Procurement Commission of Sri Lanka, n.d.)

G. FINANCIAL REGULATIONS

The Financial Regulations (FR) of Sri Lanka, issued by the Ministry of Finance, provide a comprehensive framework for managing public finances, covering areas such as budgeting, accounting, procurement, asset management, and auditing across government institutions. This regulation aims to ensure transparency, accountability, and proper stewardship of public resources. Section F.R. 795 of the Government Financial Regulations pertains to the "Purchase of Spares for Machinery and Equipment" and clearly outlines the procedures to be followed under normal circumstances, limited or selective procurement methods, and emergency situations. Further, Chapter III of the regulation emphasizes financial management and accountability and states that an accounting officer can delegate his financial authority under F.R 135, which is relevant in acquisition of spare parts (Treasury, Government of Sri Lanka, 1992).

H. SUMMARY

This chapter provides the background details about spare parts acquisitions system in SLN and the different levels that are required to be coordinated with the spare parts acquisition along with the general acquisition process, particularly related to the acquisitions initiated by SOP (SPDC). The succeeding chapter lays out the relevant literature and reviews possible bottlenecks in acquisition.

III. LITERATURE REVIEW

The literature review for this study mainly focused on research relating to the acquisition of spare parts, procurement challenges in public sector organizations worldwide (including Sri Lanka), military logistics and procurement systems, supply chain disruptions, and root cause analysis of supply chain inefficiencies. Although there were very limited articles specifically related to spare parts procurement bottlenecks in military sectors, these studies provided valuable theoretical and empirical foundations for understanding the underlying causes of procurement bottlenecks in different sectors that relate to the defense sector as well. The insights gained from prior research helped contextualize the challenges faced by the SLN in acquiring spare parts. Moreover, the literature offered a range of mitigation strategies, which can also be relevant to the SLN to mitigate the supply chain bottlenecks in spare parts acquisition. Accordingly, the literature review is organized into eight sections, as outlined in Table 3.

Table 3. The areas focused through the literature review

Section	Title of focused area
A	Procurement cycle
B	Supply chain bottlenecks in procurement
C	Budget constraints and financial limitations
D	Major global economic disruptions
E	Quality inspection and assurance challenges
F	Lack of manpower requirement
G	Regulatory compliance, lengthy procurement processes and payment processes
H	Non-responsiveness of bids
I	Poor supplier relationship and interdepartmental collaboration

A. PROCUREMENT CYCLE

The procurement cycle is a comprehensive process that begins with the planning of required goods and concludes with their delivery and acceptance at the receiving point.

The cycle typically involves three major phases, namely supply planning, purchasing activities, and contract performance, each containing a series of structured steps. These stages together may include 15 sequential actions that guide the process from budgeting to delivery and acceptance as depicted in Table 4 (USAID, 2013).

Table 4. Common procurement steps and bottlenecks. Source: USAID (2013).

Step	Function	Bottleneck(s)
I. Supply Planning		
1	Define supply requirements	Inaccurate or omitted requirements.
2	Complete budgeting and approval process	Budget cycle timing does not match the funding cycle.
3	Submit procurement requisitions and specifications	Requisitions not submitted on time. Inadequate or missing specifications. Specification changes after purchasing procedures initiated.
4	Release funds to procuring units	Timing does not match resupply needs. Mid-term budget cuts; programmed funds withheld.
II. Purchasing Activity		
5	Plan the purchasing work: Assess procurement options; plan contract groupings and schedule purchasing work	Slow contract planning by procurement unit (p). Slow work on procurement schedule (p). Delayed input and approval from line supervisor. Uncertainty over dates and amount of funds available.
6	Prepare bidding documents, obtain approvals	Slow or flawed preparation of draft by procurement unit (p). Slow or flawed decision-making at higher levels. Slow processing by funder or monitor.
7	Invite offers: Advertise, provide bidding documents, pre-bid meeting, respond to bidder questions	Problems with advertising. Bidding document revision required (p). Bid deadline extended to accommodate amendments.
8	Select suppliers and obtain approvals: Bid opening, evaluation, committee deliberation	Slow preparation of examination worksheet (p). Disagreements over evaluation results. Slow approval process. Rejection by monitor due to unsupported decision or flawed process.
9	Award contracts: Notify successful bidder, publish results, negotiate, process	Protests by losing bidders. Cancellation of bid. Irregularity in performance security.

	signatures, obtain performance security	
10	Arrange payment guarantee: Down payment, issue letter of credit	Delay in requesting letter of credit/down payment (p). Delay in processing by finance unit or Ministry of Finance. Insufficient funds to collateralize letter of credit or make down payment.
III. Contract Performance		
11	Process order and manufacture goods	Raw materials shortage. Overbooked manufacturing schedule. Distributor issues.
12	Perform pre-shipment inspection/testing	Failed or disputed results.
13	Deliver to port of entry	Shipping problems.
14	Clear goods through customs	Slow processing of documents. No access to funds for port fees. Irregularities in goods or documents. Pharmaceutical registration issues.
15	Perform post-shipment inspection/testing	Delayed or failed inspection/testing. Slow reporting and/or release.

* (p) = bottleneck attributable to procurement unit personnel

B. SUPPLY CHAIN BOTTLENECKS IN PROCUREMENT

According to the terms and glossary list updated in 2013 by the Council of Supply Chain Management Professionals (CSCMP, n.d., p.22), a bottleneck is defined as "a constraint, obstacle, or planned control that limits throughput or the utilization of capacity." However, in differentiating between a bottleneck and a constraint, the Theory of Constraints Institute (n.d.) defines a bottleneck as "any resource with lower capacity than the current load, and if several bottlenecks are present in the same line of flow, the one with the least capacity is considered the constraint." In supply chain terms, a bottleneck refers to a point, such as a process, stage, or resource where limited capacity slows the entire workflow. In the context of spare part acquisition within the SLN, bottlenecks may emerge at any of the steps illustrated in Figure 3 of Chapter II, particularly when the process is constrained by limited capacity.

These constraints can significantly disrupt logistics, procurement efficiency, and overall supply chain performance. When such constraints are not addressed, they can lead to delays, increased costs, and diminished operational effectiveness. In the procurement cycle, bottlenecks commonly manifest as delays, the duration of which varies depending on the specific stage at which the constraint arises. These delays can occur at multiple points such as requisition approval, supplier selection, or contract finalization and significantly disrupt the overall efficiency of procurement operations (USAID, 2013). A 2023 annual detailed management audit report relating to the SLN emphasized nonoperational ships belong to the SLN, highlighting the delay of receiving spare parts. The reports states, "Some of these vessels are currently being repaired, and spare parts have been ordered for others, but the parts have not been received yet" (National Audit Office of Sri Lanka, 2024, p.9)

C. BUDGET CONSTRAINTS AND FINANCIAL LIMITATIONS

The efficiency of the procurement process in an organization is frequently associated with the budget allocation (Kakai & Mokono,, 2022). Budgetary constraints are a common challenge in public sector procurement, affecting the timely acquisition of necessary goods and services (Brainial, 2025). One of the significant resource constraints faced by defense procurement is the substantial financial burden imposed by defense related expenditures (Patil & Bhaduri, 2020). The National Audit Office has adequately highlighted the budget constraints faced in the repair and maintenance of ships and crafts of the SLN. It emphasized that the estimated amount required for ship repair and maintenance from 2019 to 2023 was Sri Lankan Rupee (LKR) 38,146,514,747 whereas the actual budget received was only LKR 17,850,651,000 (National Audit Office of Sri Lanka, 2024). This indicates that the treasury department allocated less than half of the estimated amount requested by SLN for maintenance of ships and crafts, emphasizing an underfunding gap.

D. MAJOR GLOBAL ECONOMIC DISRUPTIONS

Global supply chains have been challenged by the disruptions such as the COVID 19 pandemic, issues in major trade routes including Suez Canal closure and global tensions periodically emerging (Antai & Hellberg, 2023). The COVID 19 pandemic

vividly demonstrated how rapidly cascading effects can accumulate, leading to significant disruptions and adverse consequences across global supply chains (Moosavi et al., 2022). The fragility of global supply chains impacted by these disruptions has adversely affected the worldwide defense sector, despite the considerable capabilities possessed by modern militaries. Wright (2022) emphasized that the global disruption caused by the COVID-19 pandemic affected the U.S. Navy's supply chain, with early signs of constraints emerging in the shipbuilding industry leading to significant delays. These delays illustrate how global events could significantly strain highly structured and mission-critical procurement systems in the defense sector.

E. QUALITY INSPECTION AND ASSURANCE CHALLENGES

One of the key procurement-related issues highlighted in scholarly literature is the failure of deliverables to meet quality inspection standards. Deliverables that do not conform to the required specifications and performance benchmarks are identified as a persistent problem in procurement processes, particularly in industries where compatibility with prevailing systems or functions and prior standards are essential (Gunawardana et al., 2021). Such quality deficiencies not only disrupt estimated timelines but also contribute to increased costs and rework, thereby undermining procurement efficiency, and this issue can be considered as a common constraint in almost every industry.

F. LACK OF MANPOWER REQUIREMENT

Inadequate human resource capacities within the departments that involve acquisition/procurement also leads to delays in processing requisitions, managing supplier communications, and executing timely follow-ups, ultimately affecting the overall efficiency and timeliness of procurement operations. A study conducted to analyze material procurement delays in a steel manufacturing company in Indonesia identified the shortage of manpower allocated to procurement functions as a significant contributing factor to procurement inefficiencies (Nugroho et al., 2020). SLN has identified a shortage of SLN personnel as a concerned challenge and overarching issue since the manpower shortage influences every operational and administrative effort in effort in SLN (Parliament of Sri Lanka, 2023).

G. REGULATORY COMPLIANCE, LENGTHY PROCUREMENT PROCESSES AND PAYMENT PROCESSES

Public sector acquisition and procurement are governed by established processes and procedures that are mandatory to follow, ensuring transparency, accountability, and compliance with regulatory frameworks (Brainial., 2025; Hellberg, 2023)). Lengthy procurement processes are a significant constraint in public sector acquisitions, often resulting in delayed project execution and operational inefficiencies. The mandatory adherence to multistage approval cycles, strict compliance protocols, and rigid documentation requirements, while intended to ensure transparency, frequently slows down the timely procurement of critical items such as spare parts or any other required materials. In time-sensitive environments, these delays can directly hinder maintenance schedules, manufacture capabilities, compromise readiness, and magnify numerous challenges across specific sectors. The study conducted to find ins and out of procurement contracting from Military-affiliated entrepreneurs also stated that the government bidding processes and the contract approval processes are more complex and challenging than the cooperate sectors (Pritchard & Maury, 2025). Moreover, a survey conducted with procurement decision makers found that inefficient or lengthy payment processes also lead to frustration and demotivation by suppliers which has a direct influence towards subsequent procurement activities (Spend Matters, 2021).

