EVALUATING THE EFFICACY OF SUSTAINABILITY INITIATIVES AND DEVELOPMENT OF A FRAMEWORK TO IMPROVE SUSTAINABILITY IN THE CANADIAN PORT SECTOR

by

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ABSTRACT

Ports are critical connecting nodes in Canada's resource-based economy that have adverse environmental and social impacts. Despite being federal entities, the Canada Port Authorities (CPAs) inconsistently report sustainability performance and are absent from Canada's Federal Sustainable Development Strategy (FSDS). The CPAs rely on the Green Marine Environmental Program (GMEP) to assess their environmental performance, but do not explicitly assess their sustainability, necessitating an evaluation of the program's efficacy. GMEP performance indicators (PIs) were linked to 14 of 36 relevant UN Sustainable Development Goal (SDG) targets. To address performance gaps in the GMEP, a complementary framework was developed using relevant Global Reporting Initiative (GRI) Standards. This framework provides CPAs with a unified approach to achieve all 36 relevant UN SDG targets. Use of this sustainability framework on its own, or in conjunction with the GMEP, ensures that CPA sustainability performance is more closely aligned with the UN SDGs and Canada's FSDS.

LIST OF ABBREVIATONS USED

AIS	Aquatic Invasive Species
CMA	*Canada Marine Act*
CO_2	Carbon Dioxide
CPA	Canada Port Authority
CS	Corporate Sustainability
CSR	Corporate Social Responsibility
DFO	Fisheries and Oceans Canada
EC	European Commission
ECCC	Environment and Climate Change Canada
EMAS	Eco-Management and Audit Scheme
EMS	Environmental Management System
EP	Environmental Policy
EPI	Environmental Performance Indicator
ESPO	European Seaports Organization
EU	European Union
FSDS	Federal Sustainable Development Strategy
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GMEP	Green Marine Environmental Program
GRI	Global Reporting Initiative
HAP	Hazardous Air Pollutant
IAHP	International Association of Ports and Harbors
ICS	International Chamber of Shipping
IMO	International Maritime Organization
IAEG	Inter-Agency and Expert Group
ISO	International Standards Organization
LOSC	Law of Sea Convention
NO_x	Nitrogen Oxide
OECD	Organization for Economic Co-operation and Development
PA	Port Authority

PERS	Port Environmental Review System
PI	Performance Indicator
PM	Particulate Matter
POP	Persistent Organic Pollutants
PORTOPIA	Ports Observatory for Performance Indicators Analysis
PRISM	Port Performance Indicators, Selection and Measurement
SDG	Sustainable Development Goals
SDM	Self-Diagnosis Method
SO_2	Sulphur Dioxide
SWOT	Strengths, Weaknesses, Opportunities, and Threats
TBL	Triple Bottom Line
TEU	Twenty-foot Equivalent
TRC	Truth and Reconciliation Commission
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNDRIP	United Declaration on the Rights of Indigenous Peoples
VOC	Volatile Organic Compounds
WBCSD	World Business Council for Sustainable Development
WHMIS	Workplace Hazardous Materials Information System
WPCI	World Ports' Climate Initiative
WPSP	World Ports Sustainability Program

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CHAPTER 1: INTRODUCTION

1.1. Context

The maritime industry is burgeoning, due largely in part to globalization causing an increase in international trade. This is especially true for Canada's resource-based economy, which depends on the export and import of products produced for both national and international markets. According to Transport Canada (2018), the maritime industry moved 19% ($101 billion CAD) of Canada's exports to global markets and 21% ($116 billion CAD) of Canada's total imports. Ports play a vital role in the transportation supply chain, contributing significantly to economic development by acting as transition points for raw materials and manufactured goods to enter and leave the country. Approximately 60% of the cargo tonnage in Canada is handled specifically by the Canada Port Authorities (CPAs) (Transport Canada, 2018; Government of Canada, 2019a). The CPAs also contribute approximately 213,000 direct and indirect jobs, accounting for over $25 billion dollars of Canada's Gross Domestic Product (GDP) (Association of Canadian Port Authorities, 2016).

The CPAs were designated under the 1998 *Canada Marine Act (CMA)* as "federally incorporated, autonomous, non-share corporations that operate at arm's length from the federal government" (Government of Canada, 2019a, para. 5). Though they are financially self-sufficient, they are also responsible for fulfilling public policy objectives and regulatory requirements, creating a balance between commercial autonomy and the accountability required for the use of public assets (Government of Canada, 2019a). Because the CPAs serve a national interest strategically, they are likely to remain under the control of the Minister of Transport, who appoints board members (Brooks, 2017a).

Despite their positive economic impact, ports are complex systems whose existence, and continued expansion to accommodate economic growth, inevitably lead to environmental impacts like habitat loss, waste water, air emissions, dust generation and the release of fine particulate matter (PM) in the air; noise and light pollution, sediment contamination, dredging, the accidental release of ballast water and fuel oil residues from ships; as well

as marine debris from land-based activities (Darbra et al., 2004; Merk, 2014; Council of Canadian Academies, 2017; Lam & Notteboom, 2014; Walker et al., 2019; Hossain et al., 2019). Port development has typically resulted in positive economic gains, negative environmental impacts, and both positive and negative social impacts (Schipper et al., 2017). The anticipated growth of the maritime industry will exacerbate these negative impacts to local communities and ecosystems if ports are not able to plan for and mitigate these externalities (Acciaro, 2015). In Canada, this responsibility falls primarily on the CPAs.

A previous study by Hossain et al. (2019) identified the sustainability initiatives employed by each CPA and found that many are lagging in terms of sustainability performance, as they do not appear to be fully committed to incorporating improved sustainability performance in their strategic goals. Despite being federal entities, the CPAs do not meet the same governance reporting standards that are required in the private sector in Canada, inconsistently reporting financial, social, and environmental performance (Brooks, 2018). This inconsistency in reporting across the sector suggests that there is significant room for improvement. This is an opportunity for the Government of Canada, as well as the CPAs themselves, to implement mechanisms to ensure that sustainability performance is focused on continuous improvement, above and beyond regulatory compliance.

1.2. Problem Statement

Canada has committed to the United Nations' 2030 Agenda for Sustainable Development through the creation of the Federal Sustainable Development Strategy (FSDS), which operationalizes the United Nations (UN) Sustainable Development Goals (SDGs) into a domestic strategy. Central to this commitment, the Government of Canada continues to develop policies and programs that will focus on reconciliation with Indigenous peoples, reducing poverty, strengthening the middle class, advancing gender equality, justice for all Canadians, and climate action through clean energy and oceans (Environment and Climate Change Canada, 2019a). The federal government has previously recognized the shortcomings in the port sector with its Port Modernization Review in 2016; however,

since undertaking that review, the Government of Canada has not explicitly included the CPAs in the FSDS (Transport Canada, 2018).

