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Improving Logistics Operational Effectiveness and Efficiency Through Modernization for a Future Operating Environment

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IMPROVING LOGISTICS OPERATIONAL EFFECTIVENESS AND EFFICIENCY THROUGH MODERNIZATION FOR A FUTURE OPERATING ENVIRONMENT

By Major D.E. Demers

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LIST OF ACRONYMS

ADM IM – Assistant Deputy Minister Information Management
ADM DIA – Assistant Deputy Minister Data, Innovation, Analytics
ADM Mat – Assistant Deputy Minister Materiel
AGV – Automated Guided Vehicles
AI – Artificial Intelligence
AIT – Automatic or Automated Identification Technology
AV – Asset Visibility
A2AD – Anti-access area denial
BI – Business Intelligence
CAF – Canadian Armed Forces
CANOSCOM – Canadian Operational Support Command
CARF – Consignment Authorization Request Form
CBSA – Canadian Border Services Agency
CDS – Chief of the Defence Staff
CFD – Chief of Force Development
CFLTC – Canadian Forces Logistics Training Centre
CFSD – Canadian Forces Supply Depot
CJOC – Canadian Joint Operations Command
CM – Customs Module
CMSG – Canadian Materiel Support Group
COP – Common Operating Picture
COTS – Commercial-Off-The Shelf
COE – Contemporary Operating Environment
CVS – Cargo Visibility System
C2 – Command and Control
C4ISR – Communications, Computers, Intelligence, Surveillance and Reconnaissance
DCB – Defence Capabilities Blueprint
DCBS – Defence Customs Brokerage System
DLA – Defense Logistics Agency
DLS – Disconnected Light Solution
DND – Department of National Defence
DOB – Deployed Operating Base
DOD – Department of Defence
DRDC – Defence Research and Development Canada
DRMIS – Defence Resource Management Information System
DSC – Defence Supply Chain
ERP – Enterprise Resource Planning
E2E – End-to-End Visibility
FLMS – Forward Logistics Management System
FMS – Fleet Management System
FOC – Full Operational Capability
FOE – Future Operating Environment

GoC – Government of Canada
GPS – Global Positioning System
GTS – Global Trades Services
HPR – High Priority Requisition
IRL – Intelligent Retail Lab
IDEaS – Innovation for Defence Excellence and Security
IOC – Initial Operating Capability
IT – Information Technology
ITV – In-transit Visibility
IM – Information Management
JADC2 – Joint All Domain Command and Control
JBMC – Joint Battle Management Capability
JCCL – Joint Concept for Contested Logistics
JIIFC – Joint Information and Intelligence Fusion Capability Project
JWC – Joint Warfighting Concept
KPI – Key Performance Indicators
LMP – Logistics Modernization Program
LOGASSESSREP – Logistics Assessment Report
LOGSA – Logistics Support Activity
MISL – Modernization and Integration of Sustainment and Logistics
MLSA – Mutual Logistics Services Agreement
NATO – North Atlantic Treaty Organization
NFR – National Freight Run
NGDS – Next Generational Distribution System
NMDS – National Movement and Distribution System
NSN – NATO Stock Number
OAG – Office of The Auditor General
OJT – On the Job Training
OPP – Operational Planning Process
OSH – Operational Support Hubs
PDET – Portable Data Entry Terminals
PFEC – Pan-domain Force Employment Concept
PMF – Performance Measurement Framework
PPE – Personal Protective Equipment
QLF – Quintalateral Logistics Forum
RCLS – Royal Canadian Logistics Service
RCEME – Royal Canadian Electrical and Mechanical Engineering Corps
RDD – Required Delivery Date
RFI – Request For Information
RFID – Radio Frequency Identification Device
RLP – Recognized Logistics Picture
ROSP – Recognized Operational Support Picture
SA – Situational Awareness

SOCD – Statement of Capability Deficiency
SSE – Strong Secure and Engaged
STO – Supply Transfer Order
S&RL – Sense and Respond Logistics
TCN – Transportation Control Number
TF – Task Force
TM – Transportation Management
USMC – United States Marine Corps
USTRANSCOM – United States Transportation Command
VCDS – Vice Chief of the Defense Staff
WSBL – Waybill
W&D – Warehousing and Distribution

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PREFACE

Throughout my career as a logistician at the tactical and operational levels, and both deployed and at home, I have come to realize the vastness and complexity of the CAF logistics system and DSC. Likewise, I have learned how critical they are in enabling the DND and CAF to succeed in its day-to-day operations.

As a Logistics Officer with transportation and movement specialties, the majority of my career has been focused on the distribution aspect of our supply chain. Based upon my experiences, I have seen how the CAF logistics system and its applicable Information Technology (IT) and Information Management (IM) systems do not necessarily enable operational effectiveness or readiness, or exercise good stewardship practices over key resources. Additionally, while deployed on theatre closure missions including Camp Mirage and Kandahar, as well as operations such as Operation IMPACT in Kuwait, I experienced first-hand the materiel management and asset visibility challenges that the DND/CAF has. After being posted to the Canadian Operational Support Command (CANOSCOM), and later the CJOC, I also learned of the operational level challenges. These were apparent by the inefficient equipment tracking methods that were used via legacy systems, as well as excel spreadsheets and white boards. These challenges are important to recognize as they impacted our ability to efficiently identify and assess trends in the distribution of materiel, and to develop solutions so that they were less likely to occur in the future. However, despite these limitations and inefficiencies in our systems/processes, the team was always capable of answering the Commander's Requests For Information (RFI), and most importantly supporting the operation and the warfighter. I believe much of the credit for these successes goes to the professionalism, proficiency, and

dedication of all DND/CAF personnel, and in particular those involved in the operational function and art of ‘sustainment’.

Despite these successes, I, like many other logisticians and those within the greater support community, have wondered what could be done to improve the operational effectiveness and stewardship of our logistics system and DSC? How could we support operations in a future pan-domain environment by working smarter, more efficiently, and not at the expense of our most valued resource, our personnel?

With this in mind and based upon our Senior Leadership’s vision of modernizing the CAF logistics system through projects such as the Modernization and Integration of Sustainment and Logistics (MISL), I was inspired to write this DRP. I was also motivated to build-upon the previous research on the topic of modernizing and revolutionizing our logistics system, by highlighting the DND/CAF future logistics projects. My intent behind this DRP was to provide those who work in both operator occupations and supporter roles with a better understanding of the critical role of sustainment and technology within the DND/CAF today, and also well into the Future Operating Environment (FOE). Based on the information found in the chapters to follow, I believe readers will also recognize the importance of strong leadership in implementing the many future logistics and DSC projects, and ultimately transforming sustainment into a more effective and efficient combat enabler.

Servitium Nulli Secundus

ABSTRACT

The role of sustainment, logistics, and supply chains within militaries and the DND/CAF today and into the FOE are key to ensuring the readiness of a military force. Within this FOE, the DND/CAF will require a logistics system and DSC that is modernized to be as operationally effective and efficient as possible. This level of effectiveness and efficiency is also critical at a time when the DND/CAF will face those threats that are pan-domain in nature and which will challenge the resiliency and robustness of logistics systems and supply chains. Through greater use of technology such as Automated Identification Technology (AIT), Business Intelligence (BI) and analytics, the system and DSC can improve while also addressing many of the current challenges that exist. Identified in Office of the Auditor General (OAG) reports these challenges have impacted the operational effectiveness and efficiency of the DND/CAF and include IT/IM issues with the current ERP, limited end-to-end visibility, and the lack of DSC performance measurements. Leveraging examples of technology being used in industry and other allied nations, the DND/CAF will be able to improve its logistics system and supply chain. Initiatives such as AIT, the MISL, and the Recognized Logistics Picture (RLP) capability are a few of the projects being pursued by the DND/CAF which include greater use of technology. However, as the DND/CAF logistics system and DSC are modernized for the FOE certain challenges will exist. These challenges include those associated with the greater use of technology and its vulnerabilities, as well as those involving the interaction between humans and technology. As the DND/CAF modernizes its logistics system and DSC it must ensure that these challenges are recognized and that sufficient resources are devoted to them in order to ensure that the system and supply chain remain both operationally effective and efficient into the FOE.

CHAPTER 1: INTRODUCTION

Future warfare will be fought against adversaries who will attempt to dominate and create conflict across multiple domains (i.e. land, air, maritime, space, information, cyber). The CAF will be employed in this environment through what is called the Pan-domain Force Employment Concept (PFEC).[1] This ever-changing and evolving security environment, combined with the fast paced development of technology, requires the DND/CAF to modernize its key enabling capabilities in order to project an "integrated, innovative, flexible, adaptable and interoperable force."[2] For the force to be more operationally effective within this FOE, its logistics system must also be prepared to support the fight. Preparedness means readiness, and readiness includes those joint capabilities that are postured during 'Phase Zero' of an operation, such as sustainment and the logistics system.[3] Modernizing the logistics system will assist with 'Phase Zero' by 'shaping' and informing decision-makers of the materiel readiness for CAF operations. Simultaneous to these efforts, the DND/CAF must also ensure good stewardship of public resources by being transparent, accountable, and "managing the business of defence effectively".[4] This is especially important given the Government of Canada's (GoC) 10 year commitment of $32.7 billion to defence spending, which must be managed carefully by the

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[1] Canadian Army Today, "Manoeuvre in the information domain", Last accessed 26 November 2020, https://canadianarmytoday.com/manoeuvre-in-the-information-domain/; Department of National Defence, "Joint Operations Symposium 2020", Last accessed 26 November 2020, https://www.canada.ca/en/department-national-defence/maple-leaf/defence/2020/03/joint-operations-symposium-2020.html; Canadian Global Affairs Institute, "How Canada Fights," 28 August 2020, https://soundcloud.com/user-609485369/defence-deconstructed-how-canada-fights?in=user-609485369/sets/defence-deconstructed. PFEC is the CAF's vision for how it can be successful in future conflict. It includes ensuring that the CAF can build today's force to meet the requirements of tomorrow's threat environment, an environment which goes beyond traditional warfare.

[2] Department of National Defence, *Strong, Secure, Engaged (SSE): Canada's Defence Policy (*Ottawa: DND, 2017), 41.

[3] Department of National Defence, JDN 02-2014, *Joint Doctrine Note Command & Control of Joint Operations* (Ottawa: DND, 2014), 9. There are five phases that CJOC exercises Command and Control over current operations. Phase Zero is the 'shaping' phase that includes monitoring, planning, posturing joint capabilities (i.e. sustainment), and mission preparation/rehearsal/training and exercises.

[4] Department of National Defence, *Defence Investment Plan 2018 – Annual Update 2019* (Ottawa: DND, 2019), 4.

leaders and stewards of the profession while remaining cognizant that future funding priorities could change.[5] In order for the DND/CAF to maintain its operational effectiveness while being fiscally responsible, it must focus on how to better integrate both its processes (i.e. procurement), and its organization. This integration should be pursued through critical thinking and creativity, and by taking a holistic systems approach as opposed to an approach that assesses problems as single stand-alone issues. Only after taking this holistic approach will the DND/CAF arrive at solutions that can enable mission success while attaining Government objectives.[6] The ability to be more operationally effective while exercising stewardship of resources and logistics will require the use of technology throughout the FOE. Technology should include BI, analytics, and digitalization. This should be shaped by a DSC Governance framework that "effectively balance[s] supply chain outcomes [in order] to deliver CAF operational needs, while meeting its departmental stewardship obligations in an efficient manner".[7] Modernizing the business of logistics through technology is key for the DND/CAF, with a failure impacting the DND/CAF's ability to project a fully integrated and interoperable force. Over the last number of decades the ability to modernize the DND/CAF logistics system so that it can be more operationally effective while being good stewards of public funds has been challenged for many reasons.[8] These reasons included the lack of a strategic process owner (i.e. Strategic J4), no requirement or urgency to modernize, and fundamentally because the system has been able to support operations, albeit not

[5] *Strong Secure Engaged*, 11.

[6] Lieutenant-General Mike Rouleau, "VCDS Open Letter to the Capability Development Community", 29 October 2020.

[7] Department of National Defence, "Defence Supply Chain Governance," (Ottawa; DND Canada, 18 October 2018). Business Intelligence will be discussed further in Chapter 5, but can be explained as a technology-driven process that combines information or data and uses analytical tools, 'analytics', to present the information to those responsible for planning and making decisions. See Solomon Negash "Business Intelligence", *Communications of the Association for Information Systems* (Vol 13, 2004) for additional information.

[8] The CAF logistics system refers to the entire logistics enterprise, which includes the software or Information Technology that supports CAF logistics.

as effectively as it could be. Not until recently have the necessary collaborative steps towards modernization been made, as seen with current and near term CAF projects and initiatives.[9] These projects and initiatives will take several years to reach their Full Operational Capability (FOC), and with implementation will require continuous investment in order to maintain their operational effectiveness and sound stewardship of resources. A failure to continually invest in these systems will likely result in the systems falling behind in their ability to support operations and impacting the DND/CAF's overall operational readiness and effectiveness.

This paper intends to fulfill two objectives. Firstly, it intends to update and add to previous academic literature on modernizing the DND/CAF's logistics system. Secondly, by focusing on technology, it will highlight the need for modernization in order for the DND/CAF to be able to operate more effectively in a future pan-domain operating environment. It will argue that technology can improve the operational effectiveness and stewardship of the DND/CAF logistics system and DSC, but not without challenges. Challenges include having an understanding of both the past issues that impacted previous modernization efforts, as well as those that may occur in the future. Through the identification, and understanding of these challenges, efforts can be made to mitigate them in the future. Comprised of three parts, the paper will begin with providing an overview of the DND/CAF logistics by focusing on the supply chain and distribution, and the use of technology within these functions. This will be followed by an explanation of how technology can enable operational effectiveness and stewardship by leveraging examples from industry and other nations. Subsequently, the paper will discuss the logistics system and supply chain projects that the CAF are developing at this

[9] Projects and initiatives include the Modernization and Integration of Sustainment and Logistics (MISL), Automated Identification Technology (AIT), and the Recognized Logistic Picture (RLP). These will be discussed further in Chapter 7.

time. In the final section, past and future challenges that have and will impact modernization efforts will be identified with recommendations for improvements.

CHAPTER 2: WHAT IS LOGISTICS?

Logistics has many definitions but is generally defined as "the aspect of military science dealing with the procurement, maintenance, and transportation of military materiel, facilities and personnel."[10] Within the CAF it is identified as "the science of planning and carrying out the movement and maintenance of forces,"[11] whereas according to the North Atlantic Treaty Organization (NATO) it is "the bridge between deployed forces and the industrial base, which produces the material and weapons deployed forces need to accomplish their mission."[12] Similarly, within business it can be defined as "ensuring that all the material and personnel are in the right place at the right time and in the right condition."[13] In history, early references to logistics can be traced to Sun Tzu's written work from as early as 500 BC, to Alexander the Great who studied logistics in campaign planning.[14] Others such as the French General Jomini dedicated an entire chapter to logistics and how it enables strategy and tactics in his 1838 book titled *The Art of War.*[15] Throughout history, logistics has been regarded as enabling the movement of materiel, and personnel, and has become more professionalized with the word 'logistics' becoming officially recognized by the United States and its allies following the end of World War II.[16] For the purposes of this paper the CAF definition of logistics will be used

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[10] Merriam-Webster Dictionary, "Definition of logistics", Last accessed on 26 November 2020, https://www.merriam-webster.com/dictionary/logistics.

[11] Department of National Defence, B-GL-005-400-FP-001, *Canadian Forces Joint Publication Support Doctrine CFJP 4-0* (Ottawa: DND Canada, 2016), 1-1.

[12] North Atlantic Treaty Organization, "Logistics," Last accessed on 26 November 2020, https://www.nato.int/cps/en/natolive/topics_61741.htm#:~:text=NATO%20defines%20logistics%20as%20the,movement%20and%20maintenance%20of%20forces.&text=Logistics%20can%20be%20seen%20as,need%20to%20accomplish%20their%20mission.

[13] Market Business News, "What is logistics? Definition and meaning," Last accessed on 26 November, 2020, https://marketbusinessnews.com/financial-glossary/logistics-definition-meaning/.

[14] Stephen, Rutner, Maria Aviles, and Scott Cox, "Logistics Evolution: A Comparison of Military and Commercial Logistics Thought," *International Journal of Logistics Management* 23, no 1 (2012): 97.

[15] *Ibid.,* 98.

[16] Department of National Defence, A-LM-031-000/AG-000, *Canadian Forces Logistics Branch Handbook* (Ottawa: DND Canada, 1993), 8.

because it focuses on planning and sustaining the force through the movement of materiel, which technology and modernizing the logistics system can greatly enable.

Technology and The Modernization Of Logistics

The use of technology within logistics systems can be traced throughout history with the use of organized supply chains, but most recently starting in the mid-19th century with the mobilization of armies, and the revolution of both weapons technology and management of an organization.[17] Following the mid-19th century, the most significant technological inventions that impacted logistics systems were the telegraph for communications, and specifically rail traffic, the railroad, and also the steamship.[18] Later, the powered vehicle, internal-combustion engine, and air power, also greatly changed logistics by assisting with the distribution of materiel at a time when there was mass consumption due to war.[19] Decades later came the invention of the high speed computer and tools to provide administration and management over resources. Then within the last five to ten years there has been a surge in the use of Artificial Intelligence (AI), BI and analytics, and the demand for supply chain visibility. The incorporation of greater automation and autonomous vehicles has become more prevalent as well. These technological advances continue to change the business of logistics within both the industry and defence sectors. Within both sectors, recent modernization efforts have been focused on creating responsive and resilient logistics systems and supply chains, so that the systems can fulfill their role as critical enablers as effectively and efficiently as possible. However, within the past few decades, technological innovation within logistics has been thought of in an ad hoc manner and has shifted from supply to distribution-based logistics, and more recently from platform to

[17] Encyclopedia Britannica, "Historical Development – Logistic Systems before 1850", last accessed 1 December 2020 https://www.britannica.com/topic/logistics-military/Historical-development.

[18] *Ibid.*

[19] *Ibid.*

network-centric warfare in the 2000s.[20] The shift towards modernization has also occurred for several other reasons. Specifically, there have been changes in the nature of warfare from symmetrical to asymmetrical, increases in globalization, and finally a change in priorities to more modular and agile logistics that is premised on decreasing stocks in favour of just-in-time logistics.[21] The entire shift to modernization has been commonly referred to as a 'Revolution in Military Logistics'.[22] This 'revolution' can improve operational effectiveness through the 'revolution's' "six tenets: seamless logistics system, distribution-based logistics, agile infrastructure, total asset visibility, rapid force projection, and an adequate logistics footprint."[23] Finally, the increased requirement to modernize and leverage technology within logistics has enabled the collection of mass amounts of information, which can subsequently inform those in decision-making positions. Despite the benefits of technology and the superiority it can provide, it does have limitations and challenges which must be recognized when modernizing a logistics system such as the DND/CAFs. These challenges and limitations are discussed further in Chapter 8.

Previous Literature On The Modernization Of Logistics

Previous academic contributions to the modernization of military logistics and the DSC have been made over the last 15 years. In particular, Adam Zima's 2012 paper, "A Canadian Revolution in Military Logistics – Improving the CF Operational Supply Chain through

[20] Zoe Stanley-Lockman, "Revisiting the Revolution in Military Logistics: Technological Enablers Twenty Years on", in *Disruptive and Game Changing Technologies in Modern Warfare Logistics* (Switzerland: Springer Nature, 2020), 198.

[21] *Ibid.,* 198-199. Just-in-time logistics or just-in-time delivery is enabled by using data to deliver the required equipment 'just-in time'. The data used is provided by technologies such as Automated Identification Technology and Business Intelligence such as algorithms and predictive analysis. The ability to conduct just-in time logistics is only possible by having situational awareness and asset visibility. These technologies and concepts are discussed later in the paper.

[22] *Ibid.,* 198-199.

[23] *Ibid.,* 201.

