

Canadian  
Forces  
College

Collège  
des  
Forces  
Canadiennes



## A Conceptualized Framework for Outsourcing Reverse Logistics

Major Galeung Lau

**JCSP 48**

**Master of Defence Studies**

**Disclaimer**

Opinions expressed remain those of the author and do not represent Department of National Defence or Canadian Forces policy. This paper may not be used without written permission.

© Her Majesty the Queen in Right of Canada, as represented by the Minister of National Defence, 2022

**PCEMI 48**

**Maîtrise en études de la défense**

**Avertissement**

Les opinions exprimées n'engagent que leurs auteurs et ne reflètent aucunement des politiques du Ministère de la Défense nationale ou des Forces canadiennes. Ce papier ne peut être reproduit sans autorisation écrite.

© Sa Majesté la Reine du Chef du Canada, représentée par le ministre de la Défense nationale, 2022

CANADIAN FORCES COLLEGE – COLLÈGE DES FORCES CANADIENNES

JCSP 48 – PCEMI 48

2021 – 2022

Master of Defence Studies – Maîtrise en études de la défense

**A Conceptualized Framework for Outsourcing Reverse Logistics**

**Major Galeung Lau**

*“This paper was written by a student attending the Canadian Forces College in fulfilment of one of the requirements of the Course of Studies. The paper is a scholastic document, and thus contains facts and opinions, which the author alone considered appropriate and correct for the subject. It does not necessarily reflect the policy or the opinion of any agency, including the Government of Canada and the Canadian Department of National Defence. This paper may not be released, quoted or copied, except with the express permission of the Canadian Department of National Defence.”*

*“La présente étude a été rédigée par un stagiaire du Collège des Forces canadiennes pour satisfaire à l'une des exigences du cours. L'étude est un document qui se rapporte au cours et contient donc des faits et des opinions que seul l'auteur considère appropriés et convenables au sujet. Elle ne reflète pas nécessairement la politique ou l'opinion d'un organisme quelconque, y compris le gouvernement du Canada et le ministère de la Défense nationale du Canada. Il est défendu de diffuser, de citer ou de reproduire cette étude sans la permission expresse du ministère de la Défense nationale.”*

## **Acknowledgements**

The family foundation continues to be a steadfast anchor to propel the Canadian Armed Forces to achieve operational success. Thus, my heartfelt gratitude to my family for their unconditional love and support throughout the academic marathon. To my dearest wife and children, “*I love you,*” and “*thank you*” for life’s memorable moments and the service and support I received as I completed this academic journey. Finally, special acknowledgements to my academic supervisor, Major T.D. Wentzell for mentoring and coaching me through the research process while on the sidelines cheering me on to complete this dissertation; with that said, “*thank you.*”

## **Abstract**

The dissertation aims to determine whether outsourcing supply chain functions within the Canadian Armed Forces (CAF) will create value and elevate competitive advantages and operational efficiencies. Canada's "Strong, Secure, Engaged" reflects Canadian values and concerns for sustainable ecological solutions to combat climate change. The ambitious SSE's vision leads to opportunities to optimize the Defence Supply Chain (DSC) by outsourcing reverse logistics functions to relieve the CAF's inventory management and warehouse operations challenges and address climate change concerns.

Given the nature of the CAF's business and function within the Government of Canada (GoC), the CAF perpetually balances between lean and agile supply chain strategies to maximize value to Canadians while being prepared to respond to crises at home and abroad. Moreover, the evidence presented herein supports and proposes outsourcing the CAF's reverse logistics under a Third Party Logistics Closed-Loop Vendor Managed Inventory framework to sustain "below the threshold of war" expeditionary operations.

Although the evidence presents a value-added proposition to alleviate the current challenges in the inventory management and warehouse operations domain, there remain gaps in the research to implement and integrate such a framework within the Department of National Defence (DND). Furthermore, the dissertation concludes with future research areas to question whether such an outsourced framework will continue to enhance the CAF's competitiveness during operations under war.

## Table of Contents

Acknowledgements.....	i
Abstract.....	ii
List of Figures and Tables.....	v
List of Abbreviations .....	vi
<b>Introduction.....</b>	<b>1</b>
1.1 Defence Supply Chain Challenges Amplifies Climate Change Concerns.....	1
1.2. “Strong, Secure, Engaged” Investment to Renew the Canadian Armed Forces.....	2
1.3. The National Shipbuilding Strategy: Renewed Inventory Management Challenges .....	3
1.4. The Royal Canadian Navy’s Supply Chain Management Dilemma .....	5
1.5. The Cost of an Inefficient Inventory Management Program.....	7
1.6. The Research Question .....	11
1.7. Research Aim and Objectives.....	11
1.8. Analysis of the Current RCN’s Supply Chain Management Processes.....	12
1.9. Chapter Introduction and Outline .....	13
<b>Literature Review .....</b>	<b>17</b>
2.1. Introduction.....	17
2.2 Value Streams Elevate Competitive Advantage and Market Position.....	17
2.3. Reverse Logistics: “The Unwanted Step-Child of Supply Chain Management.” .....	21
2.4. Spotlight on Sustainable Reverse Logistics’ Relevance in the 21 <sup>st</sup> Century .....	24
2.5. Defence Renewal and Canada’s Defence Policy Cornerstone for Change.....	27
2.6. Reverse Logistics Aligns with Canada’s Defence Policy .....	31
2.7. Outsourcing Reverse Logistics: Third-Party Logistics (3PL) .....	33
2.8. Third Party Logistics Closed-Loop Vendor Managed Inventory Integration.....	41
2.9. Risk Considerations for Outsourced Logistics and Technical Functions .....	43
2.10. Contribution to Existing Literature.....	49
<b>The Royal Canadian Navy Case Study .....</b>	<b>57</b>
3.1. Introduction.....	57
3.2. The Supply Administration Manual: The Policy to Enable Material Throughput .....	58

3.3.	The Pandemic and Centralized Decision Matrix Leads to a Bottleneck .....	59
3.4.	Current End-of-Life Divestment Process: Limitations and Opportunities Analysis .....	61
3.5.	The RCN is “Ready, Aye, Ready,” but a Bottleneck Limits Disposal Throughput .....	63
<b>Findings and Results.....</b>		<b>66</b>
4.1.	Introduction.....	66
4.2.	Alignment of Outsourcing Supply Chain Functions to “Strong, Security, Engaged” ...	67
4.3.	Risks Assessment of Outsourcing Supply Chain Functions .....	72
<b>Discussion.....</b>		<b>77</b>
5.1.	Introduction.....	77
5.2.	Benefits and Limitations to Outsourcing Below the Threshold of War .....	78
5.3.	Evolving the Business towards a Sustainable Closed-Loop Supply Cycle .....	80
5.4.	Recommendation to Outsource Reverse Logistics .....	81
5.5.	Limitations of the Study and Future Research Considerations.....	82
<b>Conclusion .....</b>		<b>85</b>
6.1.	Concluding Remarks.....	85
Bibliography .....		88
Appendix.....		A-1

## List of Figures and Tables

Figure 1.1: Inventory Management Mitigation Strategy .....	6
Figure 2.2: Closed-Loop Supply Chain .....	35
Figure 2.3: Impact of Retailer Heterogeneity: Average Retailer's Inventory cost .....	38
Figure 2.4: Impact of Retailer Heterogeneity: The Vendor's Inventory Cost .....	39
Figure 2.5: Proposed Integrated Data Environment Framework .....	41
Figure 2.6: The Bullwhip Effect .....	54
Figure 3.7: Canadian Forces Base Halifax - Base Logistics Quantity Disposed (2018 to 2022). 60	
Figure 3.8: Divestment of End-of-Life Flowchart .....	62
Figure 3.9 Base Logistics Warehouses Locations in the Halifax Regional Municipality .....	64
Figure 4.10: Outsource Reverse Logistics Aligned to "Strong, Secure, Engaged" Values .....	72
Table 2.1: Decision Matrix to Determine Supply Chain Posture .....	51

## List of Abbreviations

Arctic/Offshore Patrol Ship	AOPS
Arctic/Offshore Patrol Ship Joint Support Ship In-Service Support Contract	AJISS Contract
Australian Defence Force	ADF
Build Partnership Capacity	BPC
Bulgarian Armed Forces	BAF
Canadian Armed Forces	CAF
Canadian Army	CA
Canadian Forces Base	CFB
Canadian Surface Combatants	CSC
Controlled Technology Access Transfer	CTAT
Coronavirus-19	COVID-19
Corporate Social Responsibility	CSR
Defence Resource Information Management System	DRMIS
Defence Supply Chain	DSC
Department of National Defence	DND
Deputy Commanding Officer	DCO
Directorate Maritime Equipment Management - Non-Combatants	DMEPM - NC
Directorate of Supply Chain Operations	DSCO
Electronic Data Exchange	EDE
Enterprise Resource Planning	ERP
Executive Officer	XO
Government of Canada	GoC
End of Life	EOL
Her Majesty's Canadian Ship	HMC Ship
In-Service Support Contract	ISSC
Integrated Data Environment	IDE
Information System	IS
Joint Support Ship	JSS
Just-in-Time	JIT
Material Management Technician	MMT
North Atlantic Treaty Organization	NATO
Operational Support Hub – Southwest Asia	OSH-SWA
Original Equipment Manufacturer	OEM
Royal Canadian Air Force	RCAF
Royal Canadian Navy	RCN



Strong, Secured, Engaged	SSE
Supply Chain Strategy	SCS
Supply Administration Manual	SAM
Supply Chain Management	SCM
Supply Chain Management Professional	SCMP
Supply Chain Operations Reference - Professional	SCOR-P
Technical Authority	TA
Third-Party Logistics	3PL
Toyota Production System	TPS
Value Stream Mapping	VSM
Vendor Managed Inventory	VMI
Vendor Managed Inventory – Stock Out Cost Sharing	VMI-SOCS

# HOARDING, CLIMATE CHANGE, AND THE DEFENCE SUPPLY CHAIN: A CONCEPTUALIZED FRAMEWORK FOR OUTSOURCING REVERSE LOGISTICS

## Introduction

### 1.1 Defence Supply Chain Challenges Amplifies Climate Change Concerns

Canadian values and concerns, such as climate change, influence the Government of Canada's (GoC) priorities to pursue "peace, order, and good government."<sup>1</sup> As a result of these underlining priorities, the Department of National Defence (DND) published "Strong, Secure, Engaged" (SSE) to ambitiously address climate change and strategy to enhance the Canadian Armed Forces (CAF) capabilities. In dovetailing climate change concerns and supply chain management challenges, the dissertation sets to understand the implications of outsourcing segments of the Defence Supply Chain (DSC) functions and ponders the value proposition to gain competitive advantage and operational efficiencies.

The Independent Auditor's Report (Spring 2020) highlighted that inventory management is a critical enabler in sustaining CAF operations at home and abroad.<sup>2</sup> Moreover, the audit identified that the DSC "often did not deliver material supplies when needed [...] and often rerouted."<sup>3</sup> During the "the last mile" delivery, the rerouted material directly contributes to increased carbon emissions and undermines sustainable initiatives to combat climate change.<sup>4</sup> Further analysis demonstrated supply chain inefficiencies related to inventory stockouts and

---

<sup>1</sup> Gerald L. Gall, and Anne A. McLellan, "Peace, Order, and Good Government," The Canadian Encyclopedia, 29 July 2020, 1. [www.thecanadianencyclopedia.ca/en/article/peace-order-and-good-government](http://www.thecanadianencyclopedia.ca/en/article/peace-order-and-good-government). [Accessed on 25 April 2022].

<sup>2</sup> Office of the Auditor General, "Spring 2020 Reports of the Auditor General to the Parliament of Canada-Independent Auditor's Report -Report 3: Supplying the Canadian Armed Forces – National Defence", (Ottawa: DND, 2020), 7.

<sup>3</sup> *Ibid.*, 5.

<sup>4</sup> Jiang Li, Hongxia Change, Suping Zhao, Junfeng Dong, and Wenxing Lu, "A Travelling Salesman Problem with Carbon Emission Reduction in the Last Mile Delivery," *IEEE Access* 7, (2019): 61620.

“poor stock management [inventory management and warehouse operations]” as gaps in “fulfilling [customer] demand.”<sup>5</sup>

The inefficient inventory management strategies promoted a culture of excessiveness held in the warehouses to mitigate against stockouts. In addition, the excessive inventory minimized material accountability while negatively impacting the CAF’s ability to forecast future demand and disposal of over 1 million stock items highlighted in the Inventory Management Modernization and Rationalization Project objectives.<sup>6</sup> The onset of new equipment envisioned in “Strong, Secure, Engaged” (SSE) further compounds the current inventory management and warehouse operations challenges with competing priorities. Therefore, the existing straddling objectives raised research interest in examining potential opportunities for a sustainable supply chain while optimizing operational efficiencies by outsourcing the CAF’s reverse logistics portion of the supply chain to the Canadian industry.

## 1.2. “Strong, Secure, Engaged” Investment to Renew the Canadian Armed Forces

“Strong, Secure, Engage,” published in 2017, is the GoC’s strategic vision to empower the CAF with a “long-term investment and funding commitment [to] grow the CAF’s capacity and capabilities (i.e. personnel and equipment)” over the next 20-years.<sup>7</sup> Ultimately, the ambitious Defence Policy aims to “modernize, renew, and restore” infrastructure, equipment and material so that CAF members, who personify Canadian values, are empowered to achieve the GoC’s mandate and operations at home and abroad.<sup>8</sup>

---

<sup>5</sup> Office of the Auditor General, "Spring 2020 Reports of the Auditor General to the Parliament of Canada-Independent Auditor’s Report -Report 3: Supplying the Canadian Armed Forces – National Defence”, (Ottawa: DND, 2020), 6.

<sup>6</sup> *Ibid.*, 1.

<sup>7</sup> Department of National Defence, “Strong, Secure, Engaged: Canada’s Defence Policy”, 2017, 11.

<sup>8</sup> *Ibid.*, 33.

Subsequently, the SSE identifies various capital projects as long-term investments to ensure that the Royal Canadian Navy (RCN), Canadian Army (CA), and the Royal Canadian Air Force (RCAF) to able to project “[strength] at home, [security] in North America, [and engagement] in the world.”<sup>9</sup> Furthermore, through an integrated “Whole of Government” framework, the SSE aims to set the conditions to invigorate the CAF’s competitiveness as a credible and agile future force of 2040.

### 1.3. The National Shipbuilding Strategy: Renewed Inventory Management Challenges

The National Shipbuilding Strategy is an example of a “Whole of Government” approach to synergize coordination and capacity by collaborating with inter-governmental departments and “groups outside of government” to achieve national and united objectives.<sup>10</sup> In this case, the National Shipbuilding Strategy partners with industry to renew the RCN’s and the Canadian Coast Guard’s fleets.<sup>11</sup> Although both fleets are ocean-worthy, distinct authorities and responsibilities uniquely delineate the RCN’s and the Canadian Coast Guard’s roles and purpose. For example, the Canadian Coast Guard is an operating agency of the Department of Fisheries tasked with ensuring safe maritime travel and protecting the marine environment within Canadian waters.<sup>12</sup> Equally, the GoC mandate empowers the RCN as “an instrument of national power” in defending and protecting Canada’s sea lanes and the “world’s fifth-largest Exclusive Economic Zone.”<sup>13</sup>

---

<sup>9</sup> Department of National Defence, “Strong, Secure, Engaged: Canada’s Defence Policy”, 2017, 14.

<sup>10</sup> Tom Christensen, and Per Lægreid. “The Whole-of-Government Approach to Public Sector Reform.” *Public Administration Review* 67, no. 6 (2007): 1059.

<sup>11</sup> Department of National Defence, “Strong, Secure, Engaged: Canada’s Defence Policy”, 2017, 34.

<sup>12</sup> Government of Canada, “Mandate.” <https://www.ccg-gcc.gc.ca/corporation-information-organisation/mandate-mandat-eng.html>. [Accessed on 25 April 2022].

<sup>13</sup> Department of National Defence, “Strong, Secure, Engaged: Canada’s Defence Policy”, 2017, 34.

The National Shipbuilding Strategy endeavours to enable the RCN's operational readiness over the next 20 years by delivering the RCN's future force of 15 Canadian Surface Combatants (CSC) and two Joint Support Ships (JSS).<sup>14</sup> In addition, the National Shipbuilding Strategy has started to deliver the Arctic Offshore Patrol Ships (AOPs) to enhance the RCN's operational capability in Canada's North, coastal and inshore regions and international waters. For example, Her Majesty's Canadian Ship (HMCS) HARRY DEWOLF recently deployed on Operation CARIBBE to support GoC's counter-narcotics operations with international partners in the Caribbean Sea.<sup>15</sup>

In the meantime, the RCN's 13,000 talented sailors will continue to operate a fleet, with the majority of the sea-going platforms are over 25 years old, of 12 frigates, four long-range patrol submarines, 12 coastal defence vessels, and eventually six Arctic/Offshore Patrol Ships (AOPS).<sup>16</sup> Consequently, one of the RCN's primary lines of effort is to remain a visible naval force to project Canada's presence in domestic and international waters. As a result, to project presence, the RCN will heavily rely on an agile supply chain to sustain the current fleet's operational availability and readiness until the RCN receives the future force over the next 15 years.

---

<sup>14</sup> Department of National Defence, "Strong, Secure, Engaged: Canada's Defence Policy," 2017, 34.

<sup>15</sup> Department of National Defence, "Her Majesty's Canadian Ship Harry DeWolf becomes the First Arctic and Offshore Patrol Ship Commissioned by the Royal Canadian Navy," 26 June 2021. <https://www.canada.ca/en/department-national-defence/news/2021/06/her-majestys-canadian-ship-harry-dewolf-becomes-the-first-arctic-and-offshore-patrol-ship-commissioned-by-the-royal-canadian-navy.html>. [Accessed on 25 April 2022].

<sup>16</sup> Department of National Defence, "Royal Canadian Navy," 21 December 2021. <https://navy-marine.forces.gc.ca/>. [Accessed on 25 April 2022].

#### 1.4. The Royal Canadian Navy's Supply Chain Management Dilemma

Ship readiness is a percentage of time that determines the Her Majesty's Canadian Ship (HMC Ship) operational availability to deploy to complete delegated tasks.<sup>17</sup> Consequently, inventory management within the DCS becomes a vital process to ensure optimal operation availability while delivering cost-effectiveness movement of equipment at the "right time and place, in the right condition, as required by the CAF, while respecting the materiality and stewardship demand of the Government of Canada." Moreover, research supports and asserts a dilemma where armed forces straddle between agile and lean supply chain strategies to sustain operations in an unpredictable environment within established governmental financial boundaries.<sup>18</sup>

Furthermore, operational readiness and availability maximize optimal material throughput while minimizing material stockout. Thus, risk mitigation of stock unavailability leverages a "just-in-case" inventory management strategy to realize an agile supply chain capability to reduce delays due to stockout and shortages.<sup>19</sup> Therefore, armed forces adopt an inventory management culture centred on overstocking warehouses & depots with consumable material and spare parts as a mitigation factor.<sup>20</sup>

---

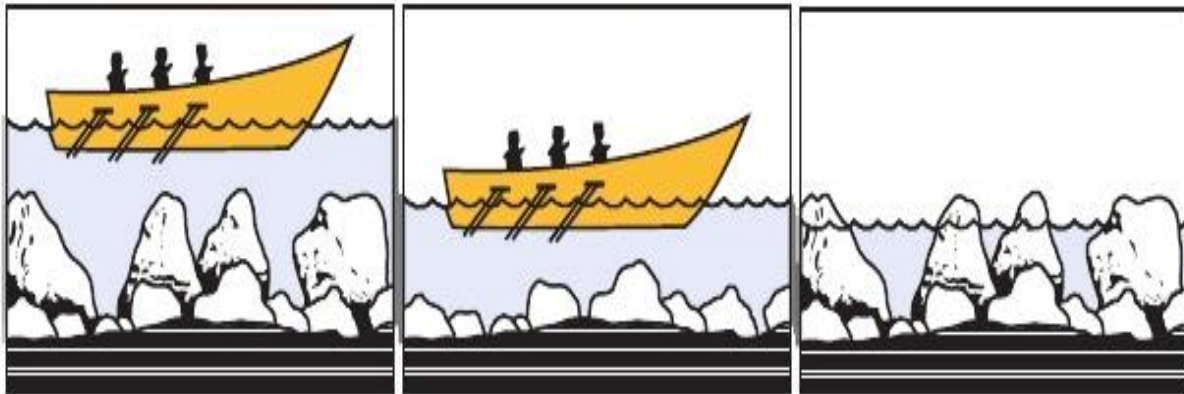
<sup>17</sup> W.D. Rustenburg, G.J. van Houtum, W.H.M. Zijm, "Spare parts management for technical systems: resupply of spare parts under limited budgets," *IEEE Transactions* 32, no.10 (2000): 1013.

<sup>18</sup> Pankaj, Sharma, and Makarand S. Kulkarni, "Framework for a dynamic and responsive – time separated – lean-agile spare parts replenishment system in Army," *International Journal of Productivity and Performance Management* 65, no. 2 (2016): 213.

<sup>19</sup> Office of the Auditor General, "Spring 2020 Reports of the Auditor General to the Parliament of Canada- Independent Auditor's Report -Report 3: Supplying the Canadian Armed Forces – National Defence", (Ottawa: DND, 2020), 3.

<sup>20</sup> Pankaj, Sharma, and Makarand S. Kulkarni, "Framework for a dynamic and responsive – time separated – lean-agile spare parts replenishment system in Army," *International Journal of Productivity and Performance Management* 65, no. 2 (2016): 213.

As a result, naval warehouses are overstocked with inventory to avoid stockout and delay deploying to support the GoC’s mandate at home and abroad. Figure 1.1 illustrates the current “just-in-case” strategy implemented to mitigate risks against stockouts and uncertainties in deploying HMC Ships to support GoC mandates at home or abroad. The first graphic on the left represents an HMC Ship underway at sea. The water symbolizes inventory levels in the warehouse. As the inventory level increases, the root issues (i.e. inventory stockout, equipment with long lead time, waste, schedule misalignment, and bottlenecks) remain hidden within the supply chain. In essence, HMC Ships’ deploys because the RCN overstocked their warehouses with excess inventory. Conversely, lowering the inventory level exposes the supply chain's root problems but negatively impacts the HMC Ship’s operational readiness to deploy.



**Figure 1.1: Inventory Management Mitigation Strategy**

Source: Market Business News, “What is Just in Case? Definition and examples,” [www.marketbusinessnews.com/financial-glossary/just-case-definition-meaning/](http://www.marketbusinessnews.com/financial-glossary/just-case-definition-meaning/). [Accessed on 28 April 2022].

Moreover, the current inventory management strategy only minimizes the seriousness of fundamental issues within the supply chain because overstocking inventory levels enable HMC Ships to deploy at a moment’s notice. In addition, overstocking inventory negates the real

problems and weaknesses that need attention to improve the supply chain's efficiencies. However, current events such as the terror attacks on the World Trade Centre on 11 September 2001 reinforce the practice of overstocking inventory to ensure operational readiness during periods of uncertainty. As a result, this inventory management strategy enabled the RCN to rapidly deploy HMCS IROQUOIS to the Atlantic Ocean to support the GoC's contribution to the American-led Operation Enduring Freedom within 24 hours.<sup>21</sup>

The RCN's supply chain demonstrated a highly resilient and agile response to internal and, more importantly, external factors that might disrupt material delivery and maintain a competitive advantage during periods of crisis. Additionally, RCN straddles between implementing a cost-effective inventory management strategy and rapidly deploying ships to sea to support CAF's mandate. The conflicting priorities further complicate inventory management and optimization of warehouse operations dilemma because there are costs incurred to concurrently warehouse inventory intended for end-of-life (EOL) parts, equipment disposal, and unforeseen operations. Although this strategy mitigates unanticipated disruptions, the "insurance policy" of overstocking spare and EOL parts, such as circuit cards and mechanical pumps, leads to financial and opportunity costs, which negatively impact the RCN and the GoC in the long term.

#### 1.5. The Cost of an Inefficient Inventory Management Program

Although the "just-in-case" inventory model strategy mitigates unanticipated disruptions, the "insurance policy" of overstocking spare and EOL parts, such as circuit cards and mechanical pumps, leads to financial and opportunity costs, which negatively impact the RCN and the GoC

---

<sup>21</sup> Richard, Howard, Gimblett, *Operation Apollo: The Golden Age of the Canadian Navy in the War Against Terrorism* (Ottawa : Magic Light Publishing, 2004), 11.



in the long term. Furthermore, these associated costs resulting from inefficient inventory management practices continue to be re-occurring themes highlighted in the various Auditor General's reports since 1987 regarding material visibility and accountability, warehouse operational costs, and inventory forecasting processes.<sup>22</sup>

Forecasting inventory is customer-driven to satisfy demand based on data and analytics to optimize inventory levels. However, global events are a source of uncertainties that add complexity to determining optimized inventory levels that account for mitigating stockout risk.<sup>23</sup> For example, when a critical part demanded is unavailable, a stockout occurs, which may have catastrophic results to the mission or mission failure. As a result, the current forecasting model leads to overstocking warehouses with parts and obsolete equipment as a mitigating factor to stockout consequences. Moreover, with HMC ships approaching over 25 years of service, the pressure to overstock on Original Equipment Manufacturer (OEM) parts exasperates an accurate forecast of demand requirements and inventory levels.

A forecasting process prioritizing inventory stockout mitigation leads to an overstocked warehouse and depots. Research demonstrates that the "just-in-case" inventory held in the warehouse leads "to an escalation inventory carrying costs."<sup>24</sup> Moreover, the Auditor General's report highlighted that DND incurred additional transport costs because material inventory locations do not align with the operational elements.<sup>25</sup> For example, there are circuit cards for

---

<sup>22</sup> Department of National Defence, Auditor General, "Materiel Support -Report of the Auditor General of Canada to the House of Commons," Ottawa, Minister of Public Works and Government Services Canada, 1987: 9.