As federal entities, responsible for serving public interests, the CPAs sustainability performance should be in-line with that of the federal government, especially with respect to the goals of the FSDS. Presently, each CPA has been certified, to varying levels, by the Green Marine Environmental Program (GMEP) (Hossain et al., 2019). There is a reliance on this program to improve environmental performance; however, the program itself has not been evaluated to determine if it effectively addresses the goals outlined in the FSDS or UN SDGs. This study focuses on evaluating the GMEP to determine how effectively it addresses these goals and to identify performance gaps that exist in the program. With the identification of performance gaps in the GMEP, a framework will be developed to bridge these gaps so that CPAs can align their sustainability performance with the FSDS and UN SDGs. The creation of this sustainability framework is the primary goal of this research.

1.3. Research Questions

Question 1: How is sustainability defined in the port sector?

Question 2: Are sustainability initiatives in the Canadian Port Sector effectively addressing all dimensions of sustainability?

Question 3: Using the environmental and social dimensions of sustainability, can a framework be developed that draws from robust and credible metrics used in pre-existing initiatives, to effectively address sustainability in the Canadian context?

1.4. Research Objectives

Objective 1: The first objective was to conduct a literature review to determine what components are required for ports to be classified as sustainable. The literature review examined academic and grey literature, as well as programs currently employed to improve port sustainability in other jurisdictions.

Objective 2: The second objective was to evaluate the GMEP to determine if it effectively addresses sustainability in the Canadian Port Sector. The efficacy of the program was evaluated by identifying links between the GMEP performance indicators (PIs) and SDG targets.

Objective 3: Upon completing the review of the GMEP, performances gaps in the program were identified based on the understanding of what constitutes a sustainable port from the literature review. The framework fills performance gaps in the GMEP using robust and credible metrics from a globally-recognized sustainability standard to create a holistic framework that allows CPAs to improve their sustainability performance, in alignment with Canada's FSDS and the UN SDGs.

1.5. Scope

The Canadian context was chosen to limit the scope of the study and to contribute to the limited academic research evaluating sustainability initiatives in the Canadian Port Sector. As there is limited research pertaining to the Canadian Port Sector, the literature review begins from a global context. The primary body of literature on port sustainability is focused on European Ports, with additional studies scattered across other jurisdictions. Despite differences in jurisdictions and the inherent complexity of ports due to their varying geographic and spatial characteristics, the overall themes associated with port sustainability are similar. For this reason, the findings from the literature can be applied to the Canadian context with special consideration taken for the regulatory, legislative, and governance differences associated with Canadian Ports. In evaluating sustainability initiatives in the Canadian Port Sector, the CPAs were chosen as the primary focus because they are integral to Canada's economic strategy, serve a national interest, and are extensions of the federal government (Transport Canada, 2018).

1.6. Thesis Organization

This thesis is organized into five chapters. The first chapter is an introduction to the project, which provides the context, problem statement, research questions and

objectives, as well as the project's scope. The second chapter is a literature review that begins with the global perspective due to the limited body of research for the Canadian Port Sector. The second half of the literature review focuses on the Canadian context to provide an understanding of the governance, regulatory, and legislative environment within which Canadian Ports are operating. The third chapter builds on the knowledge gained from the literature review by evaluating the current sustainability initiatives employed by the Canada Port Authorities to improve sustainability performance. The fourth chapter is a continuation of the work from the third chapter, filling in the performance gaps identified in current sustainability initiatives to create a holistic framework that can be used to improve sustainability performance for the CPAs. The final chapter provides a conclusion to the work conducted throughout this thesis.

CHAPTER 2: LITERATURE REVIEW

2.1. Maritime Industry

The maritime industry is a fundamental component of the global economy. According to the International Chamber of Shipping (2017), approximately 90% of world trade is carried out by the maritime industry, with over 50,000 merchant ships in 150 countries moving between international waters, carrying raw materials, finished goods, food, and fuel. In 2017, approximately 10.7 billion tons of goods were loaded worldwide – a 4% increase from 2016 (UNCTAD, 2018). The Organization for Economic Co-operation and Development (OECD) has predicted that due to globalization and rapid economic development, particularly in China and India, this growth will double over the next 25 years, potentially tripling by 2060 (2011; UNCTAD, 2011). The United Nations' Conference on Trade and Development (UNCTAD) anticipates a more modest growth of 3.5% between 2019 and 2024 in containerized, dry bulk, and gas cargoes, due to protectionism and trade tensions occurring among global trade partners (2019a). Despite its importance to the global economy, maritime shipping has had major environmental impacts, both locally and through cross-boundary environmental impacts to air, water, and land (Lister et al., 2015).

Maritime transport has typically been seen as a greener mode of transportation because ships emit less carbon dioxide (CO_2) per tonne of cargo transported than rail, air, or truck transport; however, due to the large scale of operations, the industry is still responsible for approximately 3% of CO_2 emissions globally (Lister et al., 2015; International Chamber of Shipping, 2017; Puig & Darbra, 2019; Walker et al., 2019). Despite CO_2 emission levels decreasing in many sectors, it is anticipated that emission levels will continue to rise in the maritime industry as the amount of freight transportation continues to increase (Acciaro & Wilmsmeier, 2015). With the global climate action movements, society is demanding that industries do more to mitigate their environmental impacts and improve accountability and transparency. As growth in the maritime industry continues, initiatives and policies like the 2030 Agenda for Sustainable Development, the Paris Agreement, and the Sendai Framework for Disaster Risk Reduction are causing industries

to focus on sustainable development to improve both environmental performance and build resilience in a changing climate (UNCTAD, 2019a).

With environmental sustainability becoming a priority for policymakers worldwide, the maritime industry is facing increasing pressure to improve their environmental and social responsibilities (UNCTAD, 2019a; Hossain et al., 2021). The International Maritime Organization (IMO) is actively working towards the 2030 Sustainable Development Goals (SDGs) by focusing on improving sustainable transport to facilitate world trade (International Maritime Organization, 2020). Though the primary focus has been on maritime shipping, the port sector can also play a significant role in achieving the targets outlined in the SDGs. Ports are critical nodes in the maritime transport chain that have had significant environmental impacts at the local level. With increased public scrutiny, ports are now expected to reconsider their strategies and operational performance to align with sustainability concerns and to reduce negative externalities (UNCTAD, 2019b; Hossain et al., 2021).