Benchmarking", outlined the shortcomings of the supply chain in terms of effectiveness, and argued that "the Canadian Armed Forces needs a proactive approach to transform the operational supply chain, [by] streamlining processes and maximizing the use of technology" in order to achieve mission success.[24] To help prove his point, he compared the CAF supply chain with that of its allies; the United States, the United Kingdom, and Australia, and arrived at identifying best practices for the CAF supply chain to adopt.[25]

Others, such as Ken Mills, explained the reduction in effectiveness of logistics and the lack of focus being attributed to the interrelated factors of "understanding, integration, and strategic ownership" of the logistics system.[26] Drawing on examples from CAF operations, he discussed technology, business processes, and structures, to argue that in order to improve the operational effectiveness of the CAF, it must establish a single process owner and create a "unified vision among logisticians" which would reduce friction within the DND and CAF.[27] In Brandon Sing's research and approach in 2017 on the modernization of the CAF logistics system, he provided a comparative analysis of the CAF to industry, and other armed forces. In his research, he identified possible industry best practices that could be incorporated into the CAF to address the DND/CAF logistics system gaps.[28] Furthermore, he discussed logistic innovations that have failed to support the needs of the Contemporary Operating Environment (COE), while also citing some positive changes within the CAF such as the creation of a

[24] Major S.A. Zima, "A Canadian Revolution in Military Logistics – Improving the CF Operational Supply Chain through Benchmarking," (Directed Research Project, Canadian Forces College, 2012), 10.

[25] *Ibid.,* 10.

[26] Major Ken Mills, "Logistics: Reducing Friction Through Understanding, Integration, and Ownership," (Directed Research Project, Canadian Forces College, 2014), vi.

[27] *Ibid.,* vi.

[28] Major B. Sing, "Service Second to Some: Innovation and Best Practices in Defence Logistics," (Joint Command Staff Program Course Paper, Canadian Forces College, 2017), 2.

Strategic J4; an indication of a cultural change to one that highlights the importance of 'support' or 'sustainment' in operations.[29]

Finally, Chris Zimmer's paper titled: "For want of a nail the campaign was lost. DND's supply chain: a state of performance paralysis" from 2009 concentrated on the DSC and how it "was designed with a procurement and materiel life cycle focus", instead of being agile to support an expeditionary force and the customer or command.[30] He argued for DND supply chain management that was based on industry practices, but shaped to what the Department needed to support operations.[31] In his analysis of the DSC he used the five core supply chain management disciplines, and comparisons between industry and the United States military, which led him to make recommendations for improvements.[32]

Amongst each of these previous research projects were common recommendations for improvements. These recommendations were based on industry/business or other allied nation best practices and included ideas such as using technology to improve logistics and supply chain processes, creating an end-to-end architecture, and incorporating DSC performance measurements. Many of these recommendations are being initiated and will be discussed later in Chapter 7.

This paper intends to add to the previous research on the topic of modernization by highlighting the need for technology to support a fully integrated fighting force in a pan-domain operating environment, while also being good stewards of public resources. Furthermore, it aims

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[29] Major B. Sing, "Service Second to Some: Innovation and Best Practices in Defence Logistics," (Joint Command Staff Program Course Paper, Canadian Forces College, 2017), 19-20, 24.

[30] Major Chris Zimmer, "For want of a nail the campaign was lost. DND's supply chain: a state of performance paralysis," (Directed Research Project, Canadian Forces College, 2009).

[31] *Ibid.,* 8.

[32] *Ibid.,* 9. The five core supply chain management disciplines are: view supply chain as a strategic asset, develop end-to-end process architecture, design your organization for performance, build the right collaborative model, and use metrics to drive business success.

to discuss recent DND/CAF efforts at modernizing and improving its operational effectiveness and stewardship through projects such as the MISL.

The Royal Canadian Logistics Service (RCLS)

The term 'administration' was originally adopted by Canada from the British to include logistics and personnel management.[33] Later, the term 'logistics' and the 'Logistics Branch' were used to capture many of the logistics functions, including the Engineering Branch and Royal Canadian Electrical and Mechanical Engineering (RCEME) Corps which provided logistic related enablers.[34]

Following the 1966 Canadian Forces Reorganization Act (Bill C-243), the individual service logistic components and the services of transportation, supply, finance, and food services were unified as the Logistics Branch on 1 February 1968.[35] Over the last 50+ years the Logistics Branch has provided support functions to the entire DND/CAF both at home and on operations abroad. In commemoration of its 50 year anniversary the branch received its Royal designation on 16 October 2018 from the Governor General and Commander-in-Chief of Canada, becoming the RCLS.[36] Comprised of nine occupations,[37] and 13,467 members,[38] professional logisticians

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[33] Department of National Defence, A-LM-031-000/AG-000, *Canadian Forces Logistics Branch Handbook* (Ottawa: DND Canada, 1993), 9.

[34] *Ibid.,* 9.

[35] *Ibid.,* 13. Components included: Royal Canadian Navy Supply Branch, Royal Canadian Army Service Corps, Royal Ordnance Corps, Royal Canadian Army Pay Corps, Royal Canadian Air Force Branches: Mobile Support Equipment, Supply, Finance, Food Services Branch.

[36] Department of National Defence, The Maple Leaf, "Logisticians celebrate their 50th anniversary", Last accessed on 11 December 2020, https://ml-fd.caf-fac.ca/en/2018/11/21551.

[37] Department of National Defence, A-LM-031-000/AG-000, *Canadian Forces Logistics Branch Handbook* (Ottawa: DND Canada, 1993), 10. Occupations include: Financial Services Administrator, Human Resources Administrator, Cook, Postal Clerk, Supply Technician, Traffic Technician, Ammunition Technician, Mobile Support Equipment Operator, and Logistics Officer.

[38] E-mail from Royal Canadian Logistics Service Integrator, Staff Officer Production 3, Captain Simpson to Author, 30 November 2020. The Royal Canadian Logistics Service includes 9,889 Regular Force and 3,578 Reserve members for a total of 13,467 Canadian Armed Forces Logisticians. This does not include the thousands of logisticians who are DND civilian employees, and fulfill key roles alongside CAF logisticians as Defence Team members.

complete mission essential activities on a daily basis and directly contribute to the success and credibility that the CAF has had worldwide. Through the motto of 'Servitium Nulli Secundus' or 'Service Second to none',[39] the strength of the RCLS, the logistics system, and its logisticians are critical to continuing to deliver the GoC's and the DND/CAF mandate of being "strong at home, secure in North America, and engaged in the world."[40]

Having identified and discussed logistics in general, the DND/CAF logistics, and the modernization of logistics through technology in this chapter, the paper will transition to focusing on a key part of the DND/CAF logistics, the DSC. By discussing the DSC, one will have a better understanding of how the role of technology can improve the operational effectiveness and stewardship of the DND/CAF logistics.

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[39] Department of National Defence, A-LM-031-000/AG-000, *Canadian Forces Logistics Branch Handbook* (Ottawa: DND Canada, 1993), 15.

[40] *Strong, Secure, Engaged*, 6.

CHAPTER 3: THE DEFENCE SUPPLY CHAIN

A key function of the DND/CAF logistics system is the DSC as shown in Figure 3.1. This figure shows the many components (i.e. Bases/Wings, CJOC) of the DSC that are involved in procuring and receiving materiel from industry in order to support operations. The figure also depicts the relationship that the ADM (Mat) has with industry in order to procure materiel that the DND/CAF requires. ADM (Mat) is also responsible for the DND/CAF materiel inventory of approximately 300,000 line items valued at $7.6 billion, and also reports to the GoC on its consumption and inventory annually.[41] Providing first, second, third, and fourth line support, the DSC supports operations at home and on deployment. CAF depots, such as 7 Canadian Forces Supply Depot (CFSD) in Edmonton, and 25 CFSD in Montreal, hold the majority of the DND/CAF inventory until it is distributed amongst the different elements (Army, Navy, Air Force, Special Operation Force), or around the world in support of operations.

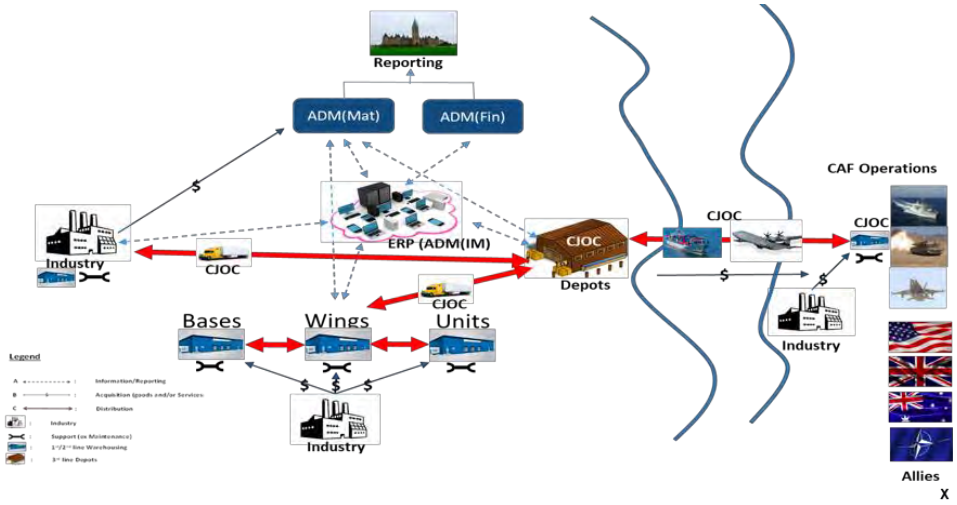

Figure 3.1 – The Defence Supply Chain

Source: DND, Strat J4 MISL Presentation

[41] Department of National Defence, "Strategic J4 Logistics Modernization and Integration of Sustainment and Logistics (MISL) Presentation," Slide 13/38, 28 January 2020.

Included in the DSC's functions are warehousing and distributing (or transporting) the right materiel to the soldier. Distribution includes delivering 10,000 shipments annually through the CAF's domestic and global system of transportation and movements at a cost of approximately $35 million.[42] Within Canada, CJOC's CMSG is responsible for warehousing materiel in its depots, as well as distributing it through the National Freight Run (NFR) to Bases, Wings and Units as shown in Figure 3.1. For deployed operations, the CJOC provides logistics support by ensuring that materiel is prioritized and shipped via military and commercial air or sea lift, and as required through CAF Operational Support Hubs (OSH).[43] The ultimate goal of the DND/CAF logistics systems and the DSC is to provide the right equipment, at the right location, at the right time in order to support personnel, while ensuring effectiveness and efficiency. The materiel process and capability (as shown in Figure 3.2) is a shared responsibility between the Deputy Minister (DM) and the Chief of the Defence Staff (CDS). The delineation of responsibilities being that the DM is responsible for the national procurement of materiel, whereas the CDS is responsible for the weapon system maintenance and sustainment. The middle of Figure 3.2. indicates the shared responsibility that the DM and CDS have for overseeing the Warehousing and Distribution (W&D), and more specifically speaks to stewardship and accountability, as well as operational effectiveness.[44]

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[42] Department of National Defence, "Strategic J4 Logistics Modernization and Integration of Sustainment and Logistics (MISL) Presentation," Slide 14/38, 28 January 2020.

[43] Department of National Defence, "Operational Support Hubs", last accessed 9 November 2020, https://www.canada.ca/en/department-national-defence/services/operations/military-operations/conduct/support/hubs.html.

[44] Department of National Defence, "Strategic J4 Modernization and Integration of Sustainment and Logistics (MISL) Presentation," Slide 13/47, 4 February 2020.

Figure 3.2 – Materiel Sustainment Capability – Concept of Operations

Source: DND, Strat J4 MISL Presentation

Shown in Figure 3.3 is the relationship between the Enterprise Resource Planning (ERP) software and the materiel sustainment capability, specifically the W&D function. Managed by the ADM IM, the ERP software is critical to enabling the entire sustainment capability of the DND/CAF logistics system. It plays a vital role as it reaches across the entire functional area spectrum and includes the Defence Resource Management Information System (DRMIS) (Warehousing), Ammunition Information Management System (AIMS) (Ammunition), National Movement and Distribution System (NMDS) (Shipping), Fleet Management System (FMS) (Fleet Management), and Defence Customs Brokerage System (DCBS) (Customs). Each of the systems within the ERP software are stand-alone systems that have different languages, and have no single centralized owner that can maintain them with any required updates.[45] Within the current system's construct there is also no organization responsible for taking a macro look at how changes in one system can impact another.[46] Additionally, due to the lack of automation and interface between the individual systems, manual inputs are required to help ensure the operational effectiveness and materiel management, and accountability or stewardship of the

[45] Department of National Defence, "Strategic J4 Modernization and Integration of Sustainment and Logistics (MISL) Presentation," Slide 18/47, 4 February 2020.

[46] *Ibid.,* Slide 18/47.

DSC. This includes providing End-to-End (E2E) visibility of all equipment throughout the sustainment process. This poses a significant risk and a limitation, as relying on manual entries creates a susceptibility of errors and a loss of overall reliability and credibility of the DSC.

Figure 3.3 – Materiel Sustainment Capability – ERP Software

Source: DND, Strat J4 MISL Presentation

Logistics Support to Operations

Effective logistics operational support to CAF operations in Canada and overseas includes incorporating the principles of support (or sustainment). These principles include foresight, economy, flexibility, simplicity, cooperation, self-sufficiency, visibility, responsiveness, and survivability.[47] These principles also form the basis of achieving operational effectiveness and stewardship of resources through the *CAF Support Framework*. Figure 3.4 depicts the *Support Framework* which is comprised of three main parts and their respective organizations to include: National Support, Strategic lines of communication, and theatre support, as well as the levels of sustainment: strategic, operational, and tactical.[48]

[47] Department of National Defence, B-GL-005-400-FP-001, *Canadian Forces Joint Publication Support Doctrine CFJP 4-0* (Ottawa: DND Canada, 2016), 1-3.

[48] *Ibid.,* 2-3, 2-4.

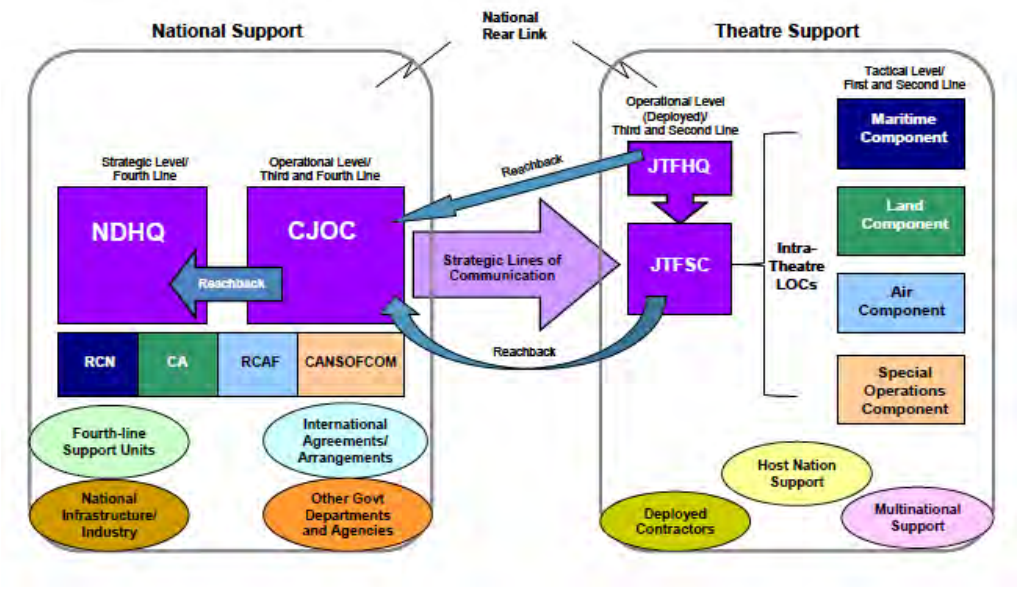

Figure 3.4 – CAF Support Framework

Source: DND, *Canadian Forces Joint Publication Support*, 2-3.

Understanding the levels of sustainment is important as it delineates responsibilities and effort to provide sustainment within the *CAF Support Framework*. Strategic level sustainment focuses on enabling the operational level to support operations, and includes national acquisition, readiness, force generation, project and sustainment.[49] Operational sustainment provides operational support to theatres of operation and links the strategic with the tactical levels.[50] Finally, the tactical level includes the provision of materiel and services to forces conducting tasks that range from replenishment to health services and personnel administration.[51]

To conclude the understanding of support, Figure 3.5 indicates how lines of support (i.e. first, second, third, fourth) are based on capabilities, and more specifically the need to provide

[49] Department of National Defence, B-GL-005-400-FP-001, *Canadian Forces Joint Publication Support Doctrine CFJP 4-0* (Ottawa: DND Canada, 2016), 2-4.
[50] *Ibid.,* 2-4.
[51] *Ibid.*

flexibility based on certain capabilities at different levels.[52] This Figure also illustrates the relationship between the levels of sustainment and lines of support, and how they overlap in certain areas. By examining the relationship between Figures 3.4 and 3.5, it is understood that first and second line support, or tactical and operational levels of sustainment fall within 'In-Theatre Support' and are provided by the Task Force (TF), the Host Nation, contractors, or multinational organizations. Whereas, 'National Support', or operational/strategic levels of sustainment, includes third- and fourth-line support relationships which are enabled through reach back to Canada. For example, through CJOC to supply depots or industry.

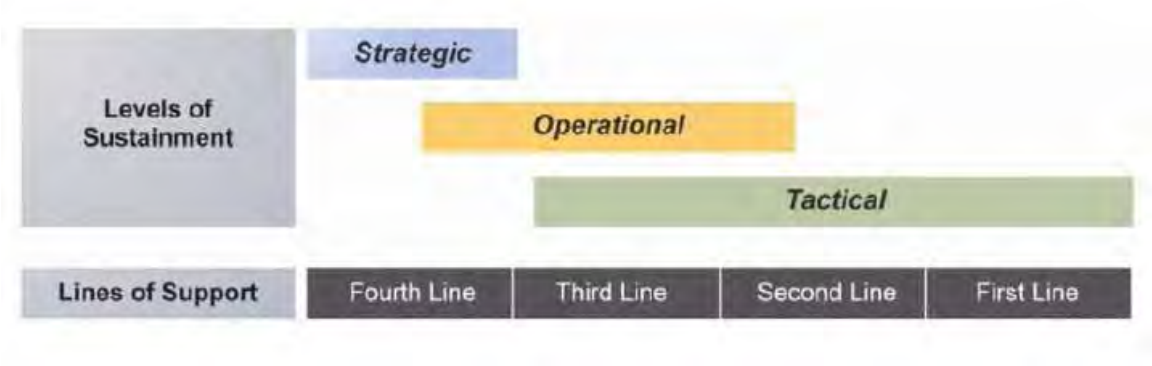

Figure 3.5 – Relationship between levels of sustainment and lines of support

Source: DND, *Canadian Forces Joint Publication Support*, 2-5.

During an operation overseas, the sustainment of materiel occurs through a 'push' or a 'pull' system. In a 'push' system in particular, command and control IT systems and asset tracking are utilized to assist in determining anticipated requirements or consumption rates, at which time the equipment is shipped to the operation from a depot or another location without creating stockpiles of unnecessary equipment in the theatre of operations. Alternatively, a 'pull'

[52] Department of National Defence, B-GL-005-400-FP-001, *Canadian Forces Joint Publication Support Doctrine CFJP 4-0* (Ottawa: DND Canada, 2016), 2-4.

system is one where the unit itself will requisition certain commodities based on their consumption.[53] In both a 'pull' and 'push' system, the use of technology is critical to enabling those organizations who are involved in the sustainment process across the levels of sustainment and lines of support. Technology, such as decision support tools, automated inventory systems, and full asset visibility (AV) are used in industry such as with Walmart and Amazon to provide support to day-to-day operations.[54] These are a few examples of how technology can facilitate decision-making within CAF units and organizations by maintaining situational awareness (SA) on inventory levels.[55]

Materiel Ordering Process

Within a theatre of operations, and in Canada, the process of requisitioning materiel that is unavailable is initiated through either the 'pull' or 'push' system within DRMIS. Figure 3.6 shows the materiel ordering process starting with the materiel (also known as a consignment) being requested. Based on the Required Delivery Date (RDD) for the specific item, the item will be assigned a Materiel Priority Code (MPC) as operational critical or a 'high priority', also known as a High Priority Requisition (HPR), as 'essential', or as 'routine'.[56] The next step in the process involves the system confirming if there is sufficient stock or inventory available to fill the requisition. If there is enough stock the item(s) are set aside for movement. If there is insufficient stock, the items are unavailable, or there are limitations on its availability, then the

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[53] Department of National Defence, B-GL-005-400-FP-001, *Canadian Forces Joint Publication Support Doctrine CFJP 4-0* (Ottawa: DND Canada, 2016), 7-4.

[54] In Chapter 5, the use of technology within Walmart and Amazon will be discussed.

[55] Department of National Defence, B-GL-005-400-FP-001, *Canadian Forces Joint Publication Support Doctrine CFJP 4-0* (Ottawa: DND Canada, 2016), 7-4.