<sup>23</sup> Hassan, Jakiul, Khan Faisal, and Hasan Mainul, "A Risk-Based Approach to Manage Non-Repairable Spare Parts Inventory," *Journal of Quality in Maintenance Engineering* 8, no. 3 (2012): 344.

<sup>24</sup> Pankaj, Sharma, and Makarand S Kulkarni., "Framework for a dynamic and responsive – time separated – lean-agile spare parts replenishment system in Army," *International Journal of Productivity and Performance Management* 65, no. 2 (2016): 212.

<sup>25</sup> Office of the Auditor General, "Spring 2020 Reports of the Auditor General to the Parliament of Canada – Independent Auditor's Report -Report 3: Supplying the Canadian Armed Forces – National Defence", (Ottawa: DND, 2020), 6.

HMC Ship's radar located at a depot in Edmonton, Alberta. For the RCN to receive the part, additional delay and cost will be required to transport it to the ship stationed in Halifax, Nova Scotia. This example highlights poor inventory management and inefficiencies within the CAF. However, research shows that when warehouse operation is at its maximum capacity, there are opportunities for the organization to optimize and eliminate inefficiencies.<sup>26</sup>

In addition to burdening operational costs, an overstocked warehouse leads to material accountability and visibility issues. Within academia studies, evidence analytically complemented the 2008 Auditor General's report that material discrepancies between actual and recorded inventory lists resulted from overstocking and stockouts.<sup>27</sup> The following is a practical example of the Auditor General's comment regarding material visibility challenges onboard an HMC Ship at sea. The Logistics Department locates the repairable spare part in the Defence Resource Management Information System (DRMIS) onboard the ship's warehouse in a specific bin. However, when the Materiel Management Technician (MMT)<sup>28</sup> goes to the bin location, the repairable part is missing, contrary to the data indicated in DRMIS. As a result, the spare part is expedited as a high priority request, through commercial transport, to the requesting HMC Ship. Unfortunately, as the repairable spare part transits to the next port of call, the Logistics Department locates the repairable spare part onboard the ship in another bin or warehouse. This example highlights the rerouting challenges and the lack of material accountability and visibility.

---

<sup>26</sup> Pankaj Sharma, and Makarand S. Kulkarni, "Framework for a dynamic and responsive – time separated – lean-agile spare parts replenishment system in Army," *International Journal of Productivity and Performance Management* 65, no. 2 (2016): 211.

<sup>27</sup> Pankaj Sharma, Makarand S. Kulkarni, and Ajith Parlikad, "Capability assessment of Army spare parts replenishment system: Suitability for a dynamic time separated lean-agile supply," *Benchmarking: An International Journal* 24, no. 5 (2017): 1169.

<sup>28</sup> "Materiel Management Technicians ensure that all of the supplies and services necessary for Canadian Armed Forces (CAF) operations are available when and where they are required". / Department of National Defence, "Materiel Management Technicians," [www.forces.ca/en/career/materiel-management-technician/](http://www.forces.ca/en/career/materiel-management-technician/). [Accessed on 26 April 2022].

Moreover, the May 2008 Auditor General report concluded that the CAF lacked total asset visibility to account for inventory and, more importantly, throughout the material's life-cycle.<sup>29</sup> This second example deals with a sea container used as a "bridge" for ten years until the owner discovered a \$2-million engine that belonged to HMCS ATHABASKAN.<sup>30</sup> Although the engine was obsolete and replaced during the ship's refit in 1994, this example explicitly highlights a significant gap regarding material visibility and accountability within the CAF. Consequently, the presented two examples are a porthole of many other examples to demonstrate the CAF's "lack of stock visibility" and material accountability within the supply chain, which is a result of excessiveness and "retention of redundant [obsolete] inventory."<sup>31</sup>

Therefore, CAF's dilemma straddles between agile and lean supply chain principles to logistically maintain operational readiness. The CAF's supply chain principles are contradictory; minimize costs (lean supply chain characteristics) during periods of peace while at all times "Ready, Aye, Ready" to quickly deploy (agile supply chain characteristic) HMC Ships to sea during emergencies (i.e., humanitarian aid, war, etcetera).<sup>32</sup> However, maintaining operational readiness under uncertainty leads to significant inefficiencies and expenses for the GoC. As a result of overlapping principles, the CAF overstocks warehouses with repairable parts and obsolete equipment to maintain this responsive operational capability.

---

<sup>29</sup> Department of National Defence, "Report of the Auditor General of Canada to the House of Commons: Chapter 2 Support for Overseas Deployments – National Defence," May 2008: 23.

<sup>30</sup> CBC News, "Cargo container yields \$2M surprise," posted 08 September 2009. <https://www.cbc.ca/news/canada/nova-scotia/cargo-container-yields-2m-surprise-1.821211>. [Accessed on 02 April 2022].

<sup>31</sup> Pankaj Sharma, and Makarand S. Kulkarni, "Framework for a dynamic and responsive – time separated – lean-agile spare parts replenishment system in Army," *International Journal of Productivity and Performance Management* 65, no. 2 (2016): 212.

<sup>32</sup> Gyöngyi Kovács, and Peter Tatham. "Responding to Disruptions in the Supply Chain Network -From Dormant to Action," *Journal of Business Logistics* 30, no. 2 (2009): 218.

## 1.6. The Research Question

The results of the “just-in-case” inventory management model establish the problem statement, and the research focuses on critically examining the current reverse logistics model and processes. The research objective is to determine whether there are opportunities to improve inventory management and warehouse operations by outsourcing supply chain functions. Furthermore, this dissertation endeavours to answer the following research questions: Will outsourcing reverse logistics of the Defence Supply Chain lead to operational efficiencies and add value to optimizing operational competitiveness? Could the CAF apply an outsourced reverse logistics model that contributes to a sustainable supply chain to complement GoC’s priorities of “greening [the] defence [supply chain]”?<sup>33</sup>

## 1.7. Research Aim and Objectives

This dissertation aims to understand reverse supply chain characteristics and strategies from a private industry perspective. In addition, based on existing academic literature, the research examines the applicability and feasibility of implementing an outsourced closed-looped reverse supply chain model, such as third-party logistics, to complement and augment the Defence Supply Chain (DSC). Under the threshold of war, the hypothesis considers that an outsourced closed-looped reverse supply chain through third-party logistics will realize CAF operational efficiencies and propagate value to the GoC.

Moreover, the dissertation seeks to identify and observe the most critical theories or models concerning supply chain characteristics to determine reverse supply chain strategies. In establishing the foundation, the research will evaluate the reverse supply chain characteristics

---

<sup>33</sup> Department of National Defence, “Strong, Secure, Engaged: Canada’s Defence Policy,” 2017, 75.

and design derived from literature based on industry emerging practices, military supply chains, and current practices within the RCN supply chain. Further examination will reveal critical advantages and disadvantages regarding the risks of outsourcing the reserve logistics process to determine whether the risks outweigh the gain in optimizing the sustainment capacity and capability of the current RCN fleet and future force. Finally, the research evaluates the applicability of an appropriate reverse supply chain model that aligns with the themes and values, such as emerging industry practices, sustainability and environmental concerns, and the “Whole of Government” approach, as presented in the “Strong, Secure, Engaged” Canada’s Defence Strategy.

#### 1.8. Analysis of the Current RCN’s Supply Chain Management Processes

The author will undertake a qualitative approach based on applied and theoretical research methods to address the research question for an appropriate reverse supply chain model in the CAF. Moreover, the author intends to establish the baseline of the current RCN supply chain challenges regarding disposal and inventory management to complement the academic research. In addition, a review of the Supply Administration Manual (SAM)<sup>34</sup> will form the “real world” basis for understanding the current CAF systems and processes to derive gaps and bottlenecks within the supply chain.

First, academic research will facilitate the development of “new knowledge that advances [one’s] understanding of the real world.”<sup>35</sup> In this case, “the real-world understanding” of reverse supply chain management theories and outsourcing models, based on academic literature, will

---

<sup>34</sup> Department of National Defence, Supply Administration Manual, December 2021.

<sup>35</sup> John Adams, Hafiz T.A. Khan, Robert Roeside, and David I. White, “Research Methods for Graduate Business and Social Science Students,” (New Delhi: SAGE Publications, 2007), 3.

serve as the basis to evaluate emerging trends and relationships that may improve the current CAF's disposal, divestment, and reverse logistics processes.<sup>36</sup> Second, drawing on the theory researched, the author conducts an applied research method to conclude whether an outsourced reverse logistics model will add value to the DSC. In addition, the breadth of knowledge derived through the applied research method will set the conditions to influence a deliberate approach to facilitate the inventory management and warehouse operations challenges. Additionally, the applied research method aligns with the research philosophy to "collaborate and cooperate with other practitioners in the field" to identify a practical framework to evolve the current DSC model.<sup>37</sup>

#### 1.9. Chapter Introduction and Outline

The dissertation evaluates the current supply strategy concerning disposal and outsourcing of the reverse logistics process within the CAF. In addition, the dissertation will examine various outsourced reverse logistics models and determine whether one or more models would optimize warehouse operations and add value to the Defence Supply Chain. Finally, the drawn conclusions will address the proposed research question of whether there are opportunities for the CAF to outsource segments of the reverse logistics to optimize the material throughput and development of a holistic, sustainable supply chain that aligns with the SSE's environmentally conscious vision.

The second chapter, *Literature Review*, aims to provide insights into existing reverse logistics and sustainable supply chain management theories concerning an outsourced model to

---

<sup>36</sup> Ted Gournelos, Joshua R. Hammonds, and Maridath A. Wilson "Doing Academic Research: A Practical Guide to Research Methods and Analysis First Edition," (Milton: Routledge, 2019), 72.

<sup>37</sup> John Adams, Hafiz T.A. Khan, Robert Roeside, and David I. White, "Research Methods for Graduate Business and Social Science Students," (New Delhi: SAGE Publications, 2007), 3.

address the CAF's disposal bottleneck. The chapter also bridges current research gaps by linking outsourcing segments of reverse logistics within a military context as a value proposition to optimize warehouse and inventory management operations. Moreover, the *Literature Review* will establish the theoretical framework to highlight an alternative perspective concerning an integrated outsourced reverse logistics model within the military context. Furthermore, the *Literature Review* cross-examines the themes, arguments and counter-arguments for outsourcing the supply chain from a private industry perspective to further research interest and debate regarding the benefits and risks of outsourcing reverse logistics in the armed forces.

The third chapter, *The RCN Case Study*, stems from the dissertation's research purpose and process philosophy. First, the research strategy is defined and substantiated with processes and methods to analyze the established supply chain model regarding disposal and inventory management as documented in the CAF's Supply Administration Manual (SAM). The research will be qualitative, with the appropriate explanation, to support this approach by analyzing the current disposal process derived from SAM to underline material throughput bottlenecks within the DSC. In addition, the BLog and DSCO consultations will form the basis of the disposal challenges at the tactical and strategic level and establish a data-driven baseline to support the research approach. Finally, the research approach identifies the current supply chain gaps to highlight steps to address whether outsourcing the reverse logistics model would enrich the DCS by improving the disposal throughput of end-of-life (EOL) and declaring surplus obsolete parts and equipment.

The fourth chapter, *Findings & Results*, presents the qualitative evidence and analysis derived from the reviewed literature and case study. In addition, the fourth chapter will present and discuss the various outsourced reverse logistics strategies and industry practices to reconcile

the inventory management challenges based on the reviewed academic literature. The data and information collected from the academic literature will form the theoretical framework to answer the research question empirically. In addition, the fourth chapter addresses significant links and trends concerning a sustainable reverse logistics system within the DSC to address the dissertation's research question.

In the fifth chapter, *Discussion*, the evidence previously presented in *Findings & Results* is analyzed. First, the chapter deliberates the benefits and risks of outsourcing the reverse logistics process and its impact on warehouse operations and the sustainment of naval operations. Second, this chapter will transition towards a holistic examination of the information system requirements, methodology and process to outsource reverse logistics, and considerations to implement the model successfully. Third, the fifth chapter evaluates the outsourcing strategy that aligns and links to SSE themes, such as the “Whole of Government” approach to support the Federal Sustainable Development Strategy to address climate change in close collaboration with industry and academia.<sup>38</sup> Finally, based on the conducted research, the author will offer a recommendation and further investigation to satisfy and set conditions for the GoC for implementation.

The final chapter, *Conclusion*, provides a summation of the dissertation concerning the research question presented in the first chapter. Finally, this chapter concludes with a brief discussion on the scope for further research concerning future logistics on integrating and implementing an outsourced reverse logistics model. The integrations will require significant coordination between industry and DND to develop a synchronized process that incorporates an

---

<sup>38</sup> Department of National Defence, “Strong, Secure, Engaged: Canada’s Defence Policy,” 2017, 73.



information system and electronic data exchange. Finally, with increasing reliance on contractors to complement the military sustainment, there are opportunities to investigate whether outsourcing supply chain management processes and sustainment will continue to benefit the CAF in a total war scenario with a near-peer adversary.

## Literature Review

### 2.1. Introduction

While there has been much research on sustainable reverse logistics, third-party logistics (3PL) and other model characteristics implemented within the private and public sectors, few researchers have considered outsourcing reverse logistical functions within the military context. In addition, the chapter examined literature associated with industry and military models leveraging reverse and closed-loop supply chain management approaches as part of an integrated value chain management strategy. Moreover, the supporting literature highlighted the benefits and risks of an outsourced supply chain that includes a vendor-managed inventory (VMI) model. Finally contributing to the existing literature, this chapter concluded with a proposition that lean and agile supply chain strategies co-exist within a non-binary state. Second, the concluding remarks established the theoretical framework to propose an integrated reverse logistics strategy as a critical DSC component that adds value to the CAF's organization and competitive advantage.

### 2.2 Value Streams Elevate Competitive Advantage and Market Position

Since the early 1980s, prominent business strategy and economics academic Michael E. Porter remains the grassroots pioneer regarding value chain, competitive strategy and advantage theory.<sup>39</sup> Moreover, Porter reasoned that competitive strategy is a framework of a "favourable position in an industry [to] sustain [long-term] profitability."<sup>40</sup> Hence, the analysis derived

---

<sup>39</sup> Michael E. Porter, "Competitive advantage of nations: creating and sustaining superior performance", (The Free Press, New York, NY, 1985). / Michael E. Porter, "On Competition," (Harvard Business School Publishing Corporation, Boston, MA, 1985).

<sup>40</sup> Michael E. Porter, "Competitive advantage of nations: creating and sustaining superior performance", (The Free Press, New York, NY, 1985), 1.

competitiveness as an action in which the company leverages its processes product to sustain its competitive advantage and market position.<sup>41</sup> While several empirical studies further defined competitive advantage as a unique resource or a process that overmatches rivals due to scarcity and unsubstituted availability in the market.<sup>42</sup> Furthermore, Porter introduced the value chain concept to highlight that cumulative internal actions and processes create value and market competitive advantages and profitability.<sup>43</sup> In light of mounting interests regarding competitiveness and value, prominent researchers continue to evolve and refine Michael E. Porter's initial theories to mirror industry requirements and changing environment.

James P. Womack and Daniel T. Jones authored several global books introducing lean production and value chain philosophies. Additionally, Womack and Jones further refined the value proposition as a product to highlight a value stream that “line up value-creating actions in the best sequence, conduct these activities without interruption [...], and perform [these activities more effectively] to elevate competitive advantage.”<sup>44</sup> Subsequent early works of Womack and Jones established the foundation for lean thinking from a manufacturing perspective based on five lean principles: value, value stream, flow, pull, and perfection. In addition, the lean principles implicitly underlined an organizational culture of continuous improvement to optimize the value stream of activities and eliminate waste or inefficiencies in the manufacturing process.

---

<sup>41</sup> Bruce D., Henderson, “Competitive Advantage: Creating and Sustaining Superior Performance,” *Journal of Business Strategy (Pre-1986)* 6, no. 1 (Summer 1985): 93.

<sup>42</sup> Abigail McWilliams, and Donald S. Siegel, “Creating and Capturing Value: Strategic Corporate Social Responsibility, Resource-Based Theory, and Sustainable Competitive Advantage,” *Journal of Management* 43, no. 5 (2011): 1484. / Ruixue Li, Can Peng, Conwoo Koo, Ge Zhang, and Hong Yang, “Obtaining sustainable competitive advantage through collaborative dual innovation: empirical analysis based on mature enterprises in eastern China,” *Technology Analysis & Strategic Management* 33, no. 6 (2020): 697. / Evin Özkan, Neda Azizi, and Omid Haass, “Leveraging Smart Contract in Project Procurement through DLT to Gain Sustainable Competitive Advantages,” *Sustainability* 13, no. 23 (2021): 13384.

<sup>43</sup> Michael, Schrage, Washington Post, Staff Writer, “Sustaining Competitive Advantage,” *The Washington Post (1974-)*, 23 December 1984.

<sup>44</sup> James P. Womack, and Daniel T. Jones, “Lean Thinking,” (New York: Simon & Schuster, 1996), 15.

Furthermore, Womack and Jones globally demonstrated Taiichi Ohno's 1978 published research on the Toyota Production System (TPS) by highlighting Lantech's competitiveness in streamlining its stretch-wrapper equipment manufacturing process. The analysis underlined Lantech's manufacturing processes regarding lean principles and illuminated Taiichi Ohno's production philosophies.<sup>45</sup> This published research promoted the Taiichi Ohno's TPS "as the best system for operations" that "forged the alternative western term Lean Production."<sup>46</sup>

Taiichi Ohno, the grassroots founder of TPS and lean production principles, transformed the manufacturing processes into an integral part of Toyota Motor Company's value chain and competitiveness in the automobile manufacturing market.<sup>47</sup> As the leading proponent of waste reduction and Kaizen philosophy of continuous improvement, Toyota adopted Taiichi Ohno's research to develop the Toyota Production System (TPS) centred on two pillars: Just-in-Time (JIT) delivery and automation.<sup>48</sup> In addition, TPS aimed to eliminate waste and inefficiency (*Muda*) to deliver value-added service operations to Toyota's customers and sustain a competitive advantage.

Further research aligned the Kaizen philosophy to TPS by developing an integrated supply chain relationship between customers to synergize company performance and

---

<sup>45</sup> A set of precision rollers exert force to stretch the plastic before it was wound around the pallet and its load (J.P. Womack and D.T. Jones, "Beyond Toyota: How to Root Out Waste and Pursue Perfection," *Harvard Business Review* 74, no. 5 (1996): 142.).

<sup>46</sup> Andrea Chiarini, Claudio Baccaranni, and Vittorio Mascherpa, "Lean production, Toyota Production System and Kaizen philosophy: A conceptual analysis from the perspective of Zen Buddhism," *The TQM Journal* 30, no.4 (2018): 428.

<sup>47</sup> Britannica Academic, s.v. "Ohno Taiichi," accessed 17 April 2022, <https://academic-eb-com.cfc.idm.oclc.org/levels/collegiate/article/ohno-taiichi/1089>.

<sup>48</sup> Andrea Chiarini, Claudio Baccarani, and Vittorio Mascherpa, "Lean Production, Toyota Production System and Kaizen Philosophy: A Conceptual Analysis from the Perspective of Zen Buddhism," *Total Quality Management Journal* 30, no. 4 (2018): 426-427.

competitiveness.<sup>49</sup> As a result, the TPS matured in four years to include the Kaizen philosophical approach regarding a deliberate methodology to improve the value of the business and eliminate “*Muda*.”<sup>50</sup> The “whole-of-government” approach mirrors the Kaizen philosophy that aims to set a workplace culture that incorporates an open-minded workforce willing to take ownership of long-term change through inclusivity of the group towards a series of continuous improvement milestones. In addition, the literature suggested practical applications of the Kaizen philosophy to underline, as a long-term strategy, to improve workplace morale and competitiveness in the marketplace.<sup>51</sup>

Moreover, this principle of incremental continuous improvement led to opportunities to refine the supply chain by identifying and eliminating “*Muda*” activities or processes that offer “zero benefits” to gain efficiencies and create value.<sup>52</sup> Furthermore, the continuous improvement movement sought to eliminate inefficiencies for a business to evolve its competitiveness. The continuous improvement ideology invoked a culture that reiterates Porter’s research that each point within the supply chain incrementally created value to gain the advantage of achieving long-term profitability.<sup>53</sup> Likewise, as a value chain, the supply chain requires strong internal and external partnerships and collaboration to instill a Kaizen culture of continuous improvement.<sup>54</sup>

---

<sup>49</sup> Galankashi Masoud Rahiminezhad, and Syed Ahmad, Helmi, “Assessment of hybrid Lean-Agile (Leagile) Supply Chain Strategies,” *Journal of Manufacturing Technology Management* 27, no. 4 (May 2016): 471.

<sup>50</sup> K.M. Krupa, Sukumar Patil, and Bhoopendrakumar Singh, “Importance of Kaizen and its Implementation in Design and Manufacturing System,” *IEEE* (2022): 2.

<sup>51</sup> Manuel F. Suárez-Barraza, and L. Kerbache, “Thoughts on Kaizen and its Evolution: Three Different Perspectives and Guiding Principles,” *International Journal of Lean Six Sigma* 2, no. 4 (November 2011): 288-308. / Katsuki Aoki, “Transferring Japanese Kaizen Activities to Overseas Plants in China,” *International Journal of Operations & Production Management* 28, no. 6 (2008): 518-539.

<sup>52</sup> K.M. Krupa, Sukumar Patil, and Bhoopendrakumar Singh, “Importance of Kaizen and its Implementation in Design and Manufacturing System,” *IEEE* (2022): 2.

<sup>53</sup> Michael E. Porter, “Competitive advantage of nations: creating and sustaining superior performance”, (The Free Press, New York, NY, 1985), 1.

<sup>54</sup> Dwayne G., Whitten, Kenneth Green, and Pamela J. Zelbst, “Triple-A Supply Chain Performance,” *International Journal of Operations & Production Management* 32, no. 1 (2012): 28.

This collaboration is part of an information flow system that involves customers, material suppliers, production facilities, and distribution centres. Therefore, customer collaboration facilitates the elimination of “*Muda*” by collaborating with customers to examine the current organization’s processes and determine which method or activity adds value to the customer experience.<sup>55</sup> Moreover, during the late-eighties, the TPS dovetailed with Kaizen philosophy and revolutionized the American and European automotive industries as the “best system of operations [and] alternative western termed Lean production.” As a result, Toyota’s integrated customer-based value chain shifted the automotive mass production paradigm and sustained Toyota’s competitive advantage.

### 2.3. Reverse Logistics: “The Unwanted Step-Child of Supply Chain Management.”

Accordingly, a general academic consensus advocated that integrated value chain management is synonymous with an “agile, adaptable, and aligned” supply chain strategy.<sup>56</sup> Furthermore, the literature supported that an agile supply chain is highly flexible to react to change quickly. This characteristic is necessary for organizations that want to adapt to unanticipated external economic, technological, or customer demand changes. Moreover, a successful supply chain strategy collaboratively partners with one’s customers to leverage “tools to control the flow of supply, transportation, production, warehouse, and distribution of products [or materials] to the [end-user] customer.”<sup>57</sup> Process integration based on long-term partnership

---

<sup>55</sup> Andrea Chiarini, Claudio Baccarani, and Vittorio Mascherpa, “Lean Production, Toyota Production System and Kaizen Philosophy: A Conceptual Analysis from the Perspective of Zen Buddhism,” *Total Quality Management Journal* 30, no. 4 (2018): 428.

<sup>56</sup> Dawayne. G. Whitten, Kenneth Green, and Pamela J. Zelbst, “Triple-A Supply Chain Performance,” *International Journal of Operations & Production Management* 32, no. 1 (2012): 29.

<sup>57</sup> Galankashi Masoud, Rahiminezhad, and Syed Ahmad, Helmi, “Assessment of hybrid Lean-Agile (Leagile) Supply Chain Strategies,” *Journal of Manufacturing Technology Management* 27, no. 4 (May 2016): 470.

and collaborative networks, such as shared information systems and data, are examples of tools to create value and optimize product distribution.

Therefore, the public and private sectors understand that supply chain management adds value to the organization and competitive advantage. To highlight supply chain management value as a key enabling competitiveness, Souchen, a Canadian academic, reasoned that the “[efficient and] colossal logistical network” was a critical success factor in setting conditions for an Allied victory in the Second World War.<sup>58</sup> Based on the historical success, supply management theory evolved to include numerous educational courses and professional designations, such as Six-Sigma Lean Supply Chain, Supply Chain Operations Reference - Professional (SCOR-P), and Supply Chain Management Professional (SCMP), to enable individuals and companies to optimize their forward supply chain synergies to create value continually.<sup>59</sup>

Consequently, private sectors pursue the traditional supply chain process to attain a competitive advantage with an efficient throughput of products to the customers.<sup>60</sup> Nevertheless, with globalization, supply chains “require greater resilience and efficiencies in the flow of goods between and within countries.”<sup>61</sup> For example, the coronavirus-19 (COVID-19) pandemic illustrates supply chains’ profound interdependency on global events and its impact on the flow of material and equipment, such as the semiconductor shortage in the automobile industry.<sup>62</sup> The

---

<sup>58</sup> Alex, Souchen, “Recycling war machines: Canadian munitions disposal, reverse logistics, and economic recovery after World War II,” *Business History* (2020): 1.

<sup>59</sup> Based on the author’s experience throughout their professional career. In particular, this was most apparent during SCOR and SCMP courses; the discussion and course work focused on improving throughput to the customer.

<sup>60</sup> Vaidyanathan, Jayaraman, and Yadong, Luo, “Creating Competitive Advantages Through New Value Creation: A Reverse Logistics Perspective,” *Academy of Management Perspectives* (May 2007): 56.