2.2. Ports

2.2.1. Overview

Ports are critical connecting nodes in the maritime industry, providing access to markets, supporting supply chains, and linking producers with consumers globally (UNCTAD, 2019a). The European Commission (2004) defined a port as "an area of land and water made up of such construction works and equipment as to permit, principally, the reception of ships, their loading and unloading, the storage of goods, the receipt and delivery of these goods to the hinterland, and the embarkation and disembarkation of passengers". Puig and Darbra (2019) suggest that this definition demonstrates the complexity of a port, as it notes the interaction between land and water areas, as well as the connection between economic, social, cultural, and environmental elements in the port.

The port itself is a hierarchical structure, with the port authority (PA) being the governing body for the operations within the port (Puig & Darbra, 2019). The PA was traditionally

created at the national or regional level to provide a regulatory role, as well as to oversee ownership of infrastructure and operational activities (Brooks, 2017b). The PA provides services within the port, including collecting user fees and ensuring the movement of ships into and out of the port occurs safely (Puig & Darbra, 2019). There are also licensed companies operating within the port area that provide additional services to the PA and their customers, like cargo loading/unloading and the fuelling of ships (Peris-Mora et al., 2005). The PAs are not just responsible for overseeing their own activities, they must also ensure that they are offering facilities and procedures so that the licensed companies operating within the port area are complying with local, national, and international legislation (Acciaro, 2015; Puig & Darbra, 2019).

Though the PA can be a public or private entity, reforms in port governance have led to an increase in devolution and privatization of ports globally (Brooks, 2017b). With privatization, there has been a natural shift towards making ports more profitable, operationally efficient, competitive, and sustainable (Acciaro, 2015; Brooks, 2017b). Publicly-operated PAs are ultimately responsible for maintaining the public interest in a transparent manner, though any port failing to consider the negative externalities resulting from operations can become vulnerable competitively due to interruptions in development and expansion, loss in investment, increasing costs, loss of market share, and dissatisfaction among key stakeholders (Acciaro, 2015). Similarly, ports who have continuously demonstrated strong environmental performance have been able to attract investors and maintain community support (Lam & Notteboom, 2014).

2.3. Environmental and Social Impact of Port Operations

Understanding the impact that port activities have on local environments and communities is critical to improving sustainability performance in the port sector (Hossain et al., 2021). The United Nations (UN) Convention on the Law of the Sea (LOSC) provides ports with jurisdiction over ships entering their waters – this gives the ports the authority to implement mandatory mitigation strategies to reduce the impacts caused by ships entering the port (Hildreth & Torbitt, 2010). As a result, ports have direct control over the emissions and pollution generated by port activities, indirect emissions

from the generation of electricity needed for these activities, and emissions resulting from the transport of materials and cargo to and from the port (Gonzalez-Aregall et al., 2018). Historically, ports have been developed in urban areas, meaning that any adverse environmental impacts associated with the port have had a greater impact on local populations (Darbra et al., 2004). With rising environmental concerns, greater attention has been cast on port operations, leading ports in jurisdictions to take actions to ensure local communities are shielded from the negative external effects of ports (Acciaro, 2015). Despite port cities having a unique and diverse culture, port development typically results in positive economic gains, negative environmental impacts, and both positive and negative social impacts (Schipper et al., 2017; Fenton, 2017).

The interaction between ports and the local environment is complex – their existence alone leads to a loss in habitat, in addition to impacts to water, land, and soil (Darbra, et al., 2004). Coastal erosion and habitat loss can also occur as a result of dredging harbours and channels (Merk, 2014). Ships anchoring in the port can impact habitat and increase turbidity by disrupting sediment in the harbour bed, which has a negative impact on water quality and local flora and fauna (Darbra et al., 2009; Council of Canadian Academies, 2017). The release of ballast water from ships arriving in the port can cause the introduction of invasive species, which can negatively impact local biodiversity, though there have been regulations in Canada and the United States since 1993 to ensure that ballast water is exchanged in mid-ocean saltwater to reduce the risk of aquatic invasive species locally (Bailey et al., 2011; Dinwoodie et al., 2012; Council of Canadian Academies, 2017). The oxidization of sulphur and nitrogen from ship emissions can also contribute to ocean acidification which can harm local flora and fauna (Merk, 2014). The continuous movement of ships can lead to an increased risk of accidents that cause hazardous spills, though water pollution also occurs via ballast water, fuel oil residue, waste disposal from ships, and cargo residues (Darbra et al., 2004; Lam & Notteboom, 2014; Walker et al., 2019). Marine mammals are often killed by ship strikes and underwater noise from the ships entering and leaving ports can also disrupt communication and migration of these species (Council of Canadian Academies, 2017;

Taylor & Walker, 2017).

Both ships and the various types of equipment used in the port area create air contaminants – predominantly CO_2, sulphur dioxide (SO_2), nitrogen oxides (NO_x), and other particulate matter (PM) – that have a direct impact on the health of local communities (Council of Canadian Academies, 2017). These air contaminants can lead to illnesses like asthma, heart attack, a higher risk for cardiopulmonary cancer, as well as premature death (Corbett et al., 2007). The dust generated by bulk cargo handling can also have an adverse impact on individuals with respiratory issues living near or working in the port area (Council of Canadian Academies, 2017). Despite the fact that emissions from the port sector are a minor contributor to total air emissions globally, reducing these emissions will improve air quality in local communities, which can lead to a reduction in lost work days and decreased costs to society for health care related to respiratory illness (Merck, 2014; Acciaro & Wilmsmeier, 2015).

The movement of goods between the port and the hinterland, via truck and rail, can also lead to increased urban congestion that creates noise and air pollution, as well as a higher risk for accidents that cause delays and increased tension in local communities (Merck, 2014; Council of Canadian Academies, 2017). Industrial noise from port operations and berthed ships can also be a source of tension between the PA and local communities. Though the literature is limited in identifying the specific impacts attributed to the prolonged exposure to noise from ships and operations on local populations, the chronic exposure has been associated with sleep disturbances and annoyance, which can exacerbate pre-existing health conditions (Merk, 2014). The European Sea Ports Organization (ESPO) has continuously identified noise pollution as one of the most pressing environmental issues in European ports (2013). Light pollution can become a nuisance to local communities, though the long-term exposure to artificial lights in the port area can also impact local biodiversity, causing disorientation and upsetting their circadian rhythms (Merck, 2014; Council of Canadian Academies, 2017).

There are also many implications associated with the use of land in or around the port. Ports take up a significant amount of urban land space, which often results in land-use

conflicts between the port, city, and community, especially when ports look to expand and develop (Merk, 2014). There are also issues with safety and security in the port area. In Canada, the major ports are vulnerable to the smuggling of counterfeit goods, contraband, and other hazardous materials (Public Safety Canada, 2015). These large commercial marine ports see a large volume of container traffic processed, making it difficult to inspect and seize smuggled goods (Public Safety Canada, 2015). In addition to illicit goods crossing international borders and entering through ports, there are also security threats related to installations located in the port area. Ports can become a target for attacks or serious accidents because the industrial nature of ports means that installations like fuel tanks, refineries, pipelines, chemical and power plants, and high-density populations are found within close proximity (Merck, 2014; Council of Canadian Academies, 2017).