[56] Office of the Auditor General (OAG) of Canada, Report of the Auditor General of Canada to the Parliament of Canada, Independent Auditor's Report: *Report 3 Supplying the Canadian Armed Forces – National Defence*, Last accessed 15 December 2020, https://www.oag-bvg.gc.ca/internet/English/parl_oag_202007_03_e_43574.html, 5. For additional information on the materiel requisition process please see the Supply Administration Manual – A-LM-007-100/AG-001, Chapter 3.2.

request is directed to the supply manager who makes the decision to either release the equipment or procure the items.[57]

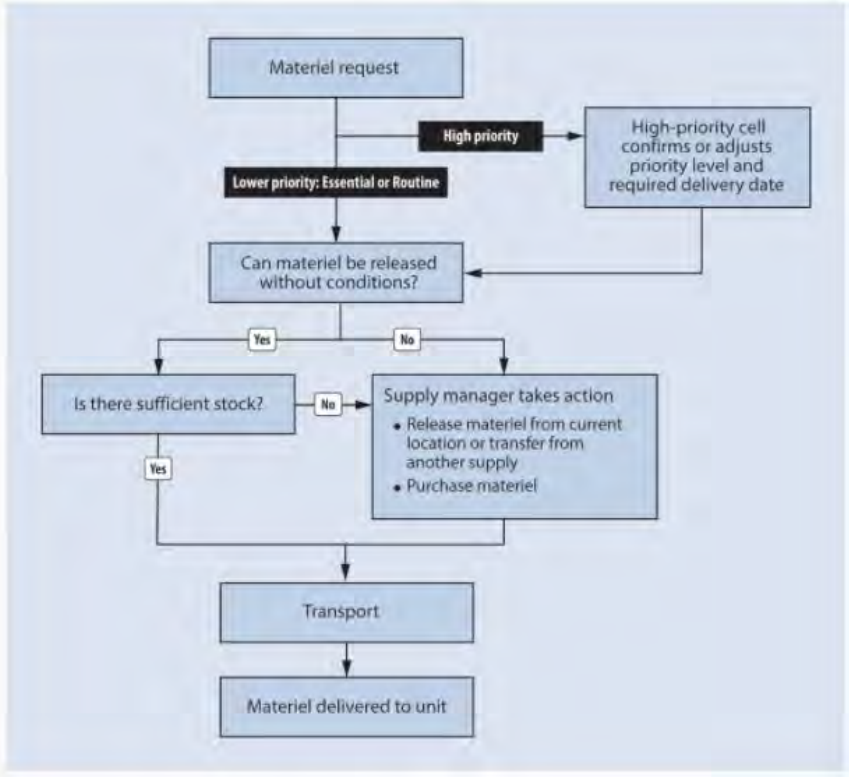

Figure 3.6 – Process for materiel requests

Source: OAG, *Report 3 Supplying the Canadian Armed Forces*

Subsequently, DRMIS creates a Consignment Authorization Request Form (CARF) and the items are prepared for shipment. DRMIS then interfaces with the NMDS to assign the item a Transportation Control Number (TCN) which is used to create the item's shipping Waybill (WSBL). The item's mode of transportation is then chosen based on the destination and RDD. Prioritization of equipment for overseas operations is determined by the CJOC in collaboration with the deployed TF. The movement of equipment is also coordinated by the CJOC J4

[57] Office of the Auditor General of Canada. Report of the Auditor General of Canada to the Parliament of Canada, Independent Auditor's Report: *Report 3 Supplying the Canadian Armed Forces – National Defence*. Last accessed 15 December 2020, https://www.oag-bvg.gc.ca/internet/English/parl_oag_202007_03_e_43574.html, 4.

Movement Operations cell with 2 Air Movements Squadron in Trenton; the CAF's only Air Movements Squadron.[58]

Throughout the sustainment process operational effectiveness and stewardship are key concepts that are enabled by materiel management and AV. However, current AV in the CAF is limited as it is only available by conducting a TCN search in either the DRMIS or NMDS. Furthermore, the ability to provide AV is only possible if the item's location/status has been updated manually. What that search can provide is if the item has either been dispatched (from origin) or receipted (at destination). Another limitation with the current system is that detailed location data or estimated arrival timing information is not available. Finally, once the equipment arrives at destination, the requesting unit is advised that the shipment has arrived, and the shipment entry is closed.

Within the DND/CAF logistics, the DSC serves as the conduit to provide materiel to support both expeditionary operations abroad and operations in Canada. To provide this support the DSC relies upon a sustainment system and an established materiel ordering process. This system is enabled by technology such as the ERP suite of software programs. However, the current individual software programs within the ERP are not well integrated or optimized to effectively and efficiently support the CAF of today or tomorrow's FOE. The limitations of the current technology have therefore impacted the CAF, its readiness, and accountability. In the following chapter these limitations and challenges will be discussed further as will the need to modernize DND/CAF logistics using technology.

[58] 2 Air Movements Squadron is based at 8 Wing/CFB Trenton and is responsible for receiving, planning, building equipment onto CAF or chartered aircrafts in support of CAF operations at home and overseas. For additional information please refer to http://www.rcaf-arc.forces.gc.ca/en/squadron/2-squadron.page.

CHAPTER 4: THE LOGISTICS SYSTEM AND DEFENCE SUPPLY CHAIN CHALLENGES

Within the previous chapter, some of the challenges of the logistics system and DSC were briefly identified. These challenges have impacted the operational effectiveness and performance of the system and DSC, and as a result they are operating at less than optimal levels. This conclusion is especially important to recognize and address for current operations and as the CAF transitions to fighting in a pan-domain operating environment. This pan-domain environment will be challenging as it will include multiple concurrent operations and domains competing for logistics support and closely managed resources, while having significant influence on mission success or failure.[59] Furthermore, these system and DSC concerns and challenges not only impact the CAF's readiness, but also denote departmental risk in financial reporting and the stewardship of materiel.[60] These concerns are not new, and have been raised in the past 10 years through the Office of the Auditor General (OAG) of Canada reports. One such concern is improper accounting of materiel inventory, which DND is addressing with corrective measures by creating an inventory management action plan.[61] Additional logistics system and DSC issues and challenges are discussed below by examining the 2008 and 2020 OAG reports.

2008 OAG Report

This audit focused on whether the supply chain could maintain sufficient stock levels for repair and maintenance, and if it had the ability to provide AV and management over the

[59] Department of National Defence, "Strategic J4 Logistics – Modernization and Integration of Sustainment and Logistics (MISL) Presentation," Slide 12/47, 4 February 2020.

[60] *Ibid.,* Slide 13/47.

[61] Office of the Auditor General of Canada, Report of the Auditor General of Canada to the Parliament of Canada, Independent Auditor's Report: *Report 3 Supplying the Canadian Armed Forces – National Defence*, Last accessed 15 December 2020, https://www.oag-bvg.gc.ca/internet/English/parl_oag_202007_03_e_43574.html, 1.

supplies as they moved to Afghanistan.[62] In summary, it found that the Department was able to successfully deliver equipment, but that there were concerns and deficiencies that needed to be addressed in order to ensure no impact to operations.[63] These issues were centered upon the inability to meet delivery timelines, ineffective tracking methods, limited to no available data on supply chain performance monitoring, and that the management of stock levels needed to be improved.[64] Although the report cites that Commanders did not notice any significant impact to operations as a result of the issues, it was determined that the issues were often mitigated by the efforts of personnel, or by multiple ordering, which increased the stock and challenges of tracking equipment.[65] In the Department's response it indicated that efforts were being pursued to address the deficiencies through the use of technology, such as AV tracking, and the implementation of a key performance measurements for the supply chain.[66] These efforts will be discussed later in the paper.

2020 OAG Report

This audit focused on determining if the CAF had been delivering the right equipment in a timely manner without unnecessary transportation costs.[67] The report's findings indicated poor supply chain management practices; summarized as late deliveries, "poor stock management, inefficient processing of requests, and inadequate control over transportation costs."[68] It also concluded that at least half of the delivery of spare parts, uniforms, and rations were late by 15

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[62] Office of the Auditor General of Canada, *Report of the Auditor General of Canada to the House of Commons: Chapter 2 Support for Overseas Deployments-National Defence* (Ottawa: Office of the Auditor General of Canada, 2008), 1.

[63] *Ibid.*

[64] *Ibid.,* 10-14.

[65] *Ibid.,* 21.

[66] *Ibid.,* 12-13.

[67] Office of the Auditor General of Canada, Report of the Auditor General of Canada to the Parliament of Canada, Independent Auditor's Report: *Report 3 Supplying the Canadian Armed Forces – National Defence*, Last accessed 15 December 2020, https://www.oag-bvg.gc.ca/internet/English/parl_oag_202007_03_e_43574.html, 3.

[68] *Ibid.,* 6.

days due to unavailability of stock and the need to reroute shipments to find availability (which increased the time to fill the request and the transportation costs).[69] Other findings indicated that there were a high number (almost 8% of requests) that were submitted as HPRs without the proper justification, with half of those requests arriving six days late.[70] Finally, the audit reported that there were insufficient performance measurements built into the DSC, which impacted the ability for item managers to know where materiel was available, or if it was suitable for what was needed.[71] Within each of these concerns the operational effectiveness and stewardship of the DSC was impacted. Specifically, materiel was not available at the right place resulting in delays, extra effort by personnel to track the items, and increased costs due to the need to procure and ship items, most often commercially.[72]

Based on the deficiencies of the 2020 report there were a number of recommendations provided. These included completing a review of materiel requirements and their location within Canada, enhancing the oversight of HPRs, and finally taking steps to ensure that all transportation costs are well articulated to enable the mode of transportation decision-making process.[73] Each of these recommendations were followed-up by the DND with action plans to improve materiel management and accountability through data analysis powered by technology. Ultimately, these action plans would also assist with improving the operational effectiveness and the stewardship of resources.

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[69] Office of the Auditor General of Canada, Report of the Auditor General of Canada to the Parliament of Canada, Independent Auditor's Report: *Report 3 Supplying the Canadian Armed Forces – National Defence*, Last accessed 15 December 2020, https://www.oag-bvg.gc.ca/internet/English/parl_oag_202007_03_e_43574.html, 3.

[70] *Ibid.,* 3.

[71] *Ibid.*

[72] *Ibid.,* 8.

[73] *Ibid.,* 10-12.

Information Technology (IT) Challenges

Some of the challenges associated with the DSC and highlighted in the OAG reports discussed above involve the DND/CAF IT and the ERP warehousing and distribution systems. These challenges have created inefficiencies with the DND/CAF and specifically as it relates to logistics and the DSC. As a result, both operational effectiveness and good stewardship over resources has been negatively impacted.

Firstly, the current warehousing and distribution systems were individually developed over time and therefore their business processes are not integrated.[74] This lack of integration has interrupted the ability for DSC users and decision-makers to have both visibility and a high level of accountability across the spectrum of the supply chain.[75] Furthermore, consultant reports such as the KPMG Defence Renewal Change Management Services Warehousing and Distribution report from 2015 found that the warehousing and distributions system's data was either missing or was of a poor quality.[76] The accuracy of system data is important as it is used to create reports, and due to these issues it left users having lower levels of confidence in the system. The consultant report further identified that the system was not using metrics to establish performance measurements, a similar finding to that of the 2008 and 2020 OAG reports.[77]

Enabling operational effectiveness and efficiencies through AV and accountability of materiel across the DSC has also been impacted by the lack of integration between the warehousing and distributions systems. Despite the system's lack of integration and limitations,

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[74] Department of National Defence, "Strategic J4 Logistics – Modernization and Integration of Sustainment and Logistics (MISL) Presentation," Slide 14/47, 4 February 2020.

[75] *Ibid.,* Slide 14/47.

[76] KPMG, *Defence Renewal Change Management Services Warehousing and Distribution Final Report* Volume 1, 23 November 2015.

[77] Department of National Defence, "Strategic J4 Logistics – Modernization and Integration of Sustainment and Logistics (MISL) Presentation," Slide 14/47, 4 February 2020; KPMG, *Defence Renewal Change Management Services Warehousing and Distribution Final Report* Volume 1, 23 November 2015.

which came at the cost of efficiency, the system has continued to support the high operational tempo of the DND/CAF. For example, the DND/CAF has had to overcome the system deficiencies by holding additional excess materiel, and also employing additional people to execute manual/duplicate entries in functional areas (i.e. procurement to distribution/invoicing).[78] As a result of holding additional materiel in order to maintain the sustainment system and operational effectiveness of the DND/CAF, there has been a requirement for additional materiel warehousing and infrastructure. With additional infrastructure, the cost to the DND increases. Furthermore, the limitation of the systems, combined with their lack of integration and manually driven processes, has diminished DSC SA and the ability to provide accurate information to decision-makers.[79] These inefficiencies can be summarized as poor stewardship of public resources. Finally, the DSC's ability to anticipate and provide foresight to the Operational Planning Process (OPP), and execution phase of an operation has also been impacted by the system's inefficiencies, which can subsequently lower readiness levels (i.e. Force Generation requirements) for CAF operations.[80]

In summary, today's DSC includes challenges in terms of the IT systems that are used to manage the logistics system and the operational function of 'sustain'. Integration issues, the lack of performance measurements and monitoring, and redundant processes are a few of the issues that have been highlighted. In order to mitigate and diminish the impact that these challenges have had on DND/CAF logistics and the DSC, surplus inventory has been procured and warehoused, and additional personnel have been employed to conduct key sustainment activities. To maintain support to current and future operations as effectively and efficiently as possible, the

[78] Department of National Defence, "Strategic J4 Logistics – Modernization and Integration of Sustainment and Logistics (MISL) Presentation," Slide 12/47, 4 February 2020.
[79] *Ibid.,* Slide 11/47.
[80] *Ibid.,* Slide 13/47.

DND/CAF must address these inefficiencies by implementing the use of technology and by integrating with all stakeholders within the defence community and across multiple domains. Many technologies exist within industry that can assist with operational effectiveness and stewardship. However, the DND/CAF needs to understand their power and how to implement them so that the system can operate as effectively and efficiently as possible.

CHAPTER 5: TECHNOLOGY AND LOGISTICS

The important role of technology in modern day logistic systems is apparent now more than ever, and its use can also assist in addressing the challenges within the DSC. Technology has played a part in transitioning logistics from inefficient and ineffective practices of stockpiling 'Iron Mountains' of supplies, to distribution-based logistics practices of delivering the right things to the right place at the right time, referred to as 'just-in-time'. It is clear that the use of technology within logistics systems and supply chains will continue to evolve towards 'Sense and Respond Logistics' (S&RL), known as "a network-centric, knowledge-driven, knowledge-guided concept . . . to execute Joint and Coalition effects-based operations . . . for achievement of commander's intent."[81] Despite S&RL having been discussed for the last few decades, it has not been fully integrated into the DND/CAF logistics system or DSC. This must change with the nature of warfare and threats shifting to those of a pan-domain environment, and the greater requirement for operational effectiveness and stewardship, through data analytics and 'smart logistics'.[82] Central to this shift is technology, through AIT, as well as BI and analytics. Technology has the power to automate AV across a logistics system and supply chain and can also assist with combining mass data in order to effectively analyze information. To adopt this approach, a more fulsome and concerted effort needs to be made towards implementing technology itself. Industry's use of technology to improve logistic processes and systems should also be recognized, with consideration given to incorporate their uses of technology into the business of defence and with militaries worldwide. A few of the industry leaders in logistics and

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[81] United States Department of Defence, "Logistics Transformation Strategy: Achieving Knowledge-Enabled Logistics," 2004, 7, http://www.acqnotes.com/Attachments/DoD%20Logistics%20Transformation%20Strategy%20%E2%80%9CAchieving%20Knowledge-Enabled%20Logistics%E2%80%9D%2010%20Dec%2004.pdf.

[82] Kevin J, Stewart, "Future Logistics Challenges." *Marine Corps Gazette* 102, no. 12 (12, 2018): 57, https://search-proquest-com.cfc.idm.oclc.org/trade-journals/future-logistics-challenges/docview/2154151026/se-2?accountid=9867.

supply chains include Amazon, Maersk, and Walmart. After providing an understanding of key logistics and supply chain concepts, the use of technology within those large companies will be discussed.

AV and In-Transit Visibility (ITV)

One way that technology assists a logistics system and a supply chain is by providing AV or ITV on materiel as it moves from a warehouse to its final destination. AV can be used to track items of varying sizes, value, or importance. This can also include tracking individual high value items, or an entire shipment of individual items that have been manifested within a sea container or on an aircraft pallet. The way AV is used is entirely dependent on the specific organization's requirement to track items from one location to another. Given its functionality, AV enables an organization to maintain operational effectiveness and stewardship of resources across its supply chain through materiel management, and by assisting in setting priorities and re-routing shipments based on operational requirements.[83] The situational and real-time information that AV provides decision-makers of an organization is therefore highly valuable. Finally, by possessing an AV capability an organization can track its materiel more accurately, which increases user confidence in the system, and avoids the need and cost associated with holding unnecessary surplus materiel at a location.[84] To enable effective and automated AV along a supply chain and logistic system, AIT should be used.

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[83] Department of National Defence. B-GL-300-004/FP-001, *Sustainment of Land Operations* (Ottawa: DND Canada, 2010), 3-5.

[84] Department of National Defence. B-GL-300-004/FP-001, *Sustainment of Land Operations* (Ottawa: DND Canada, 2010), 3-5; Jeremy Smith, *Defence Logistics: Enabling and Sustaining Successful Military Operations*. Limited, 2018. *ProQuest Ebook Central*, https://ebookcentral.proquest.com/lib/cfvlibrary-ebooks/detail.action?docID=5231112, 349.

AIT

For an organization to have an AV capability they must possess the capability to track materiel. This capability is provided either manually or automatically. As an example, manual tracking involves dedicated individuals who document when an item has departed or arrived at a location. The use of personnel to complete these tasks is therefore cumbersome and susceptible to errors. From a human resourcing point of view manual AV is also inefficient, as these tracking tasks can be conducted through the use of technology. Many businesses within industry have therefore invested in AIT to provide AV as it is more accurate and allows personnel who were once used to track items to be employed in other tasks which cannot necessarily be completed by automatic systems. Types of AIT used in both industry and with militaries globally include Radio Frequency Identification Tags (RFID), Global Positioning Systems (GPS), and barcode systems.

Radio Frequency Identification Devices (RFID)

In 2014, RFID global sales surpassed 20 million USD, a testament of how valued this technology is to organizations worldwide.[85] RFID is comprised of a device or tag that can be attached to an individual item, sea container or vehicle, and that uses radio waves to communicate its location. The radio waves communicate with a reader or interrogator; a two-way transmitter that can both receive information and transmit information to a software system for tracking purposes.[86] Globally, RFID is used in supply chains to track materiel from production to final destination, and in particular for cargo that is of high-value, or is temperature

[85] Maria G. Burns, *Logistics and Transportation Security: A Strategic, Tactical, and Operational Guide to Resilience* (Boca Raton: CRC Press, 2016), 255.

[86] *Ibid.,* 255.

sensitive (i.e. food, medicine, hazardous material).[87] RFID technology is further defined as either passive or active depending on the type of tag or device used. Passive tags are those that do not contain their own power, and are only powered-on and 'read' when they pass an interrogator at a port or warehouse entrance/exit.[88] Alternatively, active tags are more expensive but possess their own battery, and can emit signals over a longer distance to a reader in order to communicate their precise location. Finally, certain types of RFID are also employed globally to transmit data, and to enable 'smart logistics' through total AV. Types of data that can be transmitted include the temperature and humidity of cargo, or security information, such as if the items have been tampered with, or if the container has been opened.[89] This information can provide organizations and supply chain managers with the status, readiness, or condition of their cargo. Examples of RFID providing AV are vast, to include freight forwarders and major shipping companies who provide ITV to their customers through IT internet-based software programs.

Global Positioning System (GPS)

Owned by the United States of America, the GPS provides civilian and military users with "positioning, navigation, and timing services" through satellites that orbit around the world every 12 hours.[90] This technology can be used to provide AV through a signal that is emitted from an item, for example a vehicle. In order for an item to communicate its position to one of the GPS satellites, the item must emit a signal to a system or a cellular network. The signal

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[87] Maria G. Burns, *Logistics and Transportation Security: A Strategic, Tactical, and Operational Guide to Resilience*, (Boca Raton: CRC Press, 2016), 256.

[88] A. Boukhtouta and J. Berger, "Improving in-transit and in-theatre asset visibility of the Canadian Armed Forces supply chain network," *2014 International Conference on Advanced Logistics and Transport (ICALT)* (Hammamet, 2014), 152. http://ieeexplore.ieee.org/document/6864109/author.