H. NON-RESPONSIVENESS OF BIDS

Responsiveness of bids is vital for any procurement entity for the overall success in the procurement and is considered crucial in the process of choosing responsible contractors for any given project (Volmink, 2018). It is a universally accepted principle in public procurement that bids failing to meet the minimum criteria specified in the bidding documents must be deemed non responsive and disqualified from further evaluation (Ott, 2010). The study on enhancing bid evaluation specific to the construction projects in Sri Lanka emphasized that non-responsiveness or poor response to the bids has led to a series of negative consequences such as reduced competition, bid requirements, and delay of overall process (Alwis et al., 2022; Uduwage-Don et al., 2024).

I. POOR SUPPLIER RELATIONSHIP AND INTERDEPARTMENTAL COLLABORATION

Prior studies on acquisition in various industries have emphasized that supplier relationships and collaboration among departments involved in acquisition play a critical role in ensuring efficiency and timeliness of the overall process. Poorly defined practices between different departments and communication delays or gaps cause real issues on entire process (Spend Matters, 2021). Moreover, maintaining healthy supplier relationship is also important throughout procurement process as possible consequences of poor supplier relationships include missed delivery deadlines, quality issues and overall delay in the procurement process (Harmon, 2024; Kennemer, 2025). It is important to have trust, shared goals and objectives, collaboration and clear communication among the involved parties to overcome the issues related to procurement process (Hellberg, 2023).

J. SUMMARY

Upon reviewing the existing literature, it was found that there are considerable numbers of procurement-related bottlenecks related to diverse industries all over the world. Table 5 outlines the key focus areas of the literature review, emphasizing the major relevance towards the thesis on spare parts acquisition process in the SLN.

Table 5. Summary of literature review and relevancy to the thesis

Section	Theme	Description
A	Procurement Cycle	Provides an overview of the general stages of procurement process starting from requisition to delivery and emphasizes the potential bottlenecks in each stage.
B	Supply chain bottlenecks in procurement	Explains the concept of bottlenecks vs constraints and examines how they manifest within procurement processes, forming the theoretical basis for analyzing bottlenecks in the SLN.
C	Budget constraints and financial limitations	Explores how inadequate budget allocation leads to inefficiency in the procurement in public sector and timely allocation of resources.

D	Major global economic disruptions	Provides context on external shocks (pandemics, global tensions) that directly influence procurement related activities.
E	Quality inspection and assurance challenges	Highlights how quality deficiencies and prolonged inspection procedures undermine the procurement efficiency.
F	Lack of manpower requirement	Emphasize how inadequate human resource capacities for procurement functions slow down the overall procurement process.
G	Regulatory compliance, lengthy procurement processes and payment processes	Discusses the consequences of lengthy procurement processes, complexity of regulatory compliances and inefficient payment processes towards timely and efficient procurement highlighting the negative aspects such as discouraging critical suppliers whose engagement is crucial for future and reducing procurement agility.
H	Non-responsiveness of bids	Provide the context of how limited supplier participation, non-responsiveness or refusal to comply with required standards stagnate procurement at the bidding stage.
I	Poor supplier relationship and interdepartmental collaboration	Highlights how coordination gaps among involved parties such as suppliers or other essential departments undermine timely fulfillment of contracts and long-term reliability.

The literature review underscores that budgetary constraints, delivery of substandard items, lengthy regulatory compliance procedures, inadequate manpower to manage procurement activities, non-responsiveness of bids, and poor communication and relationships among involved parties can contribute to delays in the procurement process, particularly within the internal environment. Furthermore, major global disruptions also cause significant delays in procurement processes across diverse industries worldwide. However, the number of scholarly works specifically addressing bottlenecks in spare parts acquisition within the military is extremely limited, and the author could not locate any scholarly articles related to the context of the SLN. Most of the available literature is either tangentially related to the subject or focuses more broadly on public procurement practices without offering insights into defense or naval procurement processes. Furthermore, there is a notable absence of in-depth discussions on enhancing public

procurement within the Sri Lankan context, particularly in relation to military or naval logistics. To date, no substantial research has been identified that comprehensively examines this issue within the operational framework of the SLN.

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IV. ROOT CAUSE ANALYSIS

This chapter presents a detailed description of the tools used under the methodological framework outlined in Chapter I, followed by the results from the root cause analysis. As described in the methodology, procurement data at SOP (SPDC) was used for the purpose of this analysis, as this study focuses on identifying potential stagnation stages of spare part procurement process under the SOP (SPDC) thus, recognizing the root causes. Accordingly, the procurement actions raised in 2024 that remained incomplete at the time of data collection were considered for the analysis. Procurement files were classified according to the stage where progress had stagnated, enabling the identification of delays and bottlenecks. The subsequent sections in this chapter further elaborate on the remaining stages of the analysis process.

A. PARETO ANALYSIS

The foundations for the Pareto analysis formed with the asymmetry in influences, which considers a small proportion of causes generally responsible for a disproportionately substantial number of influences (Majka, 2024). This concept sprang from economic expert, Vilfredo Pareto, during his studies related to unequal distribution of wealth, which was observed to be consistent with most of other systems comprised with inputs and outputs. Hence, Pareto analysis is considered as a robust technique used to identify and prioritize the most significant elements in each cluster of elements, based on the understanding that not all elements have equal contribution to the outcome (Dovetail, 2023). Central to Pareto analysis is the 80/20 rule, also known as Pareto principle, which describes that 80% of outcomes are based on 20% of causes (Bonnici, 2015). Moreover, Pareto analysis offers good understanding about which causes need to be treated without delay as 80 % of the issues are due to 20% of dominant sources or causes (Nadiyah & Dewi, 2022).

Construction of the Pareto chart, which graphically denotes the causes and their cumulative effects, is the primary step in conducting Pareto analysis. The Pareto chart is a bar chart which showcases each cause with frequency, arranged in descending order from left to right (Nadiyah & Dewi, 2022). Pareto charts are used when they are required to

analyze data related to frequency of issues or causes in a process or when it is required to focus on most significant issues among many other issues or problems (What Is a Pareto Chart?, n.d.). Accordingly, to conduct Pareto analysis, the author categorized the stages of the acquisition process that cause delays/stagnations and quantify their frequencies, which were subsequently used to construct a bar chart. By arranging the stagnated positions in descending order of frequency and plotting their cumulative impact, a Pareto chart was developed, as shown in Figure 5 and 6 below. This analytical tool was employed to highlight the most significant contributing factors to procurement bottlenecks in spare part acquisition under the SOP (SPDC), thereby identifying key areas that warranted further root cause analysis.