2.4. Importance of Sustainability in the Port Sector

When examining sustainability across an organization, many businesses will focus on the triple bottom line (TBL) – a concept first coined by Elkington (1994) that noted the importance of balancing economic prosperity with environmental quality and social justice. When looking at the TBL, the social and environmental dimensions are focused on minimizing negative impacts from industrial activities, while the economic dimension focuses primarily on efficient business operations, thus creating a balance in the use of resources (Di Vaio et al., 2018). In the context of ports, Sislian et al. (2016) suggest that return on investment and operational efficiency should be carefully balanced with improving environmental performance (air quality, waste management, and noise pollution) and social factors like direct/indirect employment and improving relationships with local communities.

To date, sustainability in the port sector has typically focused on improving environmental performance in response to changes in environmental regulation and increased societal pressure (Adams et al., 2009; Sislian et al., 2016; Hossain et al., 2021). PAs have the ability to become environmental stewards through community management and the adoption of voluntary environmental action beyond their own operational

boundaries; however, to date, PAs have not applied strategies that lie beyond organizational boundaries (Poulsen et al., 2018). There has been an expectation more recently that ports will adhere to the best practices employed by the business sector with respect to improving environmental performance and engaging key stakeholders (Adams et al., 2009). A common strategy employed by the private sector to reduce negative externalities is the adoption of corporate social responsibility (CSR) practices.

PAs have adopted CSR practices to varying degrees – many actively pursue these practices, while others only adopt practices in response to societal pressure (Acciaro, 2015). In a survey of Canadian and US ports, Ashrafi et al. (2019) found that only 29% of respondents disclosed their sustainability performance using a standalone sustainability report. The survey also found that 65% of ports had adopted a sustainability initiative of some sort, with the International Standards Organization (ISO) 14001 standard being the most common sustainability standard adopted (Ashrafi et al., 2019). As the authors note, these management tools and process standards do not dictate what level of corporate sustainability (CS) the port must achieve, instead, they "help ports to identify CS aspects of their operations, define CS objectives and targets, implement programs to attain CS goals, monitor and measure effectiveness, correct deficiencies and problems, and review their management systems to promote continuous improvement" (Ashrafi et al., 2019, p. 392). Ashrafi et al. (2019) noted that the main drivers in the adoption of CS initiatives and standards in North American Ports were growth, return on investment, risk management, and corporate citizenship. Similarly, Vejvar et al. (2018) and Ashrafi et al. (2020) noted that ports were reluctant to invest in initiatives that had a long-term payoff and were more likely to implement sustainability practices that lowered costs, increased efficiency, and avoided receiving fines.

In a study of European ports by Darbra et al. (2009), a questionnaire was administered to participant ports and the results indicated that 93% had environmental policies that detailed their compliance with legislation as well as their commitment to sustainable development; however, only 64% of respondents were accredited by recognized certifications or standards, namely ISO 14001 and the Port Environmental Review System (PERS). The development of an environmental management system (EMS)

allows an organization to plan for any situation and have solutions to deal with any environmental issue that arises from the organization's operations (Peris-Mora et al., 2005). It requires the "quantification of objectives and goals as well as the effort and commitment for continuous improvement" (Peris-Mora et al., 2005, p. 1655). Monitoring environmental performance has become increasingly important to PAs because it reinforces compliance with legislation, allowing management to address gaps in performance, and providing PAs with their social license to operate (Puig et al., 2017). The main drivers for environmental monitoring in these ports were the ability to maintain their operations related to cargo handling and the movement of ships, followed by international legislation, European directives and national legislation; and finally, local responsibilities related to maintaining the port's reputation (Darbra et al., 2009).

The adoption of CSR strategies is not used for the sole purpose of improving sustainability performance; it can also improve competitiveness by allowing the PA to identify operational inefficiencies and business opportunities, improve stakeholder management, and be proactive in their response to changing legislation and regulations pertaining to environmental concerns (Acciaro, 2015). The adoption of strategies to mitigate environmental and social impacts also allows PAs to prepare for the inevitable changes that sea ports will face with climate change. Port planning is typically driven by short-term returns because the profit margins are so thin, meaning that they often are not actively planning for events that may occur in the longer term, such as the anticipated increase in natural disasters associated with climate change (Becker et al., 2013). The importance of public support is found throughout the literature, especially with respect to local communities providing PAs with a social license to operate. Dooms et al. (2015) suggest that conveying to local communities and governments the socioeconomic benefits of ports, including employment and value added, will allow ports to maintain their social license to operate and continue to obtain investments and regulatory support from governments. Many studies also demonstrate that the environment in which people work can have a significant impact on employee performance and retention; improving working conditions can lead to reduced accidents and costs associated with missed workdays and employee turnover (Antão et al., 2016).

Though the benefits of measuring and improving port sustainability performance are demonstrated consistently in academic literature, there remains no unifying global standard or guide for PAs. Despite various programs focused on elements of sustainability, the port sector does not have an integrative initiative that incorporates the three dimensions of sustainability (economic, social, and environmental) that is often seen in other industries (Langenus & Dooms, 2018). To understand the multi-faceted nature of measuring sustainability in the port sector, the sections that follow will discuss the use of performance indicators in the port sector and provide an overview of the current initiatives available to PAs to measure sustainability in different jurisdictions.

2.5. Measuring Sustainability Performance

2.5.1. Use of Indicators

In their systematic literature review of port sustainability performance, Lim et al. (2019) highlighted the issues with measuring port sustainability performance. The authors suggest that it is difficult to create an integrated evaluation standard because ports are complex organizations, whose size, organizational structure, location, and environmental impact will vary from port to port (Lim et al., 2019). Ports have been compared to complex ecosystems, requiring those managing the organization to use systems-thinking to identify the relationships between the variables acting within the port system (Peris-Mora et al., 2005). This complexity makes it difficult to identify cause and effect relationships, so to facilitate the measurement of these variables and simplify analysis, Peris-Mora et al. (2005) suggest that indicators be used to replace direct measurements that are only sometimes obtainable. The OECD (2001) defines an environmental indicator as "a parameter, or a value derived from parameters, that points to, provides information about and/or describes the state of the environment, and has a significance extending beyond that directly associated with any given parametric value. The term may encompass indicators of environmental pressures, conditions and responses." The rationale for using indicators is that they reduce the amount of measurements that would typically be required to provide a complete overview of a situation (OECD, 1993). Developing indicators for the port requires knowledge of the material, energy, and information flow within the port and generally follows the stages outlined in Figure 1

(Peris Mora et al., 2005).