<sup>61</sup> Chia-Nan, Wang, Thanh-Tuan, Dang, and Ngoc-Ai-Thy, Nguyen, “Outsourcing Reverse Logistics for E-Commerce Retailers: A Two-Stage Fuzzy Optimization Approach,” *Axioms* 10, no. 1 (2021): 1.

<sup>62</sup> Craig, Cole, “Why the heck is there still an automotive chip shortage?,” 04 February 2022. <https://www.cnet.com/roadshow/news/features/why-automotive-chip-shortage/>. [Accessed on 04 February 2022].

COVID-19 Pandemic underlines the mounting symbiotic influence between globalization and supply chains. Additionally, the interdependence further drives business towards an efficient forward logistics supply chain to “deliver the desired product to consumers at the right time and in the right place.”<sup>63</sup>

Nevertheless, although there is a concentrated effort to create value to elevate the business’ competitive advantage by managing an effective supply chain, there remains a significant gap regarding a unified, sustainable reverse logistics model within the supply chain management framework. As a result, reverse logistics continues to be a secondary priority as the industry remains focused on minimizing supply chain demand uncertainty.<sup>64</sup> Furthermore, Huscroft et al. concluded in their examination of future sustainable logistics research trends that “many manufacturers are prepared to look at more effective and efficient ways of reducing both returns and costs, but [they] are not prepared to allocate resources” to operationalize reverse logistics.<sup>65</sup>

This statement resonates with validity within the private sector and at the public sector level. For example, Canada’s Defence Policy asserts a firm position to green the DSC from material flow through distribution points to the end-user to enable operations. Moreover, in reviewing the publication, there is a lack of financial commitment associated with realizing concrete sustainability action within the CAF. In the last decade, subsequent prominent supply

---

<sup>63</sup> Slobodan Aćimović, Veljko Mijušković, and Marko Golubović. "Military Logistics vs. Business Logistics." *Economic Analysis* 54, no.1 (2021): 124.

<sup>64</sup> Mario Turrisi, Bruccoleri Manfredi, and Cannella, Salvatore, “Impact of Reverse Logistics on Supply Chain Performance,” *International Journal of Physical Distribution & Logistics Management* 43, no. 7 (2013): 565.

<sup>65</sup> Joseph R., Huscroft, Benjamin T., Hazen, Dianne J., Hall, Joseph B., Skipper, and Joe B., Hanna, “Reverse Logistics: Past Research, Current Management Issues, and Future Directions,” *International Journal of Logistics Management* 24, no. 3 (2013): 317.



chain academics often considered reverse logistics and sustainable supply chains “the unwanted step-child of supply chain management.”<sup>66</sup>

#### 2.4. Spotlight on Sustainable Reverse Logistics’ Relevance in the 21<sup>st</sup> Century

However, today, the “step-child of supply chain management” analogy is fallible and inappropriately backward due to changing governmental concerns and consumer interests regarding the environment and sustainable corporate social responsibilities (CSR). For example, Levi Strauss, as part of its CSR strategy, collaborates with other companies to create value by leveraging reverse logistics to repurpose material to manufacture new jeans.<sup>67</sup> Therefore, the value stream may not always be downstream towards the supplier or customer to gain market share and competitive advantage. Accordingly, the literature highlights a holistic closed-loop relationship approach to reverse logistics considerations regarding strategy and planning.

Recent literature demonstrated the value and relevance that reverse logistics functions, such as refurbishing, recycling, disposal, and salvage, add value to the organization as a basis of competitive advantage.<sup>68</sup> In addition, the literature validated that reverse logistics functions foster a sustainable competitive advantage by incorporating partners and stakeholders to invigorate creative process flow and optimize warehouse operations.<sup>69</sup> Consequently, reverse logistics is a crucial component within the supply chain that enables process synergies to

---

<sup>66</sup> Diane A. Mollenkopf, and David J. Closs, “The Hidden Value in Reverse Logistics,” *Supply Chain Management Review* (July/August 2005): 34.

<sup>67</sup> Abby Jenkins, “A Guide to Reverse Logistics: How It Works, Types and Strategies,” Oracle Netsuite, <https://www.netsuite.com/portal/resource/articles/inventory-management/reverse-logistics.shtml>. [Accessed on 06 March 2022].

<sup>68</sup> Dale S., Rogers, and Ronald, Tibben-Lembke, “An Examination of Reverse Logistics Practices,” *Journal of Business Logistics* 22, no. 2 (2001), 133.

<sup>69</sup> Vaidyanathan, Jayaraman, and Yadong, Luo, “Creating Competitive Advantages Through New Value Creation: A Reverse Logistics Perspective,” *Academy of Management Perspectives* (May 2007): 70.

empower the company's corporate social responsibility agenda while generating profit through reclamation and "retention of second-hand goods."<sup>70</sup>

Douglas M. Lambert and James R. Stock offered the earliest reverse logistics definition as "going the wrong way on a one-way street because most product shipments flow in one direction."<sup>71</sup> Further research highlights the singular flow of material at "the point of consumption toward the point of origin" to reduce the supply chain environmental impact.<sup>72</sup> Moreover, the sustainability definition describes the "use [of] resources to meet the present needs without compromising the ability of future generations to meet their own needs."<sup>73</sup> Subsequent research augmented the academic definition by further expressing sustainability as an opportunity to mitigate resource and waste management risks.<sup>74</sup> Finally, in their future study, Dale S. Rogers and Ronald Tibben-Lembke incorporated sustainability into their widely accepted academic definition of reverse logistics as "the process of planning, implementing, and controlling the efficient, cost-effective flow of goods to recapture value or proper [sustainable] disposal."<sup>75</sup>

Moreover, researchers have recently examined sustainability and reverse logistics due to global climate change and finite natural resource concerns in the past decade.<sup>76</sup> Current

---

<sup>70</sup> Xumei, Zhang, Zhizhao, Li, and Yan Wang, "A review of the criteria and Methods of Reverse Logistics Supplier Selection," *Processes* 7, no. 2 (2020): 704.

<sup>71</sup> Douglas M. Lambert, and James R. Stock, "Strategic Physical Distribution Management," (Homewood, IL: Irwin, 1981), 19.

<sup>72</sup> Dale S. Rogers, and Ronald Tibben-Lembke, "An Examination of Reverse Logistics Practices," *Journal of Business Logistics* 22, no. 2 (2001): 129.

<sup>73</sup> Komeyl Baghizadeh, Julia Pahl, and Guiping Hu, "Closed-Loop Supply Chain Design with Sustainability Aspects and Network Resilience under Uncertainty: Modelling and Application," *Mathematical Problems in Engineering* 2021, (30 March 2021): 2.

<sup>74</sup> Mario Turrisi, Bruccoleri Manfredi, and Cannella, Salvatore, "Impact of Reverse Logistics on Supply Chain Performance," *International Journal of Physical Distribution & Logistics Management*, Vol. 43, No. 7, 2013: 565.

<sup>75</sup> Dale S., Rogers, and Ronald, Tibben-Lembke, "An Examination of Reverse Logistics Practices," *Journal of Business Logistics* 22, no. 2 (2001): 130.

<sup>76</sup> Mario, Turrisi, Bruccoleri, Manfredi, and Cannella, Salvatore, "Impact of Reverse Logistics on Supply Chain Performance," *International Journal of Physical Distribution & Logistics Management* 43, no. 7 (2013): 564.

sustainable academic research revealed that private industries' reverse logistics initiatives significantly influence the protection of the environment "to promote ecological methods of production, distribution, and logistics processes."<sup>77</sup> At the corporate level, private industries understand that a socially responsible and sustainable corporate strategy will augment value and profitability in the long run. Moreover, consumers are not opposed to price differences when purchasing environmentally friendly products because consumers believe that "they are making a difference" and enabling conditions for socially responsible companies to manage an efficient, sustainable supply chain.<sup>78</sup>

As a result of mounting consumer concern for sustainability, private industries recognize the financial implications of reverse logistics and inefficient inventory management of overstocked end-of-life and obsolete inventory in warehouses.<sup>79</sup> Subsequent research highlights the private sector's value in reconciling "unwanted" products through recovery processes such as repair, reconditioning, recycling, and disposal.<sup>80</sup> An efficient and optimized reverse logistics strategy is twofold. First, organizations achieve and satisfy their internal (i.e. stakeholders) and external environmental expectations (i.e. governmental and consumers interest) concerning sustainability.<sup>81</sup> Second, economically, an operationalized reverse logistics strategy improves the organizational financial position and competitive market advantage over its rivals.<sup>82</sup> Therefore,

---

<sup>77</sup> Patrik Richnák, and Klaudia Gubová, "Green and Reverse Logistics in Conditions of Sustainable Development in Enterprises in Slovakia," *Sustainability* 2021, no. 13 (06 January 2021): 10.

<sup>78</sup> Ehsan, Shekarian, and Simme Douwe, Flapper, "Analyzing the Structure of Closed-Loop Supply Chains: A Game Theory Perspective," *Sustainability* 2021 13, no.3 (2021): 1.

<sup>79</sup> Nizar, Zaarour, Emmanuel Melachrinoudis, Marius, Solomon, and Hokey, Min, "A Reverse Logistics Network Model for Handling Returned Products," *International Journal of Engineering Business Management*, (28 June 2014): 2.

<sup>80</sup> Hanane Rachih, Fatima Zahara Mhada, and Raddouane Chiheb, "Simulation Optimization of an Inventory Control Model for a Reverse Logistics System," *Decision Science Letters* 11, no. 1 (2022): 44.

<sup>81</sup> Rachih, Hanane, Zahara, Mhada, Fatima, and Chiheb, Raddouane, "Simulation Optimization of an Inventory Control Model for a Reverse Logistics System," *Decision Science Letters* 11, no. 1 (2022): 44.

<sup>82</sup> Xumei Zhang, Zhizhao Li, and Yan Wang, "A review of the criteria and Methods of Reverse Logistics Supplier Selection," *Processes* 7, no. 2 (2020): 705.

the highlighted factors demonstrate that the key motivation for private industry to integrate a reverse logistics strategy is profit-driven, to “create wealth” based on market performance metrics such as stock price, return on investment, and market share growth.<sup>83</sup>

However, unlike private industries, government organizations such as DND and CAF are not motivated by generating profit or achieving market-based metrics. Instead, the primary incentive for the CAF is to maintain operational readiness to be “available at all times to respond” to accomplish the GoC’s mandate at home and abroad.<sup>84</sup> Therefore, although operational readiness is a priority, the DND is keenly aware of its financial stewardship and accountability concerning expenditures to the Government of Canada and Canadians. Finally, governments typically define competitiveness as enhancing governing creditability through transparency and accountability to increase “value to taxpayers.”<sup>85</sup>

## 2.5. Defence Renewal and Canada’s Defence Policy Cornerstone for Change

Ensuring value and accountability to taxpayers concerning inventory management and reverse logistics are not new 21<sup>st</sup> Century issues facing the CAF. Literature documented that at the end of the Second World War, the Canadian Armed Forces’ Bases moved surplus equipment and material to parking lots to start the disposal process due to an “unprecedented [logistics] event.”<sup>86</sup> Although not necessarily from a volume perspective, the CAF’s current inventory management challenges mirror the logistics crisis highlighted at the end of the Second War. The

---

<sup>83</sup> Chin-Chun, Hsu, and Keah-Choon, Tan, “Strategic orientations, sustainable supply chain initiatives, and reverse logistics: Empirical evidence from an emerging market,” *International Journal of Operations & Production Management* 36, no. 1 (2016): 87.

<sup>84</sup> Department of National Defence, “*Strong, Secure, Engaged*,” 2017, 83.

<sup>85</sup> Alfred Tat-Kei, Ho, and Tobin Im, “Challenges in Building Effective and Competitive Government in Developing Countries: An Institutional Logics Perspective,” *American Review of Public Administration* 45, no. 3 (2015): 265.

<sup>86</sup> Alex, Souchen, “Recycling war machines: Canadian munitions disposal, reverse logistics, and economic recovery after World War II,” *Business History* (2020): 2.

convergence of legacy and future force CAF equipment will only heighten the current inventory management challenges resulting from inventory management and warehouse operational inefficiencies.

Published in 2012, the Defence Renewal establishes a roadmap to minimize inefficiency (i.e. performance measurement) and streamline business (i.e. organizational practices) processes to maximize value and operational results delivered for Canada and Canadians.<sup>87</sup> In many ways, the Defence Renewal echoes the Ministry of Defence's (MoD), in the United Kingdom, "Smart Acquisition" as part of their Strategic Defence Review conducted in 1998. For example, currently, there is a renewed focus, within DND's procurement function (line of effort), on leveraging competitive advantages to realize the value of money in the defence environment through industry best practices in the public-sector bureaucracy.<sup>88</sup> Furthermore, the Defence Renewal aimed to emulate "the insights, best practices, and lessons learned from [...] other public and private sector organizations in Canada and worldwide."<sup>89</sup>

The Defence Renewal objectives reinforce the GoC's collaborative nature to maximize industry best practices to realize an economy of effort and substantial value to DND and Canadians. Furthermore, an integrated defence industry enables an economy of effort to enhance Canada's sovereignty and assurance to streamline support during CAF operations. To realize a

---

<sup>87</sup> Department of National Defence, Defence Renewal Charter: Department of National Defence and the Canadian Armed Forces – October 2013, 5. [www.forces.gc.ca/assets/FORCES\\_Internet/docs/en/about/defence-renewal-charter.pdf](http://www.forces.gc.ca/assets/FORCES_Internet/docs/en/about/defence-renewal-charter.pdf). [Accessed 03 February 2022].

<sup>88</sup> Department of National Defence, "Defence Investment Plan 2018 – Part II: Maximizing Defence's Success," 04 June 2019. [www.canada.ca/en/department-national-defence/corporate/reports-publications/defence-investment-plan-2018/maximizing.html](http://www.canada.ca/en/department-national-defence/corporate/reports-publications/defence-investment-plan-2018/maximizing.html). [Accessed on 26 April 2022].

<sup>89</sup> Department of National Defence, Defence Renewal Charter: Department of National Defence and the Canadian Armed Forces – October 2013, 5. [www.forces.gc.ca/assets/FORCES\\_Internet/docs/en/about/defence-renewal-charter.pdf](http://www.forces.gc.ca/assets/FORCES_Internet/docs/en/about/defence-renewal-charter.pdf) [Accessed 03 February 2022].

cohesive economy of effort, the Defence Renewal incorporated nine focus areas with four of the 33 initiatives to achieve the stated objectives.

The first domain intended to streamline the project approval process review by identifying the process “*Muda*.” Ultimately, the project approval process review aimed “to double throughput and reduce the process cycle time” to approve projects while adhering to the Treasury Board policies<sup>90</sup>. Second, the Defence Renewal envisioned “rationalizing the real portfolio to be efficient, effective, affordable, [and] sustainable to support” CAF missions<sup>91</sup>. Third, the procurement process remains a stumbling block in the timely delivery of critical operational projects. Subsequently, the Defence Renewal proposed to “apply best practices to spend [...] using all DND controlled procurement levers to maximize value to DND”<sup>92</sup>. Inventory management is the final domain aimed “to avoid incurring the cost of unnecessary items by optimizing the amount of inventory procured and held” to realize material accountability and visibility<sup>93</sup>.

At the end of the 2017/2018 fiscal period, the Defence Renewal integrated the various initiatives as part of DND’s business routine.<sup>94</sup> Although the Defence Renewal concluded, the philosophy and the themes continue to resonate, with DND as a coordinated Defence Team (civilian and military personnel) effort to endeavour “value for money [and] minimize operational inefficiency results [...] while encouraging a stronger culture of innovation and

---

<sup>90</sup> Department of National Defence, “Review of the Defence Renewal,” Slide 8. [www.canada.ca/content/dam/dnd-mdn/migration/assets/FORCES\\_Internet/docs/en/about-reports-pubs-audit-eval/271p7055-64.pdf](http://www.canada.ca/content/dam/dnd-mdn/migration/assets/FORCES_Internet/docs/en/about-reports-pubs-audit-eval/271p7055-64.pdf). [Accessed 04 April 2022].

<sup>91</sup> *Ibid.*, Slide 9.

<sup>92</sup> *Ibid.*, Slide 8.

<sup>93</sup> *Ibid.*

<sup>94</sup> Department of National Defence, “Defence Plan: 2018-2023”, 18, 2018. <https://www.canada.ca/content/dam/dnd-mdn/documents/reports/2018/defence-plan-2018-2023.pdf> [Accessed 10 January 2022].

collaboration”.<sup>95</sup> Furthermore, the Defence Renewal emphasized leveraging core competencies to realize “maximum value for money” by emulating industry best (emerging) practices into the public-sector bureaucracy.<sup>96</sup> C.K. Prahalad and Gary Hamel, corporate and social strategists, formed the basic definition of core competency as “harmonizing streams of technology” to form an individualized skill set in the marketplace.<sup>97</sup> This unique skill-set elevates competition because the organization’s performance, leveraging its skill-set, is unmatched in this domain. These underlining themes and philosophy form the fundamental core values to guide the publication of Canada’s Defence Policy, “Strong, Secure, Engaged.”

In tandem with the SSE values, the Australian Defence Force’s (ADF) recent publication titled “Concept for Future Support” definitively summarizes the publication’s intent as a “long-term partnership” between the government of [Canada] and industry to collaboratively provide the [CAF] supply chain “flexibility for iterative capability development [...] and promote innovation and adaptation”.<sup>98</sup> As a system within systems, the ADF’s Defence Logistics Enterprise (DefLogEnt) sets the conditions to “enable[s] the Future Force through the provision of hardened, resilient, adaptive and assured logistics.”<sup>99</sup>

Additionally, the ADF aims to exploit opportunities to create competitive advantages to complement and sustain a broad “spectrum ranging from stable peace to general war.”<sup>100</sup> More importantly, with similarities to Canada’s Defence Renewal and SSE envisioned whole-of-

---

<sup>95</sup> Department of National Defence, “Defence Renewal Charter: Department of National Defence and the Canadian Armed Forces – October 2013”, 4, 2013. [www.forces.gc.ca/assets/FORCES\\_Internet/docs/en/about/defence-renewal-charter.pdf](http://www.forces.gc.ca/assets/FORCES_Internet/docs/en/about/defence-renewal-charter.pdf) [Accessed 09 January 2021].

<sup>96</sup> Department of National Defence, “*Strong, Secure, Engaged: Canada’s Defence Policy*,” 2017, 7.

<sup>97</sup> C.K. Prahalad, and Gary Hamel, “The Core Competence of the Corporation.” *Harvard Business Review* 68, no. 3 (1990): 81.

<sup>98</sup> Australian Defence Force, “Concept of Future Logistics,” 11 November 2020, 37-38.

<sup>99</sup> *Ibid.*, 27.

<sup>100</sup> *Ibid.*, 24.

government approach, the “Concept of Future Logistics” publication also highlights that one of its pillars to achieving a competitive advantage is through collaboration with industry and academic partners and integration with other governmental departments. The whole-of-government approach sets conditions to “shape the strategic environment, deter actions against Australia, and respond with a credible force.”<sup>101</sup>

The ADF’s “Concept of Support” illustrates common values shared between rule-based democracies towards shaping national defence. Likewise, Canada’s Defence Policy encourages an integrated collaborative approach that supports the defined governmental competitiveness as highlighted to deliver accountability and “deliver [transparent] results [and value] for all Canadians.”<sup>102</sup> Nevertheless, SSE acknowledges that climate change is crucial for destabilizing entire regions and “disrupting the lives and livelihoods of millions worldwide.”<sup>103</sup> Furthermore, climate change will undoubtedly influence future global competition for finite resources to sustain life. Consequently, Canada’s Defence recognizes the long-term impact of climate change by mandating the CAF to collaborate with like-minded partners and the private sector to innovate sustainable solutions to add value to the DSC and revolutionize the CAF’s “green” defence logistics strategy.<sup>104</sup>

## 2.6. Reverse Logistics Aligns with Canada’s Defence Policy

Canada’s Defence Policy, SSE defines several vital priorities and values to guide the DND to deliver new capabilities to the CAF over the next two decades. However, throughout the publication, there lacks a genuine discussion on modernizing and “greening” the DSC to sustain

---

<sup>101</sup> Australian Defence Force, “Concept of Future Logistics,” Australian Defence Force, 11 November 2020, 25.

<sup>102</sup> Department of National Defence, “Strong, Secure, Engaged: Canada’s Defence Policy,” 2017, 16.

<sup>103</sup> *Ibid.*, 49.

<sup>104</sup> *Ibid.*, 77.



and enable the CAF's future force. Furthermore, there remains a significant gap in developing a sustainable supply chain model and processes to complement the GoC's vision of legacy and future force equipment. The highlighted priorities in the SSE implicitly highlight and establish a value framework to ascertain the feasibility of outsourcing the reverse logistics portion of the DSC.

The first value aims to establish a green and sustainable defence. As part of a Whole Government approach, the "Greening Defence" priority incorporates objectives identified in the Federal Sustainable Development Strategy. In addition, the GoC explicitly identified that "a clean environment and sustainable economy are priorities" in which DND, as the largest employer in Canada, has a substantial "role in helping [to] advance these objectives."<sup>105</sup> This priority poses unique opportunities to develop a holistic, sustainable supply chain that integrates reverse logistics principles and strategies.

The second value underlines a transformative culture to encompass and cultivate innovation within the Canadian defence industry. A central theme presented in the SSE is an integration of the private sector and academics through the Innovation for Defence Excellence and Security (IDEaS) program to establish "clusters to simulate collaborat[itive]" research and development synergies for future defence requirements.<sup>106</sup> For example, outsourcing reverse logistics will lead to opportunities to involve the industry to collaboratively develop information systems such as electronic data exchange (EDE), blockchain technology and cloud systems to track material accountability and visibility.

---

<sup>105</sup> Department of National Defence, "Strong, Secure, Engaged: Canada's Defence Policy," 2017, 75.

<sup>106</sup> *Ibid.*, 78.

The final value defines a “Whole of Government” approach toward maturing the defence industry. The “Whole of Government” approach integrates other government departments with the private sector to collaboratively “deliver on the defence mandate [and] to support services to enable the military to succeed directly.”<sup>107</sup> Establishing close cooperation with industry will ensure the CAF remains operationally competitive on the global stage with advanced technologies for seamless interoperability with Canada’s allies. At the same time, “keep[ing] Canada’s economy vibrant and innovative.”<sup>108</sup>

## 2.7. Outsourcing Reverse Logistics: Third-Party Logistics (3PL)

The three principles and values previously discussed lead to consider whether outsourcing a third-party reverse Logistics (3PRL) vendor-managed inventory (VMI) model would alleviate the CAF’s inventory (EOL equipment and material) and warehouse operation inefficiencies. For example, large corporations, such as Barilla SpA, Intel, Shell Chemical, and Campbell Soup have outsourced to third-party logistics organizations and adopted the VMI model to achieve warehouse operations and inventory management efficiencies.<sup>109</sup> Moreover, the literature research defined 3PL as “activities carried out by a logistics service provider [...] to manage inventory management, material accountability, transportation and warehousing.”<sup>110</sup> In later academic research, the third-part logistics definition included any service that adds value and sustainability to the organization.<sup>111</sup> Furthermore, reverse logistics functions as a system to

---

<sup>107</sup> Department of National Defence, “Strong, Secure, Engaged: Canada’s Defence Policy,” 2017, 74.

<sup>108</sup> *Ibid.*, 74.

<sup>109</sup> Jun-Yeon, Lee, Richard K., Cho, and Seung-Kuk, Paik, “Supply chain coordination in vendor-managed inventory systems with stockout-cost sharing under limited storage capacity,” *European Journal of Operational Research* 248, No. 1 (2016): 95.

<sup>110</sup> Magnus, Berglund, Peter, van Laarhoven, Sharman, Graham, and Wandel, Sten, “Third-Party Logistics: Is there a Future?” *International Journal of Logistics Management* 10, no. 1 (1999): 59.

<sup>111</sup> Chia-Nan, Wang, Thanh-Tuan, Dang, and Ngoc-Ai-Thy, Nguyen, “Outsourcing Reverse Logistics for E-Commerce Retailers: A Two-Stage Fuzzy Optimization Approach,” *Axioms* 10, no. 1 (2021): 1.

“collect and reuse end of life products in a forward flow supply chain” within a closed-loop supply chain.<sup>112</sup>

The closed-loop supply chain strategy has garnered significant consumer and government interest in sustainability and climate change in the last decade. This strategy derives its forward value stream inflow of material, information, and profitability within the supply chain context by encompassing four processes: repair, reuse, recycle, refurbish and remanufacture.<sup>113</sup> Although this definition provides the fundamental elements and components to outline a closed-loop supply chain, there lack definitive properties to illustrate the circular flow (forward and reverse) of material, information, and profitability within this strategy.