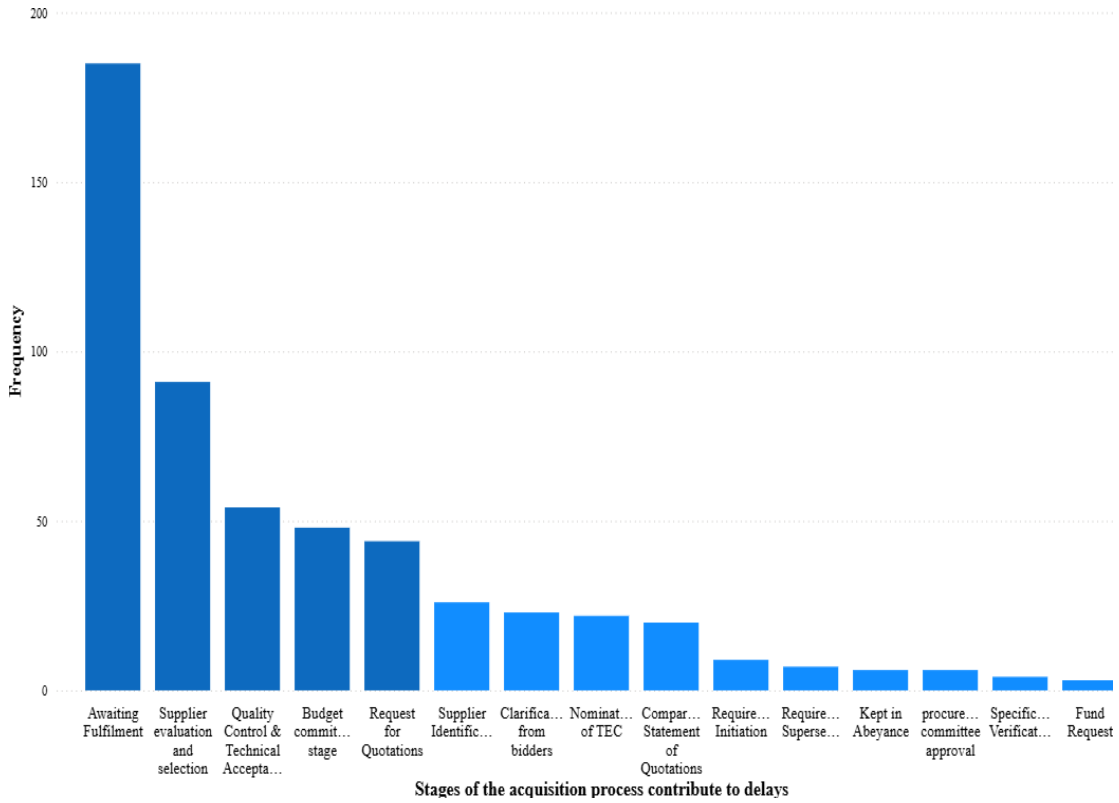

Figure 5. The stagnation positions of spare parts acquisition in SOP(SPDC), SLN

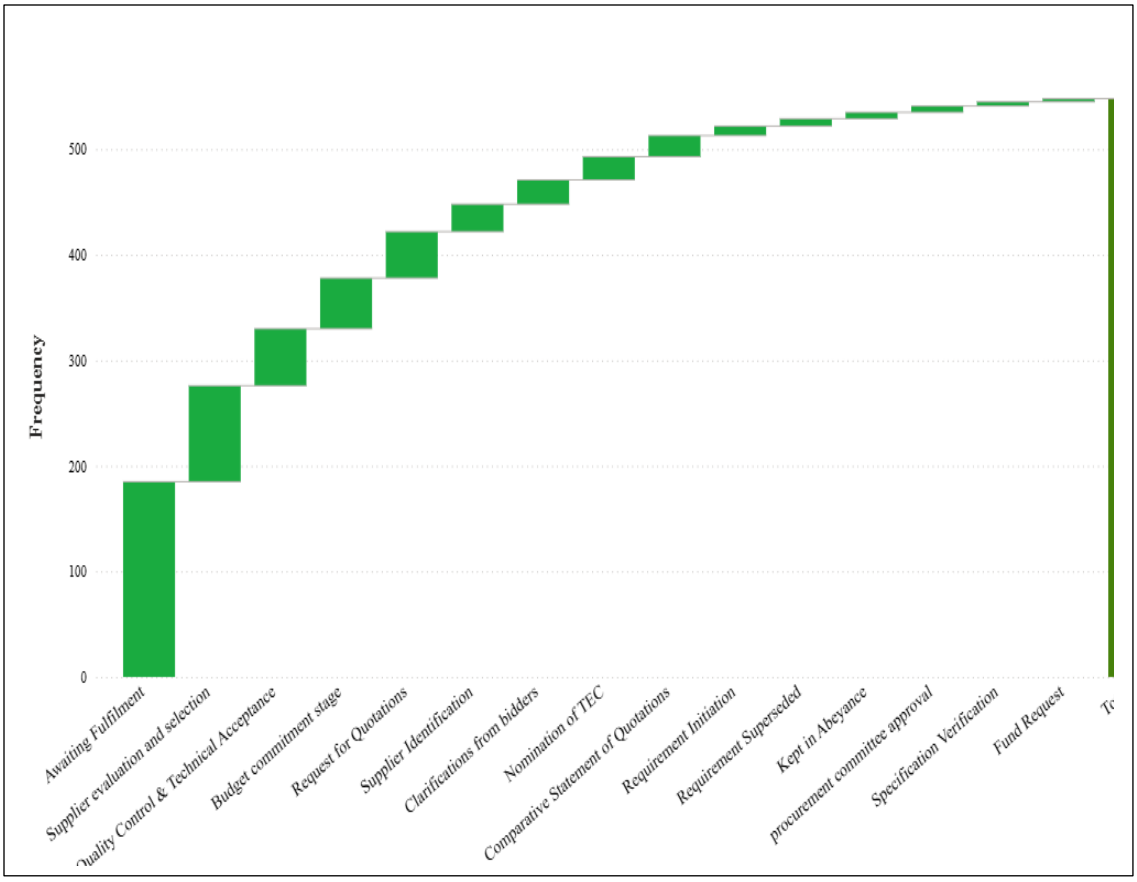

Figure 6. The stagnation positions of spare parts acquisition in SOP(SPDC), SLN with cumulative frequency

Summarizing the above charts and following the Pareto principle, the author considered that undermentioned stages are the most significant areas that cause delays and stagnation in the spare parts acquisition process in SOP(SPDC), thereby treating those as the major bottlenecks which required root cause analysis.

- Awaiting fulfillments
- Supplier evaluation and selection
- Quality control and technical acceptance
- Budget commitment stage
- Request for quotations

B. ISHIKAWA / FISHBONE AND THE FIVE WHYS PROCESS

In 1960, Dr. Kaoru Ishikawa popularized the cause and effect diagram, which is also known as fishbone or Ishikawa (Nadiyah & Dewi, 2022). The fishbone diagram is a structured process in recognizing the underlying issues and sources of problems and the

relationship between the problem, and the factors that contribute to it can be analyzed using these diagrams (Andersen & Fagerhaug, 2006b; Kumah et al., 2024). Similarly, the "five whys" process also relates to solving the problems systematically by delving deeper into the level of causes, inquiring 'why' constantly for each level (Serrat, 2017). Researchers have concurrently applied both tools to improve the accuracy and depth of root cause analysis (Cirone et al., 2023). Similarly, once the major bottleneck stages are identified through the Pareto analysis, the root cause analysis in this study employs a modified approach that integrates the Ishikawa fishbone diagram with the "five whys" technique.

The initial fishbone diagram, presented in Figure 7, illustrates the primary research question along the spine, with each major bottleneck in spare parts acquisition under the SOP (SPDC) represented as a main bone branching from it.

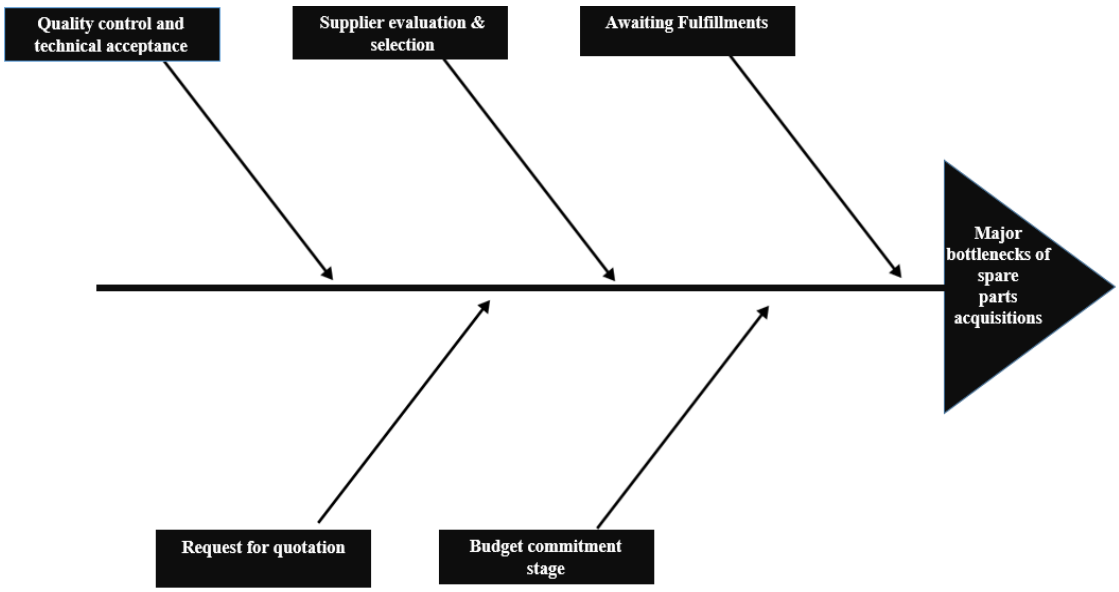

Figure 7. Initial fishbone diagram

C. MAJOR BOTTLENECK 1: AWAITING FULFILLMENT FROM THE SUPPLIERS

The Pareto analysis revealed that a significant proportion of awarded contracts are delayed at the fulfillment stage due to the failure of suppliers to deliver the required orders within the expected timeframe.

1. Root Cause 1: Supplier Internal Issues

Delays of fulfillment frequently occur due to various delays on suppliers' side. The situations, such as their internal cashflow issues, stock outs, shipping delays, port congestion, and customs clearance backlogs, significantly extend lead times for spare parts. These logistical bottlenecks are further intensified by currency fluctuations, creating uncertainty about the profitability of local suppliers, thereby weakening suppliers from fulfilling the orders in given time.

2. Root Cause 2: Inefficient Financial Processes

In the context of spare parts under SOP(SPDC), SLN operates with a relatively limited supplier base that qualifies with required standards. From the supplier perspective, they are highly dependent on the timely settlement of payments from SLN for previously delivered spare parts to sustain and continue their operations and to process subsequent orders in a timely manner. Once spare parts are delivered, they must undergo a series of internal procedural verifications and approvals, including quality control and inventory management, before the document reaches the payment section under Deputy Director Finance (DDF). Then it will be again verified by the staff under DDF. This multi-step process often extends the timeline for payment. Moreover, payments are contingent upon the availability of liquid cash allocations within the relevant budget cycle. As a result, even after the necessary documentation is completed, suppliers frequently experience considerable delays in receiving payment.

Hence, if the suppliers are unable to receive payments on time or payments are delayed, most of them are discouraged about proceeding with upcoming transactions with SLN. This dependency creates a cycle in which delayed payments directly translate into delays in the fulfillment of future orders, thereby intensifying procurement bottlenecks in the fulfillment stage. Moreover, payment backlog results in suppliers withholding orders by deferring or suspending the delivery of contracted spare parts until outstanding payments are settled. It can extend further, as suppliers may refuse future relationships with SLN. The underlying root cause is the inefficient financial process, which constrains the financial flexibility of suppliers towards fulfillment of orders.

3. Root Cause 3: External Uncontrollable Risk

The suppliers dealing with spare parts procurement under SOP(SPDC) are heavily reliant on import and supply basis, which sometimes restricts the supplier control over delivery spare parts on time. Local suppliers must accept unforeseen delays at the principal supplier's location when manufacturing delays are exacerbated due to issues such as geopolitical tensions and environmental factors. Collectively, these external factors, which can be described as uncontrollable risks, contribute to procurement stagnation and prolong the fulfilment of spare parts within the required timeframe.

4. Root Cause 4: Manpower Shortage

Manpower shortage is one of the key issues faced by SLN, and this shortage indirectly affects towards the spare parts acquisition process by further exacerbating delays in the fulfillment process. At present, the number of staff has reduced to three at SOP(SPDC) to manage both pre-tender work and most of post-tender works, such as supplier communication and coordination and order tracking. This shortage leads to reduced visibility of ongoing orders due to communication gaps and inadequate follow up with suppliers, which results in the stagnation of orders at the fulfillment stage. Moreover, this shortage leads to prolonging the resolution of supplier- related issues. In addition, the number of transport assistants and store assistants assigned to order collection and handling in Rear Link-Colombo remains insufficient to meet the daily operational requirement. Collectively, the effects of these limitations hinder smooth procurement flow, thereby contributing to the persistence of bottlenecks at the "Awaiting Fulfillment" stage.

5. Root Cause 5: Less Motivation Due to SLN Payment Term

SLN payment term for the local procurement primarily based on credit payment terms, which means payment for the respective supplier will not be made at the time of purchase and instead payment needs to be done within the given credit period. Accordingly, the procurement of spare parts under SOP (SPDC) is initiated following credit payment terms, and payments are typically disbursed to supplier, only after delivery and completion of lengthy verification procedure and availability of liquid cash

at payment section which often exceed the agreed credit period. Consequently, the delay in receiving payments leads suppliers to give less priority to SLN orders, even when spare parts are readily available, in favor of customers who guarantee faster cash flows. This disincentive structure weakens supplier commitment to timely delivery and reduces responsiveness to SLN requirements. The underlying root cause, therefore, is the rigidity of credit-based payment practices, often exceeding the agreed credit period, which fails to provide adequate incentives for suppliers to prioritize fulfillment of naval orders.