Figure 1. Stages for identifying port environmental impacts (adapted from Peris-Mora et al., 2005)

The indicators become "signals which allow data to become available for decision-making" and facilitate the analysis and control of information within the system (Peris-Mora et al., 2005, p. 1651). Antão et al. (2016) advocate for the use of indicators by PAs to facilitate compliance with legislation, environmental protection, as well as reducing costs and risks because they are able to demonstrate performance trends over time. Indicators can then be used to guide strategic and operational decision-making for the PA. Unfortunately, though ports understand the importance of using environmental performance indicators (EPIs), there is no common approach regarding which indicators should be used.

The OECD has provided general criteria for indicator selection, which are outlined in Figure 2. It denotes the importance of having an appropriate number of indicators – too many clouds the overview, while too few does not sufficiently provide the information required to make decisions (OECD, 1993). It is important to note that the OCED (1993) does state that indicators demonstrate the best-available knowledge and are not always capable of demonstrating causal chains that would be provided by strict scientific demands because their purpose is, ultimately, to simplify the communication of information.

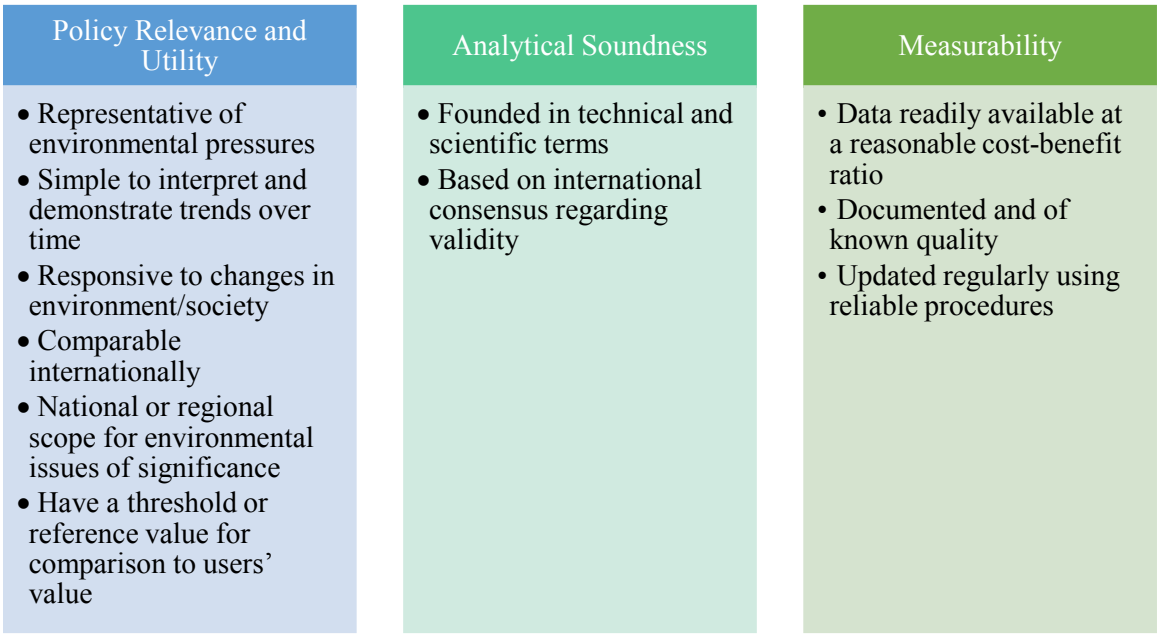


Figure 2. Environmental indicator selection criteria (adapted from OECD, 1993)

Lim et al. (2019) suggest that there are discrepancies between the indicators identified by researchers and those prioritized by port authorities/managers. For example, water pollution was the most frequent indicator identified in the literature, while port authorities viewed atmospheric pollution management and energy consumption as more valuable indicators of environmental performance (Lim et al., 2019). It is suggested that "a model or tool which can reflect both the international evaluation criteria and the characteristics of each port should be developed in order to overcome the challenge of the conflicting claims" (Lim et al., 2019, p. 60). This demonstrates the necessity for interdisciplinary collaboration so that any initiative developed to measure sustainability in the port sector is based on rigorous academic research with the input from professionals/experts in the port industry.

2.5.2. Global Sustainability Initiatives

The shift towards port sustainability began in Europe in the mid-1990s. Initially, PAs only had access to global standards and certifications available to all industries, like the ISO 14001 certification and the Eco-Management and Audit Scheme (EMAS). The main purpose of these initiatives was to facilitate the development of an EMS. In response to a

demand for initiatives that would address the intricacies of the port sector and allow ports to track environmental performance, ESPO began to focus on the use of PIs that could be used to monitor and improve performance. The section that follows discusses port-specific programs and globally-recognized standards and certifications that have been employed by the port sector to improve their sustainability performance.

2.5.2.1. European Sea Ports Organization

The European Sea Ports Organization (ESPO) was developed in 1993 when a working group came together to lobby on behalf of sea ports' interests (European Sea Ports Organization, 2020). Though the organization focuses on a wide range of relevant issues to the European Port Sector, ESPO published their Environmental Code of Practice in 1994, when PAs began to show an increased interest in improving their environmental performance (Darbra et al., 2004). The Code recommended that PAs "comply with the letter and spirit of environmental legislation and abide by internationally agreed conventions, directives and resolutions intended to protect the environment" (Darbra et al., 2004, p. 422).

In 2001, ESPO published their Environmental Review to provide ports with a more comprehensive guide for improving environmental performance. The Review recommended that all ports publish environmental performance strategies, establish environmental indicators and targets to achieve, as well as move beyond regulatory compliance (European Sea Ports Organization, 2003). ESPO also administered a survey in 2005, using data collected from ports to establish a European benchmark for environmental performance and identify key environmental issues impacting ports (Puig et al., 2017). In 2009, the most comprehensive survey was administered to European ports and established the use of EPIs for measuring environmental performance.

ESPO has had several projects throughout the years that have focused on improving port sustainability. The Port Performance Indicators: Selection and Measurement (PRISM) project focused on the development of environmental indicators related to management, operations, and conditions in an effort to create a culture of performance measurement among ports in Europe (Seguí et al., 2016). The Ports Observatory for Performance

Indicators Analysis (PORTOPIA) was a project conducted to monitor European ports' key performance data in an online integrated platform (Puig et al., 2015). The PORTOPIA online database allows ports to benchmark their data against industry standards in environmental management, environmental monitoring, environmental priorities, and services to shipping (Seguí et al., 2016). Now fully integrated into ESPO, the EcoPorts program is the premier initiative used by European ports to improve environmental performance.