Alternatively, researchers in the engineering field mathematically described the closed-loop supply chain as a circular economy that incorporates both the “forward flow” of the supply chain activities (i.e. procure, distribute to end-users) and the “reverse flow” of the supply chain activities (i.e., EOL disposal, recycle, salvage, reuse) into a “cradle-to-grave” strategy.<sup>114</sup> As graphically illustrated in Figure 2.2, this definition of a closed-loop supply chain clearly articulates a continuous flow of material to the end-user (forward channel) while respecting that material return (reverse channel) into the supply chain as part of the reverse logistics continuum. In addition to Figure 2.2, to holistically visualize a closed-loop supply chain, there would be arrows crossing between reverse logistics and forward logistics to highlight the circular flow of material. For example, a sailor returns reusable material, such as Naval Environment Combat

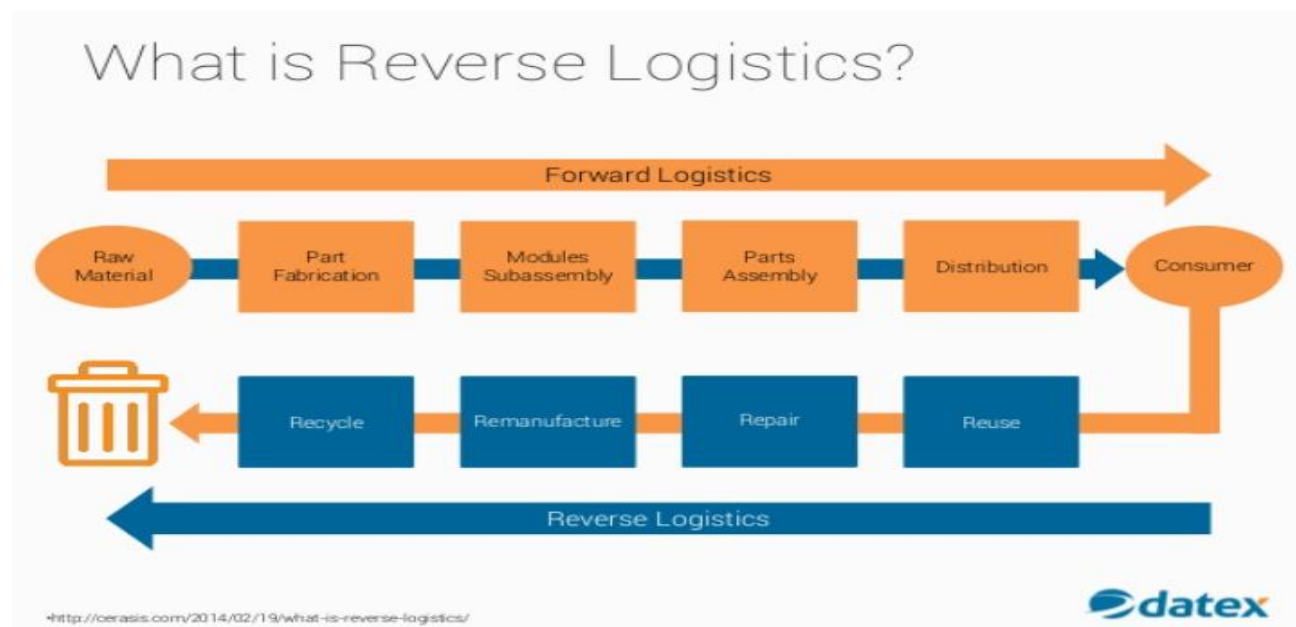
---

<sup>112</sup> Fatemeh Keshavarz-Ghorbani, and Seyed Hamid Reza Pasandideh, “Optimizing a Two-Level Closed-Loop Supply Chain Under the Vendor Managed Inventory Contract and Learning: Fibonacci, GA, IWO, MFO Algorithms,” *Neural Computing and Applications*, Vol. 33, No. 15, 2021: 9425.

<sup>113</sup> Jose M. Framinan, 2022, “Modeling Supply Chain Dynamics,” Cham, Switzerland: Springer International Publishing AG, 151.

<sup>114</sup> Komeyl Baghizadeh, Julia Pahl, and Guiping Hu, “Closed-Loop Supply Chain Design with Sustainability Aspects and Network Resilience under Uncertainty: Modelling and Application, *Mathematical Problems in Engineering* Vol. 2021, 30 March 2021: 1.

Uniforms (NECUs)<sup>115</sup>, that could be returned to clothing distribution points for re-issue to other sailors.



**Figure 2.2: Closed-Loop Supply Chain**

Source: <https://www.datexcorp.com/supply-chain-management-basics-reverse-logistics/>  
[Accessed on 21 April 2022]

The mathematical evidence validated that organizational oversight throughout the material life-cycle from material inception to EOL fosters value in the supply chain. Furthermore, as previously highlighted, the management of material throughput hinges on a collaborative partnership and willingness to exchange data and share information to optimize results and flow within a closed-loop supply chain. Moreover, recent academic literature supported and demonstrated value in leveraging a VMI model within a closed-loop supply chain

<sup>115</sup> NECUs are issued to sailors who will be operating onboard HMC Ships or at Naval bases.

to address the bullwhip effect (oscillation of demand requirements) and EOL material and equipment management challenges.<sup>116</sup>

Academic literature defined the VMI model as a consignment relationship where the inventory risk and ownership remain with the vendor (contractor).<sup>117</sup> Likewise, in recent studies, the VMI definition evolved the model centred on partnerships and relationships to optimize inventory management efficiencies to realize cost savings.<sup>118</sup> Moreover, the contractor (vendor) manages the inventory for the customer (CAF) and determines optimized levels (maximum and minimum) to replenish and continuously improve EOL throughput and flow.<sup>119</sup> As a result, the onus rests on the contractor to deliver the “right amount and time so that there is no stock out” impact on operational readiness.<sup>120</sup> Therefore, incentivizing the vendor is a critical part of contract management to ensure the vendor is motivated to generate profits while adding value to the DSC.

---

<sup>116</sup> Fatemeh Keshavarz-Ghorbani, and Seyed Hamid Reza Pasandideh, “Optimizing a Two-Level Closed-Loop Supply Chain Under the Vendor Managed Inventory Contract and Learning: Fibonacci, GA, IWO, MFO Algorithms,” *Neural Computing and Applications* 33, no. 15 (2021): 9426. / D. Ernawati, E. Pudji, N. Rahmawati, and M. Alfin, “Bullwhip Effect reduction using Vendor Managed Inventory (VMI) Method in Supply Chain of Manufacturing Company,” *Journal of Physics: Conference Series* 189, no. 1 (May 2021): 2.

<sup>117</sup> Sheng-shi Zhou, Li-hong Yang, and Yong-qiang Huang, “Risk Analysis and Control of Vendor Managed Inventory Model Implementation for Manufacturers,” *International Conference on Artificial Intelligence, Management Science and Electronic Commerce*, (2011): 7229 / Joong Y. Son, and Subhadip Ghosh, “Vendor Managed Inventory with Fixed Shipping Cost Allocation,” *International Journal of Logistics* 23, no. 1 (2020): 1.

<sup>118</sup> Astanti Ririn Diar, Yosef Daryanto, and Parama Kartika Dewe, “Low-Carbon Supply Chain Model Under a Vendor-Managed Inventory Partnership and Carbon Cap-and-Trade Policy,” *Journal of Inventory Partnership and Market, and Complexity* 8, no. 1 (2022): 30. / D. Ernawati, E. Pudji, N. Rahmawati, and M. Alfin, “Bullwhip Effect reduction using Vendor Managed Inventory (VMI) Method in Supply Chain of Manufacturing Company,” *Journal of Physics: Conference Series* 189, no. 1 (May 2021): 2. / Ilhaam A. Omar, Raja Jayaraman, Khaled Salah, Mazin Debe, and Mohammed Omar, “Enhancing Vendor Managed Inventory Supply Chain Operations using Blockchain Smart Contracts,” *IEEE Access* 8, (2020): 182706.

<sup>119</sup> Sheng-shi Zhou, Li-hong Yang, and Yong-qiang Huang, “Risk Analysis and Control of Vendor Managed Inventory Model Implementation for Manufacturers,” *International Conference on Artificial Intelligence, Management Science and Electronic Commerce*, (2011): 7229 / Ilhaam A. Omar, Raja Jayaraman, Khaled Salah, Mazin Debe, and Mohammed Omar, “Enhancing Vendor Managed Inventory Supply Chain Operations using Blockchain Smart Contracts,” *IEEE Access* .8, (2020): 182705.

<sup>120</sup> D. Ernawati, E. Pudji, N. Rahmawati, and M. Alfin, “Bullwhip Effect reduction using Vendor Managed Inventory (VMI) Method in Supply Chain of Manufacturing Company,” *Journal of Physics: Conference Series* 189, no. 1 (May 2021): 2.

Jun-Yeon Lee, Richard K. Cho, and Seung-Kuk Paik hypothesized that incentivizing an integrated contractor in a VMI model centred on partnered collaborative relationships will optimize efficiencies while minimizing stockout costs.<sup>121</sup> Thus, the collaborative approach between the vendor and the customer led to improved supply chain and inventory visibility.<sup>122</sup> In addition, this partnership theory hypothesized that a definitive contractual agreement, mutually benefiting both parties, would facilitate similar supply chain results and efficiencies with limited storage. Their particular area of research highlighted the VMI model with stockout cost-sharing (VMI-SOCS). The VMI-SOCS system begins with the customer drafting and offering a contract to the supplier. Then, the supplier manages the inventory on behalf of the customer and optimizes EOL material and equipment flow. In this model, the customer is responsible for the holding costs and the contractor shoulders the management of the reverse logistics and divestment functions.<sup>123</sup>

Furthermore, Lee et al. demonstrated mathematically that VMI-SOCS and integrated systems would facilitate similar replenishment decisions, supply chain performance, and cost savings in the completed research and computations. Their mathematical calculations, based on a singular VMI relationship between a supplier and customer, illustrated under a VMI SOCS that customer operating costs were impressively reduced by 103.58%. In addition, the supplier reduced their operating expenses by 14.75% and a further 35% reduction in the supply chain

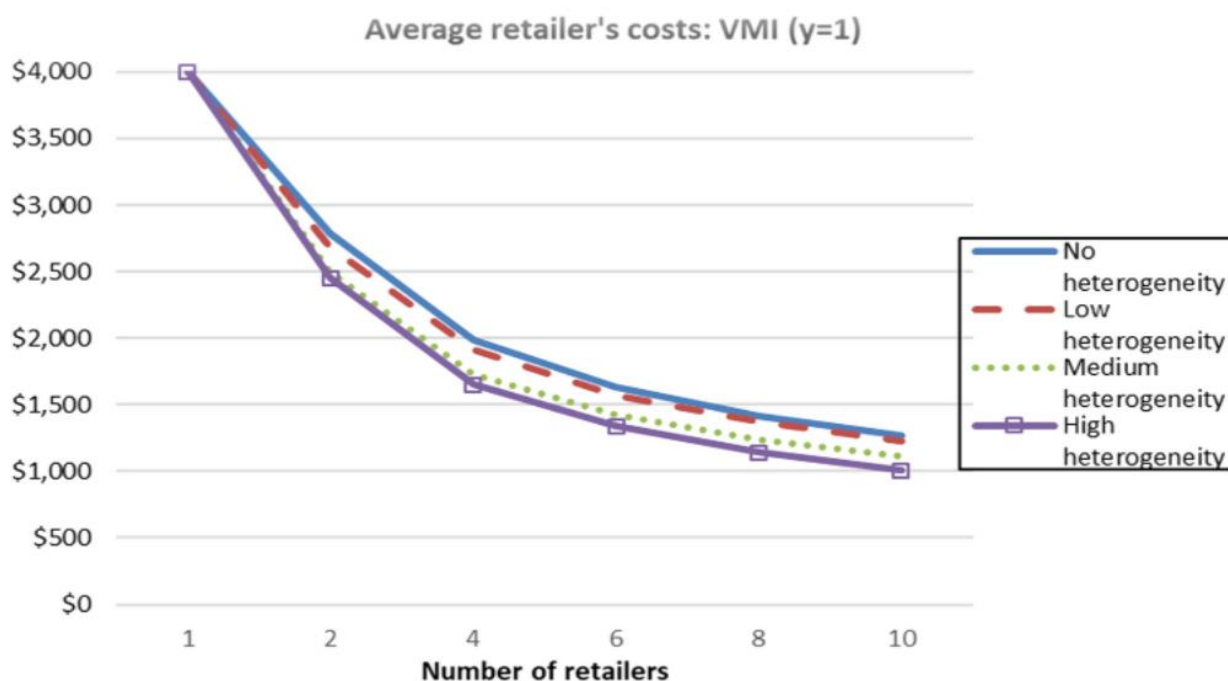
---

<sup>121</sup> Jun-Yeon Lee, Richard K. Cho, and Seung-Kuk Paik, "Supply chain coordination in vendor-managed inventory systems with stockout-cost sharing under limited storage capacity," *European Journal of Operational Research*, no. 248 (2016): 101.

<sup>122</sup> Astanti Ririn Diar, Yosef Daryanto, and Parama Kartika Dewe, "Low-Carbon Supply Chain Model Under a Vendor-Managed Inventory Partnership and Carbon Cap-and-Trade Policy," *Journal of Inventory Partnership and Market, and Complexity* 8, no. 1 (2022): 30. / Ilhaam A. Omar, Raja Jayaraman, Khaled Salah, Mazin Debe, and Mohammed Omar, "Enhancing Vendor Managed Inventory Supply Chain Operations using Blockchain Smart Contracts," *IEEE Access* 8, (2020): 182706.

<sup>123</sup> Jun-Yeon Lee, Richard K. Cho, and Seung-Kuk Paik, "Supply chain coordination in vendor-managed inventory systems with stockout-cost sharing under limited storage capacity," *European Journal of Operational Research*, no. 248 (2016): 96.

total cost.<sup>124</sup> Moreover, other research complemented the financial benefit based on a singular VMI relationship. Furthermore, the research advanced the study by examining a VMI structure based on multiple retailers vice a distinct modal relationship to quantitatively illustrate mutual financial benefits to the vendor and the customer. Figures 2.3 and 2.4 showed that the mathematical calculations significantly reduced inventory costs within competitive and diverse distribution channels.<sup>125</sup>

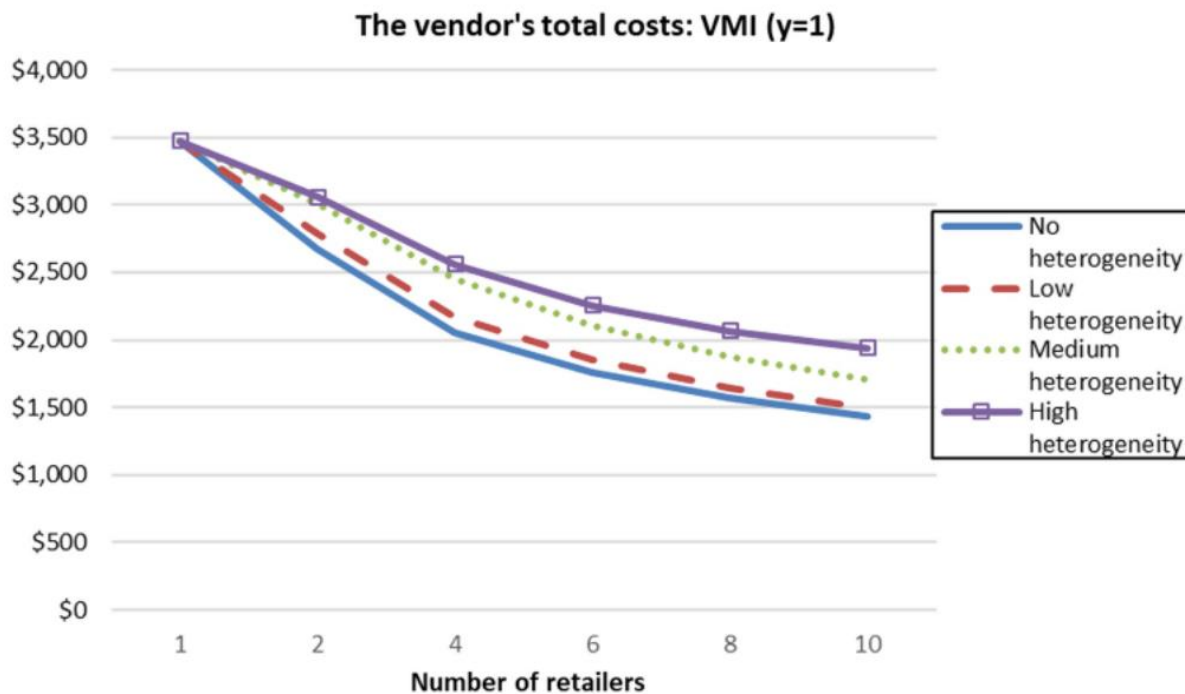


**Figure 2.3: Impact of Retailer Heterogeneity: Average Retailer's Inventory cost**

Source: Joong Y. Son, and Subhadip Ghosh, "Vendor Managed Inventory with Fixed Shipping Cost Allocation," *International Journal of Logistics* 23, no. 1 (2020): 15.

<sup>124</sup> Jun-Yeon Lee, Richard K. Cho, and Seung-Kuk Paik, "Supply chain coordination in vendor-managed inventory systems with stockout-cost sharing under limited storage capacity," *European Journal of Operational Research*, no. 248 (2016): 101.

<sup>125</sup> Source: Joong Y. Son, and Subhadip Ghosh, "Vendor Managed Inventory with Fixed Shipping Cost Allocation," *International Journal of Logistics* 23, no. 1 (2020): 15.



**Figure 2.4: Impact of Retailer Heterogeneity: The Vendor's Inventory Cost**

Source: Joong Y. Son, and Subhadip Ghosh, "Vendor Managed Inventory with Fixed Shipping Cost Allocation," *International Journal of Logistics* 23, no. 1 (2020): 15.

Finally, a consensus existed within the literature that for a VMI strategy to succeed, a coordinated and collaborative partnership approach is critical to enabling knowledge-based decisions and optimizing replenishment levels primarily based on trust.<sup>126</sup> In addition, the partnership and collaboration synergize efficiencies and synchronized approaches to develop solutions to benefit all stakeholders mutually innovatively. Similarly, these ideas and values reflect the themes highlighted in SSE to leverage mutual benefits to realize competitiveness in the markets.

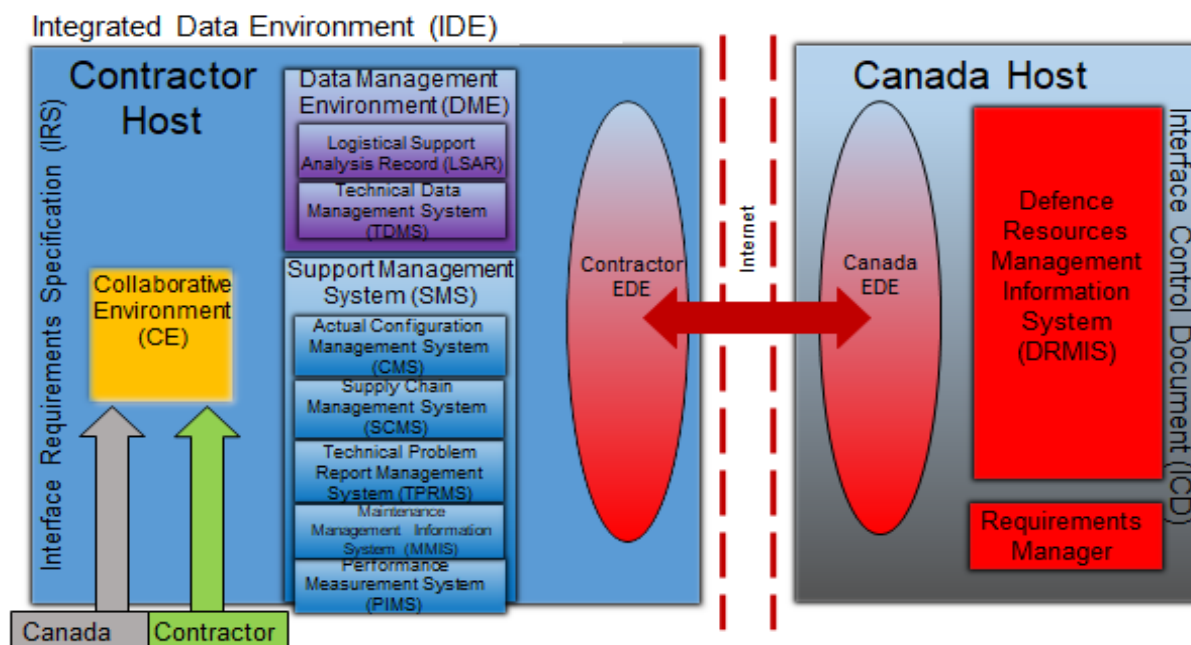
<sup>126</sup> Joong Y. Son, and Subhadip Ghosh, "Vendor Managed Inventory with Fixed Shipping Cost Allocation," *International Journal of Logistics* 23, no. 1 (2020): 3. / Ilhaam A. Omar, Raja Jayaraman, Khaled Salah, Mazin Debe, and Mohammed Omar, "Enhancing Vendor Managed Inventory Supply Chain Operations using Blockchain Smart Contracts," *IEEE Access* 8, (2020): 182705.



There is substantial evidence within research and literature on the benefits of implementing a third-party closed-loop chain VMI. Moreover, the literature revealed that a 3PL closed-loop VMI requires a collaborative relationship between the customer and the vendor to focus on their core competencies. However, this synergetic relationship underlined significant coordination and integration of systems and processes, which may be more challenging for governmental organizations and private industries to apply a 3PL closed-loop VMI model. For example, Figure 2.5 highlights the complexity of developing an integrated data environment (IDE) solution that enables the GoC to share and exchange data with the contractor. While posted to the Directorate General of Maritime Equipment Program Management - Non-Combatant (DGMEPM -NC), the author supported an IDE solution development process to enable data and information flow between GoC and the awarded contractor.<sup>127</sup>

---

<sup>127</sup> The contractor performed the in-service support for the AOPs and JSS platforms. The author collaborated with IBM to develop the IDE solution while posted to DGMEPM -NC as the Material Introduction Officer for the AOPS/JSS In-Service Support (AJISS) contract in 2017. This graphic was developed for various presentations to illustrate the components required to develop the IDE Solution and to highlight progress.



**Figure 2.5: Proposed Integrated Data Environment Framework**

Source: Author, 2017

## 2.8. Third Party Logistics Closed-Loop Vendor Managed Inventory Integration

A successful military closed-loop supply chain VMI model requires an information management system that enables data exchange between two or more entities, such as an IDE solution. Research supported the importance of information infrastructure integration and suggested that an IDE solution will enable accurate demand forecasting of inventory and EOL.<sup>128</sup> Furthermore, evidence from literature reinforces that collaboration was critical to developing virtual inventory management based on credible data exchange (information-based vice inventory-driven) between customers and suppliers.<sup>129</sup> In addition, the research proved that business analytical intelligence applications empowered organizations to reduce lead time

<sup>128</sup> Hero Chiu, Ching-Torng Lin, and Po-Young Chu, "Agility index in the supply chain," *International Journal of Production Economics* 100, no. 2 (2006): 293.

<sup>129</sup> *Ibid.*, 288.

compression and be “demand-driven rather than forecasted driven.”<sup>130</sup> Moreover, an IDE solution further supported the importance of trust and partnership in the data exchange of sensitive information between two parties.<sup>131</sup>

The literature proved that the integrated system (IS) combined with an integrated data exchange compresses lead time and optimizes material flow to the customer. Furthermore, the lead time compression minimizes the long lead inventory items to the vendor, facilitating the reverse logistics processes of EOL and obsolete equipment. Therefore, for VMI to succeed in a military construct, there needs to be a collaborative process with private industry to optimize inventory and replenishment levels. Moreover, empirical evidence within the literature demonstrated that an integrated defence infrastructure as part of the country’s economic and development plan would realize long-run economic benefits.<sup>132</sup> The research further considered a supplier’s pricing strategy in a VMI model by mathematically comparing centralized and de-centralized decision-making models.

A series of mathematical formulas compare the two decision-making models (centralized and de-centralized) with a VMI relationship within the military. The research concluded that a centralized model proved to be better suited for supply chain efficiency and value. In addition, the article demonstrated a considerable advantage in a centralized supply chain by optimizing the allocation of national resources equally between social and economic development and military modernization. The balancing between civil and military needs and growth is realized by

---

<sup>130</sup> Pia Huxel, and Elene Gelashvili, “Use of Lean and Agile Commercial Supply Chain Practices in Humanitarian Supply Chains,” (2014): 7.

<sup>131</sup> Sheng-shi Zhou, Li-hong Yang, and Yong-qiang Huang, “Risk Analysis and Control of Vendor Managed Inventory Model Implementation for Manufacturers,” *IEEE*, (2011): 7230.

<sup>132</sup> Wen Liu, Hai-yan Wang, and Long-gang Li, “Quartermaster’s pricing problems in dual channel strategy of VMI & TPL mode,” *Procedia Computer Science* 111, (2016): 277.

investing in a VMI model dovetailed strategies that include e-commerce and leveraging the online markets.<sup>133</sup>

However, the researchers assumed a centralized decision-making model and direct sales channel focused on e-commerce as part of the military-civilian integration. A centralized model would be much more beneficial when the government plays a direct and commanding role in determining the nation's economy and growth, a stark contrast to the values presented in the SSE of collaboration from industry. Nevertheless, the literature highlighted that cooperation and long-term partnership enable organizations, such as the RCN, to focus on their core competencies. Furthermore, as introduced in the "Strong, Secure, and Engaged," long-term relationships and greater industry engagement in the Canadian defence strategy are important factors.

## 2.9. Risk Considerations for Outsourced Logistics and Technical Functions

An outsourced logistics service (i.e. inventory management, disposal, distribution, warehouse operations) or supply chain portions raises significant challenges and benefits. The most obvious is ensuring that an implemented supply chain delivers value for money (cost-savings) without compromising operational effectiveness and availability. The evolution of outsourcing military-technical to support services functions has resulted in greater dependence on outsourcing traditional military functions.<sup>134</sup> Stefanov supported and demonstrated that the armed forces' primary focus rests on developing their core competencies (i.e. niche operations

---

<sup>133</sup> Wen Liu, Hai-yan Wang, and Long-gang Li, "Quartermaster's pricing problems in dual channel strategy of VMI & TPL mode," *Procedia Computer Science* 111, (2016)., 285.