Considering the above facts, Figure 8 displays the fishbone diagram for the major bottleneck 1, Awaiting fulfillment.

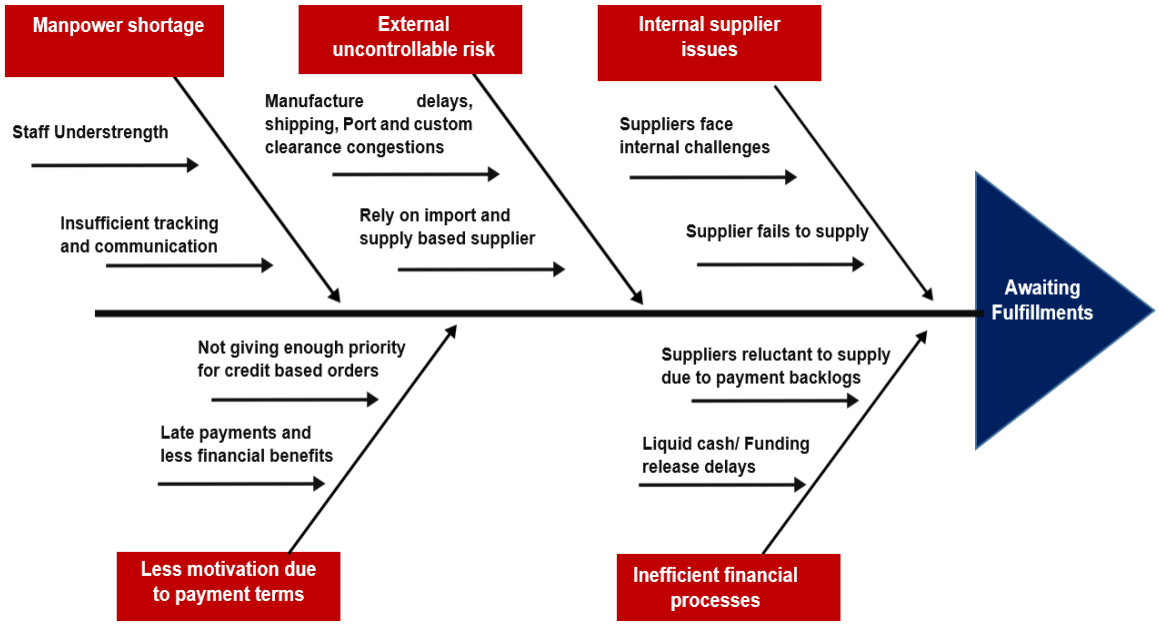

Figure 8. Fishbone diagram for major bottleneck 1, awaiting fulfillment

D. MAJOR BOTTLENECK 2: EVALUATION AND SELECTION OF SUPPLIERS

The Pareto analysis revealed that a significant proportion of initiated procurements files are stagnated at the evaluation and selection of suppliers stage.

1. Root Cause 1: Dual Process -ILMS and Manual Documentation

In SLN, all procurement actions are initiated through the ILMS and continue until dispatching procured spare part to relevant store; however, SLN remains maintaining the manual documentation alongside with ILMS and the procurement file needed to be

circulated all necessary steps simultaneously. Accordingly, the requirement to operate in system and maintain manual documentation in parallel makes the overall procedure more time-consuming. Further, in certain cases, the ships that have requested spare parts are stationed in different naval areas other than eastern naval area where the SPDC complex is located. Sometimes, the procurement evaluations for certain spare parts need to be carried out by the ship's staff or samples need to be checked at the ship; such procurement files, along with the samples, need to be sent to their respective ships. As a result, evaluation files must be physically transferred between areas for evaluation purposes, which consume considerable time, contributing to delays in the evaluation and selection stage.

2. Root Cause 2: Inefficiency of Procurement Staff

In some instances, the Technical Evaluation Committee (TEC), which does the evaluation to select substantially qualified offer, requests the procurement entity to get clarifications or any additional information from certain bidders prior to finalizing the recommendations. However, considerable number of such requests are not followed up in a timely manner by the procurement staff due to excessive workload, which often arises due to staff inefficiency. Hence, the delays of procurement staff in providing necessary clarifications from bidders indirectly exacerbate the delays in the evaluation and selection stage, resulting in procurement files remaining stagnant until all clarifications are received and reviewed.

3. Root Cause 3: Excessive Workload Due to Manpower Shortage

In the SLN, evaluations are carried out by the officers in parallel to their wide range of routine, operational and administrative duties as there are no officers assigned exclusively to conduct the technical and financial evaluation of bidders. As highlighted in Chapter III under the topic of manpower shortage, SLN is presently experiencing a significant disparity between its approved cadre and the actual cadre strength of both officers and sailors. This shortfall has created notable challenges in maintaining the required level of human resources across key functions. In the context of spare parts acquisition, evaluations are typically carried out by the TEC, which is composed of both

technical officers and logistics officers. However, the persistent issue of manpower shortage directly affects the availability and efficiency of these officers, and because of this disparity, a considerable number of procurement files are allocated per officer, making it difficult to prioritize evaluations within the strict timelines expected by procurement guidelines, since the workload becomes disproportionate to the time available. Hence, this excessive workload due to manpower shortage often leads to delays and stagnation in the supplier evaluation and selection stage.

Accordingly, Figure 9 showcase the fishbone diagram for major bottleneck 2, Evaluation of bids and selection of suppliers.

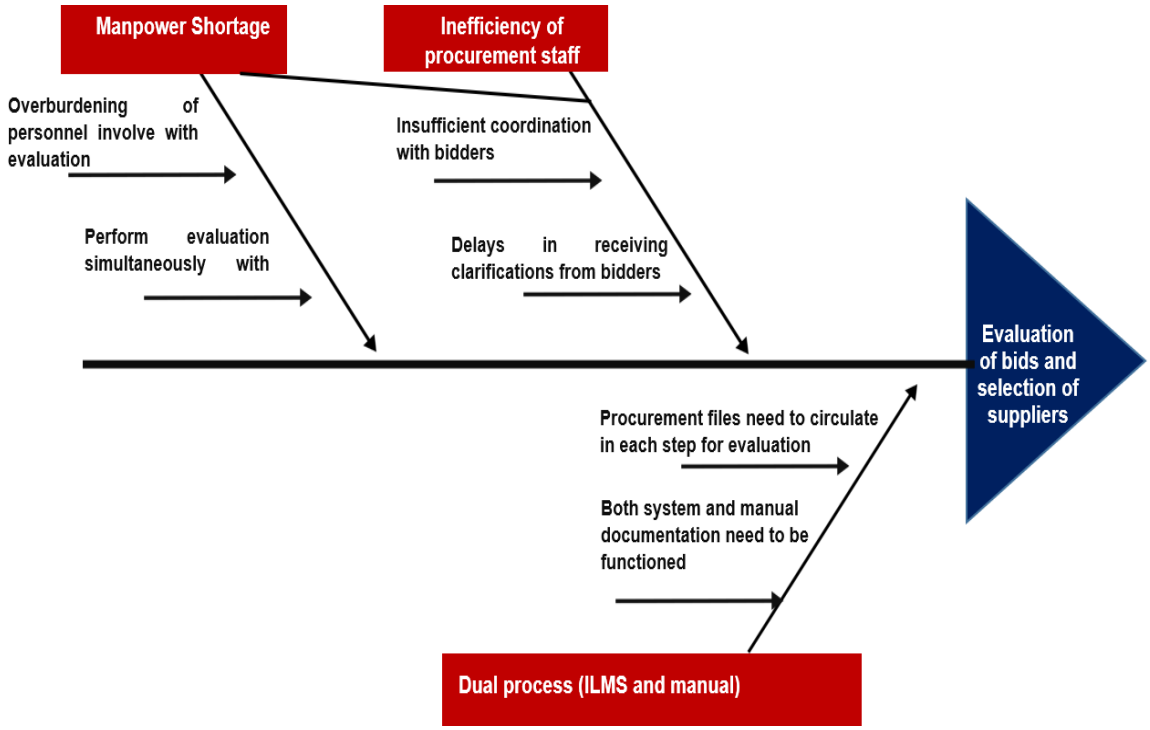

Figure 9. Fishbone diagram for major bottleneck 2, evaluation and selection of suppliers.

E. MAJOR BOTTLENECK 3: QUALITY CONTROL AND TECHNICAL ACCEPTANCE

The Pareto analysis discovered that a substantial proportion of initiated procurements files are also stagnated at the stage of quality control and technical acceptance.

1. Root Cause 1: Supplier Non-Compliance with Specifications

The noncompliance of the supplier-delivered spare parts with the required specification often leads to delays in the quality control and technical acceptance stage. In some cases, the requirements only partially comply with the SLN requirement, and the rest do not fully comply with the required specifications. Moreover, there are occasions when spare parts are delivered without essential documents, such as Original Equipment Manufacturer (OEM) certification or with inferior quality. These results disqualify at the quality control and technical acceptance stage and require sending back the disqualified spare parts to the supplier and await for spare parts that comply with specifications required by SLN. This process often takes considerable time as most of the local suppliers rely on an import and supplier basis and on most occasions, the repeating process is required on the supplier's side.

2. Root Cause 2: Onboard Quality Control Requirement

In some instances, quality control and technical acceptance for the procured spare parts for ships cannot be conducted at post-tender premises or at workshops as their compatibility, and the performance can only be confirmed through functional testing on the specific platforms for which they are intended. Hence, such spare parts must be dispatched to the respective ships for inspection and functional settings, before quality control and technical acceptance can be finalized. However, when these ships are deployed in different naval areas, sending the spare parts for verification onboard needs extra coordination and transports arrangement, which consumes additional time and effort. Moreover, at times, the ship has already sailed on operational duties by the time the spare parts are received, resulting in the quality control process being postponed until the ship's return. Moreover, there are infrequent incidents where some spare parts are required to test when a ship is at sail. Additionally certain spare parts need to be kept until some ships become operational from their non-operational condition to do the technical acceptance test. Accordingly, the dependency on onboard based testing at ships delays the quality control and technical acceptance decisions, although it is impractical to avoid.

3. Root Cause 3: Inadequate Supplier Relationship and Interdepartmental Collaboration

Another important root cause of delays in quality control and technical acceptance is the insufficient coordination with the relevant department, ship or personnel for conducting quality control, which leads to stagnating spare parts at post-tender area for certain duration. Further, on particular occasions when spare parts fail at the quality control and technical acceptance stage, those are required to be returned to the respective supplier as early as possible; nevertheless, this requirement is not consistently fulfilled in practice due to inadequate coordination and relationships with certain suppliers. Occasionally, inflexibility and rigidity of personnel who engage with the quality control activities drag the process, which emphasizes the inadequate interdepartmental collaboration. In view of above facts, Figure 10 depicts the fishbone diagram for major bottleneck 3, Quality control and technical acceptance.