2.5.2.2. EcoPorts

EcoPorts is the main environmental initiative adopted by the European Port Sector. It was developed by ports with a vested interest in improving their sustainability performance and is now fully integrated in the ESPO (EcoPorts, 2020a). The program's founding principle is to provide ports with an equal opportunity to improve environmental performance through cooperation and knowledge sharing between ports (EcoPorts, 2020). It provides ports with "applied, practical value tools and methodologies that assist port environmental managers in their daily work" (European Sea Ports Organization, 2017). The EcoPorts tools include both the Self Diagnosis Method (SDM) and the PERS. From the data obtained through these tools, ESPO is able to determine what the top environmental priorities are for ports. Over the last 3 years, these priorities have remained the same, though their relative position has changed (European Sea Ports Organization, 2019). The top two priorities in European ports for the past three years have been air quality and energy consumption (Figure 3). There has, however, been an increased priority in addressing climate change in the port sector, with this priority jumping from number seven to number three between 2018 and 2019 (European Sea Ports Organization, 2019). ESPO (2019) reports that issues like complying with climate regulations, reducing CO_2 emissions, and ensuring infrastructure is resilient for climate-related changes have become of increasing concern for European ports.

Figure 3. Top 10 environmental priorities for European ports in 2019 (adapted from ESPO, 2019)

2.5.2.2.1. Self-Diagnosis Method

The guidelines for implementing an EMS involved complex methodologies that required significant effort and experience with environmental management systems. Due to operational intricacies, Darbra et al. (2004) developed a simple and accessible tool that allowed inexperienced ports to assess their environmental performance and management strategies. Because it was designed specifically for ports, it is often used as a precursor for broader international standards like ISO 14001 and EMAS. The SDM allows ports to carry out an evaluation of their environmental management using a strategic analysis questionnaire, whose categories are outlined in Table 1. The qualitative questionnaire uses Yes/No questions to provide a checklist for "the fundamental components of a credible Environmental Management System" (Puig et al., 2017, p. 112). The main objective of the SDM is to review the activities and procedures pertaining to the way the port is dealing with environmental aspects and is best used by port managers to review annual environmental management performance, revise current procedures/activities, and develop strategies for continuous improvement (Darbra et al., 2004).

Table 1. Sections of the Self-Diagnosis Method Questionnaire (adapted from Puig et al., [2017])

Section	Title
A	Environmental Policy
B	Management organization and personnel
C	Environmental awareness and training
D	Communication
E	Operational management
F	Emergency planning
G	Environmental issues and monitoring
H	Review and audit
I	Services to shipping

To incentivize the use of the SDM tool, ports have access to their baseline results to facilitate the analysis of their year-over-year performance compared to the European benchmark that is compiled from the data of all ports participating in the EcoPorts program (Puig et al., 2017). The ports are also offered a gap analysis, as well as an analysis of the strengths, weaknesses, opportunities and threats (SWOT) present in the port sector. This allows the port to determine if there are gaps between their performance and the European benchmark, as well as identify opportunities to improve their environmental practices and prepare for threats that create business risks (Darbra et al., 2004). Most importantly, the tool offers port managers a user-friendly method of evaluating their environmental performance as a first step to implementing an EMS and receiving certification.

2.5.2.2.2. Port Environmental Review System

PERS works in conjunction with the SDM. It was designed within the EcoPorts framework to assist ports with the implementation of recommendations set out by ESPO's Environmental Review (Darbra et al., 2004). PERS incorporates the main requirements of environmental management standards, like ISO 14001, while accounting for the specific characteristics of ports (EcoPorts, 2020b). It was the first tool to address the issue of complexity in the port system from an environmental management perspective by allowing the user to review a single port facility or the port area as a whole (Darbra et al., 2004). Like other standards used to develop an EMS, the PA is required to establish procedures to identify the significant environmental aspects of its

operations (Puig et al., 2015). Standards that are used to develop an EMS do not have a standardized procedure to identify these environmental aspects because they recognize that each port is unique; instead, they define the requisites to identify rather than the means for achieving them (Puig et al., 2015). Once the review is complete, the results are independently reviewed by Lloyd's Register, and PERS certification is then granted for a two-year period (EcoPorts, 2020b).

2.5.2.3. International Standards Organization

ISO 14001 is a set of process standards. They are descriptive standards that allow organizations to implement an environmental management system to achieve their own environmental performance targets and objectives (Vastag, 2009; Matuszak-Flejszman et al., 2016). The use of an environmental management system helps organizations "identify, manage, monitor and control their environmental issues in a holistic manner" (International Organization for Standardization, 2015, p. 3). It focuses on the environmental aspects that are relevant to the individual company, including air pollution, waste management, climate change mitigation and adaptation, issues with sewage and water, soil contamination, and resource use and efficiency (ISO, 2015; Sartor et al., 2019). Additionally, it requires the organization to follow all regional, national, and international environmental legislation, as well as complying with the conditions of their operating license (Borella & Rordigues de Carvello Borella, 2016). Despite findings that companies who adopted ISO 14001 only had moderate success in improving environmental performance, Arimura et al. (2016) found that its adoption can have spinoff effects in the supply chain, with ISO14001-certified facilities being more likely to require improved environmental practices by their suppliers.

2.5.2.4. Global Reporting Initiative

The Global Reporting Initiative (GRI) is an organization that helps "businesses and governments worldwide understand and communicate their impact on critical sustainability issues such as climate change, human rights, governance and social well-being" (GRI, 2020a). The GRI was initially based on the US financial reporting system, with the intent being to expand their global reach, scope (social, environmental and

economic reporting), and stakeholder base, to facilitate a participatory discussion regarding what sustainability performance should look like in different business sectors (Szejnwald Brown et al., 2009). The purpose of disclosing sustainability information is to encourage accountability, identify and mitigate risks, as well as identify new opportunities for the organization; this encourages organizations to focus on improving environmental and social performance, while maintaining economic benefits (GRI, 2020a).

The GRI Sustainability Reporting Standards have become the global standard for sustainability reporting. They are a "modular, interrelated structure, and represent the best practice for reporting on a range of economic, environmental and social impacts" (GRI, 2020b). The GRI requires organizations to report both their positive and negative economic, environmental, and social impacts, as well as how these impacts are managed (GRI, 2020c). The GRI Reporting Principles in Table 2 must be applied by any organization publishing a sustainability report in accordance with GRI Standards (GRI 2016a). These Principles are integral to a high-quality sustainability report that provides consistent and credible reporting (GRI, 2020b). In addition to the Reporting Principles, each standard has recommendations and guidelines to provide organizations with the appropriate information needed to understand what is expected for each standard; these, in turn, facilitate the organization in fulfilling the requirements needed to satisfy the standard (GRI, 2020c).