[89] Maria G. Burns, *Logistics and Transportation Security: A Strategic, Tactical, and Operational Guide to Resilience*, (Boca Raton: CRC Press, 2016), 256.

[90] United States Air Force, "Global Positioning System," Last accessed on 30 December 2020, https://www.af.mil/About-Us/Fact-Sheets/Display/Article/104610/global-positioning-system/; United States of America, "The Global Positioning System," Last accessed on 30 December 2020, https://www.gps.gov/systems/gps/.

information is then used to pinpoint the location of the item, and if needed can transmit other item information such as velocity or speed. The information is then made available to stakeholders or decision-makers via an IT software program. To function, GPS' require their own power source, such as a vehicle's battery, and are generally more expensive than RFID. Consideration for using GPS for AV versus RFID is entirely dependent on the level of importance an organization has for the specific commodity being shipped. The recent global pandemic involving COVID-19 and tracking vaccines provides an example of the use of GPS technology. Specifically designed by Cathay Pacific Cargo, 'Ultra Track' is a system that can track and transmit location, as well as temperature, vibration and humidity data.[91] This information is transmitted to operations staff who monitor the cargo seven days a week, 24 hours a day, and as required can rectify situations when shipments such as vaccines reach high temperatures.[92]

Barcoding

Barcoding assists logistics systems and supply chains in maintaining operational effectiveness through inventory management and AV. Typically using a symbol of various dark bars or dark areas, a barcode system provides automatic identification. Alternatively, barcodes can be two-dimensional, and can capture large amounts of information into a small space. In both types, items can be quickly and accurately identified, while reducing human error.[93] Both of these are critical factors for operationally effective logistics system and supply chains. In today's

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[91] Inside Logistics – Canada's Supply Chain Magazine, "Next gen track and trace for air cargo," https://www.insidelogistics.ca/products/next-gen-track-and-trace-for-air-cargo/?utm_medium=email&utm_source=newcom&utm_campaign=MMandD&utm_content=2020122265502, 17 December 2020.

[92] *Ibid.*

[93] Max Muller, "CHAPTER 4: The Basics of Bar Coding." In *Essentials of Inventory Management*, 89–113. American Management Association International, 2003. http://search.ebscohost.com.cfc.idm.oclc.org/login.aspx?direct=true&db=bth&AN=32725593&site=ehost-live&scope=site, 89.

global commercial sector, manufacturers use barcodes, known as Universal Product Code's, which are used for point-of-sale identification at almost all retail stores.[94] The use of barcodes in retail is both operationally effective and efficient as it increases the rate at which a sales attendant (or in some cases a self-checkout machine) can process the sale of an item for a customer, while also ensuring that the customer has been charged for the correct item and price. In warehousing, companies will also use a barcode system to track inventory and assist with stocktaking. Other applications of barcodes are within the airline industry, which uses the codes to track traveler baggage as it moves from one location to another. Finally, similar to the commercial sector, militaries also employ barcoding to ease with tracking materiel, performing stock taking functions, as well as theatre of operation activation or closures where selecting and cataloguing what materiel is on hand is key.

AIT's ability to provide AV to a logistics system and supply chain have been recognized globally, with their usage being extremely prevalent. From RFID, GPS, and barcode systems, the speed and volume of information that is provided by AIT creates opportunities for data collection and analysis by Decision Support Systems or BI systems. Using AIT in combination with an IT or Decision Support System ensures effective supply chain management, while also keeping decision-makers fully informed.[95]

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[94] Max Muller, "CHAPTER 4: The Basics of Bar Coding." In *Essentials of Inventory Management*, 89–113. American Management Association International, 2003. http://search.ebscohost.com.cfc.idm.oclc.org/login.aspx?direct=true&db=bth&AN=32725593&site=ehost-live&scope=site, 98.

[95] A. Boukhtouta and J. Berger, "Improving in-transit and in-theatre asset visibility of the Canadian Armed Forces supply chain network," *2014 International Conference on Advanced Logistics and Transport (ICALT)* (Hammamet, 2014), 149, http://ieeexplore.ieee.org/document/6864109/author.

BI

Once referred to as "decision support, executive information systems, [or] management information systems", BI has grown significantly in the last half century.[96] To be proactive, businesses and organizations such as militaries use specialized software BI systems to collate operational data (both structured and semi-structured) and then use analytical tools to identify trends, and help with presenting future organizational direction.[97] This data-driven information is then used by both planners and decision-makers within an organization to formulate action plans. BI use not only includes those responsible for making decisions at the strategic level but extends to the tactical level of an organization as well. Within today's fast paced, and technologically advanced global market, the use of BI to support decision-makers within an organization are essential for success.

BI has many processes and aspects which can include reports, scorecards, dashboards, analyses, forecasts, models and simulations.[98] Other terms used in BI are data analytics and big data. Figure 5.1 shows the different components of BI that are used within industry today.

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[96] Solomon Negash, "Business Intelligence," *Communications of the Association for Information Systems*, 13, (13, 2004): 177-195. https://web.archive.org/web/20111215103244/http://site.xavier.edu/sena/info600/businessintelligence.pdf, 177.

[97] *Ibid*. https://web.archive.org/web/20111215103244/http://site.xavier.edu/sena/info600/businessintelligence.pdf, 177-178.

[98] Steve Williams, *Business Intelligence Strategy and Big Data Analytics: A General Management Perspective* (Cambridge, MA: Elsevier, 2016), 41.

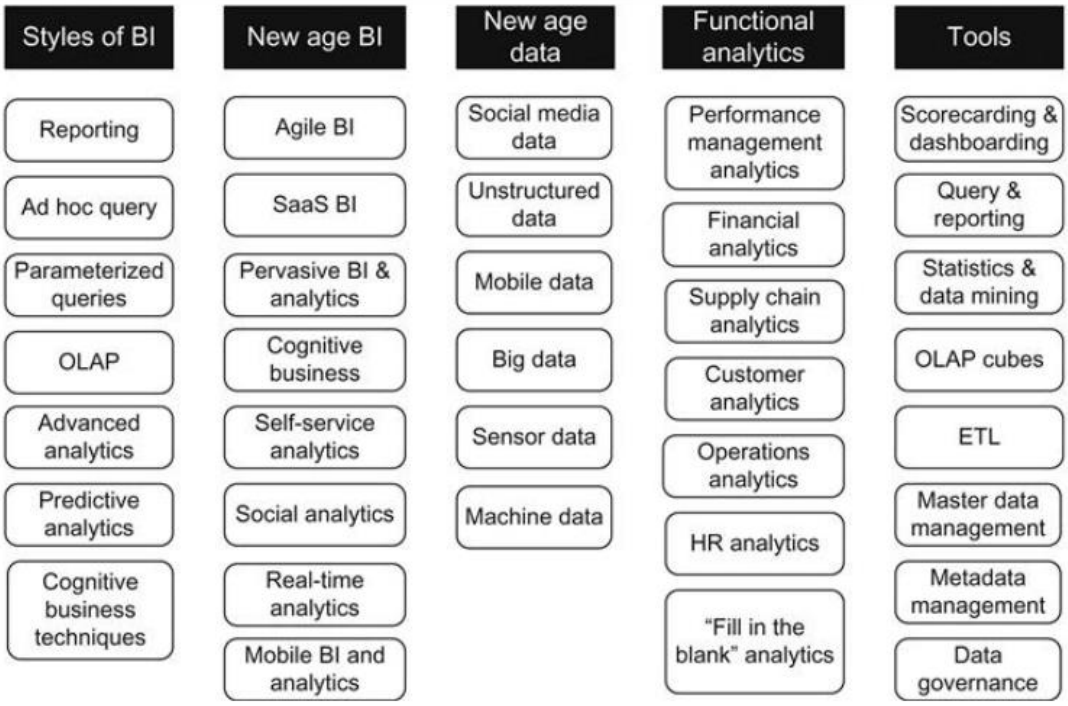

Figure 5.1 – Components or sides of Business Intelligence

Source: Steve Williams, *Business Intelligence Strategy and Big Data Analytics*, 41

Within business and specifically logistics, BI applications can assist in making smart data-driven decisions on plans such as those centered on demand, distribution, or logistics.[99] These plans then translate into action and can enable an organization's operations to be more customer focused, while also being as efficient as possible by keeping resource costs low. According to Gartner, a global leader in providing research and advice to over 14,000 client enterprises worldwide, both analytics and business intelligence "includes the applications, infrastructure and tools, and best practices that enable access to and analysis of information to improve and optimize decisions and performance."[100]

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[99] Steve Williams, *Business Intelligence Strategy and Big Data Analytics: A General Management Perspective* (Cambridge, MA: Elsevier, 2016), 59

[100] Gartner, "Analytics and Business Intelligence (ABI)", Last accessed 30 December 2020, https://www.gartner.com/en/information-technology/glossary/business-intelligence-bi; Gartner, "About Us", Last accessed 30 December 2020, https://www.gartner.com/en/about.

The commercial sector and industry's use of AV automated technology, combined with BI and analytics, assists with decision-making and continues to expand in order to ensure maximum operational output or performance for customers. It does so by also being fiscally responsible in how its resources are allocated and used. Finally, by understanding how different types of technology can support a logistics system and supply chain within industry it assists in demonstrating how militaries such as the CAF can incorporate these into their processes and procedures.

Technology In Industry

In today's global market many businesses have been extremely successful, or operationally effective, by being capable of quickly responding to customer demands while being efficient in terms of how they use their resources. These successes have been achieved through the incorporation of technology by "increas[ing] inventory turns, efficiency of receiving, stocking, picking, and shipping," and as a result organizations continue to invest in developing the latest technology.[101] These investments are also characterized by top priorities of automatic identification and data collection, and the linkages between warehousing, and both yard and transportation management.[102] A few of the most successful businesses from a logistics and supply chain perspective are Amazon, Maersk, and Walmart. Ensuring that their customer needs remain a top priority, their successes can be attributed to optimizing their operational effectiveness and cost through data-driven decision-making technology.

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[101] Material Handling Industry of America, "The Future of Warehouse Efficiency – Rapid Growth of Data Collection Technologies White Paper," Last accessed 9 November 2020, http://www.mhi.org/media/members/75421/130721984634737299.pdf, 2.

[102] *Ibid.,* 2.

Amazon

Leveraging warehouse technology such as robots and automated systems, and relying on artificial intelligence to assist with its business processes, it is predicted that Amazon's 2020 global ecommerce sales will be $416.48 billion, $12 billion more than what was predicted before the COVID-19 pandemic.[103] Through its automation of business processes, Amazon has been able to better utilize its personnel by using its historical retail data such as item availability and pricing to ensure that it can maintain its inventory levels.[104] In turn, those employees once used to perform these tasks have been assigned to developing new initiatives. In terms of using robots and automation, this world leader in online retail shopping has been able to store 50% more inventory in its approximately 1,600 facilities/warehouses due to the incorporation of robots.[105] This is because they can access more tightly packed shelves of items. Additionally, the efficient and timely shipment of items in the company's warehouses is also made possible through the use of technology. In particular are the warehouse robots that pick items, the barcodes that are used for alerting employees of packaging requirements for items, and finally, the machines that scan

[103] Business Insider, "Amazon's worldwide sales will rise 20.2% this year as reliance on e-commerce grows," 9 July 2020, Last accessed 2 January 2021, https://www.businessinsider.com/amazon-global-ecommerce-sales-will-reach-416-billion-in-2020-2020-7.

[104] Harvard Business Review, "How Amazon Automated Work and Put Its People to Better Use," 16 September 2020, Last accessed 31 December 2020, https://hbr.org/2020/09/how-amazon-automated-work-and-put-its-people-to-better-use.

[105] CNN Business, "Amazon only needs a minute of human labor to ship your next package," 6 October 2016, Last accessed 31 December 2020, https://money.cnn.com/2016/10/06/technology/amazon-warehouse-robots/index.html; MWPVL International, "Amazon Global Supply Chain and Fulfillment Center Network", Last accessed 31 December 2020, https://mwpvl.com/html/amazon_com.html. Facilitates include Fulfillment Centres, Prime Now Hubs, Delivery Stations, Airport hubs, Sortation Centres; Forbes.com, "Top 5 Online retailers: 'Electronics And Media' Is the Star of E-commerce Worldwide," 20 May 2019, Last accessed 2 January 2021, https://www.forbes.com/sites/ninaangelovska/2019/05/20/top-5-online-retailers-electronics-and-media-is-the-star-of-e-commerce-worldwide/?sh=649503a11cd9. Amazon was the top global e-commerce retailer in 2019.

address labels and move packages to the correct chutes for distribution via road through concepts such as AIT.[106]

Maersk

According to several sources, the Danish shipping company Moller-Maersk is the largest in the world in terms of sea container traffic capacity at 4.1 million containers, and with annual shipping of approximately $675 billion worth of goods spread throughout 12 million containers.[107] Maersk's use of technology to provide its customers with the best service possible is evident through initiatives such as its 'Twill platform' that allows customers to book, manage, and monitor shipments, not only for shipments via sea but also customs and trucking services.[108] This form of AV and AIT provides real-time information through its internet website. Another example of Maersk's use of technology is its 'Maersk Flow' digital supply chain software platform that can be used by businesses to track supply chain operations, improve collaboration through sharing of documents, and monitor supply chain performances.[109] In warehousing, Maersk's use of technology is highlighted with its Automated Guided Vehicles (AGV) which enable items to be picked more quickly, while minimizing the number of personnel required to perform these tasks.[110] Finally, as a leader in shipping and supply chain management, Maersk provides its expertise in electronic data interchange solutions by assisting companies around the

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[106] CNN Business, "Amazon only needs a minute of human labor to ship your next package," 6 October 2016, Last accessed 31 December 2020, https://money.cnn.com/2016/10/06/technology/amazon-warehouse-robots/index.html.

[107] Door to Door, "Top 10 sea shipping company in world 2020," 5 July 2020, Last accessed 31 December 2020, https://www.ddpch.com/top-10-sea-shipping-company-in-world-2020/; Ship Technology, "The ten biggest shipping companies in 2020," 26 October 2020, Last accessed 31 December 2020, https://www.ship-technology.com/features/the-ten-biggest-shipping-companies-in-2020/; Maersk, "Ocean Transport," Last accessed 2 January 2021, https://www.maersk.com/transportation-services/ocean-transport.

[108] Maersk, "Leveraging technology to grow," 26 June 2019, Last accessed 2 January 2021, https://www.maersk.com/news/articles/2019/06/26/leveraging-technology-to-grow.

[109] Maersk, "Maersk Flow," Last accessed 2 January 2021, https://www.maersk.com/supply-chain-logistics/maersk-flow.

[110] Maersk, "Warehousing and Distribution," Last accessed 2 January 2021, https://www.maersk.com/supply-chain-logistics/warehousing-and-distribution.

world struggling to achieve both supply chain effectiveness and efficiency, and E2E supply chain visibility.[111]

Walmart

With 265 million customers and members who visit their 11,400 stores in over 26 countries, and through their eCommerce website each week, Walmart is the largest retailer in the world with a revenue of $524 billion in 2020.[112] Walmart's successes are attributable to its use of technology throughout its logistic network of 150 distribution centers (each over 1 million square feet in size), and its fleet of over 6,100 trucks and 61,000 trailers that drive 700 million miles each day.[113] Its understanding of the power of technology in improving its operations ranges from its 'Data Café', known as its analytics hub, which it uses to solve business problems, to its Intelligent Retail Lab (IRL) where they use AI processes and services in a real-world Walmart store in Levittown, New York.[114] Using BI such as SAPs HANA, Walmart is also capable of identifying trends and enabling decision-making by processing its high volume of transaction records within moments.[115] At its IRL store in particular, sensors, cameras, and processors provide real-time information such as notifying sales associates through out-of-stock notifications and analytics when items need to be restocked, as opposed to associates having to

[111] Maersk, "EDI Solutions," Last accessed 2 January 2021, https://www.maersk.com/supply-chain-logistics/edi-solutions.

[112] Walmart, "About Us," Last accessed 31 December 2020, https://corporate.walmart.com/our-story.

[113] *Ibid.*

[114] Walmart, "Walmart's New Intelligent Retail Lab Shows a Glimpse into the Future of Retail, IRL," Last accessed 31 December 2020, https://corporate.walmart.com/newsroom/2019/04/25/walmarts-new-intelligent-retail-lab-shows-a-glimpse-into-the-future-of-retail-irl; Forbes Magazine, "Really Big Data At Walmart: Real-Time Insights From Their 40+ Petabyte Data Cloud," Last accessed 31 December 2020, https://www.forbes.com/sites/bernardmarr/2017/01/23/really-big-data-at-walmart-real-time-insights-from-their-40-petabyte-data-cloud/?sh=7b4d1766c105.

[115] Aitrends.com, "Wal-Mart Still Using SAP's HANA in Business Intelligence," Last accessed 31 December 2020, https://www.aitrends.com/big-data/wal-mart-still-using-saps-hana-in-business-intelligence/.

search-around for which items need restocking.[116] Another example of Walmart's innovation, and commitment to operational effectiveness and efficiency is how its personnel are notified through technology when shopping carts need to be corralled for customer use.[117] Walmart also uses 'automated assistants' to help their employees work smarter. From automatic shelf scanners that ensure item availability and correct item location and pricing, to the 'FAST unloaders' that work with the shelf scanners to scan and sort items based on priorities for offloading trucks, Walmart has fully incorporated smart technology to meet their operational requirements as efficiently as possible.[118] Finally, Walmart's use of technology honours its commitment to its customers. Walmart uses 'big data', simulation, and predictive analysis to optimize staffing in its pharmacies and check-out counters for effective and efficient customer services, and also analyzes item data along its supply chain routes to always keep product available at the lowest cost possible.[119] These are a few of the technological initiatives that Walmart has adopted in their business processes, some of which could be adopted or tailored for militaries such as the CAF in order to improve operational effectiveness and efficiency.

Industry Versus Military Use Of Technology

Having discussed examples of industry utilizing technology to modernize their logistics systems and supply chains, can lead to ideas of how these could be applied to militaries such as the CAF. However, before industry practices can be applied to militaries, there must be an

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[116] Walmart, "Walmart's New Intelligent Retail Lab Shows a Glimpse into the Future of Retail, IRL," Last accessed 31 December 2020, https://corporate.walmart.com/newsroom/2019/04/25/walmarts-new-intelligent-retail-lab-shows-a-glimpse-into-the-future-of-retail-irl.

[117] *Ibid.*

[118] Walmart, "#SquadGoals: How Automated Assistants are Helping Us Work Smarter," Last accessed 31 December 2020, https://corporate.walmart.com/newsroom/2019/04/09/squadgoals-how-automated-assistants-are-helping-us-work-smarter; RetailDive.com, "7 Ways Walmart is innovating with technology," Last accessed 31 December 2020, https://www.retaildive.com/news/7-ways-walmart-is-innovating-with-technology/525154/.

[119] Walmart, "5 Ways Walmart Uses Big Data to Help Customers," Last accessed 31 December 2020, https://corporate.walmart.com/newsroom/innovation/20170807/5-ways-walmart-uses-big-data-to-help-customers.

understanding of the different reasons that industry and militaries use technology to modernize their logistics systems and supply chains.

Within industry, technology is leveraged to improve its effectiveness and efficiency while keeping pace with globalization and mass consumerism. Industry is very driven to seek maximum profit.[120] In contrast, a military is focused on "maximum supply to support units", and supporting the war fighter, with less emphasis on cost savings.[121] Several other differences must also be recognized. One such difference is that military supply chains put significant importance on delivering the right thing at the right place and time in order to enable mission success. Furthermore, in a military context the failure to deliver items can result in soldiers being ill-equipped or sustained, which can decrease effectiveness, and in some cases cause injuries. The most dire outcome being the death of a soldier and mission failure. Another difference that exists is military logistics systems and supply chains must be capable of moving items to the front line or tactical level, while having the ability to return specialized equipment, and non-consumables backwards for repair and overhaul, known as 'reverse logistics'.[122] This also means that a military is responsible for maintaining and servicing certain items, which differs from items found in industry or the commercial sector, as those items are either maintained by another entity or are discarded and a new item purchased. Finally, differences exist in the inventory that a military supply chain holds. A military inventory is usually highly specialized, and vast, because it must be capable of supporting an entire deployed operation. These operations can contain

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[120] Scott S. Harabuda, "Transforming military support processes from logistics to supply chain management," Last accessed 2 December 2020, https://www.army.mil/article/162197/Transforming_military_support_processes_from_logistics_to_supply_chain_management/.