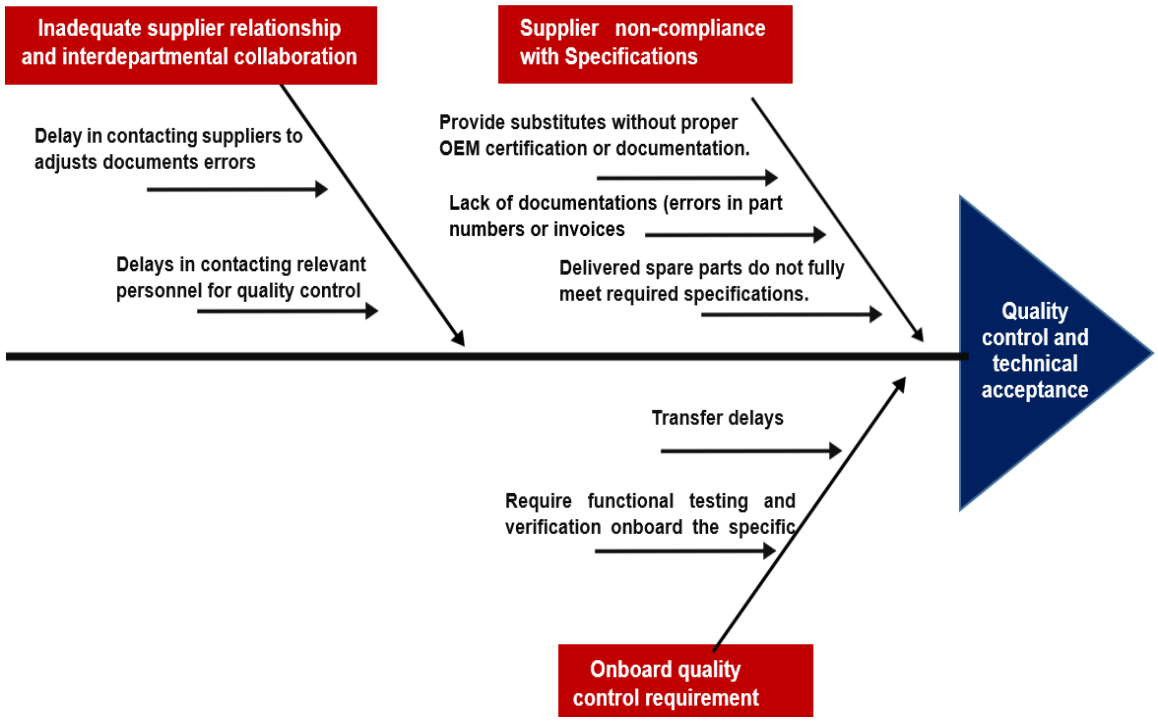

Figure 10. Fishbone diagram for major bottleneck 3, quality control and technical acceptance

F. MAJOR BOTTLENECK 4: BUDGET COMMITMENT STAGE

The pareto analysis revealed that a substantial proportion of initiated procurements files were stagnated at the budget section in various occasions.

1. Root Cause 1: The Budgetary Allocation for Spare Parts Does Not Adequately Cover the Demand for Spare Parts

Budget constraints can be considered as the primary root cause of procurement stagnation at the budget commitment stage, which leads to overall delays in spare parts procurement under SOP(SPDC). Financial allocations are limited even though the requirement of spare parts is continuously increasing, specifically because the SLN fleet is comparatively old. Since the acquisition of new platforms is limited, the SLN is required to maintain sufficient fleet capacity amidst financial challenges. If not specifically designated for certain ships, the funds allocated for the Eastern Naval area under particular Object code-2002 will be processed following a chronological sequence of requests sequentially according to receipt, where early requests receive funding while those initiated later stagnate due to restricted or exhausted allocations. Occasionally, additional budget requests for maintenance of ships and crafts are required to be made from Naval Headquarters to fulfil the requirements.

2. Root Cause 3: Insufficient Infrastructure Facilities.

Although the SLN is taking possible steps to facilitate adequate infrastructure for the proper implementation of the ILMS, several shortcomings continue to persist. The availability of computers, which are indispensable for operating the system, is particularly limited. Only a limited number of computers are accessible or operational without any issue; in most sections, they engaged in spare parts procurement, creating a significant imbalance between the available technological resources and the volume of work to be performed. This shortage not only slows down the efficiency of system usage but also places additional strain on personnel who must share limited resources to complete the work. Moreover, the reliability of the network infrastructure remains challenging at times. Intermittent failures, often resulting from weather conditions and other technical breakdowns, interrupt the smooth functioning of the system. During such periods of network failure, the system becomes temporarily inoperative until the issue is

fixed. Figure 11 displays the fishbone diagram for major bottleneck 4, Budget commitment stage.

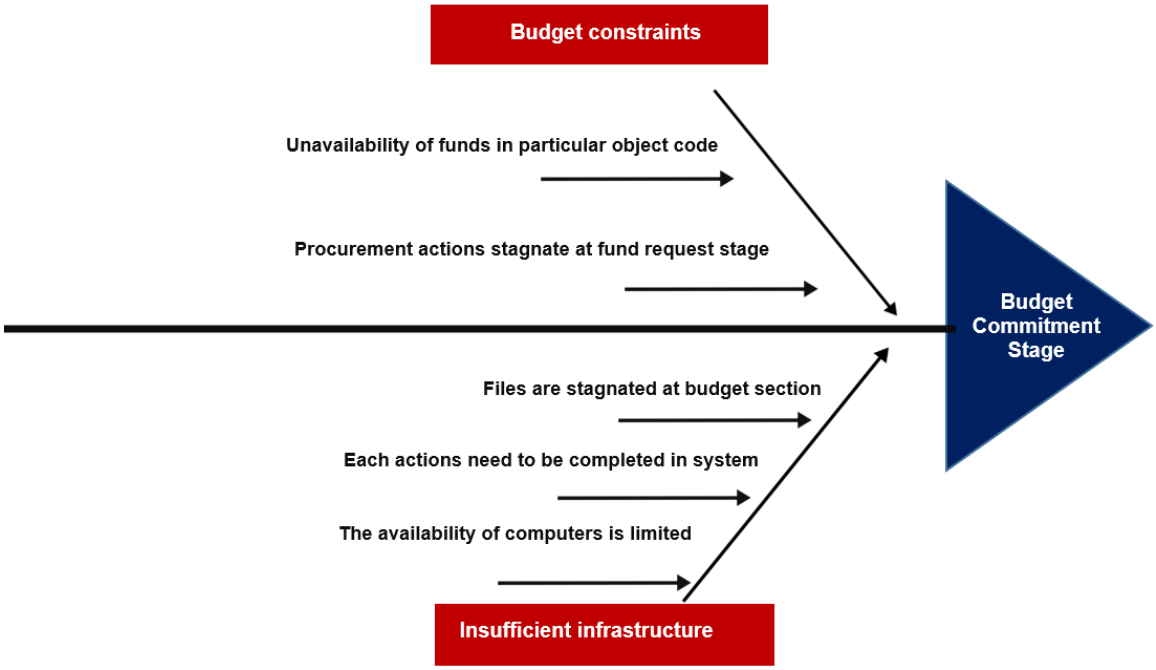

Figure 11. Fishbone diagram for major bottleneck 4, budget commitment stage

G. MAJOR BOTTLENECK 5: REQUEST FOR QUOTATIONS

The Pareto analysis revealed that a considerable proportion of initiated procurements files are stagnated at the stage of request for quotations.

1. Root Cause 1: Depends on Limited Supplier Base

Spare parts required for ships in SLN are often considered highly specialized, and most of the occasions require original equipment manufacturers (OEMs) or any compatibility certificates. Further, the supplier base for spare parts acquisition remains narrow as almost all suppliers depend on imports and supply basis and are liable for additional charges such as freight charges, taxes, and risks like foreign exchange volatility. The bargaining power of the SLN has also been restricted due to its dependence on limited supplier base.

2. Root Cause 2: Reluctance to Respond Due to Credit Basis Payment.

Most of the reputed suppliers dealing with importing spare parts are reluctant to agree to the payment term associated with SLN for spare parts acquisition under SOP (SPDC). Acquisitions initiated by SOP (SPDC) fully operate on credit-based payment systems, where suppliers are required to deliver goods first and receive the payment later in a given credit period, which does not, in most cases, depend on the liquid cash availability. This delay poses significant cash-flow risks for local suppliers, particularly small and medium-scale vendors, who often depend on immediate liquidity to continue their operations. As a result, suppliers who are in a position to provide quotations are also discouraged from submitting quotations. Occasionally, the scarcity of responses prolongs the time required to fulfil the minimum number of competitive quotations required and weakens the Navy's bargaining power, leading to disadvantages for the SLN and extending further delays.

3. Root Cause 3: Reluctance to Respond Due to Inefficient or Late Payments.

Occasionally, suppliers who initially agreed on credit payment terms are later reluctant to bid further as they do not receive the payment within the specified credit period due to various reasons, including liquid cash unavailability. This pattern of irregular disbursements due to inadequate financing undermines supplier confidence in doing business with the SLN. This negative perception by suppliers reduces the pool of responsive bidders and prolongs the RFQ and repeats the process. Consequently, SLN must depend on fewer suppliers who can afford to tolerate late payments, which also reduces the competition among the offers. Moreover, the net effect can lead to suppliers quoted with precautionary pricing due to uncertainty of the timeline for payment.

4. Root Cause 5: Outdated Technology or Obsolescence.

The SLN is functioning with an aged fleet as financial constraints restrict the acquisition of new platforms. Hence, there is evidence that procurement of spare parts are stagnated at request for quotation stage as procurement action has initiated for obsolete equipment. Hence, it is challenging to obtain positive offers from the suppliers due to the

reasons such as relocation of the spare parts by the original manufacture or discontinuation of the product due to its obsolete nature.

Considering above facts, Figure 12 displays the fishbone diagram for major bottleneck 5, request for quotations.