Table 2. GRI Reporting Principles

Reporting Principles for Defining Report Content	**Reporting Principles for Defining Report Quality**
Stakeholder inclusiveness: Identify stakeholders and explain how the organization responds to their reasonable expectations and interests	***Accuracy***: Reported information is sufficiently accurate and detailed for stakeholders
Sustainability Context: Presents the reporting organization's performance in the wider context of sustainability	***Balance***: Reported information reflects positive and negative aspects of the organization's performance
Materiality: The report covers topics that have significant economic, environmental, and social impacts, or substantively influence the assessments and decisions of stakeholders	***Clarity***: Reported information must be understandable and accessible to stakeholders

Reporting Principles for Defining Report Content	Reporting Principles for Defining Report Quality
Completeness: The report includes coverage of material topics and their boundaries to "sufficiently reflect impacts and to enable stakeholders to assess the organization's performance during the reporting period"	***Comparability***: The reporting organization must select, compile, and report information consistently so that performance can be evaluated over time and analysis relative to other companies could be conducted
	Reliability: The reporting organization must gather, record, compile, analyze and report information and processes used in the preparation of the report in a way that they can be subject to examination and that establishes the quality and materiality of the information.
	Timeliness: Report on a regular schedule so that stakeholders can make informed decisions in a timely manner

2.5.2.5. World Port Sustainability Program

The World Port Sustainability Program (WPSP) was developed in 2017 by the International Association of Ports and Harbors (IAPH) as an extension of the World Ports Climate Initiative (WPCI). The program coordinates ports globally to ensure that their sustainability management is following the targets outlined in the UN SDGs (WPSP, 2018). Ports are embedded in local and regional communities as critical nodes in global supply chains; therefore, they must respond to local and global challenges associated with climate change, digitalization, mobility, migration and social integration while continuing to add value to these supply chains (WPSP, 2018). Improving sustainability performance requires that ports engage with governments, businesses, and other key stakeholders at both the local and international levels. To facilitate ports across the world, the WPSP has compiled a collection of best practices in sustainability performance globally and fosters collaboration among ports worldwide by providing a platform to share individual port initiatives (WPSP, 2018).

The WPSP is coordinating the sustainability efforts of ports towards achieving the UN SDGs by focusing on five themes:

1. Resilient infrastructure: meeting the demands of a growing maritime sector while mitigating the impact of weather and climate changes on both port operations as well as the local communities in which they operate.

2. Climate and energy: reducing GHG emissions in accordance with the Paris Climate Agreement and implementing initiatives that allow ports to transition to green energy, improve air quality, and develop circular economies.
3. Community outreach and port-city dialogue: improving relationships with local communities through communication with stakeholders, focusing on intersecting issues like resilience and attractiveness.
4. Safety and security: recognizing the new dynamics pertaining to security in the age of digitalization and increasing regulations.
5. Governance and ethics: upholding the highest standards of corporate governance, including transparency, accountability, and ethical decision-making.

Though these five overarching themes incorporate all 17 UN SDGs, not all of these goals will be relevant to ports in different jurisdictions. The WPSP evaluated the SDGs with the highest priority, based on sustainability projects submitted by member ports. The 120 projects submitted by member ports were placed in groups according to which SDG they addressed. Figure 4 shows that WPSP member ports were focused on Goals 3, 8, 9, 11, 13, and 17, while very few ports had developed projects related to Goals 1, 2, and 5. Using this information, the WPSP grouped SDGs into five groups (see Figure 5) that reflect the highest priority goals. Of note, the majority of projects (72) were submitted by European ports, meaning that the priority of certain SDGs may change between different jurisdictions and between ports in developed and developing nations (WPSP, 2020)

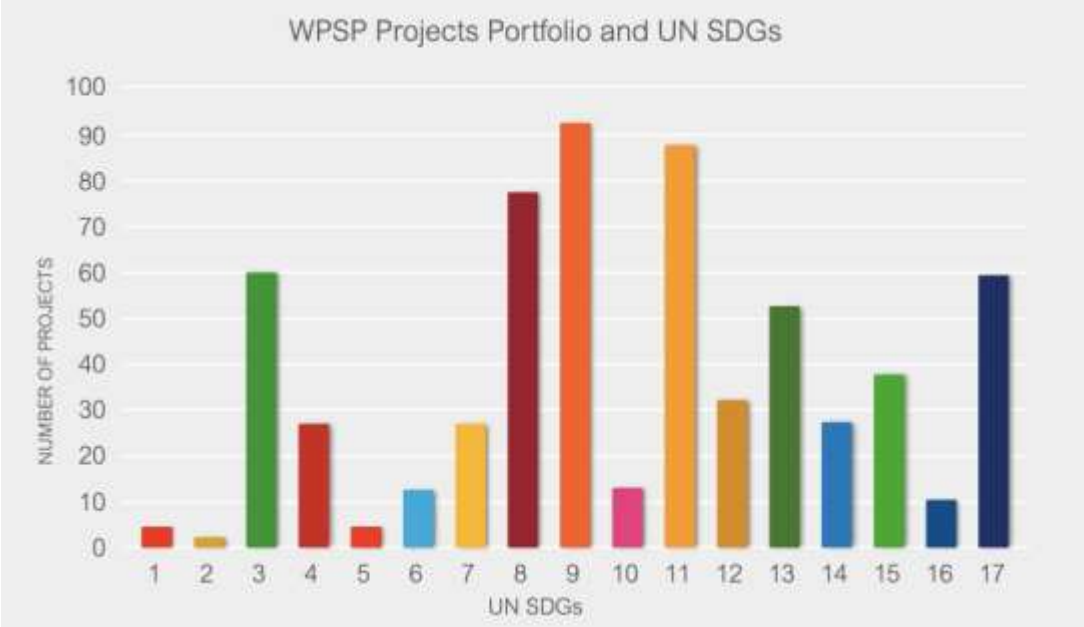


Figure 4. WPSP Projects Portfolio and UN SDGs (from WPSP, 2020)

Figure 5. Priority of projects addressing UN SDGs (from WPSP, 2020)

2.6. Canada's Port Sector

Canadian ports have a significant impact across all regions and industry sectors in the country, making ports an essential component of Canada's resource-based economy. Canadians rely on ports for the import of products consumed daily, as well as the export of products produced for international markets. According to Transport Canada (2018), in 2017, ports and marine shipping moved 19% ($101 billion CAD) of Canada's exports to global markets and 21% ($116 billion CAD) of Canada's total imports. The fact that ports play a vital role in the transportation supply chain means that they contribute significantly to economic development by allowing local industries to move goods and grow their businesses (Transport Canada, 2018). The Canada Port Authorities (CPAs) also spur economic development by contributing approximately 213,000 direct and indirect jobs, accounting for over $25 billion CAD of Canada's Gross Domestic Product (GDP) (Association of Canadian Port Authorities, 2016). The Council of Canadian Academies estimated that without shipping "Canada's long-run real GDP would be permanently reduced by 1.8% or $30 billion CAD in 2016." (2017, p. xiv).