[121] *Ibid.*

[122] The Wharton School, University of Pennsylvania, "Managing Supply Chains: What the Military Can Teach Business (and Vice Versa)," Last accessed 2 December 2020, http://knowledge.wharton.upenn.edu/article/managing-supply-chains-what-the-military-can-teach-business-and-vice-versa/.

Deployed Operating Bases (DOBs) that are similar to small towns and need a vast array of commodities for construction and maintenance purposes. It is the logistics and complexity of having these commodities stocked accordingly should they be needed in a remote operating location that is extremely challenging. A failure to hold these items can have significant impacts on the ability to achieve mission success.[123]

Despite all of these differences, militaries much like industry understand the value of E2E supply chain visibility, as well as the integration of logistic systems IT software such as ERP systems. Given that E2E supply chain visibility can be challenging for militaries such as the CAF, industry assistance can be sought to better integrate its systems. In some cases, this integration has modified existing military distribution processes to be similar to commercial processes.[124] By adopting commercial processes into the military there is also the potential to streamline operations, shift tasks to automation, and free personnel so that they can be employed in other key functional areas. There definitely are areas in which the military can learn from companies that are leaders in logistics and supply chains such as Amazon, Maersk or Walmart, and IT companies that specialize in developing digital supply chain solutions. The DND/CAF recognizes the opportunities that industry can provide and has identified areas for further development. This is formalized through the Innovation for Defence Excellence and Security

[123] For many operations commodities and equipment can be purchased from commercial suppliers who ship worldwide. However, a commercial supplier may not be able to respond to supply demands readily due to their distance or accessibility to the area of operations. This can cause delays in receiving items as well as follow-on impacts to the tactical level and warfighter. This highlights the importance of military supply chains holding sufficient stock-on-hand.

[124] The Wharton School, University of Pennsylvania, "Managing Supply Chains: What the Military Can Teach Business (and Vice Versa)," Last accessed 2 December 2020, http://knowledge.wharton.upenn.edu/article/managing-supply-chains-what-the-military-can-teach-business-and-vice-versa/.

(IDEaS) program, as well as the procurement and contracting opportunities that are presented through the Defence Capabilities Blueprint (DCB).[125]

The role of technology in logistics includes operationalizing S&RL through AV with AIT. A few of the examples of automated technologies that can enable logistics systems and supply chains in both the military and commercial sectors include RFID, GPS, and barcodes. These technologies are also a source of data for BI systems. BI systems consolidate data which can be used to identify trends and subsequently facilitate decision-making within an organization such as a military. To improve the DND/CAF logistics system and DSC, industry's use of technology should be given serious consideration, such as its use in successful companies like Amazon and Walmart. These businesses use automation and AIT to provide E2E supply chain visibility and have also incorporated BI and AI to improve the effectiveness of their operations while remaining as efficient as possible.

Despite the differences that exist between industry and military logistics and supply chains, militaries such as the CAF should take the opportunity to recognize how industry is using technology to improve their operations. Subsequently, and where possible, militaries such as the DND/CAF should implement similar uses of technology to improve their operational effectiveness. Industry initiatives are but one sector that can be used to identify how the DND/CAF can improve its logistics systems and DSC, with a more comparable one being other national militaries.

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[125] Department of National Defence, "Innovation for Defence Excellence and Security (IDEaS)," Last accessed 2 January 2021, https://www.canada.ca/en/department-national-defence/programs/defence-ideas.html. IDEaS is DND's commitment of $1.6 billion over the next 20 years in investment for innovation of defence and security for experts and entrepreneurs, academia and industry; Department of National Defence, "Defence Capabilities Blueprint," Last accessed 2 January 2021, http://dgpaapp.forces.gc.ca/en/defence-capabilities-blueprint/index.asp. DCB is comprised of approximately 240 major capital information technology, infrastructure projects, and in-service support contracts, which provides the funding ranges and timelines for certain projects in certain capability areas such as land, sea, air, space and cyber.

CHAPTER 6: LOGISTICS TECHNOLOGY BY NATION

As industry has modernized their logistics systems through the use of the latest technology, so too have many nations and their militaries. In particular, many of the nations that form a part of the Quintalateral Logistics Forum (QLF) have either modernized through technology or are in the process of taking steps to more fully incorporate technology.[126] These nations have adopted a culture of improving the operational effectiveness and stewardship of their logistics system and supply chain in order to be more responsive to the COE and the FOE. Based upon the new challenges that lie ahead for militaries in the face of future conflict, and those operations other than war, there is certainly a consensus that interoperability and finding logistics solutions to common problems will be key to improving operational effectiveness. There is also the belief that multinational and combined joint operations, such as with QLF like-minded nations will be key to addressing global issues. With these reasons in mind, and despite the likely differences in platform or software that is used within the particular nations, there is value in comparing the DND/CAF to what other nations have or are doing to both improve their logistics systems and to boost their combat effectiveness.

United States

The US Department of Defence (DoD) and the Joint Logistics Enterprise of the US includes each of the Services, Combatant Commands, the Defense Logistics Agency (DLA), and Joint Staff Operations and Logistics Directorates.[127] One of the main concepts driving modernization and innovation in the US DoD is Joint All Domain Command and Control

[126] Quintalateral Logistics Forum (QLF), *QLF Strategic Plan - Version 2.0*, 2019. The Quintalateral Logistics Forum (QLF), is comprised of the heads of joint logistics from Australia, Canada, New Zealand, United Kingdom and the United States of America. Its purpose is to focus on interoperability issues and to find solutions to shared problems, resulting in improved wartime readiness and operational efficiencies.

[127] United States of America, Department of Defense, Joint Publication 4-0, *Joint Logistics* (US DoD: 2019), ix. Combatant Commands include the following: Africa, Central, Cyber, European, Indo-Pacific, Northern, Southern, Space, Special Operations, Strategic, and Transportation.

(JADC2). JADC2 will "connect sensors from all of the military services – Air Force, Army, Marine Corps, Navy, and Space Force – into a single network" to enable the Joint Warfighting Concept (JWC).[128] This concept will modify the current stove-pipped C2 architecture into one that enables information collection and sharing via a cloud-like environment so that recommendations and decisions can be made rapidly.[129] Additionally, this is key at a time when the FOE will include adversaries who employ more and more Anti-access/Area denial (A2/AD) capabilities, with access to information being vital in order to provide decisive multi-domain effects, and ultimately result in mission success.[130] A key part to enabling the JADC2 concept and data enterprise is the Joint Concept for Contested Logistics (JCCL). The JCCL supports the JWC with the aim to provide adaptable and responsive logistics, and considers how logistics support should be developed within each of the Services, Combatant Commands and DLA to address the challenges of the FOE.[131] Core to JCCL are resilient/integrated logistics C2 (i.e. Data, AI, authorities to make decisions), assured power projection (i.e. ability to deploy rapidly and in a scalable fashion) and sustainment for distributed operations (i.e. reduce sustainment needs through local sustainment, provide resilient and global supply chains, and possess innovative business practices to meet demands).[132] The JADC2 concept and JCCL is shared with NATO and allies such as Canada, should they choose to pursue a similar approach, and is one example of the innovation and modernization that the US DoD is taking to be more operationally effective in the FOE.

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[128] United States of America, Congressional Research Service, "Joint All Domain Command and Control (JADC2) (Washington: CRS, 2020), 1.

[129] *Ibid.,* 1.

[130] *Ibid.*

[131] United States of America, Department of Defense, "Joint Concept For Contested Logistics (JCCL) Presentation", Slide 4/8.

[132] *Ibid.,* Slides 7/8, 8/8.

Focused on visibility, and access to logistics information to enable decision-making, the US, like Canada, has stressed the importance of AV and materiel distribution. Specifically, from 2014 to 2017, the US Government Accountability Office identified DoD Supply Chain Management and in particular AV and materiel distribution as areas of high risk with 18 actions/outcomes required.[133] In 2017, all these risks were resolved. These were addressed by creating an AV system that could provide 7,500 users access to "near-real time, ITV of eight million lines of items of supply and transportation data," as well as RFID.[134] A successful example of incorporating technology and RFID to enable AV was with the United States Marine Corps (USMC). The USMC improved their tracking ability and reduced inventory times from 12 days to 10 hours, by increasing the range in which it could track items through a long-range passive RFID.[135] Another example of technology improving effectiveness and stewardship of resources was the US Navy's use of RFID. Reporting 98% fewer missing parts, at a total average cost of 1.3 million USD per ship, RFID was successfully used to track parts for maintenance and overhaul of nuclear-powered attack submarines.[136] Other identifiable examples of the value of AIT is its use of RFID tags on sustainment cargo during the tactical leg of movement in theatres of operation which they estimate to have saved the DoD 1.4 million USD annually,[137] as well as DLA's contract for a solar-powered cellular sensor to track approximately 24,000 military assets worldwide.[138]

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[133] United States Government Accountability Office, "DoD Supply Chain Management," Last accessed 13 January 2021, https://www.gao.gov/highrisk/dod-supply-chain-management.

[134] *Ibid.*

[135] *Ibid.*

[136] *Ibid.*

[137] *Ibid.*

[138] RFID Journal, "DLA Plans IoT Solution For Tracking Assets at Texas Facility," Last accessed 3 December 2020, https://www.rfidjournal.com/dla-plans-iot-solution-for-tracking-assets-at-texas-facility.

In terms of materiel distribution, the US has also taken steps to implement a materiel distribution improvement plan as well as create performance metrics. The standardized performance metrics capture if equipment is delivered on time, with the right quantity and quality, and are used by the Combatant Commands to track distribution performance (i.e. delays) on tactical legs such as RDD.[139] The information collected by the Combatant Commands is also shared through US Transportation Command (USTRANSCOM) and their deployment and distribution operations centers so that appropriate action to improve distribution performance standards for operations can be taken.[140]An example is USTRANSCOM's work with DLA to realign the standard delivery timelines to account for Kuwait custom processes, and also the development of initiatives to improve services, resulting in a savings of 1.56 billion USD.[141] These US DoD initiatives highlight a few of the reasons the DND/CAF can adopt these processes and concepts to improve the operational effectiveness and stewardship of resources within its logistics system.

In terms of IT systems and the use of BI, the US has made improvements here as well. One such example is the USMC Systems Command – Global Combat Support System-Marine Corps (GCSS-MC) which they use to perform supply and maintenance functions globally.[142] This system provides a BI capability by pulling data into reports and dashboards which decreases the amount of time and work needed to process data and come to a decision.[143] As an example, the Army Logistics Support Activity (LOGSA) intends on using IBM's AI capabilities to assist

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[139] United States Government Accountability Office, "DoD Supply Chain Management," Last accessed 1 December 2020, https://www.gao.gov/highrisk/dod-supply-chain-management.

[140] *Ibid.*

[141] *Ibid.*

[142] The United States Marine Corps, "Marine Corps upgrades GCSS-MC, reduces time from data to decision," Last accessed 2 December 2020, https://www.marcorsyscom.marines.mil/News/News-Article-Display/Article/1663759/marine-corps-upgrades-gcss-mc-reduces-time-from-data-to-decision/.

[143] *Ibid.*

with decision-making and streamlining processes related to logistics. The reasons for doing so are that AI can identify the most cost-effective mode of transportation for spare parts such as those requests for air transportation requests more rapidly than humans. In 2017, LOGSA indicated that AI saved the Army "100 million USD a year by auditing 10 percent of transportation requests" and redirecting those cargo requests from air to less costly modes of transportation.[144]

Similar to the DND/CAF DSC and logistics system modernization initiatives like MISL, is the US Army Logistics Modernization Program (LMP) ERP system that "builds, sustains and generates warfighting capabilities using one of the largest, fully integrated supply chain and maintenance, repair and overhaul solutions in the world."[145] This program forms a key part to the US Army's ability to ensuring materiel readiness as well as asset management and accountability. The value of this fully integrated system is significant and illustrated by a 2016 report. In that report, the US Army stated that LMP eliminated "2 billion USD in costs to maintain the 40-year-old IT systems LMP replaced" while the integration of legacy systems also enabled decisions to be made on the divestment of 4 billion USD in spare parts.[146] To fully support LMP, Wi-Fi, tablets, and barcode scanners are being used at Army depots to replace hard copy documentation.[147]

With the US being one of the largest and most advanced militaries in the world, and Canada's closest ally, the CAF can certainly learn and adopt similar supply chain and

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[144] C4ISRNET, "Army logistics integrating new AI, cloud capabilities," Last accessed 2 December 2020, https://www.c4isrnet.com/home/2017/09/07/army-logistics-integrating-new-ai-cloud-capabilities/.

[145] United States Army, "Logistics Modernization Program," Last accessed 15 January 2021, https://www.eis.army.mil/programs/lmp.

[146] Federal News Network, "Army says logistics IT system has saved at least $6 billion," Last accessed 2 December 2020, https://federalnewsnetwork.com/dod-reporters-notebook-jared-serbu/2016/07/army-says-logistics-system-saved-least-6-billion/.

[147] *Ibid.*

logistics technologies. Another ally that has modernized their logistics system is the United Kingdom (UK).

United Kingdom (UK)

In 2015, the UK Ministry of Defence (MoD) outsourced their supply chain by contracting Leidos through what they call the Logistics Commodities and Services Transformation (LCST) program.[148] This program "provide[s] significant operational effectiveness by delivering improved responsiveness and agility" by gaining efficiencies in warehousing procurement, inventory management of food, clothing and medical supplies and also storage and distribution.[149] Estimated to save £0.5 billion over 13 years, the program integrates both procurement and distribution by moving stove-pipped legacy systems into "integrated enterprise intelligence", a digital transformation.[150] Responsible for the procurement and management of 70,000 commodity NATO Stock Numbers (NSNs), including storage and distribution, the digital transformation of the UK logistics system and DSC significantly assists the UK MoD in supporting global operations. This is accomplished by providing "a modern suite of systems that will deliver one version of the truth . . . [with] the MoD see[ing] the whole picture, as it is happening."[151]

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[148] Army Technology, "Leidos to manage UK MoD's logistics commodities and services programme," Last accessed 2 December 2020, https://www.army-technology.com/uncategorised/newsleidos-to-manage-uk-mods-logistics-commodities-and-services-programme-4517497/.

[149] *Ibid.*

[150] Team leidos, "Transforming MOD logistics through Technology, People and Process," Last accessed 2 December 2020, https://www.dsei.co.uk/__media/libraries/global-theatre/Damian-Alexander.pdf; Team Leidos, "UK Logistics & Operations," Last accessed 2 December 2020, https://www.leidos.com/company/global/uk-europe/logistics-commodities-services-transformation-programme.

[151] Team Liedos, "LCST Programme," Last accessed 15 January 2021, https://www.leidos.com/company/global/uk-europe/LCST.

Liedos achieves modernization of the UK MoD supply chain through Commercial Off-the-Shelf (COTS) applications that provide accurate near-real time data.[152] Furthermore, it uses a "Support Chain Integration Platform (SCIP)" to interact with the various MoD and Liedos systems, so that data can be accessed quickly in order to enable the decision-making process.[153] Within the areas of storage, distribution, and freight, one million NSNs are stored and distributed to 600 locations globally, with the majority of supply requests moving through its 850,000 square foot defence fulfillment centre.[154] Finally, as part of the total E2E supply chain services and modernization, the UK MoD utilizes Leidos to develop and execute multi-modal transport solutions.[155]

Although the UK MoD approach to modernizing their logistics system includes outsourcing their logistics system services to a contractor, it also highlights the benefit of incorporating technology. Specifically, by integrating its legacy IT systems through one single platform, it has been able to improve the accuracy of inventory management, and thus enabling more timely decision-making. These improvements are additional examples of operational effectiveness and stewardship over resources.

Australia

Within Australia's *2020 Defence Strategic Update* and *2020 Force Structure Plan,* are three strategic objectives: "shape Australia's strategic environment, deter actions against

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[152] Leidos, "Digital Modernisation – Logistics Commodities & Services Transformation (LCST) Programme," Last accessed 15 January 2021, https://www.leidos.com/company/global/uk-europe/digital-modernisation.

[153] *Ibid.*

[154] Team Leidos, "Storage, Distribution, and Freight – Logistics Commodities & Services Transformation (LCST) Programme," Last accessed 15 January 2021, https://www.leidos.com/company/global/uk-europe/storage-distribution-freight.

[155] Team Leidos, "Global Logistics Services – Logistics Commodities & Services Transformation (LCST) Programme," Last accessed 15 January 2021, https://www.leidos.com/company/global/uk-europe/global-logistics-services.

Australia's interests, and respond with credible military force, when required."[156] A key enabler to achieving these objectives is modernizing the joint capabilities, such as creating more durable supply chains for the FOE.[157] Like the other QLF nations, Australia's *Force Structure Plan* for its Defence Enterprise contains a vision that is centered on innovation, digitalization and improving business processes.[158] This is further enabled by their goal to improve its "enterprise information and resource management."[159]

Complementary to Australia's defence strategy documents is their *Concept for Future Logistics* which discusses their Defence Logistics Enterprise.[160] Referencing the Five-Eyes view of the 2040 FOE, the document discusses technology and specifically that "militaries must develop hardened, resilient, adaptive and assured logistics."[161] Within this vision is emphasis on "Big Data and Advanced Analytics", and the use of AI, to provide "supply network visibility and illumination, planning and decision making", all through a Common Operating Picture. (COP).[162] Following this concept of future logistics, the Australian Air Force has also developed their *Air Force Logistics Operating Concept 2030*. This concept includes fifth generation logistics; the ability to predict, anticipate and respond to the needs of the war fighter, through the ability to "sense demand and rapidly respond within an integrated logistics command and control framework."[163] Like the other QLF nations, the Australian Air Force concept is heavily focused

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[156] Australia, "2020 Defence Strategic Update & 2020 Force Structure Plan," Last accessed 15 January 2021, https://www1.defence.gov.au/strategy-policy/strategic-update-2020.

[157] Australia, "2020 Force Structure Plan: Defence Enterprise Fact Sheet," May 2020, https://www1.defence.gov.au/strategy-policy/strategic-update-2020.

[158] *Ibid.*

[159] *Ibid.*

[160] Australia, *Australian Defence Force: Concept for Future Logistics*, 25 November 2020.

[161] *Ibid.,* 27.

[162] *Ibid.,* 30.

[163] Australia, *Australian Air Force Logistics Operating Concept 2030 Information Handout.*

on the use of technology, which includes data analytics and both artificial and augmented intelligence.[164]

One of Australia's main logistics modernization projects is moving its Defence ERP to the SAP S4 HANA platform.[165] Using the same technology that the DND/CAF intends on using for MISL, this platform will merge multiple program functions into one in order to compile real time information for decision-making.[166] Furthermore, Australia is also modernizing its logistics systems in the areas of supply chain management by using SAP S4 HANA and an Inventory Management warehouse construct, or an Extended Warehouse Management for joint logistics.[167] In terms of deployable technology, Australia is planning to use an interim Disconnected Light Solution (DLS) that will replace its Forward Logistics Management System (FLMS), which will allow limited inventory and maintenance transactions to be conducted on standalone laptops when deployed or on exercise.[168] Other Australian modernization efforts include its logistics mobile device replacement project which will provide devices, known as Portable Data Entry Terminals (PDETs), for both warehousing applications (i.e. issuing, receipting and stocktaking) and their Cargo Visibility System (CVS). As part of the mobile device modernization initiative Australia continues to develop a 3G/4G/5G mobile Wi-Fi solution.[169] Finally, as an example of improving its operational effectiveness and efficiency, Australia is pursuing its Next Generational Distribution System (NGDS) which will provide near-real time distribution system

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[164] Australia, *Australian Air Force Logistics Operating Concept 2030 Information Handout.*

[165] Major Damian McFarlane, "Australian Defence Logistics Technology," Logistics Systems Branch, Joint Logistics Command, 2021, 1.

[166] *Ibid.,* 1.

[167] *Ibid.,* 2.

[168] *Ibid.,* 3.

[169] Director Logistics System Branch, Australian Joint Logistics Command e-mail with author, 3 March 2021.

information to strategic and operational level commanders including the location, quantity and timing of materiel.[170]

Common to modernization amongst all the previously discussed nations is the integration of multiple logistics systems into a single system that enables the standardization of processes, improves data reliability, and enables decision-making. Focused on S&RL, and the use of BI and analytics, QLF nations are modernizing their logistics systems and supply chains to be able to respond to the ever-changing operating environment that the war fighter will find themselves in. From the JADC2 and JCCL concepts in the US, to modernization via commercial outsourcing in the UK, and finally Australia taking a SAP S4HANA approach to modernization, the importance of operational effectiveness, and stewardship or accountability of resources within armed forces has been demonstrated. Like these nations, the DND/CAF is also pursuing several initiatives and concepts to modernize its logistics system to provide more effective and efficient support in the FOE.