<sup>134</sup> Christopher Kinsley, "Transforming war supply: Considerations and rationales behind contractor support to UK overseas military operations in the twenty-first century," *International Journal (Toronto)* 69, no. 4 (2014): 494.

and warfighting).<sup>135</sup> At the same time, contractors manage the supply chain and other non-core service support functions.<sup>136</sup>

According to Kinsley<sup>137</sup>, from an operational perspective, service support functions are considered a non-core military function because supporting operations does not necessarily “entail the taking of life as a regular part of the job.”<sup>138</sup> Hence, Kinsley argued that contractors are readily available to assume service and support services within the military supply chain. Furthermore, Kinsley defined the logistical services contractors may provide on base and deployments, such as food, waste management, and maintenance under an in-service support contract(s). Stefanov’s extensive research regarding the Bulgarian Armed Forces’ (BAF) outsourcing model highlighted similar conclusions made by Kinsley with “proven economic [and operational] impact.”<sup>139</sup> More importantly, Stefanov demonstrated significant cost savings when the BAF outsourced food services to private contractors.<sup>140</sup>

Supported by data, Stefanov illustrated that outsourcing armed forces’ core functions reverse the cost-saving trend incurred by outsourcing logistical functions within the BAF.<sup>141</sup> Moreover, the studies concurred and reaffirmed the segregation of duties between core and non-

---

<sup>135</sup> Mr. Nikolay Stefanov is the Chief Assistant Professor at the National Military University “Vasil Levski.” Mr. Nikolay Stefanov’s research and academia centres on the Bulgarian Armed Forces and military logistics with an analytical focus on the benefits and limitations of outsourcing logistical functions within the BAF.

<sup>136</sup> Nikolay Stefanov, “Analysis of the Use of Outsourcing Services for Maintenance and Repair of the Equipment and Armament Available in the Structures of the Bulgarian Armed Forces,” *International Conference Knowledge-Based Organization* 23, no. 1 (2017): 467.

<sup>137</sup> Mr. Christopher Kinsley is an academic with the Department of Defence Studies at King’s College London, London, United Kingdom. Mr. Christopher Kinsley’s academic focuses on government privatization, outsourcing and contracting services in the military domain.

<sup>138</sup> Christopher Kinsey, “Transforming war supply: Considerations and rationales behind contractor support to UK overseas military operations in the twenty-first century,” *International Journal (Toronto)* 69, no. 4 (2014): 507.

<sup>139</sup> Sevdalina Dimitrova, Nikolay Nichev, Nicolay Stefanov, “Development of Outsourcing Services,” *International Conference Knowledge-Based Organization* 21, no. 1 (2015): 196.

<sup>140</sup> Nikolay Stefanov, “Analysis of some of the Applicable Outsourcing Services in the Structures of the Bulgarian Armed Forces,” *International Conference Knowledge-Based Organization* 23, no. 1 (2017): 476.

<sup>141</sup> *Ibid.*, 478.

core functions, with the latter being more advantageous as an opportunity to reduce financial costs by outsourcing to contractors. As a result, the literature concluded and revealed (Kinsley<sup>142</sup>; and Stefanov<sup>143</sup>) greater operational efficiencies and reduced costs in maintaining overall defence capabilities and operational readiness within logistics services.

Besides the benefits previously mentioned, Kinsley<sup>144</sup> and Stefanov<sup>145</sup> recognize that armed forces have finite resources (i.e. financial, personnel) to maintain a global and regional presence; modern armed forces limiting factor is limited resources and public support. As the most critical factor, the latter underlines the profound impact of public opinion on military budgetary and equipment requirements. For example, Kinsley reported that the United Kingdom (UK) military had undergone significant force re-structure with personnel reduced to 177,000 from 305,000 personnel in 1990 while “doing more with less” during operations.<sup>146</sup> Consequently, armed forces demonstrated greater reliance on contractors by outsourcing non-core military functions to focus on and perform their core competencies.<sup>147</sup> Furthermore, Kinsley highlights outsourcing logistics and technical services as a short-term solution to relieve capability gaps to deploy personnel and resources towards warfare or overseas deployment.<sup>148</sup>

---

<sup>142</sup> Christopher Kinsey, “Transforming war supply: Considerations and rationales behind contractor support to UK overseas military operations in the twenty-first century,” *International Journal (Toronto)* 69, no. 4 (2014): 495.

<sup>143</sup> Nikolay, Stefanov, “Analysis of the Use of Outsourcing Services for Maintenance and Repair of the Equipment and Armament Available in the Structures of the Bulgarian Armed Forces,” *International Conference Knowledge Based Organization* 23, no. 1 (2017): 468.

<sup>144</sup> Christopher Kinsey, “Transforming war supply: Considerations and rationales behind contractor support to UK overseas military operations in the twenty-first century,” *International Journal (Toronto)* 69, no. 4 (2014): 500.

<sup>145</sup> Nikolay, Stefanov, “Analysis of the Use of Outsourcing Services for Maintenance and Repair of the Equipment and Armament Available in the Structures of the Bulgarian Armed Forces,” *International Conference Knowledge-Based Organization* 23, no. 1 (2017): 468.

<sup>146</sup> Christopher Kinsey, “Transforming war supply: Considerations and rationales behind contractor support to UK overseas military operations in the twenty-first century,” *International Journal (Toronto)* 69, no. 4 (2014): 500.

<sup>147</sup> *Ibid.*, 501.

<sup>148</sup> *Ibid.*, 500.

However, literature opinion diverged on how armed forces should employ contractors within the supply chain. Stefanov offers a different perspective; contractors and industry partners are an integral part of the Bulgarian Armed Forces (BAF) organization to prevent the “appearance of corruption.”<sup>149</sup> Bulgaria and the BAF are a stark contrast to the United Kingdom and their Armed Forces because of the United Kingdom’s global presence and political policies. In contrast, the BAF concentrates on primarily defending Bulgaria’s borders and domestic interests. As a result, contractors deliver regional services on replenishment, technical maintenance (repair and overhaul), warehousing, and inventory management.<sup>150</sup>

Although Stefanov and Kingsley illustrate similar benefits of outsourcing supply chain functions, Stefanov raises concerns about outsourcing logistics and technical support functions. According to Stefanov’s research, the continued downward trend in personnel reduction within the armed forces and greater dependency on contractors further exasperate the loss of core competencies and critical capabilities among serving BAF personnel.<sup>151</sup> For example, since 2001, with the acquisition of new transport equipment (i.e. Mercedes-Benz buses and trucks), the BAF outsourced military pattern vehicles’ maintenance and repair functions.<sup>152</sup> As a result, there is a lack of expertise in maintaining and repairing their transportation fleet.<sup>153</sup> Regardless of the dangers of lost capability and skillsets, Stefanov suggests that there continues to be an upward

---

<sup>149</sup> Nikolay Stefanov, “Analysis of the Use of Outsourcing Services for Maintenance and Repair of the Equipment and Armament Available in the Structures of the Bulgarian Armed Forces,” *International Conference Knowledge-Based Organization* 23, no. 1 (2017): 468.

<sup>150</sup> Nikolay Stefanov, “Analysis of the Use of Outsourcing Services for Maintenance and Repair of the Equipment and Armament Available in the Structures of the Bulgarian Armed Forces,” *International Conference Knowledge-Based Organization* 23, no. 1 (2017): 468.

<sup>151</sup> Nikolay Stefanov, “Analysis of the Use of Outsourcing Services for Maintenance and Repair of the Equipment and Armament Available in the Structures of the Bulgarian Armed Forces,” *International Conference Knowledge-Based Organization* 23, no. 1 (2017): 469.

<sup>152</sup> *Ibid.*, 470.

<sup>153</sup> *Ibid.*

trend towards outsourcing supply chain functions because there is a desire for “better quality services at lower costs.”<sup>154</sup>

One crucial risk of outsourcing is the dependency on contractors to deliver CAF’s operational readiness during wartime or high threat situations. For example, the initial RCAF’s CC-150 Airbus fleet air-to-air refuelling modification contract restricted its deployability and operation readiness in heightened threat situations.<sup>155</sup> First, the CC-150 example illustrates outsourcing limitations regarding logistics function in a high-threat environment because “[outsourcing is] often focused on supporting domestic operations.”<sup>156</sup> Furthermore, within Kinsley’s definition, armed forces are mission enablers under wartime conditions to seamlessly deliver services under hostilities and austere conditions. As highlighted in the Russian-Ukraine 2022 conflict, contractors restricted or ceased their logistics services in the region.<sup>157</sup> Alternatively, a static position such as CFB Halifax would be an excellent candidate to leverage contractors and outsourcing services to enable base and fleet operational readiness.

The second impact on operational readiness, unlike the CAF, contractors often lack diplomatic or international custom clearances to seamlessly move the parts through their supply chains to facilitate aircraft repairs or sustainment requirements.<sup>158</sup> For example, during GoC’s

---

<sup>154</sup> Nikolay Stefanov, “Analysis of the Use of Outsourcing Services for Maintenance and Repair of the Equipment and Armament Available in the Structures of the Bulgarian Armed Forces,” *International Conference Knowledge-Based Organization* 23, no. 1 (2017): 471.

<sup>155</sup> K.E. Dubreuil, “Agile and Responsive? Is the Royal Canadian Air Force Contracting Out Its Agility and Responsiveness Through Outsourcing Supply Chain Management?” (Joint Command and Staff Programme Directed Research Paper, Canadian Forces College, 2018), 14.

<sup>156</sup> *Ibid.*, 14.

<sup>157</sup> Cerullo, Megan, “U.S. corporations suspend business in Russia, citing war with Ukraine,” CBS News, 1 March 2022. <https://www.cbsnews.com/news/fedex-ups-suspend-deliveries-russia-ukraine-delta-aeroflot/>. [Accessed on: 28 February 2022].

<sup>158</sup> K.E. Dubreuil, “Agile and Responsive? Is the Royal Canadian Air Force Contracting Out Its Agility and Responsiveness Through Outsourcing Supply Chain Management?” (Joint Command and Staff Programme Directed Research Paper, Canadian Forces College, 2018), 15.



mission to build partnership capacities (BPC) on Operation IMPACT, one recent example emphasized contractors' limitations regarding diplomatic overflight clearances. The selected contractor was to complete five strategic lifts of routine replenishment material from Canada to Kuwait City, Kuwait, within the contractual context. However, the contractor could not secure the required diplomatic overflight clearances through their channels and often relied on the Operational Support Hub – Southwest Asia (OSH-SWA) to facilitate the process. As a result, the contractor successfully delivered routine cargo to Kuwait City on two occasions of five opportunities.<sup>159</sup>

Third, the example of diplomatic overflight clearances further highlighted contractor dependency and the importance of clearly identifying contractual obligations within the contract to maximize operational readiness and minimize delays in the long run. Likewise, performance-based contracting considerations are necessary elements to incentivize the contractor and to hold the contractor accountable to the terms and conditions as stipulated within the contract. Furthermore, the literature research stressed the importance of a complex contract management process as a mitigating factor to reduce the outsourcing limitations and ensure “an acceptable balance between operations capability, quality and cost.”<sup>160</sup>

The literature review demonstrated that armed forces are at a decision point to either insource or outsource some or all of their supply chain functions. The literature presented in this sub-section showed merit in outsourcing supply chain functions to gain organizational

---

<sup>159</sup> The example is based on the author's recent deployment (June 2018 to June 2019) to OSH-SWA as the Deputy Commanding Officer (DCO). The Commanding Officer and the DCO often leveraged internal contracts to facilitate the diplomatic overflight clearance process to support the contractor. The OSH-SWA is a logistics hub for the region, and its area of responsibility (AOR) included Iraq, Jordan, and Lebanon. All strategic lifts from Canada entered through OSH-SWA before being distributed into the AOR.

<sup>160</sup> Nikolay Stefanov, “Analysis of the Use of Outsourcing Services for Maintenance and Repair of the Equipment and Armament Available in the Structures of the Bulgarian Armed Forces,” *International Conference Knowledge-Based Organization* 23, no. 1 (2017): 471.

efficiencies to elevate its competitive advantage and market position. However, as the literature revealed, there is an inherent risk of outsourcing segments or the entire supply chain. More importantly, these risks dovetailed with the global advancement of technology, naturally leading to a protracted training period to surge personnel to fill traditionally outsourced positions. Furthermore, the research supported an upward political trend for more significant “interaction between the service provider and the armed forces” with evidence to support outsourcing supply chain functions for domestic or peace-time operations.<sup>161</sup> At the same time, a consideration worth deliberating and determining the balance between outsourcing the entire or segments of the supply chain because there are integral risks to militaries regarding the erosion of unique core competencies and capabilities to surge during wartime conditions in the absence of contractors.

#### 2.10. Contribution to Existing Literature

In contributing to the existing academic literature, this section examines current models and approaches to mitigate supply chain uncertainties as militaries shift from peace to war operations. Furthermore, this shift between peace and war operations leads to the deliberation of the current binary supply chain model presented herein as a possible decision point for militaries to minimize uncertainty while optimizing warehouse operations. As previously suggested, the evidence within the literature proposed several advantages for militaries to outsource; armed forces assume inherent risks to gain efficiencies through outsourcing segments of their logistic functions at the expense of significant capability gaps during hostile operations. Nevertheless, the BAF and RCAF case studies exemplified existing outsourcing dangers and limitations to suggest challenges regarding contractor dependency and transition between peacetime and

---

<sup>161</sup> Nikolay Stefanov, “Analysis of the Use of Outsourcing Services for Maintenance and Repair of the Equipment and Armament Available in the Structures of the Bulgarian Armed Forces,” *International Conference Knowledge Based Organization* 23, no. 1 (2017): 471.

wartime operations. Consequently, the literature review identified gaps regarding a comprehensive examination of an integrated outsourced reverse logistics strategy within a non-binary supply chain management construct.

Contrary to the proposed non-binary supply chain model hypothesis, academia argued that organizations, such as armed forces gain efficiencies by operating between defined routine and operational states. The model assumes that the operating or active state remains dormant during peace-time operations where lean supply chain principles streamline material flow. Furthermore, a binary co-existence “to switch from one mode [between lean and agile]” to adapt to peace or war operations based on various decision variables and the nation’s emergency levels.<sup>162</sup> The decision points for this model correlate to the nation’s emergency levels to formulate the decision path toward the adopted supply chain.

The specified conditions indicate a model that the supply chain adopts one model under routine (peace) operations and another during functional (war) states, as presented in Table 2.1.

	<b>Emergency Level</b>		
	0	1	2
Mode	Lean	Mix	Agile
Location of Bulk Inventory	Vendor’s Warehouse	Regional Warehouse	Central Warehouse
Modes of Shipment	Train by Road -3PL	By Road - 3PL By Road – Army transport	By Road – Army transport, air
Repair/Replacement	Repair of components	Repair/Replace	Replacement of Assemblies
Lateral Transshipment	Yes	Yes	No
Vendor Penetration Level	Directly to Material Supply Unit	To Regional Warehouse	To Central Warehouse
Level of Inventory	Component Level	Component Level	Assembly Level
Quantity of Spares	Low	Mid	High

<sup>162</sup> Pankaj, Sharma, Makarand S., Kulkarni, and Ajith, Parlikad, “Capability Assessment of Army Spare Parts Replenishment System,” *Benchmarking: An International Journal* 24, no. 5 (2017): 1167.

**Table 2.1: Decision Matrix to Determine Supply Chain Posture<sup>163</sup>**

Source: Sharma and Kulkarni, 2016, 217.

For example, the study suggests a lean supply chain strategy or posture during peace-time or at emergency level zero to support just-in-time deliveries. A lean supply chain posture offers an optimized economy of effort while maximizing value to the country. In this posture, consumer demand, economic considerations, and politics influence the input and flow of material within the supply chain. However, political interference and influence diminish the robustness of a lean supply chain strategy due to bureaucracy miring the decision-making process and creating waste or “*Muda*” into the supply chain. Alternatively, an agile supply chain implementation during emergency level 2 or when the nation is at war leads to ideal conditions for surging capacities and material throughput. In the example, this suggested model’s primary concern remains a reactive approach to potential future conflicts or “emergencies at level 2”.

The first flaw of this argument rests on a centralized decision point, in which one or more persons determine the emergency level and the “mode” that the supply chain will adopt.<sup>164</sup> As a result, spare parts and materials are held at strategic points and pre-positioned to be “pushed” forward only on order. This point of a centralized decision point underlines the weakness of the argument supporting a binary supply chain model because the critical decision point rests on a centralized model to “flip the switch” between lean and agile supply chains. Furthermore, the recent coronavirus-19 (COVID-19) pandemic further underscored the issues and disruptive

---

<sup>163</sup> Pankaj Sharma, and Makarand S. Kulkarni, “Framework for a Dynamic and Responsive: Time separated – Lean-Agile Spare Parts Replenishment System in Army,” *International Journal of Productivity and Performance Management* 65, no. 2 (2016): 217.

<sup>164</sup> Pankaj Sharma, and Makarand S. Kulkarni, “Framework for a Dynamic and Responsive: Time separated – Lean-Agile Spare Parts Replenishment System in Army,” *International Journal of Productivity and Performance Management* 65, no. 2 (2016): 215.

nature of a binary supply chain model that proved challenging to implement. Although the federal and provincial governments responded quickly with rapid procurement and warehousing of Personal Protective Equipment (PPE), there remained significant gaps within the supply chain to adopt an agile-based supply chain model due to the profound principles applied between lean and agile supply chains.<sup>165</sup> Consequently, vital inventory and PPE requirements were held in warehouses or at pre-positioned strategic points because the decision, due to many reasons, to switch the supply chain mode remained adrift.

The delay in decision-making leads to the second inconsistency with the circuit breaker process: rapid deployment of armed forces to support the government's mandates needs time. The research highlighted lean principles to reduce waste to realize cost savings; however, the model switches to the agile supply model at increased expense.<sup>166</sup> The author suggests that the reasoning further fuels inefficiencies experienced in the CAF's inventory management and warehouse challenges because the "switch" is not as seamless as the research implied. The lag already exists within the proposed binary model, as demonstrated in the Auditor General's Reports. Given the potential delay in the decision-making process, this model will perpetually reinforce a culture of hoarding inventory and EOL to mitigate stockouts.

The second limitation of implementing a two-phase binary model based on divergent supply chain philosophies is challenging to implement and seldom employed within the

---

<sup>165</sup> While posted to Base Logistics as the Executive Officer, the author facilitated the movement of PPE at the BLog warehouse. Concurrently, the author was seconded to Nova Scotia's Provincial Planning Team to support their planning efforts in developing the province's supply chain to administer PPE and vaccines. The example provided highlighted the challenges of a binary model to rapidly move material due to a centralized decision point, as highlighted in Sharma and Kulkarni's research.

<sup>166</sup> Pankaj Sharma, and Makarand S. Kulkarni, "Framework for a Dynamic and Responsive: Time separated – Lean-Agile Spare Parts Replenishment System in Army," *International Journal of Productivity and Performance Management* 65, no. 2 (2016): 216.

industry.<sup>167</sup> Since the two-phase binary model seldomly occurs within the industry, the CAF assumes the burdening initial capital costs to undertake this grassroots endeavour; a divergent of the values to leverage industry best practices as detailed in the SSE publication. Moreover, given the complex and challenging implementation process, the model will shift away finite resources to support current operations. It will need significant time to develop a statement of requirements and plan. In addition, a supply chain that switches between lean and agile approaches in a binary context exhibits transitional gaps as a lean supply chain strategy (peace-time) surges to adopt an agile supply chain strategy (wartime conditions). The transition gaps between the two systems introduce additional unnecessary strain and operational inefficiencies on the supply chain caused by the bullwhip effect.

As graphically depicted in Figure 2.6, the bullwhip effect amplifies the supply chain's upstream demand requirements.<sup>168</sup> Further studies defined the bullwhip effect as “a distortion of information” that leads to strengthening demand and supply requirements.<sup>169</sup> As a result of the implications, the bullwhip effect distorts demand forecasting, leading companies to overcompensate by manufacturing more products and inventory. For example, in the two-system model, the centralized decision-maker would initiate the transition from lean (peace-time) to an agile (wartime) supply chain; however, as the change triggers, the demand requirements lead to a “supply-demand” mismatch in the supply chain.<sup>170</sup> Moreover, research suggests that these

---

<sup>167</sup> Galankashi Masoud Rahiminezhad, and Syed Ahmad, Helmi, “Assessment of hybrid Lean-Agile (Leagile) Supply Chain Strategies,” *Journal of Manufacturing Technology Management* 27, no. 4 (May 2016): 472.

<sup>168</sup> Julián Andrés Durán Peña, Ortiz Bas, and Nydia Marcela Reyes Maldonado, "Impact of Bullwhip Effect in Quality and Waste in Perishable Supply Chain." *Processes* 9, no. 7 (2021): 1.

<sup>169</sup> D. Ernawati, E. Pudji, N. Rahmawati, and M. Alfin, “Bullwhip Effect reduction using Vendor Managed Inventory (VMI) Method in Supply Chain of Manufacturing Company,” *Journal of Physics: Conference Series* 189, no. 1 (May 2021): 2

<sup>170</sup> Narayanan, Arunachalam, Alan W. Mackelprang, and Manoj K. Malhotra, “System Performance Implications of Capacity and Flexibility Constraints on Bullwhip Effect in Supply Chains,” *Decision Sciences*, (2021): 2.

diverse amplifications often exasperate demand forecast planning, leading to stockouts throughout the supply chain.<sup>171</sup> Finally, since inventory stocks may negatively impact military operations, sufficient evidence suggests that the binary approach only reinforces hoarding and the “just-in-case” inventory management culture within the military context.



**Figure 2.6: The Bullwhip Effect**

Source: Hitesh, Bhasin, “ Bullwhip Effect – Example, Causes, Analysis and Consequences,” 30 July 2020, [www.marketing91.com/bullwhip-effect/](http://www.marketing91.com/bullwhip-effect/). [Accessed on 25 April 2022].

Although the research highlighted diminutive academic merit for a two-staged supply chain (Table 2.1) model, the study validated several tools in the industry and academia to mitigate inventory management and forecasting gaps. The research proposes leveraging enterprise resource planning (ERPs) applications to support predictive analysis of impending failures with a detailed list of spare parts required to either avoid that failure from occurring (prevention) or rectify the oversight if it has already happened (correction).<sup>172</sup> Moreover, the research highlighted a central theme for “real-time data and collaboration [with supplier]” to alleviate the identified gaps.<sup>173</sup> Dovetailing analytics and a collaborative environment between the supplier and customer enable a fact-based decision-making process.

---

<sup>171</sup> *Ibid.*, 2.

<sup>172</sup> Pankaj Sharma, and Makarand S. Kulkarni, “Framework for a Dynamic and Responsive: Time separated – Lean-Agile Spare Parts Replenishment System in Army,” *International Journal of Productivity and Performance Management* 65, no. 2 (2016): 218.

<sup>173</sup> Pankaj Sharma, and Makarand S. Kulkarni, “Framework for a Dynamic and Responsive: Time separated – Lean-Agile Spare Parts Replenishment System in Army,” *International Journal of Productivity and Performance Management* 65, no. 2 (2016): 218

As demonstrated, a binary supply chain model does not add value for the CAF to undertake because of the gaps identified in a binary supply chain framework that straddles two diverse strategies. Furthermore, the impact of the bullwhip effect implicitly reinforces the current inventory management construct in mitigating stockouts. However, a refined supply chain model that blends and integrates lean and agile strategies with analytics (ERP applications) may realize operational efficiencies and minimize the bullwhip effect. A “leagile” supply chain augmented with contractors resonates with militaries because various lean and agile supply chain principles are applied to realize timely support to enable peace and wartime operations. Nevertheless, the responsiveness and elasticity of outsourcing logistics functions remain questionable as armed forces transition between peacetime to wartime operations. Regardless, outsourcing the forward movement of material in the supply chain during peacetime leads to competitive advantage and operational efficiencies for the armed forces. Therefore, the literature substantiates that outsourcing (forward) logistics functions during peace-time or domestic operations gain operational efficiencies and competitive advantages to achieve operational readiness and success.

A critical factor defining success within a military organization lies within its operational readiness to support unforeseen events or missions. Although the academic research demonstrated the efficiencies gained during peace and domestic operations, these efficiencies significantly diminish and further degrade functional sustainment capacities during wartime under hostile conditions. Moreover, the study questions the efficacy of an outsourced supply chain as the literature illuminate gaps within the armed forces’ readiness to support missions where contractors may not necessarily be inclined or comfortable to continue to provide the services due to conflict and hostile environment. As a mitigation factor, complex contract management oversight will alleviate the challenges that the RCAF experienced during their



deployment overseas into hostile environments. The RCAF and the BAF cement the significance of armed forces' operational readiness and deployability to support unforeseen events or missions; however, the current outsourced forward supply chain signifies inelasticity within the model to respond rapidly to government demand requirements.

As a result, the literature demonstrated the limitations of outsourcing the supply chain to support operations and its impact on operational readiness. Conversely, research proposes that reverse logistics may not impact armed forces' operational readiness or deployment to hostile environments since EOL equipment disposal often remains in warehouses until the conflict ends. Furthermore, the evidence supports a growing public and governmental concern regarding climate change to the environment. In addition, evidence supports an outsourced reverse logistics strategy based on a Third Party Logistics Closed-Loop Vendor Managed Inventory model to address the current inventory management dilemma while optimizing throughput and warehouse operations without impacting operational readiness. Finally, this model more accurately aligns with Canada's Defence policy and values to develop sustainable strategies and integrated defence industry clusters based on collaboration and partnership toward a sustainable economy.

## The Royal Canadian Navy Case Study

### 3.1. Introduction

The case study methodology aims to complement the “*Literature Review*” to form a fulsome context to describe the RCN’s challenges regarding inventory management and warehouse operations. In addition, the case study approach intends to ascertain the divestment process to generate a hypothesis to explain the material flow of EOL and obsolete equipment.<sup>174</sup> The basis of the case study sets the current conditions and leads to the philosophical approaches to guide the qualitative research design.