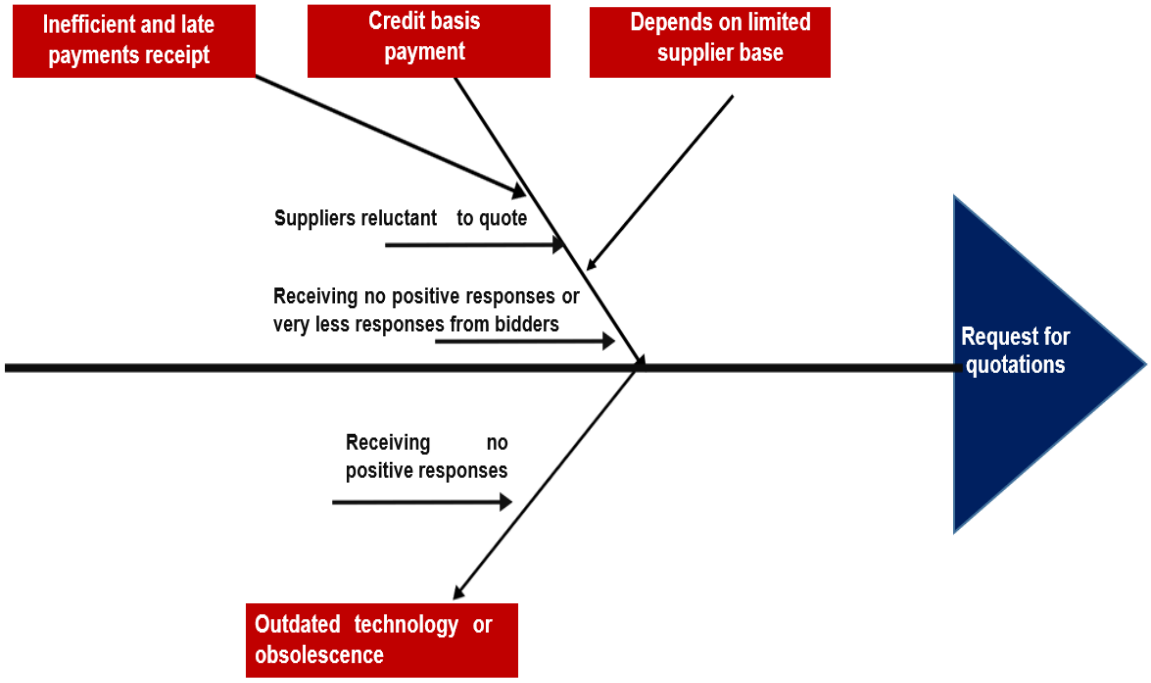

Figure 12. Fishbone diagram for major bottleneck 5, request for quotations

H. SUMMARY

This chapter presented the major bottlenecks for spare parts acquisition in SLN through the Pareto analysis and the root cause analysis using the modified versions of the Ishikawa and "five whys" analyses to showcase the reasons behind each major bottleneck. The subsequent chapter presents the conclusion, which wraps up the analysis and provides some recommendations to mitigate delays in the Spare parts acquisition process.

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V. CONCLUSION

A. SUMMARY OF ROOT CAUSE ANALYSIS

This study was initiated with the purpose of identifying major bottlenecks in spare parts acquisition under SOP(SPDC) and, following that, to identify the root causes of such bottlenecks. Accordingly, the primary and secondary research questions were successfully answered.

1. Primary: What Are the Major Supply Chain Bottlenecks Affecting Spare Parts Acquisitions in the Sri Lanka Navy?

The Pareto Analysis that was conducted using the procurement records, illustrated the stages where the spare parts acquisition process is stagnated at SOP (SPDC). Accordingly, complying with the 80/20 rule in Pareto Analysis undermentioned the major bottlenecks that were considered for root cause analysis.

- Awaiting fulfillments stage
- Supplier evaluation and selection stage
- Quality control and Technical acceptance stage
- Budget commitment stage
- Request for quotations stage

2. Secondary: What Are the Root Causes of These Bottlenecks in Acquisitions of Spare Parts?

Once major bottlenecks were identified, the author used modified versions of Ishikawa and Five Why Analysis to conduct root cause analysis in order to identify the root causes for each major bottleneck. Figure 13 illustrates the final Fishbone Diagram consisting of major bottlenecks and their root causes.

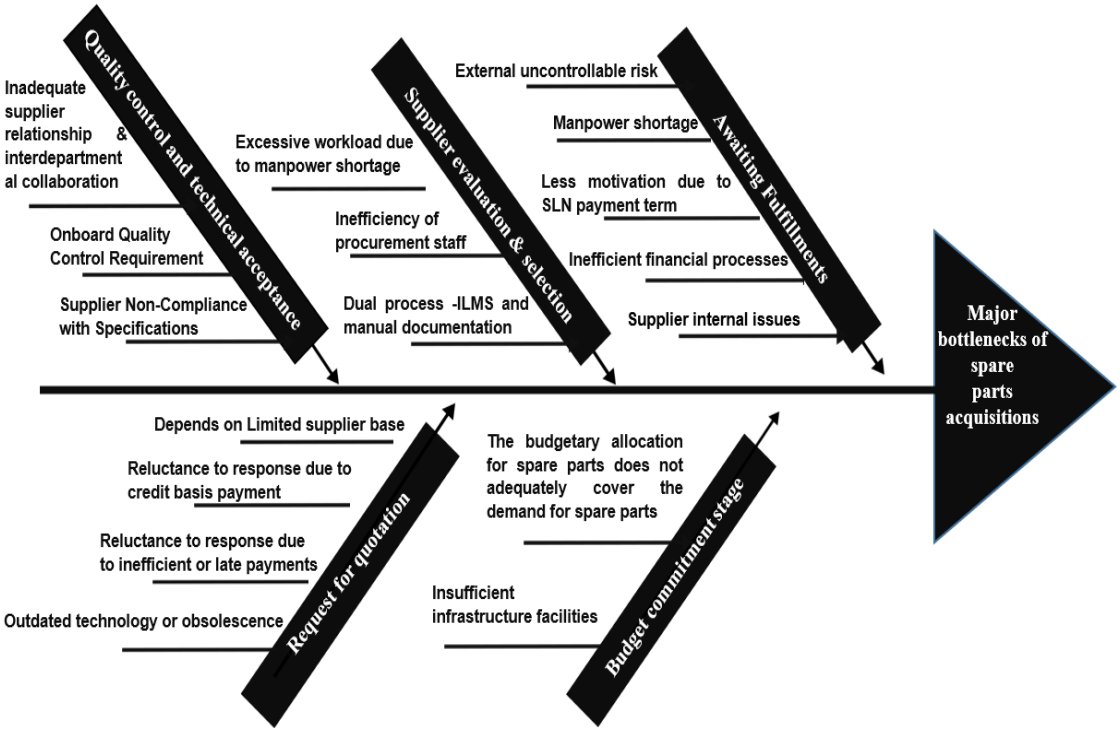

Figure 13. Final fishbone diagram

B. RECOMMENDATIONS

Based on the derived root causes in this thesis, it is recommended that the SLN take necessary actions to address each root cause separately and effectively to mitigate or eliminate delays of the spare parts acquisition process under SOP(SPDC). However, the author also presents sets of general recommendations derived from a rigorous evaluation of root causes identified in the previous chapter.

1. Recruitment of Adequate Cadre for SLN

The author recommends the SLN to study and adapt suitable recruitment strategies that attract younger generations. The SLN has already identified the gap between the approved cadre for SLN and the actual cadre, as operational readiness and future adaptability can be compromised by failure in securing a capable and well-balanced workforce (Parliament of Sri Lanka, 2023). Hence, the SLN needs to implement better recruitment strategies suited for new generations rather than continuing the conventional methods. Recruitment of a required cadre will ease the burden of excessive workload and thereby ensure the smooth flow of the procurement process.

2. Improve the Efficiency of the Payment Process and Implement Proper Tracking System for Payments so that Suppliers Can Track Their Payment Process to Ensure Transparency.

The author recommends improving the efficiency of the payment process by properly monitoring the work carried out by the staff allocated for payment-related work. Further the author recommends seeking feasibility on implementing a digital system, so that suppliers and concerned parties can track and monitor their payment process and other relevant information such as liquid cash availability and funding cycles. The efficient payment and facility to monitor the payments will enhance supplier confidence, transparency and reduced reluctance to submit quotations in the future.

3. Develop ILMS to the Extent that Continuing Manual Documentation is no Longer Necessary.

The time spent in managing both ILMS and manual documentation can be reduced if the ILMS can be further developed in order to terminate the manual documentation in a systematic way. The author recommends SLN to seek the feasibility of developing ILMs to the extent that continuing manual documentation is no longer necessary.

4. Identify Equipment that is beyond Economical Repairs and Take Necessary Actions to Phase out Equipment and Assets.

The requirement of replacing some of the existing equipment, systems and fleet units that exceed the cost benefit threshold and are obsolete by appropriate means has already been stated in the "Strategy 2030" of SLN (Perera, 2024). Hence, the author recommends initiating actions to identify such equipment and systems and take necessary actions to phase them out.

5. Establish Buffer Stock of High-Demand Consumable Spare Parts at SPDC.

Delays that occur at the supplier side are often out of the control of the SLN, especially the procurement initiated under SOP(SPDC) as its generally depends on an import and supply basis. Hence, in order to ensue fewer stockouts and to mitigate negative consequences from supplier delays due to shipping disruptions, foreign sourcing

and currency fluctuations, it is recommended to establish buffer stock of high-demand consumable spare parts at SPDC.

C. SUMMARY

This study presented a detailed analysis of root causes that delay the spare parts acquisition in the SLN. The author believes that once the root causes are identified, the mitigation actions can be successfully implemented by tackling those issues. Further, execution of recommendations mentioned above will also help to address and reduce delays of spare parts acquisition at SOP (SPDC) in the SLN.

LIST OF REFERENCES

Achetoui, Z., Mabrouki, C., & Mousrij, A. (2019, December). A review of spare parts supply chain management. *Journal System and Management of Industries*, *3*(2), 2580–2895. https://doi.org/10.30656/jsmi.v3i2.1524

Alper, O., & Boning, W. B. (n.d.). *Selected developments in commercial and Navy acquisition practices*. CNA. https://www.cna.org/archive/CNA_Files/pdf/d0008393.a2.pdf

Alwis, G. C. D., Perera, B. A. K. S., Gallage ,S. D., & Indikatiya, I. H. P. R. (2022). Enhancing the quality of bid evaluation in government refurbishment projects. *Intelligent Buildings International*, *14*(3), 375–390. https://doi.org/10.1080/17508975.2020.1753639

Andersen, B., & Fagerhaug, T. (2006a). *Root cause analysis*. Quality Press.