[170] Major Damian McFarlane, "Australian Defence Logistics Technology," Logistics Systems Branch, Joint Logistics Command, 2021, 4.

CHAPTER 7: THE FUTURE, AND FUTURE TECHNOLOGY IN THE CAF

The previous chapters have discussed the DND/CAF logistics system and DSC, and their associated challenges. Focusing on technology as a way to modernize and overcome the challenges, examples from both industry and other nations were provided as a comparison to what the DND/CAF could adopt. The focus of these comparisons was on how they each incorporate technology such as AIT, BI, and data analytics. This chapter will focus on what technological initiatives the DND/CAF intends to adopt and will explain how they can improve the operational effectiveness and stewardship of the logistics system and DSC in the FOE. First of all, based on what is known about the FOE, the DND/CAF will require a logistics system that can support operations that face pan-domain operational threats such as asymmetric warfare, as well as traditional and non-traditional threats. Within this future logistics system concepts such as BI and analytics will be adopted, along with in-development initiatives such as AIT, MISL and RLP. These initiatives will also enable the DND/CAF to provide accurate and timely information to decision-makers and the decision-making cycle.

Future Operating Environment (FOE)

Having an understanding of the FOE and its influence on logistics is important when considering modernization. This is also particularly important due to the emergence of pan-domain threats in areas such as space, cyber, and information. This FOE and its associated threats also place significant emphasis on possessing operationally effective, responsive, and resilient logistics. Within this environment, threats against logistics and defence supply chains may also greatly increase, as will supplier based risks due to the diversification of suppliers and potential vulnerabilities or security issues that have global impacts (i.e. COVID-19, key supply

routes).[171] Furthermore, the need for 'just-in-time' deliveries and S&RL will be critical due to rapid globalization, and the limited infrastructure to warehouse equipment due to competitive demand for space around key ports.[172] If technology is not leveraged to reduce the DND/CAF logistics footprint in an area of operation, these trends will pose a significant impact on the DND/CAF's ability to remain both agile and operationally effective. In order to decrease the footprint there needs to be greater emphasis on reducing the need to warehouse equipment that may not be required by implementing the concept of delivering 'precision logistics'.[173] To enable S&RL, and to keep key decision-makers informed, focus must also be given to improve AV and performance measurements. Finally, by modernizing the logistics systems there may be opportunities to reduce the number of personnel that are required to perform certain tasks, particularly those that occur in high risk/threat areas.[174] This is important when an organization's most valued resource is its personnel.

Within the DND/CAF, and its L1s (i.e. Royal Canadian Navy, Canadian Army, Royal Canadian Air Force, Special Forces) in particular, modernizing the force and logistics to be able to operate effectively in the FOE is something that has increasingly gained more attention. The reason being is that logistics is a joint capability and each of the L1s are heavily reliant upon it to conduct operations. A key aspect of the DND/CAF logistics system and DSC of the future is its ability to support operations in an environment that will be characterized by the rapid development of technology and one in which the adversary will be able to narrow the

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[171] Jeremy Smith, *Defence Logistics: Enabling and Sustaining Successful Military Operations*. Limited, 2018. *ProQuest Ebook Central*, https://ebookcentral.proquest.com/lib/cfvlibrary-ebooks/detail.action?docID=5231112, 359.

[172] *Ibid.,* 359.

[173] Michael G. Dana, "21st Century Logistics," *Marine Corps Gazette* 101, no. 10 (10, 2017): 12. https://search-proquest-com.cfc.idm.oclc.org/docview/1947362085?accountid=9867.

[174] *Ibid.,* 12.

technological superiority the DND/CAF may have once had.[175] In terms of modernization, both digitalization and networking will ensure there is a shared understanding of a situation, will increase the speed of decision-making, and will better enable effective Command and Control (C2).[176] Furthermore, due to the pace and constraints put on operations, there will also be the requirement to be agile and lean. Organizations such as the DND/CAF will therefore have to assume greater risk by focusing less on pre-positioning supplies, and more on prioritizing the rapid movement of materiel through the sustainment system.[177] To enable this, a logistics system that can provide real-time asset tracking and condition information through a shared data environment or common communications, computers, intelligence surveillance and reconnaissance (C4ISR) system will be required. Without a common C4ISR system, the ability to fully leverage the capabilities of a modernized logistics system and its suite of software will be underutilized and impacted, as will logistics readiness and decision-making. The time is now for the CAF to transform from an analog to a digital force in order to provide decisive operational effects in the FOE. Discussed in the paragraphs to follow is this digital transformation, and the concepts of data and analytics which are fundamental to both the DND/CAF and the modernization initiatives.

BI And Data Analytics

The GoC discusses its IM and IT plan in the *Digital Operations Strategic Plan*, which includes direction on digital transformation, services delivery, and security.[178] As it relates to the DND/CAF, the importance of IM, IT, and digital transformation is highlighted in SSE and in the

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[175] Department of National Defence, *Advancing with purpose: The Canadian Army Modernization Strategy*, Fourth Edition (Ottawa: DND Canada, 2020), 5.

[176] *Ibid.,* 26.

[177] *Ibid.,* 36.

[178] Canada, *Digital Operations Strategic Plan: 2018-2022*, Last accessed 2 March 2021, https://www.canada.ca/en/government/system/digital-government/digital-operations-strategic-plan-2018-2022.html.

DND/CAF Data Strategy. In those documents it states that Canada's tactical advantage is achieved by aggregating and manipulating large quantities of data with agile information management and technology tools.[179] Through the creation of ADM Data, Innovation, Analytics (ADM (DIA)), and *DND/CAF's Data Strategy*, the DND/CAF is focused on a data-driven culture that is shaped by the appropriate direction and guidance on how to use data and analytics in decision-making. As operations within the FOE will be comprised of conflict across multiple domains, and in particular the space, cyber, and information domains, this strategy will further define and enable the DND/CAF, and its logistics system.[180] Furthermore, this strategy will assist with technological advancements that are heavily centered upon accessing significant amounts of data in order to enable operational effectiveness and efficiency in terms of spending, such as those within the sustainment community.[181] Finally, with this shift towards data, is the need to modernize processes and policies in order to fully seize the power that data and digitalization can provide the DND/CAF.[182]

Both BI and data analytics can assist in improving the business of defence in several ways. For example, analytics can be used to provide a description of what has happened through reports and dashboards (i.e. Descriptive Analytics), or the data can explain why something may happen by providing hypothesis testing and visualization (i.e. Diagnostic Analytics).[183] Additionally, as analytics are further optimized they can provide value by predicting what will happen (i.e. Predictive Analytics), or they can assist in determining what should be done through

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[179] Department of National Defence, *The Department of National Defence and Canadian Armed Forces Data Strategy* (Ottawa: DND Canada), 2.

[180] *Ibid.,* 5.

[181] *Ibid.*

[182] Department of National Defence, "VCDS/DMA Planning Guidance Data and Digitalization," (Ottawa: DND Canada, 2020), 4.

[183] Department of National Defence, "Director General Data Analytics, Strategy and Innovation Presentation," 18 November 2020, Slide 6/14.

simulation (i.e. Prescriptive Analytics).[184] More specific to logistics, BI and data analytics can enable operational excellence by "provid[ing] stakeholder, information and business value to National Defence."[185] For example, *the DSC Analytics Strategy* and program will utilize BI and analytics by creating an analytics capability in order to comply with the Performance Measurement Framework (PMF) requirement from the CDS and DM.[186] This capability will provide E2E visibility on all DSC activities, and will include several key principles: decision support information, alignment through accurate data information, robust data quality, and finally agility; the ability to adjust to what the DND/CAF requires for E2E visibility.[187] Importantly, the DND/CAF's use of data analytics will also play a vital role in effectively conducting operations, while improving the ability "to report on the results, effectiveness, and efficiency of DND/CAF programs."[188] However, putting greater emphasis on adopting a data culture and digital transformation will lead to challenges that must be discussed and addressed.[189] These challenges are applicable to the modernization efforts within both the DND/CAF logistics system and DSC, and will be identified in Chapter 8.

In the following paragraphs, several of the DND/CAF's future logistics and DSC initiatives will either directly create data to enable decision support information and SA, or the initiatives themselves are IT and IM systems that have tools which will assist in aggregating data. The first of the initiatives is the AIT project.

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[184] Department of National Defence, "Director General Data Analytics, Strategy and Innovation Presentation," 18 November 2020, Slide 6/14.

[185] Department of National Defence, "Draft - Defence Supply Chain Analytics Strategy – July 2020," (Ottawa: DND Canada, 2020), 9.

[186] *Ibid.,* 7.

[187] *Ibid.,* 9.

[188] Department of National Defence, *The Department of National Defence and Canadian Armed Forces Data Strategy* (Ottawa: DND Canada), 8.

[189] Challenges include data literacy, data accuracy and a willingness to share data.

AIT Project

Focused on operational effectiveness and the stewardship of government resources, specifically those within the logistics system and the DSC, the AIT project will enable the DND/CAF ERP software through the functions of acquisition, storage, maintenance, and consumption of material.[190] A key building block to the MISL project, AIT will also operationalize AV across the DSC. This is especially pertinent given the DND/CAF's currently limited AV across the DSC, which is only provided through manual processing, and is viewed as inefficient and in some cases inaccurate due to manual data entry. AIT will have a significant role to play in the FOE that will be characterized as fast paced. It will do so by enabling the DSC to be responsive and agile through the real-time information provided to decision-makers. Utilizing Commercial Off-the-Shelf (COTS) technology, AIT will also increase operational readiness by automating supply chain processes for materiel, and also fuel management through data capture and entry.[191] Furthermore, with the DSC materiel being marked and labelled, AIT will be able to reduce manual processing, which will improve data accuracy.[192] Subsequently, this will assist in reducing inventory levels by eliminating multiple demands for certain requirements, and improving both the procurement and life cycle management of material.[193] Importantly, this project will directly assist in overcoming the previously identified AV issues

[190] Department of National Defence, *Automatic Identification Technology (AIT) Project – A Defence Supply Chain Automated Data Capture and Entry Project - Business Case Analysis* (Ottawa: DND Canada, 2018), 5.

[191] Department of National Defence, Defence Capabilities Blueprint, "Automatic Identification Technology," Last accessed 2 December 2020, http://dgpaapp.forces.gc.ca/en/defence-capabilities-blueprint/project-details.asp?id=1589.

[192] Department of National Defence, *Automatic Identification Technology (AIT) Project – A Defence Supply Chain Automated Data Capture and Entry Project - Business Case Analysis* (Ottawa: DND Canada, 2018), 7.

[193] *Ibid.,* 7.

from the OAG reports, and will contribute to effective 'Phase Zero' planning, mounting, and support that is provided to operations.[194]

AIT will also indirectly support SSE and the GoC's organizational priorities. Specifically, it will serve as an enabler for "sustainable operational excellence" and "CAF posture and readiness", while also "ensuring defence resource stewardship and affordability".[195] Although not specifically referenced in SSE, the implementation of AIT will directly support GoC commitments. These commitments include the need for a flexible and responsive force that can ensure an advantage over its adversaries, while also highlighting the importance of technology in order to maintain interoperability with allies.[196]

In summary, the importance of AIT to the DND/CAF cannot be understated. A failure to implement AIT within the larger modernization of the logistics system and DSC is likely to result in reoccurring issues of inaccurate data (i.e. due to manual and time-consuming data entry), continued compliance issues with the GoC, and ultimately reduced operational effectiveness.[197] The bottom line is that this project will greatly assist with data integrity across the ERP and will improve the overall sustainment capability across all phases of an operation by ensuring E2E AV in a timely, efficient, and responsive manner. With AV across the DSC being enabled by AIT, the MISL program will be able to leverage the data captured by the AV sensors and integrate it into one system.

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[194] Department of National Defence, *Automatic Identification Technology (AIT) Project – A Defence Supply Chain Automated Data Capture and Entry Project - Business Case Analysis* (Ottawa: DND Canada, 2018), 7.

[195] *Ibid.,* 13-14.

[196] *Strong, Secure, Engaged*, 14.

[197] Department of National Defence, *Automatic Identification Technology (AIT) Project – A Defence Supply Chain Automated Data Capture and Entry Project - Business Case Analysis* (Ottawa: DND Canada, 2018), 24.

MISL

Initiated in February 2019 under the support of the ADM DIA, and led by the Strategic Joint Staff / Strat J4, MISL aims to modernize the DSC by improving its operational effectiveness and efficiency.[198] Creating an integrated SAP based ERP for W&D across the DSC, MISL will address the previously mentioned issues with the current stand-alone logistics systems (i.e. NMDS, FMS, AIMS, DCBS) by integrating them and improving the current DRMIS/warehouse management functions.[199] Key to MISL is an improved ERP, which uses SAPs S4HANA technology across all management functions (i.e. Transportation, Fleet, Customs, Extended Warehouse Management, Explosives Management) to provide faster analytics by gathering data differently than previous SAP architectures.[200] Scheduled to reach its Initial Operating Capability (IOC) by February 2024, MISL will create "a modernized DSC through an enhanced and integrated warehouse and distribution capability, improving the overall business of defence, enabling decision making, and increasing materiel accountability and readiness."[201] Shown in Figure 7.1 are the MISL principles, which highlight its functionality as a tool to improve the business of defence, while also explaining how they will enhance the user's system operating experience.

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[198] Department of National Defence, "Strategic J4 Logistics – Modernization and Integration of Sustainment and Logistics (MISL) Presentation," Slide 18/47, 4 February 2020.

[199] *Ibid.,* Slide 18/47. See Chapter 3 for information on how the current ERP is structured.

[200] Department of National Defence, "MISL Update Presentation," Slide 7/17, 11/17, 3 February 2021. S/4HANA is SAP's high performance analytic and appliance ERP solution

[201] E-mail MISL Business CAF Solution Lead, Canadian Materiel Support Group, with author, 10 February 2021; Department of National Defence, "Strategic J4 Logistics – Modernization and Integration of Sustainment and Logistics (MISL) Presentation," Slide 30/47, 4 February 2020.

Figure 7.1 – MISL Principles

Source: DND, Strategic J4 Logistics – MISL Presentation

MISL will also address other previously mentioned logistics and DSC issues. For example, it will provide E2E supply chain visibility and will enable the implementation of a DSC PMF of business analytics and Key Performance Indicators (KPI). In providing PMFs and KPIs, MISL will be able to address the performance measurement observations that were identified in the 2020 OAG report. As it relates to E2E visibility, the integration of the stand-alone legacy systems into one will also inform several focus areas, many that were highlighted as issues in past OAG reports as well. These include, tracing customer demands and identifying late deliveries, addressing inadequate stock levels that have been caused by poor stock management, identifying inefficient processing of materiel demands, and having more control over transportation costs by virtue of having more visibility on materiel movement throughout the DSC.[202]

[202] Department of National Defence, "DSC Analytics Presentation," Slide 6/13.

Along with the integration of stand-alone systems to increase E2E visibility and address performance measurement issues, MISL will significantly improve many of the key functional areas (i.e. Fleet Management, Distribution, etc.) across logistics by providing more operationally effective and fiscally responsible logistics support to the DND/CAF.[203]

For example, within fleet management the system will provide increased visibility on vehicles, drivers and their tasks, as well as vehicle maintenance and recording the performance of fleets.[204] Within the Transportation Management (TM) module, improvements will occur in the areas of automating materiel information, providing tools to help optimize how trucks are loaded with freight for ease of distribution purposes, as well as integrate hazardous and dangerous goods information for those planning movements by road and air.[205] Through the warehousing model, operational effectiveness will also be improved. This module will be fully integrated with the TM model and will have fully automated stocktaking plans and compliance inspections.[206] This module is also expected to greatly assist with the reception, issuance, and replenishment of equipment.[207] Finally, in terms of customs processing of items, it is envisioned that the TM will have pre-formatted customs forms that will be utilized by CMSG Customs to provide to the Canadian Border Services Agency (CBSA) via the SAP Global Trade Services (GTS) or Customs Management (CM) module.[208] This will improve the ability to seek customs clearances for items through CBSA in an accurate and timely manner.

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[203] Note that some of these improvements and tools are still being defined through working groups within the CAF logistics community.

[204] Department of National Defence, "Modernization & Integration of Sustainment and Logistics (MISL) – Quick overlook of MISL Solution Presentation," Slides 3-5/24, 5 January 2021.

[205] *Ibid.,* Slides 6/24 and 23/24.

[206] *Ibid.,* Slide 9/24.

[207] *Ibid.,* Slide 11/24.

[208] *Ibid.,* Slide 12/24.

Both MISL and AIT will improve the business of defence and the DND/CAF logistics system by providing accurate and effective logistics support to operations, which will directly improve the readiness of the DND/CAF. In terms of functionality, the modernization of the current logistics systems and DSC through MISL will also enhance the user and customer experience. Finally, MISL will provide a higher level of accountability, specifically materiel accountability to the DND and GoC.

Building on the data that MISL and AIT will provide, and to improve the DND/CAF's logistics support to operations, is the RLP capability. This initiative intends on creating a COP to enhance a Commander's and key staff's SA.

RLP Capability

Originally mandated by the CDS in 2006 to "develop and maintain comprehensive operational support situational awareness for supported commanders", the CANOSCOM had developed a limited Recognized Operational Support Picture (ROSP), and eventually staffed a Statement of Capability Deficiency (SOCD) for a more robust ROSP.[209] Working collaboratively with Chief of Force Development (CFD) and Defence Research Development Canada (DRDC), a project was adopted to integrate the ROSP project into the Joint Information and Intelligence Fusion Capability (JIIFC) project, now referred to as the CAF Joint Battlespace Management Capability (JBMC).[210] The ultimate goal of the ROSP project was to enable the sharing of "operational support information for the supported operational commander."[211]

In development over the last five years, the 'RLP capability' will be the logistic component of the CAF JBMC or COP. The RLP is intended to provide joint and combined

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[209] Department of National Defence, "Recognized Operational Support Picture," (Ottawa: DND Canada), 2011, 1.

[210] *Ibid.,* 2.

[211] *Ibid.*

interoperability, and will assist with standardizing logistics reporting across the CAF.[212] Through graphical dashboards and analytics reports, it will primarily serve as a strategic level decision support tool for both logistics and maintenance issues.[213] Informing Commanders and staff at both strategic and operational levels on logistical data, the RLP will directly improve SA and will help enable the decision-making process.[214] Examples of data on capabilities will include national holdings of ammunition, fuel and rations, and statuses of Multinational Logistics Support Agreements (MLSAs) and OSHs.[215] Using information from the ERP software, such as DRMIS, and eventually MISL, the RLP will be capable of fusing and analyzing data, creating supply chain performance metrics, as well as forecasting what logistics support will be required.[216] This fusion of data will also provide staff with a quantitative analysis of what is occurring, and upon further investigation or analysis the reasons for why certain trends are occurring could be determined (i.e. qualitative analysis). Combined, the data that is projected via the RLP, and its accompanying qualitative analysis, will assist in enabling the decision-making cycle. An example of the RLP Strategic dashboard is shown at Figure 7.2, and includes information on capabilities and holdings (i.e. ammunition, fuel). The intent is for the 'Computed Status' column to be populated from DRMIS data, with the 'Strategic Assessment' and 'Comments' columns updated manually based on the data. Additional information will also be made available for each capability and holding by clicking on a link which will provide a report.