First, the author adopted a postmodern approach to emphasize an organic process to “deal with the crisis of representation” because the institution is in a perpetual flux and change brought on by uncertainty.<sup>175</sup> In this dissertation, the RCN operates within an element of uncertainty which leads to the RCN straddling between supply chain strategies and structure. For example, the current model of hoarding equipment as insurance to mitigate stockouts leads to the current inventory management challenges. From a postmodernist approach, the research challenges the current organizational concepts and theories by evolving the supply chain paradigm within the RCN.

Second, to balance the postmodernist view, the author aims to embody a pragmatist philosophy to formulate a logical recommendation in response to the research question of whether there are opportunities to outsource divestment and disposal of equipment. In this case,

---

<sup>174</sup> John Adams, Hafiz T.A. Khan, Robert Roeside, and David I. White, “Research Methods for Graduate Business and Social Science Students,” (New Delhi: SAGE Publications, 2007), 113.

<sup>175</sup> Lynn Butler-Kisber, “Qualitative Inquiry: Thematic, Narrative and Arts-Informed Perspectives,” (London: SAGE Publications, 2010), 104.

the research question examines the benefits and limitations of outsourcing and whether it includes militarized equipment. The author deems a pragmatic approach is necessary to address the research question and develop evidence to support the recommendation. The overall aim further supports a pragmatic research philosophy as the ideas presented herein will have consequences and impact future emerging practices.

The two research philosophies form a hybrid approach for the author to achieve several research objectives. First, a postmodernist perspective challenges the status quo of “just-in-case” inventory management and the divestment processes. Second, the postmodernist strategy attempts to identify process gaps and bottlenecks that currently impede material outflow. Finally, a pragmatic view evaluates the issues by addressing the current supply chain management challenges and proposing a feasible solution to assuage inefficiencies within the supply chain.

### 3.2. The Supply Administration Manual: The Policy to Enable Material Throughput

The Supply Administration Manual (SAM) sets fundamental principles regarding the policy, processes and procedures to guide DSC. Within the SAM, divestment is a process to dispose of declared surplus equipment or EOL of material.<sup>176</sup> The SAM defines EOL as beyond economical repair (BER), broken, condemned and non-repairable, consumables, and expired shelf-life material.<sup>177</sup> More specifically, the requirement for such material still exists; however, material due to maintenance and operational use has sufficiently degraded the material to be unserviceable. Therefore, following the Treasury Board (TB) Directive on Divestment of Surplus Materiel, the Department of National Defence (DND) must ensure the “divestment of surplus material is concluded as effectively as possible [...] after they become surplus [...] in a manner

---

<sup>176</sup> Department of National Defence, Supply Administration Manual, 21 December 2021: 2.34.

<sup>177</sup> Department of National Defence, Supply Administration Manual, 21 December 2021: 2.34.

that obtains the highest net value for the Crown”.<sup>178</sup> Furthermore, on behalf of DND and the CAF, the Directorate of Supply Chain Operations (DSCO) is the functional authority for all divestment of surplus material.<sup>179</sup>

### 3.3. The Pandemic and Centralized Decision Matrix Leads to a Bottleneck

Within DSCO, the Directorate of Supply Chain Operations 7 (DSCO 7) coordinates the divestment and disposal of all DND and CAF material. In addition, DSCO 7 implemented the National Inventory Disposal initiative to facilitate the divestment processes to reduce EOL and centrally managed materiel at the depots (i.e. 7 Canadian Forces Supply Depot Edmonton, 25 Canadian Forces Supply Depot Montreal) and other warehouse storage locations (Canadian Forces Bases Halifax, and Canadian Forces Esquimalt).

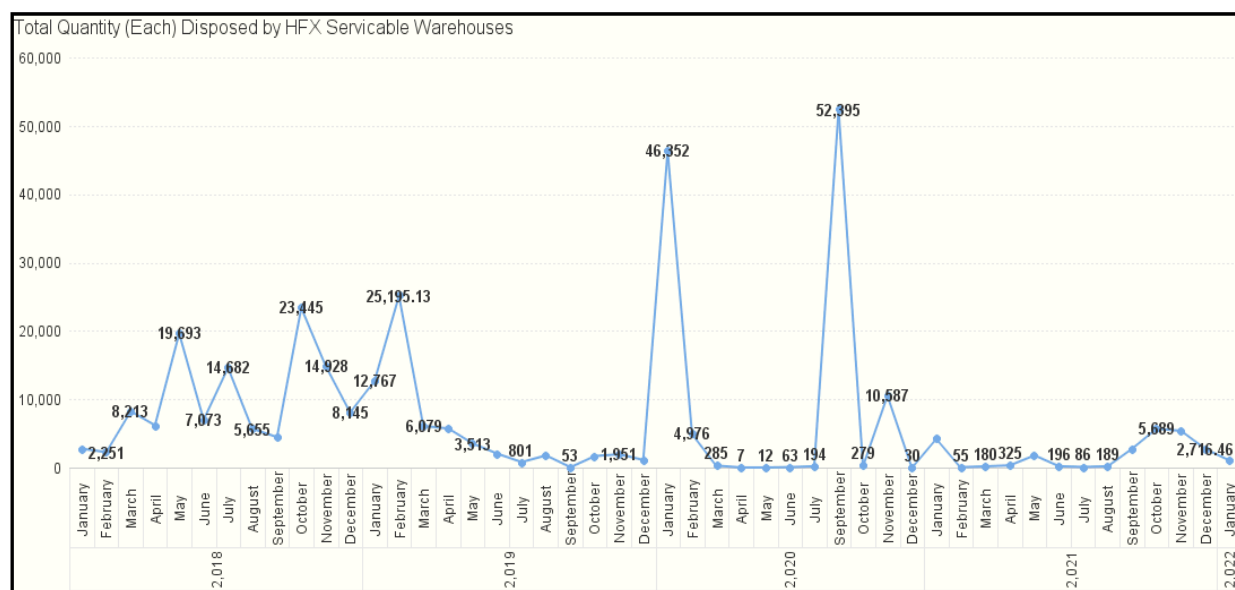
The National Inventory Disposal initiative aims to identify surplus and EOL material for bulk disposal tranches through a proactive inventory review by confirming the material status with Technical Authorities (TA). Ultimately, the initiative’s objective is to reduce “*Muda*” within the administrative processes to efficiently reduce surplus and EOL material within the depots and warehouses. As a result of this initiative, Figure 3.7 graphically illustrates the quantity of disposed of non-Controlled Technology Access Transfer (CTAT) EOL and surplus material over the past four years, from 2018 to 2022, at Canadian Forces Base (CFB) Halifax, Base Logistics. Furthermore, Figure 3.7 highlights an inconsistent trend encompassing periods of large quantities of EOL disposed of in bulk and periods of stagnancy. Nevertheless, during periods of crisis, Figure 7 exemplifies gaps within the supply chain’s responsiveness and

---

<sup>178</sup> Department of National Defence, Supply Administration Manual, 21 December 2021: Ch 8.1, 1.1.

<sup>179</sup> Department of National Defence, Supply Administration Manual, 21 December 2021: Ch 8.1, 1.1.

elasticity from 2020 to 2022 as the CAF prioritized operations to protect the force and combat the COVID-19 pandemic as mandated by the GoC.



**Figure 3.7: Canadian Forces Base Halifax - Base Logistics Quantity Disposed (2018 to 2022)**

Source: Shared with Permission from In-Charge Material Information Services Officer, CFB Halifax, BLog, 2022

The COVID-19 pandemic further disrupted an already mired divestment process due to the TA's position as a single decision point to release EOL and obsolete equipment into the disposal pipeline. The data in Figure 3.7 graphically validated the weakness of the binary centralized decision matrix model. In consultation with BLog, inconsistent output was demonstrated due to the pandemic's onset as the TAs transitioned to working from home (March to July 2020). Compared to the reporting 2018 period, the resurgence of COVID-19 variants and subsequent lockdowns in 2020 led to a significant reduction of divestment throughout BLog. Moreover, the pandemic substantiated the limitations presented in Chapter 2 regarding a centralized model to facilitate the divestment flow of surplus and EOL material. However,

surplus and EOL material categorized under CTAT will continue to benefit from a centralized model to ensure transparency and demonstrate compliance with applicable regulations.

Nevertheless, opportunities exist to leverage a de-centralized model to facilitate and optimize the disposal and divestment process of non-CTAT EOL material.

#### 3.4. Current End-of-Life Divestment Process: Limitations and Opportunities Analysis

Overall, the divestment process highlighted in Chapter 8.1 of the SAM is convoluted with approval, functions, and procedural layers. As a result, two distinct limitations exist within the DSC and divestment initiatives. First, the level of authority to declare surplus material derails the momentum and flow because of the approval bottleneck centralized at the TA level. Second, the TA's competing priorities mire warehouse operations and material disposal throughput. Concurrently, the identified limitations offer opportunities to streamline DND divestment initiatives.

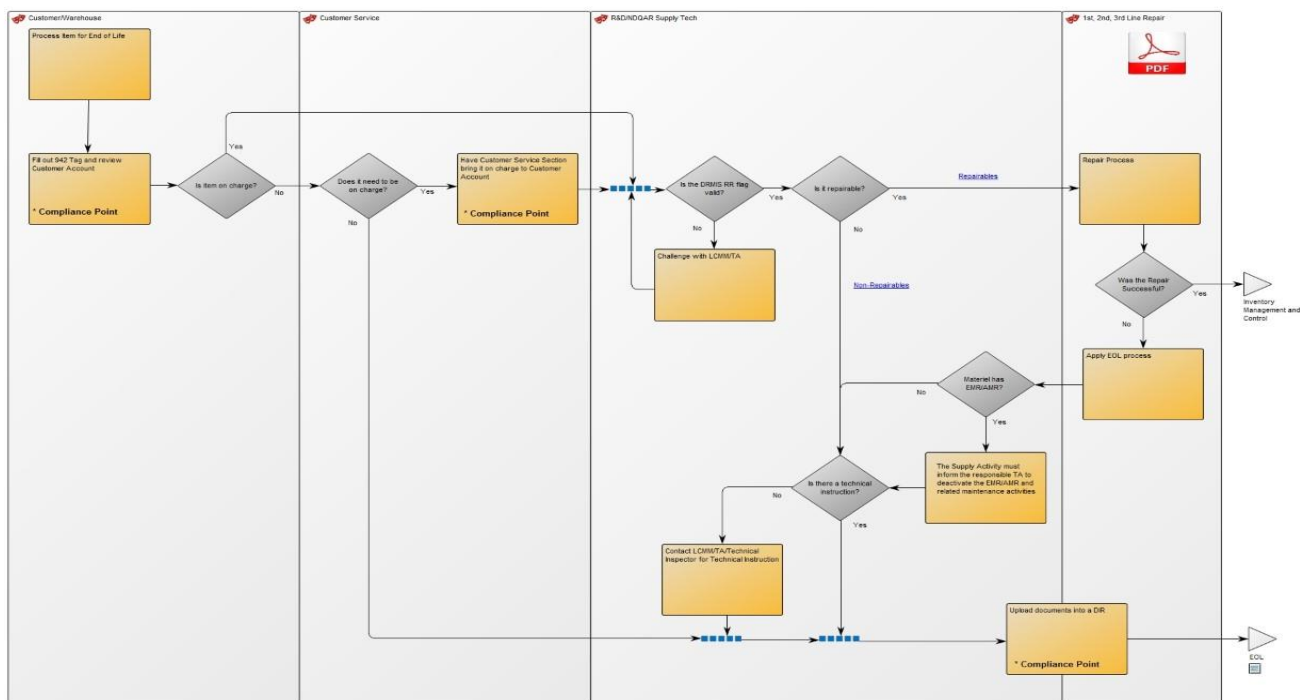
The authority levels to declare surplus material remains at the highest levels within the DND. For example, CTAT material such as centrally managed primary Major Weapon and Support Systems at any value will require the Vice Canadian Defence Staff (VCDS) authority to declare surplus as represented. Although the delegated authority for Major Weapon and Support Systems' assemblies and sub-assemblies is up to \$40M, the authority to declare surplus resides with the Level 2 Advisors.<sup>180</sup> Although achieving TB regulatory oversight and transparency of militarized equipment and systems, the consequences of the far-reaching levels of authorities to declare surplus material may explain the inventory stockpiled in warehouses and depots. In

---

<sup>180</sup> Department of National Defence, Supply Administration Manual, 21 December 2021: Ch 8.1, 2.28, Table 3.

addition, future opportunities to examine a streamlined de-centralized model for CTAT Major Weapon and Support Systems.

Alternatively, the EOL disposal process diverges from the traditional authorities regarding the surplus declaration of Major Weapon and Support Systems. Consequently, the EOL disposal process offers opportunities to examine and innovate solutions to optimize warehouse operations without impacting the supply chain throughput of material to deployed units. However, EOL's divestment process presents unique challenges regarding competing priorities with the Technical Authority's (TA) roles and responsibilities concerning material life-cycle management. As shown in Figure 3.8, the TA determines the Divestment Plan to commence the disposal process.



**Figure 3.8: Divestment of End-of-Life Flowchart<sup>181</sup>**

Source: Supply Administration Manual, Ch.8.1, 31.

<sup>181</sup> For clearer flowchart refer to Appendix A.

The TA's role is diverse and expansive because the TA is the material management group of engineers and technicians responsible for managing material throughout its life-cycle, or "cradle to grave," and ensuring material availability to support operational requirements.<sup>182</sup> In addition, the TA determines and prioritizes the material maintenance, repair and overhaul program to optimize the "four foundational principles of performance, value for money, flexibility and economic benefits."<sup>183</sup> Accordingly, the holistic role of TA leads to a limitation within the divestment and disposal process. As supported and highlighted in Figure 3.8, with the TA's centralized position to oversee the material life-cycle, the TA's responsibilities straddle between competing operational priorities that may not always align with surplus and EOL material divestment.

### 3.5. The RCN is "Ready, Aye, Ready," but a Bottleneck Limits Disposal Throughput

Consequently, Base Logistics (BLog) at CFB Halifax cannot divest and consistently dispose of their unserviceable and obsolete equipment. In addition, due to the current pandemic or global events that lead to ship deployments and competing priorities, the EOL and outdated equipment remain at the various warehouse locations spread throughout the Halifax Regional Municipality (HRM). Although BLog's footprint is within the HRM, the distances between warehouses range from 10 to 20 kilometres, with the furthestmost warehouse located at CFB Shearwater, as illustrated in Figure 3.9. Within time and space considerations for Figure 3.9, the routes between warehouses normally transit through congested urban due to single-lane roadways. Currently, Base Logistics is investigating future warehouse locations within HRM to

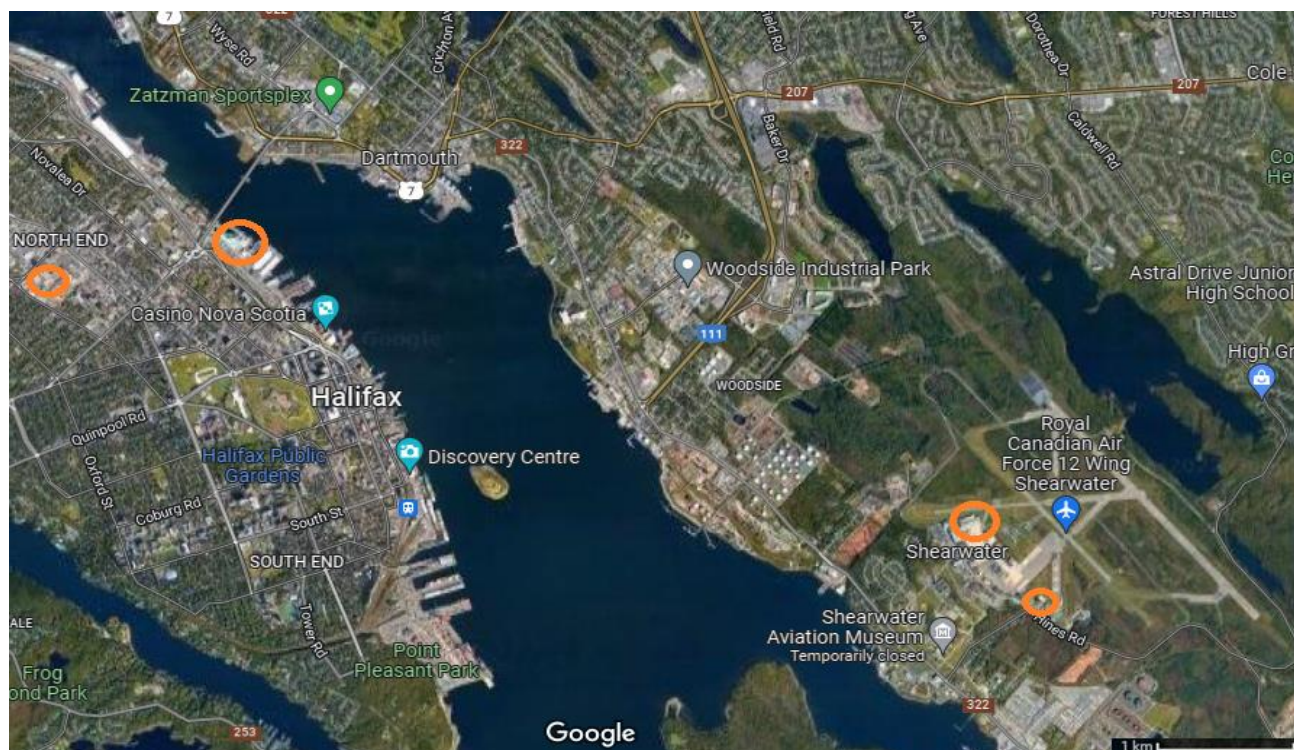
---

<sup>182</sup> Department of National Defence, Supply Administration Manual, 21 December 2021: Ch 1.3, B.3.

<sup>183</sup> Department of National Defence, Supply Administration Manual, 21 December 2021: Ch 1.3, B.4.



expand warehouse capacities in anticipation of the delivery of the Future Fleet. For example, the warehouse continues to have old and obsolete non-CTAT equipment from the paid-off ATHABASKAN Class.<sup>184</sup> Moreover, the consensus with Base Logistics Material Control Officer and their team highlights common yet opposing sentiments of frustration and enthusiasm concerning divestment of EOL and obsolete equipment.



**Figure 3.9 Base Logistics Warehouses Locations in the Halifax Regional Municipality**

Source: Author, 2022 based on Google Maps

For example, as the Future Fleet slowly integrates with the legacy fleet of HALIFAX, KINGSTON, and VICTORIA Classes, there are significant concerns that warehouses will reach their maximum capacities. As a result, the team at Base Logistics is keenly motivated, as

---

<sup>184</sup> The author's personal experience at Base Logistics as the Executive Officer (XO) in 2019. The equipment were identified for divestment with the traditional DND 942 tag attached. The parts were inputted into DRMIS; however the TA had not approved and released the EOL equipment for divestment.

stakeholders, to divest EOL and obsolete equipment and make room for future fleet sparing and repairable material. In addition, the delays will only continue to burden the RCN financially to warehouse equipment that could otherwise leverage elsewhere to augment operational readiness and deployability. However, as the case study has demonstrated, the TA remains the centralized position to release material for divestment. As a result, Base Logistics' sentiment of frustration rests on EOL, and obsolete equipment correctly identified for divestment remains "pending" in DRMIS. Lacking approval, the EOL and outdated equipment linger at the warehouse, further exasperating the inventory management challenges.

The examination of the RCN case study accentuates the desire to divest obsolete and EOL equipment. However, as demonstrated, the bottlenecks within the divestment process impede a smooth and seamless transaction. Unfortunately, the TA continues to be a primary source of this bottleneck compounded by competing for internal and external priorities. As a result, the case study proved that the backlog of identified material remaining in the warehouses continues to absorb capacities intended for the Future Fleet. Finally, the case study complements the literature research regarding limitations within a centralized model while offering opportunities for the private sector to assume the divestment role within a third-party closed-loop reverse logistics vendor-managed inventory framework.

## Findings and Results

### 4.1. Introduction

Based on the qualitative evidence derived from the reviewed academic literature and the case study, this chapter aims to present the analysis to form the theoretical framework to address the research question empirically by aligning an outsourced reverse logistics model to the values shown in SSE. Moreover, this chapter asserts a re-assessment of the notion of “supply chain” provided with evidence in the academic literature to assert a sustainable closed-loop supply cycle terminology to more accurately describe the circular flow of material within this model. In addition, the fourth chapter objectively describes the risks of outsourcing reverse supply chain functions of the DSC within an expeditionary deployment overseas. Furthermore, the evidence revealed efficiencies and optimized operational competitiveness by outsourcing reverse logistics while remaining lean and agile in response to uncertainty and mission sets at home and abroad.

Consequently, the straddling strategies are contradictory for the CAF to minimize costs (lean supply chain characteristics) during periods of peace while maximizing agility to surge for deployments. The CAF traditionally operates an overstocked warehouse of repairable and EOL equipment to maintain operational readiness to mitigate inventory stockouts. However, as specified in the Independent Auditor General’s Report, the consequences of overstocking are process inefficiencies and financial waste due to the lack of material accountability and visibility of the inventory held in the warehouses. Additionally, the “just-in-case” inventory management model leads the dissertation problem statement to examine outsourcing opportunities to leverage within the reverse logistics functional domain to realize warehouse operations and inventory management efficiencies. Under the threshold of war, the hypothesis proposes opportunities and

benefits to outsourcing a third-party, closed-loop reverse supply chain that incorporates a vendor-managed inventory model to alleviate the inventory management challenges.

As a precursor to the following chapter, reverse logistics theories and models derived from a growing concern for sustainable practices to mitigate against the effects of climate change. As a result, the identified supply chain principles formed linkages to define the rearward movement of material. In the analysis of the findings, considerations regarding risks to outsourcing and its impact on the CAF operations. These linkages established the basic principles to describe reverse supply chain strategies, including a qualitative examination of 3PL, closed-loop supply chains, and VMI models within the boundaries below the threshold of war.

The research evaluated the presented supply chain characteristics and design derived from industry best practices in establishing the foundation. As a result, the theoretical framework revealed gaps within the CAF's centralized divestment and disposal processes concerning EOL equipment. Furthermore, the chapter highlighted the benefits and limitations of outsourcing the reserve logistics process to reduce the EOL inventory through a VMI model based on 3PL. Finally, through the findings, an assessment of the reverse supply chain model and characteristics regarding the highlighted values in the SSE for a sustainable, environmentally conscious whole-of-nation solution.

#### 4.2. Alignment of Outsourcing Supply Chain Functions to “Strong, Security, Engaged”

Throughout Canada's Defence Policy publication, there was a significant emphasis on the effects of climate change and its impact on “the lives and livelihoods of millions worldwide.”<sup>185</sup> Moreover, SSE quantified that the combination of climate change and advancement in

---

<sup>185</sup> Department of National Defence, “Strong, Secure, Engaged: Canada's Defence Policy,” 2017: 49.

technology would lead to greater commercial interest from state and non-state actors in the Northwest Passage and the Arctic.<sup>186</sup> The increased commercial interests will undoubtedly require high CAF readiness and capabilities to respond to safety and security demands in the Arctic region. However, the publication recognized and challenged a whole-of-nation approach to collaboratively contribute innovative solutions to evolving the institution towards “Greening [the] Defence” to achieve the low-carbon government targets outlined in the Federal Sustainable Development Strategy.<sup>187</sup> More importantly, the envisioned objectives for “Greening [the] Defence” revealed a refreshing evolution of Canadian opinion, as active participants, towards addressing climate change in their personal and professional lives.

Furthermore, SSE directed an active and contributing role for DND, as one of its priorities, to address the low-carbon targets. Since DND is Canada’s largest employer that encompasses the CAF, there are significant opportunities to evolve the DSC towards a sustainable supply chain that integrates principles to reduce, recycle, and reuse because the research revealed inventory management and warehouse inefficiencies. For example, as a result of the inefficient inventory management strategy, the Independent Auditor General reported that the “poor supply chain management prevented [the CAF] from supplying with material [...] with one-third of some 1 million [demand] requests being rerouted”.<sup>188</sup> The repeated observations of an inefficient supply chain directly aligned with carbon emission studies regarding last-mile and rerouted deliveries.<sup>189</sup> These highlighted sustainable principles promote the relevance that

---

<sup>186</sup> Department of National Defence, “Strong, Secure, Engaged: Canada’s Defence Policy,” 2017: 51.

<sup>187</sup> Department of National Defence, “Strong, Secure, Engaged: Canada’s Defence Policy,” 2017: 112.

<sup>188</sup> Office of the Auditor General, “Spring 2020 Reports of the Auditor General to the Parliament of Canada-Independent Auditor’s Report -Report 3: Supplying the Canadian Armed Forces – National Defence”, (Ottawa: DND, 2020), 3.

<sup>189</sup> Jiang Li, Hongxia Change, Suping Zhao, Junfeng Dong, and Wenxing Lu, “A Travelling Salesman Problem with Carbon Emission Reduction in the Last-Mile Delivery,” *IEEE Access* 7, (2019): 61620.

reverse logistics functions, such as refurbishing, recycling, disposal, and salvage, create added value to the institution as a basis for competitive advantage.

Canada's Defence Policy publications presented a second underlining theme of sustaining value by enduring a competitive environment that encourages innovation "to develop solutions to emerging problems."<sup>190</sup> Similarly, the competitive concepts introduced mirrored the supply chain principles as a value chain that fosters value to overmatch market rivals.<sup>191</sup> SSE highlighted the means to internally cultivate innovation within the Canadian defence industry by clustering and integrating the private sector and academics "to simulate collaborat[itive]" research and development synergies for future defence requirements to synergize and sustain competitiveness.<sup>192</sup> The GoC's whole-of-nation partnered aspiration for a collaborative culture to combat climate change is empirically aligned to Womack's and Jones' fundamentals of lean thinking from a manufacturing perspective based on five lean principles: value, value stream, flow, pull, and perfection.<sup>193</sup> Likewise, the lean principles implicitly underlined a collaborative nature to collectively innovate and seek continuous improvement initiatives to eliminate waste and streamline processes to realize the optimized value for Canadians.