Andersen, B., & Fagerhaug, T. (2006b). *Root cause analysis: Simplified tools and techniques*. Quality Press. http://ebookcentral.proquest.com/lib/ebook-nps/detail.action?docID=1884171

Aderonke Moradeyo, A. (2018). Rudimentary causes and impacts of supply chain risks in Sub-Saharan Africa. *Journal of Operations and Supply Change Management*, *11*(2). https://doi.org/10.12660/joscmv11n2p16-31

Aggarwal, A. K., Dave, D. S., & Sharma, V. M. (2024). Supply chain disruption at the US ports: An assessment of underpinnings using the fishbone approach. *International Journal of Productivity and Quality Management*, *41*(1), 128–139. https://doi.org/10.1504/IJPQM.2024.136192

Antai, I., & Hellberg, R. (2023). Identifying total defense logistics concepts: A comparative study of the Swedish pandemic response. *Journal of Humanitarian Logistics and Supply Chain Management*, *14*(2), 208–222. https://doi.org/10.1108/JHLSCM-07-2022-0084

Apte, U., & Kang, K. (2007). Lean Six Sigma implementation for military logistics to improve readiness. *Proceedings of the Fourth Annual Acquisition Research Symposium*. https://dair.nps.edu/handle/123456789/190

ASQ. (n.d.). *What is a Pareto chart?* Retrieved July 13, 2025, from https://asq.org/quality-resources/pareto?srsltid=AfmBOoqYD0x2UBOPTVdwpTcbboCkbHXTSI7tHC4PUJpk7caHsKkFPpN-&utm_source=chatgpt.com

Au-Yong, C. P., Ali, A. S., & Ahmad, F. (2016). Enhancing building maintenance cost performance with proper management of spare parts. *Journal of Quality in Maintenance Engineering*, *22*(1), 51–61. https://doi.org/10.1108/JQME-01-2015-0001

Balafas, A., Stage, J., & Krimizas, S. (n.d.). *Impact of logistics on readiness and life cycle cost: A life cycle management approach* [MBA professional report, Naval Postgraduate School]. Defense Technical Information Center. https://apps.dtic.mil/sti/citations/ADA524658

Blom, J. (2018). *Optimizing spare-parts management* [Master's thesis, University of Gävle]. DiVA. https://urn.kb.se/resolve?urn=urn:nbn:se:hig:diva-28822

Bolner, B. L. (2021, May–June). Diminishing sources and shortages—and parts management. *Defense Acquisition Magazine*. https://www.dau.edu/library/damag/may-june2021/diminishing-sources-shortages

Bonnici, T. S.-. (2015). Pareto analysis. *Wiley Encyclopedia of Management*. John Wiley & Sons. https://www.researchgate.net/publication/272353122_Pareto_Analysis

Brainial. (2025). *5 common public sector procurement challenges*. https://www.brainial.com/tendermanagement/5-common-public-sector-procurement-challenges?

Burman, H. (2016). *Challenges and development opportunities of supply chain process in spare part services* [Master's thesis, Aalto University]. https://aaltodoc.aalto.fi/handle/123456789/20914

Celestin, M. (2020). Challenges & Solutions in Procurement Processes for Local Government Contracts in Rwanda. *International Journal of Multidisciplinary Research and Modern Education*, *6*(2), 63–70. https://www.researchgate.net/profile/Prof-Celestin/publication/388006513_Challenges_Solutions_in_Procurement_Processes_for_Local_Government_Contracts_in_Rwanda/links/6787302a1afb4e11f5e6f144/Challenges-Solutions-in-Procurement-Processes-for-Local-Government-Contracts-in-Rwanda.pdf?__cf_chl_tk=YSeK8V21nuJra0rNDPF4XrM2BTRGFKDyqxziajydR8E-1747702742-1.0.1.1-kvTetCIl0f_SQQcgt5mtilcAHgwjdCj5aLe1qluqxJc

Cirone, A. J., Glaeser, N., & Kadlec, C. M. (2023). Root cause analysis of labor shortages in the skilled trades supporting Nacy shipyard maintenance and modernization [Thesis, Naval Postgraduate School]. NPS Archive: Calhoun. https://hdl.handle.net/10945/72025

Council of Supply Chain Management Professionals. (n.d.). *CSCMP supply chain management definitions and glossary*. Retrieved August 27, 2025, from https://cscmp.org/CSCMP/CSCMP/Educate/SCM_Definitions_and_Glossary_of_Terms.aspx

Cram, R. M., Pace, G. A., & Pace, B. H. (n.d.). *Analyzing contract performance at Defense Logistics Agency*. Naval Postgraduate School. https://dair.nps.edu/handle/123456789/4804

Doggett, A. M. (2005). Root cause analysis: A framework for tool selection. *Quality Management Journal*, *12*(4), 34–45. https://doi.org/10.1080/10686967.2005.11919269

Dovetail. (2023, February 7). *Understanding and applying the Pareto principle*. https://dovetail.com/research/pareto-principle/

Fazekas, M., & Blum, J. R. (2021). *Improving public procurement outcomes: Review of tools and the state of the evidence base*. World Bank. https://doi.org/10.1596/1813-9450-9690

Gangidi, P. (2018). A systematic approach to root cause analysis using 3 × 5 why's technique. *International Journal of Lean Six Sigma*, *10*(1), 295–310. https://doi.org/10.1108/IJLSS-10-2017-0114

Grevatt, J., & Sankar, H. (2025, February 21). *Sri Lanka increases 2025 defence budget by 3%*. Janes. https://www.janes.com/osint-insights/defence-news-details/industry/sri-lanka-increases-2025-defence-budget-by-3

Gunawardana, K. A. P., Karunasena, G. I., & Jayawickrama, T. S. (2021). Problems and related causes of public procurement process to achieve sustainability in developing countries. *Proceedings of the 9th World Construction Symposium 2021 on Reshaping Construction: Strategic, Structural and Cultural Transformations towards the "Next Normal,"* 458–470. https://doi.org/10.31705/WCS.2021.40

Harmon, B. (2024, March 8). *Supplier relationship management: Consequences of poor purchasing relationships and how to avoid them*. SDI. https://www.sdi.com/resources/blog/supplier-relationship-management-consequences-of-poor-purchasing-relationships-and-how-to-avoid-them/

Harper, B. C. (2008). *Root cause analysis and mitigation paths for persistent inventory shortages to an assembly area* [Thesis, Massachusetts Institute of Technology]. https://dspace.mit.edu/handle/1721.1/43835

He, C., Milne, A., & Ataullah, A. (2023). What explains delays in public procurement decisions? *Economic Modelling*, *121*, 106201. https://doi.org/10.1016/j.econmod.2023.106201

Hellberg, R. (2023). Swedish public procurement and the defence industry: Obstacles and opportunities. *Journal of Defense Analytics and Logistics*, *7*(2), 103–137. https://doi.org/10.1108/JDAL-12-2022-0015

Hu, Q., Boylan, J. E., Chen, H., & Labib, A. (2018). OR in spare parts management: A review. *European Journal of Operational Research*, *266*(2), 395–414. https://doi.org/10.1016/j.ejor.2017.07.058

Huiskonen, J. (2001). Maintenance spare parts logistics: Special characteristics and strategic choices. *International Journal of Production Economics*, *71*(1–3), 125–133. https://doi.org/10.1016/S0925-5273(00)00112-2

International Maritime Organization. (n.d.). *SAR convention*. Retrieved July 10, 2025, from https://www.imo.org/en/ourwork/safety/pages/sarconvention.aspx

Inderfurth, K., & Mukherjee, K. (2008). Decision support for spare parts acquisition in post product life cycle. *Central European Journal of Operations Research*, *16*(1), 17–42. https://doi.org/10.1007/s10100-007-0041-z

Jenvald, M., & Hovmoller, M. (2020, Spring). *Reducing delays for unplanned maintenance of service parts in MRO workshops* [Theis, Linkoping University]. https://www.diva-portal.org/smash/get/diva2:1448735/FULLTEXT01.pdf

Kakai, P., & Mokono, A. I. (2022). Effect of budget allocation and procurement processes on budget utilization in the public sector in Kenya: A case of the judiciary. *Journal of Finance and Accounting*, *6*(4), 109–122. https://doi.org/10.53819/81018102t2103

Kellermann, T., Percy, A., & Bogan, M. (2017). *Failure is not an option: A root cause analysis of failed acquisition programs* [Technical report]. Acquisition Research Program. https://dair.nps.edu/handle/123456789/2261

Kennedy, W. J., Wayne Patterson, J., & Fredendall, L. D. (2002). An overview of recent literature on spare parts inventories. *International Journal of Production Economics*, *76*(2), 201–215. https://doi.org/10.1016/S0925-5273(01)00174-8

Kennemer, J. K. (2025, June 16). *The hidden costs of poor supplier communication how miscommunication hurts your bottom line*. Cosmo Sourcing. https://www.cosmosourcing.com/blog/the-hidden-costs-of-poor-supplier-communication

Khairullah, N. H., Hilal, M. A., & Mohammed, A. (2022). Identification of the main causes of risks in engineering procurement construction projects. *Journal of the Mechanical Behavior of Materials*, *31*(1), 282–289. https://doi.org/10.1515/jmbm-2022-0029

Kian, R., Bektaş, T., & Ouelhadj, D. (2019). Optimal spare parts management for vessel maintenance scheduling. *Annals of Operations Research*, *272*(1), 323–353. https://doi.org/10.1007/s10479-018-2907-y

Kumah, A., Nwogu, C. N., Issah, A.-R., Obot, E., Kanamitie, D. T., Sifa, J. S., & Aidoo, L. A. (2024). Cause-and-effect (fishbone) diagram: A tool for generating and organizing quality improvement ideas. *Global Journal on Quality and Safety in Healthcare*, *7*(2), 85–87. https://doi.org/10.36401/JQSH-23-42

Kumar, S., & and Schmitz, S. (2011). Managing recalls in a consumer product supply chain – root cause analysis and measures to mitigate risks. *International Journal of Production Research*, *49*(1), 235–253. https://doi.org/10.1080/00207543.2010.508952

Lankasara News. (2024, December 30). *Challenges for the new Navy commander, Banagoda*. https://lankasara.com/news/challenges-new-navy-commander-banagoda/

Latino, M. A., Latino, R. J., & Latino, K. C. (2019). *Root cause analysis: Improving performance for bottom-line results* (5th ed.). CRC Press. https://doi.org/10.1201/9780429446573

Majka, M. (2024). *Pareto analysis: The 80/20 rule for effective decision-making*. LinkedIn. https://www.researchgate.net/publication/385085105_Pareto_Analysis_The_8020_Rule_for_Effective_Decision-Making