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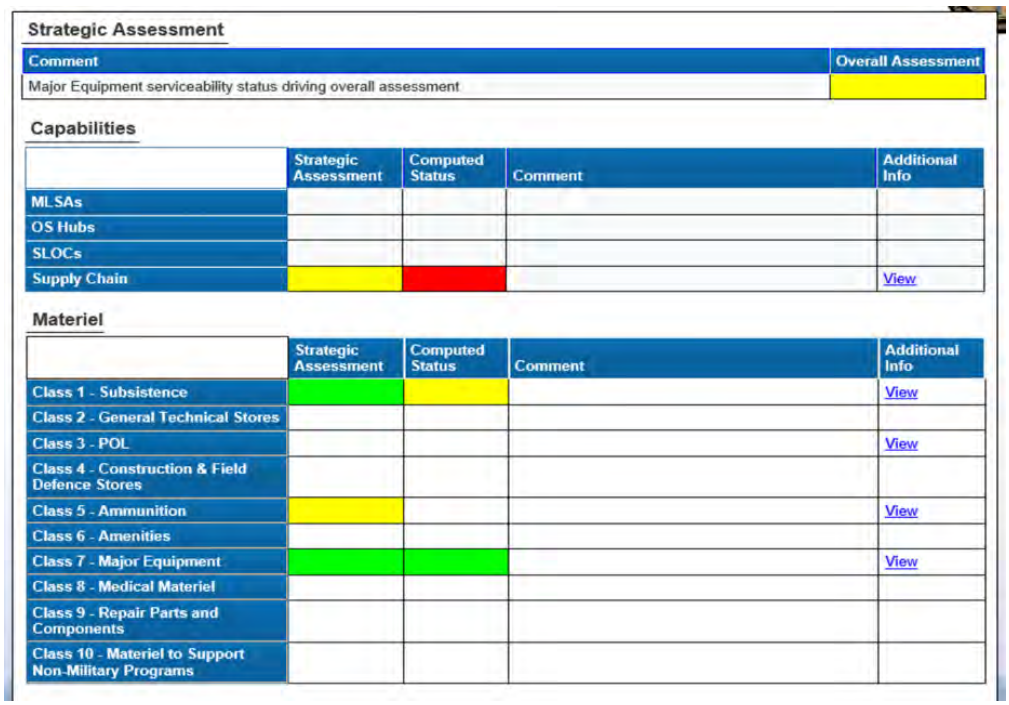
[212] Department of National Defence, "DRAFT - Strategic J4 – Recognized Logistics Picture (RLP) Strategy and Implementation Plan," (Ottawa: DND Canada, 2020), 2.

[213] Department of National Defence, "ALOC – RLP – November 2020 Version 2 Presentation," 2020, Slide 4/30.

[214] Department of National Defence, "DRAFT - Strategic J4 – Recognized Logistics Picture (RLP) Strategy and Implementation Plan," (Ottawa: DND Canada, 2020), 4.

[215] Department of National Defence, "ALOC – RLP – November 2020 Version 2 Presentation," 2020, Slide 4/30.

[216] Department of National Defence, "DRAFT - Strategic J4 – Recognized Logistics Picture (RLP) Strategy and Implementation Plan," (Ottawa: DND Canada, 2020), 4.



Strategic Assessment

Comment	Overall Assessment
Major Equipment serviceability status driving overall assessment	

Capabilities

	Strategic Assessment	Computed Status	Comment	Additional Info
MLSAs				
OS Hubs				
SLOCs				
Supply Chain				View

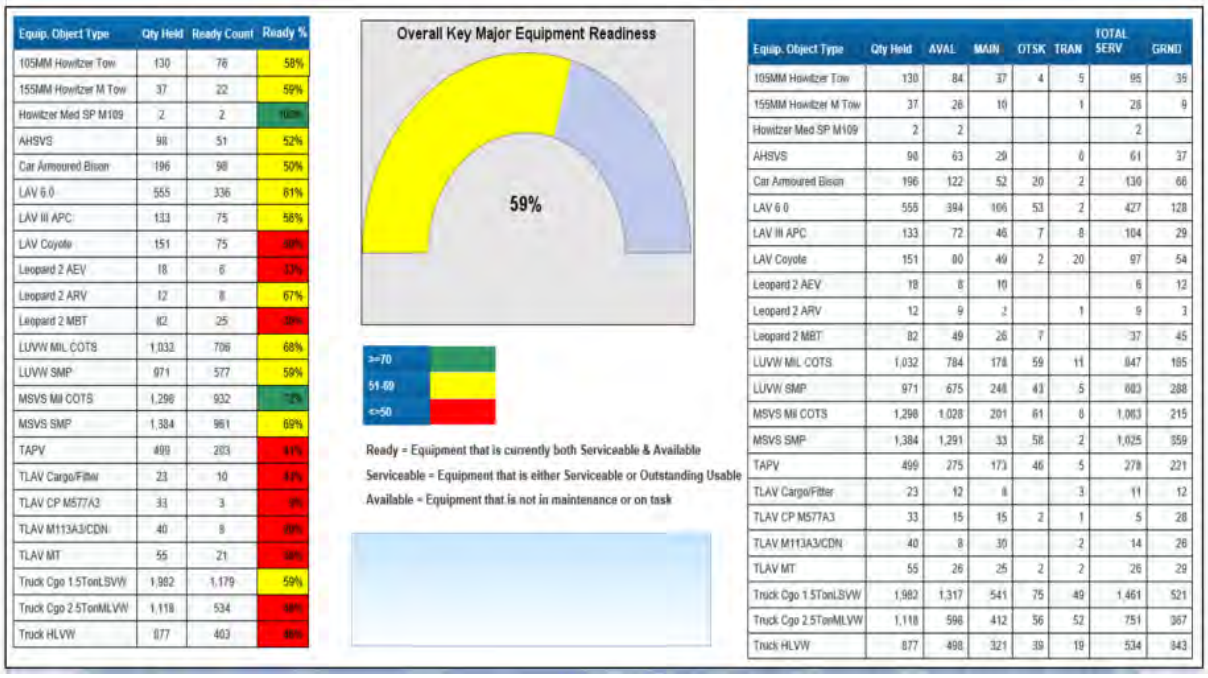
Materiel

	Strategic Assessment	Computed Status	Comment	Additional Info
Class 1 - Subsistence				View
Class 2 - General Technical Stores				
Class 3 - POL				View
Class 4 - Construction & Field Defence Stores				
Class 5 - Ammunition				View
Class 6 - Amenities				
Class 7 - Major Equipment				View
Class 8 - Medical Materiel				
Class 9 - Repair Parts and Components				
Class 10 - Materiel to Support Non-Military Programs				

Figure 7.2 – RLP Strategic Dashboard

Source: DND Canada, ALOC – RLP – November 2020 Presentation

Another example of a RLP dashboard depicting readiness or status information on materiel or classes of supply is shown in Figure 7.3. In particular, Figure 7.3 shows the readiness of major land equipment by utilizing information contained in DRMIS.



Equip. Object Type	Qty Held	Ready Count	Ready %
105MM Howitzer Tow	130	76	58%
155MM Howitzer M Tow	37	22	59%
Howitzer Med SP M109	2	2	100%
AHSVS	98	51	52%
Car Armoured Bison	196	98	50%
LAV 6.0	555	336	61%
LAV III APC	133	75	56%
LAV Coyote	151	75	50%
Leopard 2 AEV	18	6	33%
Leopard 2 ARV	12	8	67%
Leopard 2 MBT	82	25	30%
LUVW MIL COTS	1,032	706	68%
LUVW SMP	971	577	59%
MSVS Mil COTS	1,298	932	72%
MSVS SMP	1,384	961	69%
TAPV	499	203	41%
TLAV Cargo/Fitter	23	10	43%
TLAV CP M577A3	33	3	9%
TLAV M113A3/CDN	40	8	20%
TLAV MT	55	21	38%
Truck Cgo 1.5TonLSVW	1,982	1,179	59%
Truck Cgo 2.5TonMLVW	1,118	534	48%
Truck HLVW	877	403	46%

Equip. Object Type	Qty Held	AVAL	MAIN	OTSK	TRAN	TOTAL SERV	GRND
105MM Howitzer Tow	130	84	37	4	5	95	35
155MM Howitzer M Tow	37	26	10		1	28	9
Howitzer Med SP M109	2	2				2	
AHSVS	98	63	29		6	61	37
Car Armoured Bison	196	122	52	20	2	136	60
LAV 6.0	555	394	106	53	2	427	128
LAV III APC	133	72	46	7	8	104	29
LAV Coyote	151	80	49	2	20	97	54
Leopard 2 AEV	18	8	10			6	12
Leopard 2 ARV	12	9	2		1	9	3
Leopard 2 MBT	82	49	26	7		37	45
LUVW MIL COTS	1,032	784	178	59	11	847	185
LUVW SMP	971	675	248	43	5	683	288
MSVS Mil COTS	1,298	1,028	201	61	8	1,083	215
MSVS SMP	1,384	1,291	33	58	2	1,025	359
TAPV	499	275	173	46	5	278	221
TLAV Cargo/Fitter	23	12	8		3	11	12
TLAV CP M577A3	33	15	15	2	1	5	28
TLAV M113A3/CDN	40	8	30		2	14	26
TLAV MT	55	26	25	2	2	26	29
Truck Cgo 1.5TonLSVW	1,982	1,317	541	75	49	1,461	521
Truck Cgo 2.5TonMLVW	1,118	598	412	56	52	751	367
Truck HLVW	877	498	321	39	19	534	343

Figure 7.3 – RLP Dashboard – Class 7 – Major Equipment Readiness View

Source: DND Canada, ALOC – RLP – November 2020 Presentation

Finally, in terms of supply chain performance metrics, Figure 7.4 provides an example of RLP information on Outstanding Materiel Management Transactions, On Time delivery of Supply Transfer Orders (STOs), and the percentage of STOs satisfied by Materiel Priority (i.e. Essential, Routine).

Outstanding Material Management Transactions (All FYs)

Force Element	Total Count	Total Amount
Chief of the Defence Staff Branch	78,182	$991,594,131.85
Canadian Joint Operations Command	28,737	$299,481,886.61
Canadian Forces Intelligence Command	133	$220,825.29
Vice Chief of the Defence Staff Branch	3,979	$45,929,752.43
Royal Canadian Navy	21,039	$313,213,725.28
Canadian Army	16,090	$78,782,261.42
Royal Canadian Air Force	5,568	$233,993,157.56
Canadian Special Ops Forces Command	1,313	$15,374,634.82
Military Personnel Command	1,287	$4,569,264.72
Military Personnel Branch	8	$4,732.60
SJS	2	$7,220.78
Deputy Minister of National Defence	4,489	$136,429,002.60
Material Branch	4,101	$128,680,939.63
Infrastructure and Environment Branch	5	$3,840.41
Information Management Branch	307	$5,434,057.73
Judge Advocate General Branch	31	$401.30

Total Count = Purchase Orders + Purchase Requests + SLOC transfers + Stock Transport Orders

On Time Delivery - Stock Transport Orders (FY 2019)

Force Element	Total STOs	Satisfied	Not Satisfied	% Satisfied
Minister of National Defence	581,733	319,071	262,662	54.85
Chief of the Defence Staff Branch	531,388	289,636	241,752	54.51
Canadian Joint Operations Command	99,991	41,495	58,496	41.5
Canadian Forces Intelligence Command	284	143	141	50.35
Vice Chief of the Defence Staff Branch	16,365	6,853	9,512	41.88
Royal Canadian Navy	82,802	39,738	43,064	47.99
Canadian Army	249,191	154,694	94,497	62.06
Royal Canadian Air Force	71,954	42,056	29,898	58.45
Canadian Special Ops Forces Command	1,442	459	983	31.83
Military Personnel Command	9,234	4,135	5,099	44.78
SJS	5	0	5	0
Deputy Minister of National Defence	50,222	29,405	20,817	58.55
Material Branch	47,357	27,053	20,304	57.13
Infrastructure and Environment Branch	1,095	1,094	1	99.91
Information Management Branch	1,463	1,115	348	76.21
Judge Advocate General Branch	115	25	90	21.74

Requirement Priority	Total STOs	% Satisfied
Operational Critical (<= 6 days)	47,552	85.6
Essential (<= 14 days)	128,771	42.82
Routine (<= 21 days)	405,138	59.89
System Replenishment (<= 30 days)	8	88
Lowest Requirement Priority	9	100

>80	
60-79	
<60	

Figure 7.4 – RLP Dashboard – Supply Performance Metrics

Source: DND Canada, ALOC – RLP – November 2020 Presentation

These examples of the RLP capability highlight the value the program can have for DND/CAF in terms of maintaining SA and to enable decision-making. A recent example of where such a capability would have been beneficial was during the initial wave of COVID-19 and Op LASER.[217]

The impact of COVID-19 on supply chains was unprecedented, and DND/CAF was not immune to it given its reliance on global and regional supply chains for support. With the requirement to maintain operational readiness and continue providing support to operations, the DND/CAF was heavily focused on ensuring that key commodities (i.e. fuel) and equipment, such as Personal Protective Equipment (PPE), were being stocked to sufficient levels. From the

[217] Op LASER is the name of the operation for the CAF's response to a global pandemic situation, such as COVID-19.

tactical to strategic levels this resulted in a critical requirement to report on materiel holdings.[218] However, in order for Bases and Wings to provide this reporting, DRMIS and other ad-hoc tools such as SharePoint, had to be created or modified to manually populate Logistics Assessment Reports (LOGASSESSREP).[219] Upon further review of the Lesson Learned and recommendations from Op LASER, are points that relate to maintaining SA (i.e. stock levels for items), which reinforces the value of the DND/CAF having an RLP capability. More specifically, is the requirement to identify the Commanders information requirements surrounding materiel (i.e. PPE), and then using DRMIS or other tools for AV to build the logistics component of the COP.[220] It is likely that if the DND/CAF had already been using the RLP capability that dashboards and reports may have been more readily available to provide AV and SA to Commanders. This may have also negated the requirement for manual tools such as the LOGASSESSREP.

The RLP capability is yet another example of a technological solution that can improve the operational effectiveness of the DND/CAF logistics system and DSC by providing SA to Commanders and enabling decision-making. Additionally, its ability to populate visual dashboards, provide real-time information to the CAF JBMC, and produce reports in a timely manner when required, will close the logistics SA gap that currently exists within the system. Once operational, this capability will be another tool that improves the DND/CAF's ability to make accurate and timely decisions when operating in the COE and FOE.

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[218] This information is based on the author's experience and understandings while being the officer responsible for providing mission support (i.e. logistics, engineering) to 8 Wing/CFB Trenton during the initial wave of COVID-19 from January 2020 to July 2020.

[219] CJOC J4 Ops e-mail with author. This information is also based on the author's experience in reporting materiel holding levels on a weekly basis to CJOC.

[220] Department of National Defence, *CJOC Headquarters Findings and Recommendations CJOC JOPG Review of the Conduct of Op LASER To End June 2020* (Ottawa: DND Canada, 2020), 37.

In conclusion, the FOE will be one in which the CAF is required to operate across the spectrum of operations, often in multiple domains at one time. Sustaining the warfighter in this environment will therefore require a logistics system and DSC that is optimized to provide effective and efficient support. Adopting a technological approach to modernization through digital transformation, data, and analytics will ensure that the DND/CAF can maintain superiority over its adversaries and be successful in any challenges it may face. The DND/CAF's *Data Strategy*, and the initiatives that have been discussed in this chapter will not only address the challenges that are currently being experienced in the DND/CAF logistics system and DSC, but they will enable responsive, relevant, and agile support to the warfighter. These initiatives will also accurately inform decision-makers, and enable their ability to Observe, Orient, Decide, and Act.

These technological initiatives will however require continued investment and commitment to ensuring their full functionality and value to the DND/CAF and will not be without future challenges. Many of these initiatives have also taken more time than expected to reach their current status due to past challenges.

CHAPTER 8: THE CHALLENGES OF MODERNIZATION

As modernizing the DND/CAF logistics and the DSC are discussed, it is important to recognize the challenges that have and may impact the DND/CAF's ability to improve the operational effectiveness and efficiencies of its current systems. With the rapid evolution of technology, the influence of globalization, and a FOE that will present new challenges for the DND/CAF to address, there is a need to discuss how future logistics enterprise challenges could be managed and mitigated. The following paragraphs discuss the potential challenges associated with modernizing the logistics system and DSC, and provides possible recommendations for how the CAF and other militaries can address them.

To explore these challenges two categories will be used: past/legacy challenges, and future challenges. Both of these categories contain human, technological, or organizational challenges.

Past Challenges

There are at least two key challenges that have previously impacted modernization efforts within the DND/CAF. One is the limited oversight of sustainment from one strategic process owner, and the other is the logistics system and DSC continue to support operations despite operating at sub-optimal levels, often at the expense of personnel.

Strategic Process Owner And Prioritization

In Ken Mills' research he discussed the need to create one single process owner that would assist with the integration of sustainment across the DND/CAF, but also who would align processes and provide a "common vision and unity of effort within DND/CAF logistics" while also reducing any friction.[221] Similarly Brandon Sing's research mentioned that when the

[221] Major Ken Mills, "Logistics: Reducing Friction Through Understanding, Integration, and Ownership," (Directed Research Project, Canadian Forces College, 2014), 8, 60-61, 68.

Strategic J4 position was created it demonstrated some progress within the DND/CAF as it provided a "strategic level champion" for logistics.[222] Today, the Strategic J4 is responsible to the Strategic Joint Staff Director of Staff and subsequently the CDS for providing sustainment oversight, while also coordinating, prioritizing, and synchronizing strategic level sustainment activities.[223] Despite the creation of this position, challenges exist today with the Strat J4 not having the authorities, the responsibilities, or the proper organizational structure to serve as a joint sustainment capability manager.[224] More specifically there exists a requirement today to have a sole sustainment capability manager with the correct authorities.[225] Regardless, it is recognized that the Strat J4 does assist as a strategic/institutional advisor for sustainment with functional authority.[226] This is an improvement from 2014 as prior to this date the unity of sustainment and logistics across the CAF could have been perceived as limited or disjointed, with individual components providing oversight of logistics and sustainment functions. One can imagine that if there had been a Strategic J4 or champion for logistics prior to 2014, then advocacy for modernization or integration of sustainment across the CAF may have been more effectively facilitated and enacted. This may have also assisted in furthering initiatives such as MISL.

Additionally, with the creation of a Strategic J4 position planning guidance such as those provided by the VCDS/DMA on data and digitalization and sustainment focused priorities like data and digitalization, a proper C4ISR spine, and supply chain reformation can be effectively

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[222] Major B. Sing, "Service Second to Some: Innovation and Best Practices in Defence Logistics," (Joint Command Staff Program Course Paper, Canadian Forces College, 2017), 18.

[223] Department of National Defence, "Brief to the Canadian Forces Logistics Association," Slide 3/14, dated 19 May 2015.

[224] Department of National Defence, "Strategic Integration of Joint Combat Systems Questionnaire," 2020, 3. Many of the accountabilities being dispersed amongst ADM (Mat) and the L1s,

[225] *Ibid.,* 3

[226] *Ibid.*

pursued.[227] Likewise, recent VCDS' priorities on integration across the DND/CAF and moving the CAF from an analog force to becoming a modern force capable of operating in the FOE can be more effectively enabled with the establishment of a Strategic J4. It is therefore understandable to recognize that previous modernization progress may have been challenged because of the lack of a clear priority to modernize. Furthermore, without having a clear priority, or the proper strategic oversight (i.e. Strategic J4), any initiatives would likely have been challenged to garner the required advocacy and support needed to reach their current status.

Effectiveness and Efficiency

Over the last number of decades the RCLS, logistics system, and DSC have continually exemplified high levels of support to day-to-day DND/CAF operations. However, based on the information and analysis presented in previous chapters this support could be assessed as having been provided in an inefficient manner due to integration and interoperability issues. Regardless of these issues, the logistics system, supply chain, and professional logisticians continued to provide the required support to operations. To many it could be argued that the system's ability to support operations was largely attributed to its personnel, who managed to keep the less than efficient system functioning through manual 'work-arounds' or manipulation. In other words, the system's support to operations was consistent with no significant failures. Consequently, there may not have been as strong of an impetus or catalyst for needing to change. This leads to the question: is the system broken if it is supporting operations? Regardless of the answer, the time for change is now, as resources may eventually become constrained with a changing operating environment. Furthermore, past alternative or 'work-around' options and inefficiencies have

[227] Department of National Defence, "VCDS/DMA Planning Guidance Data and Digitalization," (Ottawa: DND Canada, 2020), 2.

significantly impacted DND/CAF operations, with the FOE requiring a system that must be both effective and efficient.

Understanding these past challenges can also assist in ensuring that the DND/CAF takes the required action so that they do not turn into future challenges.

Future Challenges

With the rapid advancement of technology, and its increased influence on logistics systems and supply chains around the world, there is a need to recognize both the technological risks and challenges associated with using it. In order to maintain a decisive advantage over its adversaries, and to support operations more effectively and efficiently, the DND/CAF will need to be prepared to mitigate and address these challenges. To assist in managing the future challenges the investment and development of its personnel will be important. In focusing on the personnel of an organization and their role in modernizing the logistics systems and the DSC, there also needs to be an awareness of the challenges that the personnel themselves may experience.