Regarding the research question of outsourcing supply chain functions, particularly reverse logistics, the evidence proved a cumulative secondary and tertiary order of effects and value to leveraging emerging technologies and expertise of private industries. Furthermore, outsourcing certain logistical functions enabled organizations to focus on their core

---

<sup>190</sup> Office of the Auditor General, "Spring 2020 Reports of the Auditor General to the Parliament of Canada-Independent Auditor's Report -Report 3: Supplying the Canadian Armed Forces – National Defence", (Ottawa: DND, 2020), 16.

<sup>191</sup> Michael Schrage, Washington Post, Staff Writer, "Sustaining Competitive Advantage," *The Washington Post* (1974-), 23 December 1984.

<sup>192</sup> Department of National Defence, "Strong, Secure, Engaged: Canada's Defence Policy," 2017: 78.

<sup>193</sup> James P. Womack, and Daniel T. Jones, "Lean Thinking," (New York: Sumon & Schuster, 1996), 15.

competencies to evolve niche competitive advantage in the marketplace. In Toyota's case, the collaboration skill-sets facilitated eliminating "*Muda*" to add value to the customer experience and sustain Toyota's competitive advantage in the automobile market.<sup>194</sup>

In addition, as highlighted in the RCN case study, the evidence demonstrated that TAs are inundated with competing priorities. As a result, the divestment process and disposal of material remain backlogged in warehouses across Canada. Disposal and divestment are not core competencies that add value to Canadian and CAF. However, there are private industries that specialize in reverse logistics and divestment. The research highlighted that multinational corporations, such as Levi's, are outsourcing segments of their supply chain functions to enable a concentrated effort to sustain their core competencies and competitive advantage in the global markets. Furthermore, the collaborative nature of outsourcing reverse logistics naturally led to other partnering opportunities to further enrich the relationship hinged on developing an integrated data exchange or blockchain technology to improve the organization's material accountability and warehouse operations continuously.

Outsourcing the CAF's reverse logistics touches all aspects of Canada's supply chain as Canada moves goods and materials from warehouses to customers. Therefore, evidence supports the hypothesis that an outsourced reverse logistics model expands the third SSE theme of "Whole of Government" to entail a "Whole of Canada" approach. An outsourced reverse logistics model envelopes Canadian 3PL companies and their supply chain networks to enrich the development of an integrated resilient, and agile Canadian DSC while addressing the environmental concerns documented in the SSE. Additionally, The "Whole of Canada"

---

<sup>194</sup> Andrea Chiarini, Claudio Baccarani, and Vittorio Mascherpa, "Lean Production, Toyota Production System and Kaizen Philosophy: A Conceptual Analysis from the Perspective of Zen Buddhism," *Total Quality Management Journal* 30, no. 4 (2018): 428.

approach synergizes other government departments towards a synchronized and coordinated methodology to collaboratively “deliver on the defence mandate [and] to support services to enable the military to succeed directly.”<sup>195</sup> Finally, establishing close cooperation with industry will ensure the CAF remains operationally competitive on the global stage with advanced technologies while concurrently “keep[ing] Canada’s economy vibrant, [competitive], and innovative.”<sup>196</sup>

Based on the analysis, there is a direct correlation between the SSE values to promote outsourcing reverse logistics to augment the DSC and facilitate the divestment and disposal process. As demonstrated, there are private industries to support the divestment process. As with Levi’s example, industry expertise regarding disposal and divestment alleviates the inventory management and warehouse operations inefficiencies while enabling the corporation to regimentally concentrate resources to sustain and evolve its core competencies and competitive advantage. Furthermore, outsourcing logistical functions enrich the relationship in which both companies become invested stakeholders because of the symbiotic partnership. Finally, the enrooted partnership achieves the intent of the GoC to develop a profound and integrated defence industry as it takes the next bound to “greening the defence industry.”

As a final summation of analyzing and aligning values, Figure 3.9 summarizes the findings regarding the alignment of outsourcing reverse logistics to the themes and values presented in SSE. As illustrated in Figure 4.10, the blue downward arrows represent the highlighted SSE key themes. At the same time, the reverse logistics value proposition for an outsource reverse logistics model corresponds with the SSE categorized values. Based on the

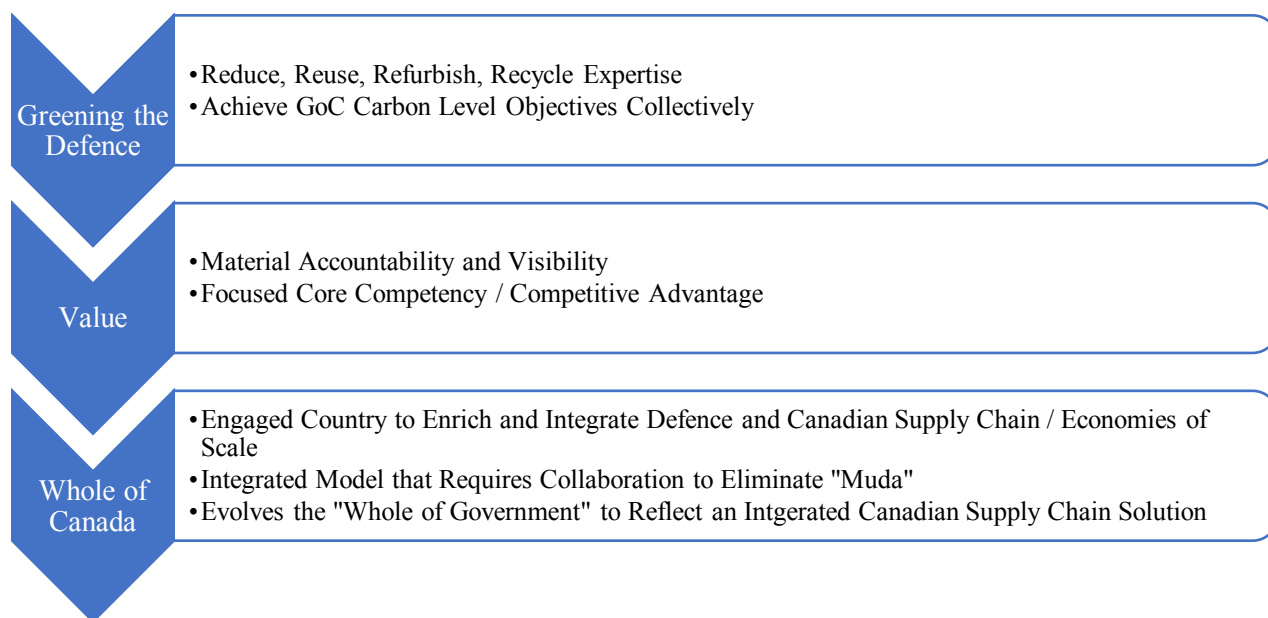
---

<sup>195</sup> Department of National Defence, “Strong, Secure, Engaged: Canada’s Defence Policy,” 2017: 74.

<sup>196</sup> *Ibid.*, 74.



analysis, there is a direct correlation between the SSE values to promote outsourcing reverse logistics to augment the DSC and facilitate the divestment and disposal process. Industry expertise exists regarding disposal and divestment that alleviates the inventory management and warehouse operations inefficiencies currently experienced in the CAF, albeit without risk.



**Figure 4.10: Outsource Reverse Logistics Aligned to "Strong, Secure, Engaged" Values**

Source: Author, 2022.

#### 4.3. Risks Assessment of Outsourcing Supply Chain Functions

Risk and risk mitigation remain the primary reasons for the CAF's current inventory management and warehouse operational inefficiencies. However, there are inherent risks associated with outsourcing services. In particular, research demonstrated that armed forces are increasingly dependent on contractors to augment service and support functions during non-hostile operations.<sup>197</sup> Consequently, there is a growing apprehension regarding the loss of

<sup>197</sup> Nikolay Stefanov, "Analysis of the Use of Outsourcing Services for Maintenance and Repair of the Equipment and Armament Available in the Structures of the Bulgarian Armed Forces," *International Conference Knowledge-Based Organization* 23, no. 1 (2017): 471.

standard skillsets due to contractors' absence to sustain a prolonged conflict, as witnessed in Russia's invasion of Ukraine. Nevertheless, the recent events extend the armed forces' core competency definition to include logistics and supply chain functions due to the significant role in sustaining combat operations. Furthermore, the analysis considers the risks of dependency, the operational environmental constraints on contractors, and their impact on the CAF.

The CAF's primary mission is to "detect, deter, and defend against threats to or attacks on Canada."<sup>198</sup> Given the primary mission, the CAF must be ready to be responsive to deploy to support the GoC's mandate rapidly. This statement reaffirmed the position that the armed forces' line of effort rests on developing and refining their core competencies in areas such as warfighting and peace support operations. Thus, based on the definition of core competencies and competitive advantage, there is merit in categorizing the notion that service support and supply chain functions are not part of the core competency of the armed forces.<sup>199</sup>

However, while there has been significant research on defining core competency and the concept of competitive advantage, few researchers have deliberated that logistical and supply chain functions are crucial components to warfighting and the application of kinetic force. The recent events during the pandemic and the conflict in Ukraine highlight the importance of mastering logistics and supply chain functions as an assurance of having the right resources to sustain operations. The CAF, unlike the United States military, does not have the financial and human resources to ensure the full spectrum of logistics to support deployments overseas self-sufficiently. As a result of finite resources, the CAF must prioritize demand requirements to the operational needs. Similar to the BAF, the prioritization analysis substantiated outsourcing

---

<sup>198</sup> Department of National Defence, "Strong, Secure, Engaged: Canada's Defence Policy," 2017: 17.

<sup>199</sup> Christopher Kinsey, "Transforming war supply: Considerations and rationales behind contractor support to UK overseas military operations in the twenty-first century," *International Journal (Toronto)* 69, no. 4 (2014): 507.

logistics and supply chain functions to leverage contractor expertise and add value to “the various sectors of the economy and military.”<sup>200</sup> Additionally, academia demonstrated concurrence for contractors to manage the logistical and support functions of the supply chain.<sup>201</sup>

More importantly, contracted services within the armed forces are a standard option as a growth sector to sustain base operations and real-life support because of the gained efficiencies and added value to the organization.<sup>202</sup> Furthermore, Kinsley concluded that as a common practice, contractors provided a broad spectrum of logistical services, such as food, waste management, and maintenance, to enable the fight. As a result, Kinsley<sup>203</sup> and Stefanov<sup>204</sup> concluded that outsourcing service and support functions led to optimized processes and efficiencies while reducing operational costs. Moreover, studies highlighted leveraging an outsourced model to support service and support gaps due to force reductions as a short-term solution “to shortfalls in a [operational] capacity where uniformed [personnel] is limited” to “release military resources [...] toward warfighting and security functions [overseas].”<sup>205</sup> In addition, the evidence supported the theme of core competencies within the armed forces construct and for contractors to assume logistics and supply chain functions, a growing trend as an expeditionary deployment. As a result, contractors enable armed forces towards a

---

<sup>200</sup> Sevdalina Dimitrova, Nicolay Nichev, and Nikolay Stefanov, “Development of Outsourcing Services,” *International Conference Knowledge-Based Organization* 21, no.1 (2015): 196.

<sup>201</sup> Nikolay Stefanov, “Analysis of the Use of Outsourcing Services for Maintenance and Repair of the Equipment and Armament Available in the Structures of the Bulgarian Armed Forces,” *International Conference Knowledge-Based Organization* 23, no. 1 (2017): 467.

<sup>202</sup> Sevdalina Dimitrova, Nicolay Nichev, and Nikolay Stefanov, “Development of Outsourcing Services,” *International Conference Knowledge-Based Organization* 21, no.1 (2015): 196.

<sup>203</sup> Nikolay Stefanov, “Analysis of the Use of Outsourcing Services for Maintenance and Repair of the Equipment and Armament Available in the Structures of the Bulgarian Armed Forces,” *International Conference Knowledge-Based Organization* 23, no. 1 (2017): 495.

<sup>204</sup> *Ibid.*, 468.

<sup>205</sup> Christopher, Kinsey, “Transforming war supply: Considerations and rationales behind contractor support to UK overseas military operations in the twenty-first century,” *International Journal (Toronto)* 69, no. 4 (2014): 500.

concentrated effort on mission tasks that sailors, soldiers, and air personnel need to do on the frontlines to support their core mission.

However, the study countered the theme that the armed forces' sole core competency is related to warfighting and operations. The current invasion of Ukraine highlighted the significance of logistical core competencies and the implications of the lack of service and support to enable operations in the region.<sup>206</sup> Academically, the research underlined a holistic review that logistics serve a rightful place in the armed forces.<sup>207</sup> Furthermore, the research and current events in Ukraine further cement that the armed forces' core competency extends beyond warfighting which includes logistical functions. Therefore, the risks associated with outsourcing logistical functions have a tangible impact during a hostile conflict because armed forces lead to greater dependency and erosion of corporate knowledge and skills.<sup>208</sup> Stevnov illustrated the BAF's dependence on contractor support regarding maintenance and the BAF personnel's impact on performing vehicle maintenance.<sup>209</sup> Consequently, the profound dependency on contractors further enroots armed forces to continually improve and seek efficiencies in outsourcing logistical functions for "better quality services at lower costs."<sup>210</sup>

In addition, the erosion of corporate logistical knowledge posed a significant risk to the delivery operational effects during wartime conditions or when contractors were unwilling to assume the risks by operating in the region. Moreover, this research demonstrated CAF's

---

<sup>206</sup> Nicholson, Kate, "Is Putin Losing in Ukraine? UK Officials Point Out Why Russia's Invasion is Faltering," *HuffPost UK*, 18 March 2022. <https://ca.news.yahoo.com/putin-losing-ukraine-uk-officials-124029928.html>. [Accessed on 11 April 2022].

<sup>207</sup> Nikolay, Stefanov, "Analysis of the Use of Outsourcing Services for Maintenance and Repair of the Equipment and Armament Available in the Structures of the Bulgarian Armed Forces," *International Conference Knowledge-Based Organization* 23, no. 1 (2017): 468.

<sup>208</sup> *Ibid.*, 469.

<sup>209</sup> *Ibid.*, 470.

<sup>210</sup> *Ibid.*, 471.

contractor dependency, which led to challenges for contractor support during wartime or perceived high threat situations.<sup>211</sup> However, historically CAF deployments, in concert with partners and allies, have been expeditionary and below the threshold of war. Factually, in terms of expeditionary forces, the GoC contributes the CAF to a strategic location as a foothold far removed from where the actual operations occur and often co-located within an allied base to leverage facilities and services.<sup>212</sup> Therefore, the assessment based on the GoC's mantra to partner and collaborate with allies minimized the risk of losing significant logistical capability and capacity during domestic operations and expeditionary deployments overseas.<sup>213</sup>

---

<sup>211</sup> K.E. Dubreuil, "Agile and Responsive? Is the Royal Canadian Air Force Contracting Out Its Agility and Responsiveness Through Outsourcing Supply Chain Management?" (Joint Command and Staff Programme Directed Research Paper, Canadian Forces College, 2018), 14.

<sup>212</sup> Department of National Defence, "Current Operations and Joint Military Lists." <https://www.canada.ca/en/department-national-defence/services/operations/military-operations/current-operations/list.html> [Accessed on 20 April 2022].

<sup>213</sup> K.E. Dubreuil, "Agile and Responsive? Is the Royal Canadian Air Force Contracting Out Its Agility and Responsiveness Through Outsourcing Supply Chain Management?" (Joint Command and Staff Programme Directed Research Paper, Canadian Forces College, 2018), 14.

## Discussion

### 5.1. Introduction

The chapter aims to address the existing “just-in-case” inventory management model due to the bullwhip effect through a pragmatic research approach to determine whether existing industry best practices through outsourcing reverse logistics functions of the DSC would add value and optimize the divestment processes. Furthermore, the Discussion chapter endeavours to qualitatively highlight the benefits of outsourcing reverse logistics functions of the supply chain to gain competitiveness and improve warehouse operations efficiencies. As highlighted in the Auditor’s Report (Spring 2020), inefficient inventory management processes exasperated the climate change problem. As a result of this finding, the long-term implications of climate change that underline fundamental thematic SSE concerns as a “security challenge that knows no borders.”<sup>214</sup>

Furthermore, with growing public concerns regarding climate change at the federal and provincial levels of government, this chapter implores significant attention to transforming the DSC towards an integrated sustainable closed-loop supply cycle to complement GoC’s priority of “greening [the] defence [supply chain].”<sup>215</sup> The Kaizen philosophy of incremental continuous improvement and contribution to eliminating “*Muda*” within the DSC leads to a circular and sustainable economy mindset. The SSE leverages an inclusive community to contribute willingly to addressing climate change through a continuous improvement perspective to achieve sustainable economies. In addition, the recommended outsourced model offered feasible

---

<sup>214</sup> Department of National Defence, “Strong, Secure, Engaged: Canada’s Defence Policy,” 2017: 52.

<sup>215</sup> *Ibid.*, 75.

solutions to alleviate the inventory management inefficiencies and “*Muda*” challenges within the DSC.

Finally, the study empirically demonstrated that an outsourced sustainable supply cycle offered a means to combat climate change by leveraging industry expertise and core competencies in repair, reuse, recycling, refurbishing, and remanufacturing processes. Moreover, given the finite resources within the CAF, an outsourced model enables the CAF to focus on refining its operational readiness to achieve its core missions highlighted in the SSE.<sup>216</sup> Furthermore, concerning the research question and objectives, the study results indicate merit in a Third-Party Reverse Logistics Closed-Loop Vendor-Managed Inventory framework to support the CAF’s divestment and disposal of non-CTAT EOL material under conditions categorized below the threshold of war.

## 5.2. Benefits and Limitations to Outsourcing Below the Threshold of War

The research results led to ponder whether armed forces should insource or outsource segments of the logistical functions. In line with the hypothesis, the findings led to conclusions to promote service support functions as core activities and refute the generalization that an armed forces’ core competency is solely on operations that “entail the taking of life as a regular part of the job.”<sup>217</sup> Moreover, as the research revealed, outsourcing developed a symbiotic relationship that led to inter-dependency that mutually benefits both parties. Although the data points demonstrated a growing trend for armed forces to outsource, the findings indicated that outsourcing led to financial savings and operational efficiencies in an expeditionary context. In a

---

<sup>216</sup> Department of National Defence, “Strong, Secure, Engaged: Canada’s Defence Policy,” 2017: 17.

<sup>217</sup> Christopher Kinsey, “Transforming war supply: Considerations and rationales behind contractor support to UK overseas military operations in the twenty-first century,” *International Journal (Toronto)* 69, no. 4 (2014): 507.

collaborative environment among allied and partnered countries, sufficient evidence showcased a correlation between armed forces and contractors' co-existence providing services to sustain military operations and the longevity of the contractor's business.

As the research illustrated, the dependency led to an erosion of core competencies within the armed forces to self-sustain operations logistically when contractors deem an existing hostile environment, as demonstrated in the presented RCAF and BAF examples. However, outsourcing merited benefits that outweigh the limitations highlighted in the case study and examples regarding the RCAF and BAF because of the expeditionary nature of the CAF's recent deployments on Operations APOLLO, IMPACT, and REASSURANCE. Hence, contractors are co-located on bases within a coalition and far removed from the combat environment endured by armed forces conducting kinetic effects on the ground. Furthermore, as demonstrated in the CAF's case, operations<sup>218</sup> are traditionally and primarily expeditionary or domestic, minimizing the risk of contractor absence in theatre.

Recent global events and the results of this study provided new insight into examining the core competency definition within the armed forces context to include logistics and supply chain functions. Evidence demonstrated and supported logistical tasks as a core competency to enable sustained military operations.<sup>219</sup> Like reverse logistics, planning at the operational level must integrate a concept of support and sustainment considerations at the tactical level. Furthermore, the academic literature highlighted that logistics and supply chain management create value in

---

<sup>218</sup> Department of National Defence, "Current Operations and Joint Military Exercise List," <https://www.canada.ca/en/department-national-defence/services/operations/military-operations/current-operations/list.html>. [Accessed on 22 April 2022].

<sup>219</sup> Kate Nicolson, "Is Putin Losing in Ukraine? UK Officials Point Out Why Russia's Invasion is Faltering," *HuffPost UK*, 18 March 2022. <https://ca.news.yahoo.com/putin-losing-ukraine-uk-officials-124029928.html>. Accessed on 11 April 2022.



the armed forces to synergize competitive advantages abroad and at home under the threshold of the war continuum.<sup>220</sup>

### 5.3. Evolving the Business towards a Sustainable Closed-Loop Supply Cycle

This chapter concluded with the findings and results to support an outsourced reverse logistics model to gain efficiencies and competitive advantage. First, as a value proposition, concrete evidence demonstrated an outsourced supply chain model with industry as a direct alignment link to the values documented in SSE. Additionally, academic literature highlighted fundamental Kaizen values that mirror the SSE to leverage an inclusive community contributing to continuous improvement concerning logistical processes or addressing climate change. Moreover, the findings showed that a sustainable closed-loop supply chain is closely dependent on the collaborative approach to minimize the bullwhip effect while optimizing the circular material flow between forward and reverse logistics. Therefore, within the findings, the CAF is at a crossroads to evolve the business from a linear process toward a notion that highlights a sustainable circular economy as a Defence Supply Cycle.

As a result, a sustainable closed-loop supply cycle that intimately incorporates reverse logistics principles presents the first milestone of achieving the GoC's whole-of-government approach to addressing climate change. Furthermore, the findings evolved the whole-of-government system toward a holistic whole-of-nation problem statement for all Canadians to directly or indirectly contribute to combating climate change. Moreover, the correlation between

---

<sup>220</sup> Nikolay Stefanov, "Analysis of the Use of Outsourcing Services for Maintenance and Repair of the Equipment and Armament Available in the Structures of the Bulgarian Armed Forces," *International Conference Knowledge-Based Organization* 23, no. 1 (2017): 468.

the SSE values promoted outsourcing reverse logistics opportunities to leverage industry expertise to realize efficiencies in streamlining the divestment and disposal process.

Based on the qualitative evidence derived from the reviewed academic literature and the case study, this chapter analytically presented the theoretical framework to address the research question empirically by aligning an outsourced reverse logistics model to the values shown in SSE. Second, the fourth chapter objectively described the risks of outsourcing supply chain functions of the DSC based on the understanding that the majority of CAF's expeditionary deployments occur overseas under a collaborative alliance endeavour. Furthermore, the evidence underlined process efficiencies gained by outsourcing that optimized CAF's competitiveness while leveraging core competencies to respond to uncertainty and mission sets at home and abroad.

#### 5.4. Recommendation to Outsource Reverse Logistics

The dissertation illustrated a conceptualized theoretical framework within the expeditionary construct that demonstrated the merits of outsourcing reverse logistics to heighten CAF's operational readiness and competitiveness. However, the current DSC structure and its entrenched procedural paradigms add multifaceted barriers to fully adopting and implementing the ideas presented today. Conversely, further research is required to understand the complexity of change management and the financial costs of developing an integrated information system. In addition, future research needs to examine the relationship between a non-permissive operational environment and its impact on outsourcing logistical functions. Subsequent studies and research should consider the implications and effectiveness of contractors providing logistical functions and services in a what are the risks during periods of war. In addition, the final consideration examines the impact of contractor absence and how armed forces will surge to fill these gaps.

Nonetheless, the dissertation qualitatively addressed the theoretical evidence to support a Third-Party Reverse Logistics Closed-Loop Vendor Managed Inventory model by highlighting advantages and aligning the model to support the SSE values and pillars. In addition, the theory demonstrated the economic benefits of leveraging private industries, particularly during peacetime and low-intensity conflict operations, to enable the CAF to focus on evolving and refining core competencies. Furthermore, the dissertation demonstrated theoretical merit for an outsourced reverse logistics model to enrich the CAF's disposal and divest non-CTAT EOL material throughput.

Nevertheless, future research is required to establish whether contractors could provide similar benefits as highlighted in this study and the implications for militaries to surge to fill the gaps in the absence of contractors. Furthermore, since the results offer only qualitative evidence, it proved to be a limiting factor to achieving a fulsome analysis of the time and financial implications of implementing the Third Party Logistics Closed-Loop Vendor Managed Inventory model within the Department of National Defence. Therefore the recommendation is qualitatively based on the academic study conducted to support a theoretical framework to initialize the possibility of realizing an implemented and integrated outsourced model with industry in practical terms.

#### 5.5. Limitations of the Study and Future Research Considerations

Beyond the scope of this study, there are future research opportunities to enrich the academic environment regarding the feasibility of outsourcing logistics functions in a high-intensity conflict with a near-peer adversary. Moreover, given the vastness of the study dovetailing the complexity of governmental processes, future research considerations must include an examination of culture change to adopt Kaizen philosophical methodologies, and the

implementation and integration process of a Third-Party Reverse Logistics Closed-Closed Loop Vendor Managed Inventory model. Furthermore, a quantitative study will be necessary to validate and determine the financial costs of implementing an outsourced model and IDE solution.

Although the literature revealed abundant resources and information on the benefits and advantages of supporting outsourcing supply chain functions, the literature demonstrated little evidence and data examining the financial value proposition for governmental organizations to undertake a long-term 3PL Reversed Logistics Vendor Managed Inventory contract.

Additionally, due to the nature of the qualitative approach, there are research limitations within the scope and time to interview subject matter experts regarding the integration data exchange process and design to encompass industry within the DSC. This dissertation highlights that the design and development will undoubtedly require significant financial and time to develop a functional IDE solution.<sup>221</sup> Nevertheless, the academic research established the theoretical framework suggesting that greater collaboration and partnership between private and public industries foster a whole country approach to optimizing economies of effort and innovative synergies.