Malacina, I., Karttunen, E., Jääskeläinen, A., Lintukangas, K., Heikkilä, J., & Kähkönen, A.-K. (2022). Capturing the value creation in public procurement: A practice-based view. *Journal of Purchasing and Supply Management*, *28*(2), 100745. https://doi.org/10.1016/j.pursup.2021.100745

Maritime Rescue Coordination Center–Colombo. (2022). *2022 annual report*. https://ifccolombo.org/assets/files/report/mrcc/annual/2022MRCC.pdf

Markowski, S., Hall, P., & Wylie, R. (Eds.). (2009). *Defence procurement and industry policy: A small country perspective*. Routledge. https://doi.org/10.4324/9780203013694

Moosavi, J., Fathollahi-Fard, A. M., & Dulebenets, M. A. (2022). Supply chain disruption during the COVID-19 pandemic: Recognizing potential disruption management strategies. *International Journal of Disaster Risk Reduction*, *75*, 102983. https://doi.org/10.1016/j.ijdrr.2022.102983

Mouschoutzi, M., & Ponis, S. T. (2022, June). A comprehensive literature review on spare parts logistics management in the maritime industry. *The Asian Journal of Shipping and Logistics*, *38*(2), 71–83. https://doi.org/10.1016/j.ajsl.2021.12.003

Mudugamua, M. (2025, January 5). Govt. procurement processes: Inefficiencies or glaring lapses? *The Morning*. https://themorning.lk//articles/OmlvpwQcgJSztx4sxRlV

Nadiyah, K., & Dewi, G. S. (2022). Quality control analysis using flowchart, check sheet, p-chart, pareto diagram and fishbone diagram. *OPSI*, *15*(2), Article 2. https://doi.org/10.31315/opsi.v15i2.7445

National Audit Office of Sri Lanka. (2023). Head 223 – Sri Lanka Navy: Financial statements and audit observations (Year ended 31 December 2023). https://naosl.gov.lk/web/images/audit-reports/upload/2023/min_dep/1-xvii/Head223Sri-lankaNavyS.pdf

National Procurement Commission of Sri Lanka. (n.d.). *Procurement guideline 2024*. Retrieved May 18, 2025, from https://nprocom.gov.lk/guidelines/

Nellore, R., & Söderquist, K. (2000). Portfolio approaches to procurement: Analysing the missing link to specifications. *Long Range Planning*, *33*(2), 245–267. https://doi.org/10.1016/S0024-6301(00)00027-3

Nugroho, M. Z., Nugroho, M. E., & Susanti, M. (2020). Study and analysis of delays in the material procurement process: A case study of steel manufacturing companies at Indonesia. *International Journal of Engineering Research and Advanced Technology*, *6*(1). https://doi.org/10.31695/IJERAT.2020.3588

Ott, P. O. (2010). UNCITRAL – United Nations Commission On International Trade Law. In H. Volger (Ed.), *A Concise Encyclopedia of the United Nations* (pp. 692–696). Brill | Nijhoff. https://doi.org/10.1163/ej.9789004180048.i-962.595

Ottou, J. A., Baiden, B. K., & Nani, G. (2020). Six Sigma project procurement application in public procurement. *International Journal of Quality & Reliability Management*, *38*(2), 646–662. https://doi.org/10.1108/IJQRM-04-2019-0111

Ottou, J. A., Baiden, B. K., Nani, G., & Tuuli, M. M. (2024). Enhancing performance measurement of public procurement processes through the application of procurement delay index. *Heliyon*, *10*(4), e25672. https://doi.org/10.1016/j.heliyon.2024.e25672

Parliament of Sri Lanka. (2023). *Sri Lanka Navy annual performance report*. https://www.parliament.lk/uploads/documents/paperspresented/1725007046002945.pdf

Patil, K., & Bhaduri, S. (2020). "Zero-error" versus "good-enough": Towards a "frugality" narrative for defence procurement policy. *Mind & Society*, *19*(1), 43–59. https://doi.org/10.1007/s11299-020-00223-7

Perera, P. (2024). *Proposal for Sri Lanka Navy's strategy 2030 and beyond (NAVSTRAT-2030)*. Sri Lanka Navy. https://www.navy.lk/assets/img/doctrine/strategy_2030.pdf

Powell, T., & Sammut-Bonnici, T. (n.d.). *Pareto analysis*. Retrieved August 7, 2025, from https://onlinelibrary.wiley.com/doi/10.1002/9781118785317.weom120202

Perera, P., Nanayakkara, S., & Perera, A. (2013). Critical evaluation on ERP applications for defence sector of Sri Lanka. *Third International Congress on Interdisciplinary Research and Development*. https://doi.org/10.6084/m9.figshare.7712363.v1

Pritchard, A., & Maury, R. V. (2025). *The ins and outs of procurement contracting: Opportunities and challenges for military-affiliated entrepreneurs*. Institute for Veterans and Military Families. https://surface.syr.edu/ivmf/487/

Rathnayake, P. (2025, February 25). Imperative overhaul of Sri Lanka's naval strategy: A call for swift modernization. *Sri Lanka Guardian.* https://slguardian.org/imperative-overhaul-of-sri-lankas-naval-strategy-a-call-for-swift-modernization/

Raymond, J. (2008). Benchmarking in public procurement. *Benchmarking: An International Journal*, *15*(6), 782–793. https://doi.org/10.1108/14635770810915940

Reliability. (2023, December 11). *7 powerful root cause analysis techniques and tools*. https://reliability.com/resources/articles/7-root-cause-analysis-technique/

Robitaille, D. (2010). *Root cause analysis*. Paton Professional.

Sebastian, R. J., & Davison, B. (2011). The root causes of contract administration problems. *Journal of Public Procurement*, *11*(2), 171–189. https://doi.org/10.1108/JOPP-11-02-2011-B001

Serasinghe, P. (2023). Exploration of the factors related to the efficiency of integrated logistics management system at Sri Lanka Navy. *Logistics Conference*, 70–77. https://nma.navy.lk/wp-content/uploads/2023/04/E-Journal-LLMC.pdf

Serrat, O. (2017). *Knowledge solutions: Tools, methods, and approaches to drive organizational performance*. Springer Open. https://doi.org/10.1007/978-981-10-0983-9_32

Sharma, P., & Kulkarni, M. S. (2016). Framework for a dynamic and responsive: Time separated – lean-agile spare parts replenishment system in army. *International Journal of Productivity and Performance Management*, *65*(2), 207–222. https://doi.org/10.1108/IJPPM-07-2014-0113

Sharma, P., Kulkarni, M. S., & Parlikad, A. (2017). Capability assessment of Army spare parts replenishment system: Suitability for a dynamic time separated lean-agile supply. *Benchmarking: An International Journal*, *24*(5), 1166–1189. https://doi.org/10.1108/BIJ-11-2015-0113

Soini, L. (2025). *Streamlining spare parts recommendation scoping* [Master's thesis]. Theseus. https://www.theseus.fi/handle/10024/877734

Spend Matters. (2021, August 3). *Poor finance/procurement processes are damaging supplier relationships*. https://spendmatters.com/2021/08/03/is-poor-communication-between-finance-and-procurement-damaging-your-supplier-relationships/

Sri Lanka Navy. (n.d.). *Vision, mission, role & task*. Retrieved July 23, 2025, from https://www.navy.lk/about-us/vision.html

TheKnowledgeAcademy. (2025, September 8). *5 whys process explained: Root cause analysis tool*. https://www.theknowledgeacademy.com/blog/5-whys-root-cause-analysis/

Treasury, Government of Sri Lanka. (2024). *Budget Estimates 2024 Volume I* (PDF). https://www.treasury.gov.lk/api/file/167d43b5-67e8-4b61-94cb-a705ba52ff87

Treasury, Government of Sri Lanka. (1992). *Financial regulations of the Government of the Democratic Socialist Republic of Sri Lanka* (PDF). https://www.treasury.gov.lk/api/file/88bd6063-fe94-40b7-aa3d-d83196eb7f92

Uduwage-Don, N. L. S., Hadiwattage, C., & Panuwatwanich, K. (2024). Enhancing the responsiveness of bids in public procurement: The case of Sri Lanka. *Public Works Management & Policy*, *29*(3), 332–363. https://doi.org/10.1177/1087724X231191724

USAID. (2013). *Addressing procurement bottlenecks: A review of procurement bottlenecks in public sector medicine supply chains and practical approaches taken to resolve them*. https://www.psmtoolbox.org/wp-content/uploads/2018/08/AddrProcBottl.pdf

Volmink, P. (2018). The treatment of non-responsive bids in South African public procurement law [Master's dissertation, University of the Witwatersrand]. Wits Institutional Repository (Wiredspace). https://wiredspace.wits.ac.za/items/60edaa32-f359-498a-8aae-35df953ddb0a

Wagner, S. M., & and Lindemann, E. (2008). A case study-based analysis of spare parts management in the engineering industry. *Production Planning & Control*, *19*(4), 397–407. https://doi.org/10.1080/09537280802034554

Wagner, S. M., Padhi, S. S., & Bode, C. (2013, February). Refining inputs for Kraljic matrix yields objective purchasing portfolios and strategies. *Industrial Engineer*, *45*(2), 34–39. https://www.researchgate.net/publication/280245782_The_Procurement_Process_-_Refining_Inputs_for_Kraljic_Matrix_Yields_Objective_Purchasing_Portfolios_and_Strategies

Wang, C. N., Lin, M. H., Huang, C. J., Huang, C. C., & Liao, R. (2017). Using TRIZ to improve the procurement process of spare parts in the Taiwan navy. *Sustainability*, *9*(10), 1908. https://www.mdpi.com/2071-1050/9/10/1908

Williams, P. M. (2001). Techniques for root cause analysis. *Baylor University Medical Center Proceedings*, *14*(2), 154–157. https://doi.org/10.1080/08998280.2001.11927753

Wright, J. A. (2022, August). Breaking the supply bottleneck. *Defense Acquisition Magazine*. https://www.dau.edu/library/damag/july-august2022/breaking-supply-bottleneck

Wu, T., Blackhurst, J., & and O'Grady, P. (2007). Methodology for supply chain disruption analysis. *International Journal of Production Research*, *45*(7), 1665–1682. https://doi.org/10.1080/00207540500362138

Wynn, M. E. (1992). *Spare parts nonavailability: The identification of impediments to spares acquisition* [Thesis, Naval Postgraduate School]. Defense Technical Information Center. https://apps.dtic.mil/sti/tr/pdf/ADA261821.pdf

Acquisition Research Program
Naval Postgraduate School
555 Dyer Road, Ingersoll Hall
Monterey, CA 93943

www.acquisitionresearch.net