Technological Risks and Challenges

In the book *Canadian Defence Policy in Theory and Practice,* Stephanie Carvin identifies challenges associated with new technologies. Although much of her focus is weapons related, a few are applicable to technology within logistics. For example, she discusses 'understanding the limits of future warfare' and refers to ensuring that the limits of technology are known, with technology only being effective if the military can apply them to its operational concepts.[228] In considering this challenge for future logistics initiatives and technology, the DND/CAF should

[228] Stephanie Carvin, "Canadian Defence and New Technologies," In *Canadian Defence Policy in Theory and Practice* eds Thomas Juneau, Philippe Lagassé and Srdjan Vucetic (Cham: Palgrave Macmillan, 2020), http://cfc.idm.oclc.org/login?url=https://doi.org/10.1007/978-3-030-26403-1, 390.

understand how innovation will fit into existing processes, and if it cannot then it will need to consider altering processes accordingly. Having an understanding of the limits of technology and digitalization are also key, especially in recognizing that possessing the data and information will not remove all of the chaos associated with warfare, and that information may not always be true.[229] Specifically, technological initiatives such as all-domain awareness platforms (i.e. JADC2 or RLP), or logistics ERP tools (i.e. MISL) and analytics will provide significant amounts of information, however they will still require a human component, such as a commander to have an understanding of the situation, weigh the risks and implications, and make certain decisions. Additionally, it must be recognized that a commander who has information rapidly available to them may be tempted to micromanage, and therefore there is need to consider how concepts such as 'mission command' may change based on technology. Finally, a possible limitation or challenge with technology, and in particular logistics IT or IM systems, is its ability to function in a deployed environment. The ability for a logistics system to operate in a deployed environment is especially significant when real-time information is required to understand the sustainment picture, and for the commander to make timely and accurate decisions. Possessing reliable and secure communication links, as well as the required bandwidth for what may be 'data hungry' systems must be considered when planning operations.[230] Possible recommendations to overcome some of the challenges associated with operating these systems in deployed environments is to adopt a tiered system approach (i.e. tier

[229] Department of National Defence, B-GL-300-004/FP-001, *Sustainment of Land Operations* (Ottawa: DND Canada, 2010), 1-21.

[230] Jeremy Smith, *Defence Logistics: Enabling and Sustaining Successful Military Operations*. Limited, 2018. *ProQuest Ebook Central*, https://ebookcentral.proquest.com/lib/cfvlibrary-ebooks/detail.action?docID=5231112, 353.

one - foundation tier, tier two - deployed servers, tier three - tablet/mobile).[231] This would be similar to what Australia is pursing with their mobile solutions.

Today's technology is also highly vulnerable to cyber-attacks, which highlights the importance of understanding how to operate in the cyber domain. The risk of cyber threats and attacks on IT and IM systems, such as those within logistics, is also more likely given that the battlefield of the COE and FOE has no 'safe area'. Due to the ability to attack IT and IM systems, the relationship between the 'shield' and 'sustain' operational functions is important and must remain strong in order to concentrate on hardening and creating resilient logistics systems. Additionally, with the ability to share more information, is the requirement to assess the risks of information being accessed by those who may use the information for illegitimate purposes. As a result of these factors, and the potential advantages that an adversary can gain by possessing information on logistics systems and supply chains, significant consideration should be given to the security aspect of any modernization initiative.

Data and Digitalization Challenges

Given that mission success within the FOE will be reliant on leveraging data and digitalization, there is a requirement to understand the possible challenges within this area. Within the *DND/CAF Data Strategy* many of the areas of concern are highlighted, while also providing recommendations for how they should be addressed. A few key additional challenges are noted in the paragraph that follow.

The ability to share and consolidate data so that it can be used for decision-making is a challenge that will continue to persist. This will be particularly relevant as new systems and

[231] Jeremy Smith, *Defence Logistics: Enabling and Sustaining Successful Military Operations*. Limited, 2018. *ProQuest Ebook Central*, https://ebookcentral.proquest.com/lib/cfvlibrary-ebooks/detail.action?docID=5231112, 354.

sensors are introduced which serve as additional sources of information for the larger data enterprise.[232] The ability to share all of this data will be critical, and will only be made possible by overcoming the DND/CAF's challenge of not possessing a common C4ISR architecture that provides a "convergence of information systems…..[and that] will enable an enterprise-wide view of data flow, storage and interfaces across ownership boundaries."[233] Along with this architecture is a need to foster and instill a data culture across the DND/CAF. This includes ensuring that personnel are willing to share data, and that they act as data stewards instead of being owners of data or working in silos.[234] Finally, there is the trust and accuracy of data. The modernization of logistics systems, and the DSC shifting towards initiatives such as MISL, will mean there is a requirement to ensure that the data being captured by AIT, or being pulled from legacy systems, is accurate and has been vetted prior to it being used for decision-making.[235] The inability to pull legacy data, or review it, may have negative consequences on decision-making.

Human Factors

Another set of challenges pertaining to modernization are those surrounding personnel, or the human factors. Carvin identifies 'understanding people power' and giving consideration to create new positions and perhaps occupations or specialties to "mirror some of the technological

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[232] Department of National Defence, *The Department of National Defence and Canadian Armed Forces Data Strategy* (Ottawa: DND Canada), 6; Department of National Defence. B-GL-300-004/FP-001, *Sustainment of Land Operations* (Ottawa: DND Canada, 2010), 1-20, 1-21.

[233] Jeremy Smith, *Defence Logistics: Enabling and Sustaining Successful Military Operations*. Limited, 2018. *ProQuest Ebook Central*, https://ebookcentral.proquest.com/lib/cfvlibrary-ebooks/detail.action?docID=5231112, 353.

[234] Department of National Defence, *The Department of National Defence and Canadian Armed Forces Data Strategy*, (Ottawa: DND Canada), 6.

[235] Jeremy, Smith, *Defence Logistics: Enabling and Sustaining Successful Military Operations*. Limited, 2018. *ProQuest Ebook Central*, https://ebookcentral.proquest.com/lib/cfvlibrary-ebooks/detail.action?docID=5231112, 353; Department of National Defence, *The Department of National Defence and Canadian Armed Forces Data Strategy*, (Ottawa: DND Canada), 6.

changes it anticipates."[236] Within the sustainment community this could include creating positions to perform analyst work on supply chain performance measurements and trends or determining if those skills should be performed by existing occupations. For example, having existing occupations perform these functions would entail providing the proper training to maintain the workforce. Providing training and professional development to the current and future workforce will ultimately be resource intensive but is necessary to ensure that new systems such as MISL are leveraged to their fullest operational effectiveness and efficiency. There may be challenges in training personnel, however training plans are being developed to assist with the transition to MISL and ensure system proficiency into the future.

Finally, in terms of the human and personnel challenges, is the fact that personnel can be both a system's greatest strength but also greatest vulnerability.[237] Despite technological advancements in areas such as automation, analytics or AI, human-machine interaction and human intervention will be required for the foreseeable future.[238] With this in mind, there must be an understanding of how human behavior, judgement, and perceptions can be influenced by stress or distress (i.e. when someone is not adequately prepared due to lack of training).[239] In order to address factors such as stress and distress, there needs to be emphasis on creating a security culture. To create this culture and safeguard the integrity of the system, emphasis is

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[236] Stephanie Carvin, "Canadian Defence and New Technologies,", In *Canadian Defence Policy in Theory and Practice* (Palgrave Macmillan, 2020), http://cfc.idm.oclc.org/login?url=https://doi.org/10.1007/978-3-030-26403-1, 393.

[237] Maria G. Burns, *Logistics and Transportation Security : A Strategic, Tactical, and Operational Guide to Resilience*, (Boca Raton: CRC Press, 2016), 306.

[238] Maria G. Burns, *Logistics and Transportation Security : A Strategic, Tactical, and Operational Guide to Resilience*, (Boca Raton: CRC Press: 2016), 305; Inside Logistics - Canada's Supply Chain Magazine, "COVID-19 has fuelled automation – but human involvement is still essential," 9 February 2021, https://www.insidelogistics.ca/opinions/covid-19-has-fuelled-automation-but-human-involvement-is-still-essential/?utm_medium=email&utm_source=newcom&utm_campaign=MMandD&utm_content=2021020983437.

[239] Maria G. Burns, *Logistics and Transportation Security : A Strategic, Tactical, and Operational Guide to Resilience*, (Boca Raton: CRC Press, 2016), 309.

required on unifying and strengthening personnel by motivating them with rewards and developing quality training so they understand how to respond to certain events.[240]

In conclusion, efforts to modernize the DND/CAF logistics system and DSC through technology have been challenged in the past and will likely encounter future challenges. As modernization within the DND/CAF logistics system and DSC progresses with the goal to improve operational effectiveness and efficiency, past challenges such as the absence of a Strategic J4 have and are being addressed. Certainly, over the next five to ten years this position will have a critical part in providing oversight of future challenges that involve technology. This is especially relevant based on the speed technology is developing, and that it is shaping industry, supply chains and armed forces such as the CAF. Furthermore, despite technology being seen as a 'force multiplier' for the DND/CAF, it needs to be recognized that it could make the DND/CAF more vulnerable to terrorism, piracy, and other state or non-state actors that may threaten the DND/CAF in the FOE.[241]

Within the sustainment community these risks and threats will be ever present especially as the focus shifts to data transformation and aggregating data from multiple systems into one holistic view or COP.[242] Due to the pan-domain threats, and the reliance on information sharing, the *DND/CAF Data Strategy* should therefore be fully utilized to create a data culture. In terms of sustainment, consideration should also be given to formulating a logistics or DSC security strategy that identifies what are the potential risks to the DSC, as well as denote how they can be mitigated. This could be similar to the US DLA's *Supply Chain Security Strategy* which is

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[240] Maria G. Burns, *Logistics and Transportation Security : A Strategic, Tactical, and Operational Guide to Resilience*, (Boca Raton: CRC Press, 2016), 310.

[241] *Ibid.,* 234.

[242] Department of National Defence, *Advancing with purpose: The Canadian Army Modernization Strategy*, Fourth Edition, (Ottawa: DND Canada, 2020), 29.

focused on how to address security challenges through "detection, protection, redundancy and resilience. . . [of] systems, processes, infrastructure and people to ensure continued support to the warfighter."[243] Finally, this chapter focused on the human factors that may impact future modernization efforts. Although cliché to say, personnel are an organization's most valued resource and therefore the DND/CAF will need to prioritize training on future systems and technology, while also recognizing the human vulnerabilities that may arise as modernization occurs.

[243] United States Department of Defence, Defence Logistics Agency, "Supply Chain Security Strategy," Last accessed 5 March 2021, https://www.dla.mil/Info/strategicplan/SupplyChainSecurityStrategy/#Leveraging.

CHAPTER 9: CONCLUSION

The future pan-domain operating environment will feature conflict that spans the spectrum of military operations and will be waged against adversaries who will attempt to gain superiority across multiple domains at any given time. Within the FOE, a nation's logistics and DSC will be contested, both at home and on deployment. Armed Forces such as the CAF will therefore need to build resilient logistics systems that are highly adaptable, agile, and integrated. Most importantly, these systems will need to be operationally effective and efficient in all activities it performs in support of the warfighter. Being more operationally effective and efficient will also contribute to ensuring materiel accountability and a high level of operational readiness for the force. For the DND/CAF, the operational effectiveness and efficiency of its logistics systems and DSC can be improved by modernizing the current system through technology, however this will not be without its challenges. These modernization efforts are key for the DND/CAF to continue supporting operations in the FOE, while also ensuring that the business of defence is managed responsibly.

By improving the operational effectiveness and efficiency of the logistics system and DSC through technology, many of the current issues and challenges that have been highlighted in the 2020 and 2008 OAG reports will be addressed. These challenges include those inherent to the current stove-piped and non-integrated ERP IT/IM system. Despite the system's shortcomings, it currently performs the required functionality for day-to-day operations, but requires high levels of manual manipulation, which can lead to errors and accountability issues. One challenge stemming from the lack of integration is the system's inability to provide sufficient performance metrics. Through metrics, trends can be identified and used to assess how effective and efficient the logistics system and DSC are in supporting operations. Most

noteworthy is that these issues can impact the ability to make accurate and timely decisions on sustainment and sustainment readiness. To assist with decision-making, E2E AV is required, which the DND/CAF currently lacks the ability to do effectively. This has directly resulted in holding excess materiel, thus increasing infrastructure costs, and ultimately poor stewardship of resources.

As referred to in this research and the research discussed in Chapter 2 by Adam Zima, Ken Mills, and Brandon Sing, it is by leveraging technological examples from industry and other Armed Forces, such as the QLF nations (i.e. United States, United Kingdom, Australia), which show how the DND/CAF logistics system and DSC can be improved. Common within those examples is the shift towards S&RL, and smart logistics. Furthermore, trends in the use of concepts such as AIT, BI, and analytics, and their ability to enable AV/ITV while also assisting with collating data to assist with decision-making are also very prevalent. Businesses such as Amazon and Walmart are also increasing their use of technology to assist with everyday business processes, such as identifying trends, providing predictive analysis, and also enabling real-time AV. Despite the differences between industry and military end goals, or the nature of their operations, industry's use of technology has illustrated how the operational effectiveness and efficiency of an organization such as the DND/CAF can be improved. Common to the QLF nations discussed in the previous chapters was also the requirement to provide the commander with joint all domain awareness. Logistics is one key component to providing this awareness. In order to successfully enable this one integrated ERP or IT software with AIT and full E2E AV is required. Furthermore, focusing on what lies ahead in the FOE, QLF nations have also realized the requirement to have resilient and highly adaptable logistics, and have taken steps to modernize their national systems, many in a similar fashion to the DND/CAF.

To improve the operational effectiveness and efficiency of the current system, the DND/CAF's initiatives are focused on developing an integrated approach. Centered upon digitally transforming current processes and policies through BI and data analytics, are the DND/CAF's key logistics initiatives. One of these initiatives is MISL. Utilizing the latest SAP S4 HANA technology, analytics will be enabled, and the latest functions/modules (i.e. Fleet Management, Extended Warehouse Management) will be combined into one fully integrated system. Implementing MISL will also assist in addressing past logistics and DSC issues, which will significantly improve support to CAF operations while providing high levels of materiel accountability. Other initiatives that have been highlighted are AIT. An enabler for MISL, and one that fills a capability gap, AIT will operationalize AV across the DSC, and improve the DND/CAF's SA and operational readiness. Finally, to ensure that decision-makers are fully aware of the logistics component to the operational readiness of the CAF, the RLP concept is also being developed. Proposed to act as a strategic level decision support tool for logistics and maintenance, RLP will utilize information from MISL to assist in populating dashboards that will function as a COP for decision-makers. The RLP will also significantly improve a commander's SA by contributing to the CAF JBMC and will enable accurate and timely decisions. It is clear that each of the DND/CAF current initiatives will assist in improving the operational effectiveness and efficiency of the logistics system and DSC.

Along with the efforts to modernize and improve the system and DSC, there will be challenges. These challenges must be understood in order to determine how they can be managed so that they do not impact future modernization efforts. Challenges include those that have occurred in the past and also those of the future. Past challenges can be viewed as having impacted or delayed the ability to reach the current point that the DND/CAF finds itself at, in

terms of modernization. Past challenges have been overcome through the creation of the Strategic J4 position, and with the VCDS prioritization towards supply chain reformation. These have also given the DND/CAF logistics system and DSC the advocacy required to improve the current processes and systems being used. Despite the creation of the Strategic J4 and emphasis on supply chain reformation, future challenges in modernization may occur. These include the risks inherent to the use of technology, as well as data and digitalization. For example, understanding the limits of technology, and the challenges such as working with systems in a deployed environment, are important factors to consider as modernization initiatives such as MISL are implemented. Other challenges include ensuring that our systems are secure and hardened to prevent the chance of cyber-attacks. Finally, when discussing technological improvements to the DND/CAF logistics system and DSC, the significance of human involvement in these systems is key. Human intervention will be required to operate all of these systems, and therefore an understanding that people can be an organization's greatest strength but are also a vulnerability is important. Likewise, is the need to consider the requirement to sufficiently train personnel on new systems, and also on how to recognize the impact of personnel judgements and stressors on the use of technology. Given the potential impacts that challenges could have on modernizing and implementing new logistics technologies, future research in this area could prove valuable.

Summary Of Issues And Recommendations For Improvement

The DND/CAF logistics system and DSC have experienced issues which have impacted their ability to be operationally effective and efficient in supporting both the DND in terms of materiel accountability and stewardship, and also the CAF for support to operations. These

issues and challenges were discussed throughout this research and are summarized below with a list of improvements and recommendations that are ongoing or could be adopted.

IT/IM Challenges

The current suite of ERP systems is stove-pipped, with multiple stand-alone systems, and no single centralized owner. This has made it challenging to provide E2E visibility, obtain performance measurements, and entails inefficient data entry processes which can result in data errors and unreliable information for decision-makers. Additionally, are the issues with not having a common C4ISR system and lacking a sound data culture. Much the same as Australia, and similar to the United Kingdom, the DND/CAF's intent to adopt both MISL and AIT will assist in rectifying the issues associated with stand-alone independent legacy systems, while also improving the operational effectiveness and efficiency of the DND/CAF logistics and the DSC. Likewise, the adoption of a *DND/CAF Data Strategy* and the eventual creation of a common C4ISR system will significantly enable the DND/CAF and specifically DND/CAF logistics and DSC to overcome the data and digitalization challenges it currently faces and those within the FOE.

E2E AV

The current ERP system has a limited E2E AV capability due to the lack of integration amongst the multiple systems. The inability to provide full, real-time AV impacts the ability to have a true understanding of materiel readiness, such as stock levels or the location of a high priority part that is needed in a theatre of operation. The issue of AV also impacts the ability to recognize DSC trends such as distribution delays, which impedes developing solutions to address the delays. Through the implementation of projects such as AIT for AV, combined with the MISL system, many of the challenges are being addressed and the system is becoming more

operationally effective in terms of readiness and ability to support operations. These projects are also improving inefficient materiel management practices.

‘Phase Zero’ And Logistics Situational Awareness For Decision-Making

Modernizing the DND/CAF logistics system and DSC will significantly address the issue of strategic and operational level commanders not having a true understanding of materiel readiness, or the required logistics SA for decision-making. Through the modernization of the system, and specifically projects such as MISL, AIT, and the RLP, the conveyance of real-time information to commanders and staff at all levels will be available. This also includes providing accurate information during the OPP and execution phase of an operation, which can assist in making decisions on upcoming Force Generation and Employment activities. Shifting to an increased use of BI and analytics will also help to improve decisions and the performance of the DND/CAF. As an example, Walmart’s use of data analytics to monitor performance and trends could be used to better allocate key resources and efforts in certain areas and may include adopting greater automation. Likewise, these technological improvements will also ensure good stewardship of public resources and materiel accountability, while satisfying the Departmental reporting requirements.

Risks With The Use Of Technology

Increased use of technology and in particular IM/IT systems to share and collaborate will not remove all the uncertainty surrounding warfare. Furthermore, with a greater reliance on technology there may also prove to be additional vulnerabilities such as those in a deployed environment. These can include systems being impractical for use in a deployed setting due to bandwidth issues. Security issues such as the probability of cyber-attacks or sustainment/readiness information being compromised are also possible with the shift towards

greater digitalization. Similar to the US' DLA, it is recommended that the DND/CAF develop a security strategy which will to identify the possible security challenges that may impact the DND/CAF logistics system and DSC, so that they can be protected through detection, redundancy and resilience. Additionally, consideration should be given to develop systems that are security hardened and tiered so that they can be deployed easily through mobile or tethered systems.

Human Factors and Issues

Through modernization there will exist human issues, and specifically is the need to have an understanding of both the power and limits of humans on a system. As systems are developed and implemented, there is a requirement to continually invest in a robust training package to maintain the proficiency of the operators using the system. For example, it is recommended that training be provided at establishments such as the Canadian Forces Logistics and Training Centre (CFLTC), through On the Job Training (OJT) offered at Units across the DND/CAF, and finally via in-service support assistance/help desks that could be centrally and strategically managed to provide this service.

In conclusion, it is evident that technology's role in modernizing the DND/CAF logistics systems and DSC to be more operationally effective and efficient is significant. The use of technology in modernization is also timely as the operating environment is evolving rapidly as conflict is likely to occur across multiple domains against an adversary who may be superior. Furthermore, in the face of the future environment and its associated threats is the need for integration that will be facilitated by digital transformation. This transformation is certainly required as it will improve the DND/CAF's ability to make accurate and timely decisions. Finally, as improvements to the current system such as those involving MISL and AIT are

further developed and reach their FOC, it will be important to ensure that they are provided with the required resources (i.e. training, funding) to remain sustainable, are well integrated with other DND/CAF initiatives, and are fully optimized. Failing in any of these areas may result in a logistics system and DSC that is less than effective and efficient in its ability to provide support to the warfighter.

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