However, the challenge for the GoC and the contractor is to nurture and mature processes without adding additional layers of bureaucracy to stifle contractor incentives and performance. As a result, specific considerations arise dealing with complex contract management and handover points for EOL material between DND. For example, at which point within the process does the ownership become the contractor's responsibility, and what are the industry's best

---

<sup>221</sup> Author's personal experience during the AJISS discussion with Thales to develop an EDE solution to support Contractor Owned Material in 2017.

practices to incentivize contractor performance? More importantly, as part of implementing the model, the relationship between the contractor and the government offers unique opportunities for further research regarding collaboration and conflict resolution. Furthermore, in the final determination to adopt an outsourced model, future research could include examining the baseline costs for governmental ownership to determine financial efficiencies gained from a Third-Party Reverse Logistics Closed-Loop Vendor Managed Inventory model.

In closing, the recent events with Russia's invasion of Ukraine reiterate the RCAF's concerns with contractor hesitancy to assume unlimited liability and the risks of operating in a hostile environment. Contractor hesitancy leads to question the impact on the armed forces, who have significantly depended on contracted services, to surge to bridge the logistical skillsets void. The second question guides further research to ascertain opportunities to investigate whether outsourcing sustainment functions will continue to benefit the CAF in a total war scenario with a near-peer adversary. Finally, this scenario questions the government's financial threshold regarding incentivizing contractors and managing complex contracts to optimize outsourced logistics during a conflict with near-peer adversaries. Moreover, the current situation affirms "sets of fresh eyes" to determine the feasibility of outsourcing supply chain functions in a hostile environment and how countries can surge capacity and capability to fill the void without contractors.

## Conclusion

### 6.1. Concluding Remarks

This dissertation endeavoured to ascertain and identify emerging outsourcing opportunities to improve the CAF's inventory management and warehouse operations. Additionally, the dissertation observed the most critical theories or models concerning supply chain characteristics to determine reverse supply chain strategies. The observations hypothesized that an outsourced reverse logistics framework would realize operational efficiencies and optimize competitiveness. Furthermore, the dissertation postulated that an outsourced reverse logistics strategy complemented the SSE's values and contributed to GoC's priorities for a "whole-of-nation" approach to include industry collaboration toward implementing an innovative and sustainable DSC.

A qualitative research approach extensively leveraged the existing academic literature to realize empirical evidence to support an outsourced Third-Party Reverse Logistics Closed-Looped Vendor Managed Inventory model to augment the DSC. In addition, the author considered current events to expand the research to determine the practicality of outsourcing supply chain functions and its responsiveness to crises. The combination of primary and secondary documents guided the qualitative research to academically enrich the supply chain management domain and form a theoretical framework.

Academically, the evidence reinforced an outsourced reverse logistics strategy based on a Third-Party Reverse Logistics Closed-Loop Vendor Managed Inventory model to address the current inventory management dilemma while optimizing throughput and warehouse operations without impacting operational readiness. In addition, the literature highlighted mathematical

evidence to promote the financial benefits through a partnered 3PL VMI strategy. Likewise, the model most accurately aligns with the SSE by developing sustainable strategies and integrating defence industry clusters. Furthermore, the integration highlights the importance of collaboration and partnership, which are vital principles for an operationalized Third-Party Reverse Logistics Closed-Loop Vendor Managed Inventory model. Moreover, throughout the study, a central theme propagated between the academic literature and the SSE to underline the values of Kaizen philosophy based on leveraging collaborative effort to realize incremental change.

Also, based on Kaizen's philosophy on continuous improvement, the dissertation asserted a novel terminology to describe green supply chains as a sustainable closed-loop supply cycle. As a result, a sustainable closed-loop supply cycle that intimately incorporates reverse logistics principles leads to prospects of achieving the GoC's whole-of-government approach to addressing climate change. Therefore the dissertation suggested that the problem statement is genuinely a whole-of-nation, vice whole-of-government, contribution to combating climate change.

The second contribution to the study of supply chain management refuted the academic literature hypothesis that a centralized decision point and a binary supply chain model would enable militaries to sustain peace and heightened emergencies seamlessly. Instead, evidence and the recent pandemic demonstrated the importance of incorporating lean and agile principles in supply chains. The current pandemic also shows the weakness in the argument for a binary supply chain model based on a centralized decision point. Furthermore, Russia's invasion of Ukraine garnered significant interest that underlined the limitations of outsourcing the supply chain to sustain operations and its implications for operational readiness. However, the dissertation argued that outsourcing reverse logistics would have minimal impact on armed

forces' operational readiness or deployment to hostile environments, but contracting forward logistics and supply functions may significantly impact the mission.

Consequently, further research is required to understand the impact of outsourcing logistical functions in a non-permissive and hostile environment. As demonstrated amid chaos, this environment is the operational niche differentiating armed forces from private industries. As seen in Ukraine, the war fog significantly complicates the situation and adds uncertainty to rapidly responding to a national crisis. Furthermore, this example further underlines the limitation of contractors in a hostile environment while emphasizing the concept that national mobilization will require time to surge and fill capability gaps.

Additionally, the study should consider whether similar advantages derived from outsourcing will prove beneficiary under hostile conditions. Furthermore, this dissertation limitation highlighted further research in identifying armed forces' capacity and capability gaps when contractors cannot provide services in a hostile environment. Finally, the Third-Party Reverse Logistics Closed-Loop Vendor Managed Inventory model demonstrated potential and advantage within an expeditionary framework. However, the model as a theoretical framework remains a theory. Integrating the contractor and governmental organization will require a revolutionary change management process within the DSC and quantitative analysis to form a business case to substantiate the financial and capital costs. Although there remains significant research into the subject, this dissertation theoretically presented an outsourced reverse logistics model to address the CAF's inventory management challenges and climate change as the CAF evolves the business to sustain the Future Force of 2040.



## Bibliography

- Aćimović, Slobodan, Veljko Mijušković, and Marko Golubović. 2021. "Military Logistics vs. Business Logistics." *Economic Analysis* 54 (1): 118-138.
- Adams, John, Hafiz T.A. Khan, Robert Raeside, and David I White. 2007. *Research Methods for Graduate Business and Social Science Students*. New Delhi: SAGE Publications.
- Aoki, Katsuki. 2008. "Transferring Japanese Kaizen Activities to Overseas Plants in China." *International Journal of Operations & Production Management* 28 (6): 518-539.
- Astanti, Ririn Diar, Yosef Daryanto, and Parama Kartika Dewa. 2022. "Low-Carbon Supply Chain Model Under a Vendor-Managed Inventory Partnership and Carbon Cap-and-Trade Policy." *Journal of Open Innovation* 8 (1): 1-16.
- Australian Defence Force. 2020. *Concept of Future Logistics*. November 11. Accessed April 25, 2022. [https://defence.gov.au/vcdf/forceexploration/\\_Master/docs/ADF-Concept-Logistics.pdf](https://defence.gov.au/vcdf/forceexploration/_Master/docs/ADF-Concept-Logistics.pdf).
- Baghizadeh, Komeyl, Julia Pahl, and Guiping Hu. 2021. "Closed-Loop Supply Chain Design with Sustainability Aspects and Network Resilience Under Uncertainty: Modelling and Application." *Mathematical Problems in Engineering* 2021: 1-23.
- Bailey, Peter. 2015. *Procurement Principles and Management. 11th Edition*. Harlow: Pearson Education.
- Berglund, , Magnus, Peter van Laarhoven, Graham Sharman, and Sten Wandel. 1999. "Third-Party Logistics: Is there a Future?" *The International Journal of Logistics Management* 10 (1): 59-70.
- Bhasin, Hitesh. 2020. *Bullwhip Effect – Example, Causes, Analysis and Consequences*. July 30. Accessed April 25, 2022. [www.marketing91.com/bullwhip-effect/](http://www.marketing91.com/bullwhip-effect/).
- Britannica Academic. 2022. *Ohno Taiichi*. Accessed April 25, 2022. <https://academic-eb-com.cfc.idm.oclc.org/levels/collegiate/article/ohno-taiichi/1089>.
- Butler-Kisber, Lynn. 2010. *Qualitative Inquiry: Thematic, Narrative and Arts-Informed Perspectives*. London: SAGE Publications.
- CBC News. 2009. "Cargo container yields \$2M surprise." <https://www.cbc.ca/news/canada/nova-scotia/cargo-container-yields-2m-surprise-1.821211>. Halifax, Nova Scotia, September 08. Accessed April 25, 2022. <https://www.cbc.ca/news/canada/nova-scotia/cargo-container-yields-2m-surprise-1.821211>.
- Cerullo, Megan. 2022. *U.S. corporations suspend business in Russia, citing the war with Ukraine*. CBS News. March 1. Accessed April 25, 2022.

- <https://www.cbsnews.com/news/fedex-ups-suspend-deliveries-russia-ukraine-delta-aeroflot/>.
- Chiarini, Andrea, Claudio Baccarani, and Vittorio Mascherpa. 2018. "Lean Production, Toyota Production System and Kaizen Philosophy: A Conceptual Analysis from the Perspective of Zen Buddhism." *TQM Journal* 30 (4): 425-438.
- Chiu, Hero, Ching-Torng Lin, and Po-Young Chu. 2006. "Agility Index in the Supply Chain." *International Journal of Production Economics* 100 (2): 285-299.
- Christensen, Tom, and Per Læg Reid. 2007. "The Whole-of-Government Approach to Public Sector Reform." *Public Administration Review* 67 (6): 1059-1066.
- Cole, Craig. 2022. *Why the heck is there still an automotive chip shortage?* February 04. Accessed April 25, 2022. <https://www.cnet.com/roadshow/news/features/why-automotive-chip-shortage/>.
- Department of National Defence. 2022. *Current Operations and Joint Military Lists*. January 13. Accessed April 25, 2022. <https://www.canada.ca/en/department-national-defence/services/operations/military-operations/current-operations/list.html>.
- Department of National Defence. 2018. *Defence Plan: 2018-2023*. Accessed April 25, 2022. <https://www.canada.ca/content/dam/dnd-mdn/documents/reports/2018/defence-plan-2018-2023.pdf>.
- Department of National Defence. 2013. *Defence Renewal Charter: Department of National Defence and the Canadian Armed Forces – October 2013*. October. Accessed April 25, 2022. [www.forces.gc.ca/assets/FORCES\\_Internet/docs/en/about/defence-renewal-charter.pdf](http://www.forces.gc.ca/assets/FORCES_Internet/docs/en/about/defence-renewal-charter.pdf).
- Department of National Defence December 2021. *Defence, Supply Administration Manual*. Ottawa, Ontario.
- Department of National Defence. 2021. *Her Majesty's Canadian Ship Harry DeWolf becomes the First Arctic and Offshore Patrol Ship Commissioned by the Royal Canadian Navy*. June 26. Accessed April 25, 2022. <https://www.canada.ca/en/department-national-defence/news/2021/06/her-majestys-canadian-ship-harry-dewolf-becomes-the-first-arctic-and-offshore-patrol-ship-commissioned-by-the-royal-canadian-navy.html>.
- Department of National Defence. Ottawa, Minister of Public Works and Government Services Canada, 1987. *Materiel Support -Report of the Auditor General of Canada to the House of Commons*. Ottawa: Minister of Public Works and Government Services Canada.
- Department of National Defence. May 2008. "Report of the Auditor General of Canada to the House of Commons: Chapter 2 Support for Overseas Deployments – National Defence."
- Department of National Defence. May 2017. "Review of the Defence Renewal." Accessed April 25, 2022. [www.canada.ca/content/dam/dnd-](http://www.canada.ca/content/dam/dnd-)

mdn/migration/assets/FORCES\_Internet/docs/en/about-reports-pubs-audit-eval/271p7055-64.pdf.

Department of National Defence. 2021. *Royal Canadian Navy*. December 21. Accessed April 25, 2022. <https://navy-marine.forces.gc.ca/>.

Department of National Defence. 2017. *Strong, Secure, Engaged: Canada's Defence Policy*. Accessed April 25, 2022. [https://publications.gc.ca/collections/collection\\_2017/mdn-dnd/D2-386-2017-eng.pdf](https://publications.gc.ca/collections/collection_2017/mdn-dnd/D2-386-2017-eng.pdf).

Department of National Defence. 2021. *Supply Administration Manual*. Assistant Deputy Minister Materiel (ADM (MAT)).

Dimitrova, Sevdalina, Nikolay Nichev, and Nikolay Stefanov. 2015. "Development of Outsourcing Services." *International Conference Knowledge-Based Organization* 21 (1): 192-197.

Dubreuil, K.E. "Agile and Responsive? Is the Royal Canadian Air Force Contracting Out Its Agility and Responsiveness Through Outsourcing Supply Chain Management?" (Joint Command and Staff Programme Directed Research Paper, Canadian Forces College, 2018.

Durán Peña, Julián Andrés, Ángel Ortiz Bas, and Nydia Marcela Reyes Maldonado. 2021. "Impact of Bullwhip Effect in Quality and Waste in Perishable Supply Chain." *Process* 9 (7): 1-18.

Ehsan , Shekarian, and Simme Douwe P Flapper. 2021. "Analyzing the Structure of Closed-Loop Supply Chains: A Game Theory Perspective." *Sustainability (Basel, Switzerland)* 13 (3): 1-32.

Ernawati, D, E Pudji, N Rahmawati, and M Alfin. 2021. "Bullwhip Effect Reduction using Vendor Managed Inventory (VMI) Method in Supply Chain of Manufacturing Company." *Journal of Physics. Conference Series* 1899 (1): 1-6.

Framinan, Jose M. 2022. *Modelling Supply Chain Dynamics,* Cham, Switzerland: Springer, 151. Cham: Springer International Publishing AG.

Galankashi, Rahiminezhad Masoud, and Syed Ahmad Helmi. 2016. "Assessment of Hybrid Lean-Agile (Leagile) Supply Chain Strategies." *Journal of Manufacturing Technology Management* 27 (4): 470-482.

Gall, Gerald L, and Anne A McLellan. 2020. "Peace, Order, and Good Government." *The Canadian Encyclopedia*, July 29: 1-9. Accessed April 25 April 2022, 2022. [www.thecanadianencyclopedia.ca/en/article/peace-order-and-good-government](http://www.thecanadianencyclopedia.ca/en/article/peace-order-and-good-government).

Gimblett, Richard Howard. 2004. *Operation Apollo: The Golden Age of the Canadian Navy in the War Against Terrorism*. Ottawa: Magic Light Pub.

- Gournelos, Ted, Joshua R Hammonds, and Maridath A Wilson. 2019. *Doing Academic Research: A Practical Guide to Research Methods and Analysis. First Edition*. Milton: Routledge.
- Government of Canada. 2019. *Mandate*. July 26. Accessed April 25, 2022. <https://www.ccg-gcc.gc.ca/corporation-information-organisation/mandate-mandat-eng.html>.
- Hassan, Jakiul, Khan Faisal, and Hasan Mainul. 2012. "A Risk-Based Approach to Manage Non-Repairable Spare Parts Inventory." *Journal of Quality in Maintenance Engineering* 18 (3): 344-362.
- Henderson, Bruce D. Summer 1985. "Competitive Advantage: Creating and Sustaining Superior Performance." *Journal of Business Strategy (Pre-1986)* 6 (1): 93-95.
- Ho, Alfred Tat-Kei, and Tobin Im. 2015. "Challenges in Building Effective and Competitive Government in Developing Countries: An Institutional Logics Perspective." *American Review of Public Administration* 45 (3): 263-280.
- Hsu, Chin-Chun, and Keah-Choon Tan. 2016. "Strategic orientations, sustainable supply chain initiatives, and reverse logistics: Empirical evidence from an emerging market." *International Journal of Operations & Production Management* 36 (1): 86-110.
- Huscroft, Joseph R, Benjamin T Hazen, Dianne J Hall, Joseph B Skipper, and Joe B Hanna. 2013. "Reverse Logistics: Past Research, Current Management Issues, and Future Directions." *The International Journal of Logistics Management* 24 (3): 304-327.
- Huxel, Pia, and Elene Elene Gelashvili. 2014. "Use of Lean and Agile Commercial Supply Chain Practices in Humanitarian Supply Chains." Masters Thesis, Umeå School of Business, Economics, and Statistics, Umeå University, Umeå, Sweden. Accessed April 25, 2022. <http://umu.diva-portal.org/smash/get/diva2:781731/FULLTEXT01.pdf>.
- Jayaraman, Vaidyanathan, and Yadong Luo. 2007. "Creating Competitive Advantages through New Value Creation: A Reverse Logistics Perspective." *Academy of Management Perspectives* 21 (2): 56-73.
- Jenkins, Abby. 2021. *A Guide to Reverse Logistics: How It Works, Types and Strategies*. January 14. Accessed April 25, 2022. <https://www.netsuite.com/portal/resource/articles/inventory-management/reverse-logistics.shtml>.
- Keshavarz-Ghorbani, Fatemeh, and Seyed Hamid Reza Pasandideh. 2021. "Optimizing a Two-Level Closed-Loop Supply Chain Under the Vendor Managed Inventory Contract and Learning: Fibonacci, GA, IWO, MFO Algorithms." *Neural Computing & Applications* 33 (15): 9425-9450.
- Kinsley, Christopher. 2014. "Transforming war supply: Considerations and rationales behind contractor support to UK overseas military operations in the twenty-first century." *International Journal (Toronto)* 69 (4): 494-509.

- Kovács, Gyöngyi , and Peter Tatham. 2009. "Responding to Disruptions in the Supply Network- from Dormant to Action." *Journal of Business Logistics* 30 (2): 215-229.
- Krupa, KM, Sukumar Patil, and Bhoopendrakumar Singh. 2022. "Importance of Kaizen and its Implementation in Design and Manufacturing System." *2022 IEEE Fourth International Conference on Advances in Electronics, Computers and Communications (ICA ECC)*. Bengaluru, India: IEEE. 1-4.
- Lambert Douglas M, and James R Stock. 1982. *Strategic Physical Distribution Management*. Homewood, Illinois: Irwin.
- Lee, Jun-Yeon, Richard K Cho, and Seung-Kuk Paik. 2016. "Supply chain coordination in vendor-managed inventory systems with stockout-cost sharing under limited storage capacity." *European Journal of Operational Research* 248 (1): 95-106.
- Li, Jiang, Hongxia Change, Suping Zhao, Junfeng Dong, and Wenxing Lu. 2019. "A Travelling Salesman Problem with Carbon Emission Reduction in the Last-Mile Delivery 61620." *Institute of Electrical and Electronics Engineers Access* 7: 61620-61627.
- Li, Ruixue, Conwoo Koo, Ge Zhang, and Hong Yang. 2021. "Obtaining Sustainable Competitive Advantage through Collaborative Dual Innovation: Empirical Analysis Based on Mature Enterprises in Eastern China." *Technology Analysis & Strategic Management* 33 (6): 685-699.
- Liu, Wen, Hai-Yan Wang, and Long-gang Li. 2016. "Quartermaster's pricing problems in dual channel strategy of VMI & TPL mode." *Procedia Computer Science* 111: 277-286.
- Market Business News. 2022. *What is Just in Case? Definition and examples*. Accessed April 28, 2022. [www.marketbusinessnews.com/financial-glossary/just-case-definition-meaning/](http://www.marketbusinessnews.com/financial-glossary/just-case-definition-meaning/).
- McWilliams, Abigail, and Donald S Siegel. 2011. "Creating and Capturing Value: Strategic Corporate Social Responsibility, Resource-Based Theory, and Sustainable Competitive Advantage." *Journal of Management* 43 (5): 1480-1495.
- Mollenkopf, Diane A, and David J Closs. 2005. "The Hidden Value in Reverse Logistics." *Supply Chain Management Review* 9 (5): 34-43.
- Narayanan, Arunachalam, Alan W Mackelprang, and Manoj K Malhotra. 2021. "System Performance Implications of Capacity and Flexibility Constraints on Bullwhip Effect in Supply Chains." *Decision Sciences* 1-19.
- Nicholson, Kate. 2022. *Is Putin Losing in Ukraine? UK Officials Point Out Why Russia's Invasion is Faltering*. HuffPost UK. March 18. Accessed April 25, 2022. <https://ca.news.yahoo.com/putin-losing-ukraine-uk-officials-124029928.html>.
- Office of the Auditor-General. 2020. "Spring 2020 Reports of the Auditor General to the Parliament of Canada- Independent Auditor's Report -Report 3: Supplying the Canadian Armed Forces – National Defence."

- Omar, Ilhaam A, Raja Jayaraman, Khaled Salah, Mazin Debe, and Mohammed Omar. 2020. "Enhancing Vendor Managed Inventory Supply Chain Operations using Blockchain Smart Contracts." *IEEE Access* 8: 182704-182719.
- Özkan, Evin, Neda Azizi, and Omid Haass. 2021. "Leveraging Smart Contract in Project Procurement through DLT to Gain Sustainable Competitive Advantages." *Sustainability* 13 (23): 13380-13406.
- Porter, Michael E. 1985. *Competitive advantage of nations: creating and sustaining superior performance*. New York, New York: The Free Press.
- Porter, Michael E.. 1985. *On Competition*. Boston, MA: Harvard Business School Publishing Corporation.
- Prahalad, C K, and Gary Hamel. 1990. "The Core Competence of the Corporation." *Harvard Business Review* 68 (3): 79-91.
- Rachih, Hanane, Fatima Zahara Mhada, and Raddouane Chiheb. 2022. "Simulation Optimization of an Inventory Control Model for a Reverse Logistics System." *Decision Science Letters* 11 (1): 43-54.
- Richnák, Patrik, and Klaudia Gubová. 2021. "Green and Reverse Logistics in Conditions of Sustainable Development in Enterprises in Slovakia." *Sustainability* 2021 13 (2): 1-23.
- Rogers, Dale S, and Ronald Tibben-Lembke. 2001. "An Examination of Reverse Logistics Practices." *Journal of Business Logistics* 22 (2): 129-148.
- Rustenburg, W.D., G.J. van Houtum, and W.H.M. Zijm. 2000. "Spare parts management for technical systems: resupply of spare parts under limited budgets." *IEEE Transactions* 32 (10): 1013-1026.
- Schrage, Michael. 1984. "Sustaining Competitive Advantage." *The Washington Post* (1974-), December 23.
- Sharma, Pankaj, Makarand S Kulkarni, and Ajith Parlikad. 2017. "Sharma, Pankaj, Makarand S. Kulkarni, and Ajith Parlikad. "Capability Assessment of Army Spare Parts Replenishment System: Suitability for a Dynamic Time Separated Lean-Agile Supply." Benchmarking: An International Journal 24, no. 5 (2017): 1166-1189." *Benchmarking An International Journal* 24 (5): 1166-1189.
- Sharma, Pankaj , and Makarand S Kulkarni. 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.
- Sharma, Pankaj, and Makarand S Kulkarni. 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.

- Son, Joong Y, and Subhadip Ghosh. 2020. "Vendor Managed Inventory with Fixed Shipping Cost Allocation." *International Journal of Logistics* 23 (1): 1-23.
- Souchen, Alex. 2020. "Recycling War Machines: Canadian Munitions Disposal, Reverse Logistics, and Economic Recovery After World War II." *Business History* 1-17.
- Stefanov, Nikolay. 2017. "Analysis of some of the Applicable Outsourcing Services in the Structures of the Bulgarian Armed Forces." *International Conference Knowledge-Based Organization* 23 (1): 473-478.
- Stefanov, Nikolay. 2017. "Analysis of the use of Outsourcing Services for Maintenance and Repair of the Equipment and Armament Available in the Structures of the Bulgarian Armed Forces." *International Conference Knowledge-Based Organization* 23 (1): 467-472.
- Suárez-Barraza, Manuel F, Juan Ramis-Pujol, , and Laoucine Kerbache. 2011. "Thoughts on Kaizen and its Evolution." *International Journal of Lean Six Sigma* 2 (4): 288-308.
- Turrisi, Mario, Manfredi Bruccoleri, , and Salvatore Cannella. 2013. "Impact of Reverse Logistics on Supply Chain Performance." *International Journal of Physical Distribution & Logistics Management* 43 (7): 564-585.
- Wang, Chia-Nan, Thanh-Tuan Dang, and Ngoc-Ai-Thy Nguyen. 2021. "Outsourcing Reverse Logistics for E-Commerce Retailers: A Two-Stage Fuzzy Optimization Approach." *Axioms* 10 (1): 1-23.
- Whitten, Dwayne G, Kenneth W Green, and Pamela J Zelbst. 2012. "Triple-A Supply Chain Performance." *International Journal of Operations & Production Management* 32 (1): 28-48.
- Womack, James P, and Daniel T Jones. 1996. "Beyond Toyota: How to Root Out Waste and Pursue Perfection." *Harvard Business Review* 74, (5): 140-172.
- Womack, James P, and Daniel T Jones. 1996. *Lean Thinking*. New York, New York: Sumon & Schuster.
- Zaarour, Nizar, Emanuel Melachrinoudis, Marius Solomon, and Hokey Min. 2014. "A Reverse Logistics Network Model for Handling Returned Products." *International Journal of Engineering Business Management* 6: 1-10.
- Zhang, Xumei, Zhizhao Li, and Yan Wang. 2020. "A Review of the Criteria and Methods of Reverse Logistics Supplier Selection." *Processes* 8 (6): 705-721.
- Zhou, Sheng-shi, Li-hong Yang, and Yong-qiang Huang. 2011. "Risk Analysis and Control of Vendor Managed Inventory Model Implementation for Manufacturers." *2nd International Conference on Artificial Intelligence, Management Science and Electronic Commerce (AIMSEC)*. Qingdao, China: IEEE. 7229-7232.





### Appendix A: Divestment of End-of-Life Flowchart