In addition to their economic impact, ports play an important role in communities, managing lands and building partnerships with local and Indigenous community groups (Transport Canada, 2018). The contributions of ports are felt at the local, regional, and national levels; however, despite their economic and social importance, ports have had negative impacts locally, particularly with respect to local environments. Ports are complex systems whose existence, and continued expansion to accommodate economic growth, inevitably lead to environmental impacts like habitat loss, waste water, air emissions, dust generation and the release of fine PM in the air; light and noise pollution; dredging and sediment contamination; the accidental release of ballast water and fuel oil residues from ships; as well as marine debris from land-based activities (Darbra et al., 2004; Merk, 2014; Council of Canadian Academies, 2017; Lam & Notteboom, 2014; Walker et al, 2019; Hossain et al., 2021). Marine shipping is responsible for approximately 1% of Canada's GHG emissions, and though this is often perceived as a low figure, ports are continuing to see an increase in GHG emissions due to increased

freight transportation as a result of international trade (Council of Canadian Academies, 2017). Knowing the potential environmental and social impacts to local communities, the CPAs must balance their role as catalysts of economic growth with the increased negative environmental impacts at the local level; to do so requires improving sustainability performance.

The rationale for improving sustainable development moves beyond simply acting ethically with respect to improved sustainable performance; being proactive in adopting good sustainable development practices is a rational business decision. Transport Canada (2018) has indicated shipping companies are increasingly focused on building larger container ships in an effort to consolidate their fleets and improve the efficiency of trade routes. The CPAs that are proactive and able to adapt to these changes will see an increase in marine traffic, as well as increased rail and road traffic, while other CPAs may see a decrease in marine traffic due to their inability to accommodate larger vessels (Transport Canada, 2018). Though there will be positive economic benefits to increased marine traffic, the increased congestion will have negative impacts on local communities if CPAs do not plan for these externalities. This responsibility will fall primarily on the CPAs themselves; however, to understand who is responsible for the changes that must be adopted to reduce the impacts caused by the evolving marine industry, it is necessary to evaluate Canada's current model of port governance.

2.6.1. Canadian Port Governance

In an effort to transfer the cost of port operations from taxpayers to users, the CPAs were formed under the *Canada Marine Act (CMA), 1998* (Transport Canada 2018). The *CMA* created 18 CPAs, classified several ports as Public Ports, and gave the Minister of Transport the capacity to regulate port activities and performance; notably, marine safety and security, as well as environmental protection (Government of Canada, 2019a). As of 2018, there are 557 port facilities, 883 fishing harbours and 127 recreational harbours in Canada (Transport Canada, 2019b). There are currently 17 ports under operation by CPAs due to their local, regional, national, and international strategic importance (Government of Canada, 2019a). Under the *CMA*, ports with a regional orientation were

designated as public ports, often owned by Transport Canada or by other non-federal bodies, like provincial or municipal governments (Government of Canada, 2019). This allowed local communities to "own and control local facilities and determine appropriate levels of service and maintenance" (Walker et al., 2015, p. 1). There are also many non-federal ports that are privately held, with federal involvement limited to monitoring regulatory compliance (Government of Canada, 2019a).

The CPAs are "federally incorporated, autonomous, non-share corporations that operate at arm's length from the federal government" (Government of Canada, 2019a, para. 5). Though they are financially self-sufficient, they are also responsible for fulfilling public policy objectives and regulatory requirements, creating a balance between commercial autonomy and the accountability required for the use of public assets (Government of Canada, 2019a). The Minister of Transport is responsible for creating the Letters Patent, which outline how CPAs are governed, as well as their major activities and powers, and the lands and waters under their management (Government of Canada, 2019a). The CPA is then governed by an independent board of directors, who are responsible for overseeing operations and guiding the port's strategic plans, while adhering to both the *Port Authorities Governance Regulations* and the *Port Authorities Operations Regulations* outlined in the *CMA* (Government of Canada, 2019a).

Because the CPAs operate at arm's length from the federal government, they do not receive federal funding to support operating costs or capital projects. Instead, they use their own revenues to finance operations and capital projects, though they are able to partner with the private sector, borrow from private lenders, or apply for government grants to finance infrastructure, environment, or security projects (Government of Canada, 2019a; 2012). With respect to environmental sustainability, the CPAs are required to comply with federal regulations that prohibit activities which impact the soil, water, or air (Government of Canada, 2019a).

The CPAs are critical to Canada's national economic strategy, with the federal government having invested $715 million CAD into the port sector since 2005 (Government of Canada, 2019a). The CPAs were responsible for handling 60% of

Canada's cargo tonnage in 2017, with the six largest CPAs (Vancouver, Montreal, Prince Rupert, Halifax, Saint John, and Quebec City) accounting for 88% of CPA revenues in 2016, an increase of $37 million CAD from the previous year (Transport Canada, 2018; Government of Canada, 2019a). Because the CPAs serve a national interest strategically, they are likely to remain under the control of the Minister of Transport, who appoints a portion of board members (Brooks, 2017a). There have been three previous port reforms to date that have led to the current model, and as Brooks (2017a) discussed, there is not likely to be a fourth reform of the port system because the current model is aligned with national trade interests. Despite being federal entities, the CPAs do not meet the same governance reporting standards that are required in Canada's private sector, inconsistently reporting financial, social, and environmental performance (Brooks, 2018). Despite some CPAs meeting, and often exceeding, these reporting standards, this inconsistency in reporting across the sector suggests that there is significant room for improvement. This is an opportunity for the federal government, as well as the CPAs themselves, to implement mechanisms to ensure that sustainability performance is focused on continuous improvement, above and beyond regulatory compliance.

2.6.2. Legislation, Regulation, and Additional Oversight

As previously noted, the *CMA* outlines both governance and operational regulations for the CPAs. The CPAs are also required to follow acts overseen by other government agencies noted in Table 3. Environment and Climate Change Canada (ECCC), Fisheries and Oceans Canada (DFO), and Transport Canada have overarching responsibilities regarding pollution prevention, environmental protection, and wildlife and habitat protection in marine environments. ECCC also focuses on the interconnected nature of economic well-being and environmental sustainability, having the responsibility of overseeing the *Federal Sustainable Development Act*, which outlines Canada's commitment to sustainable development (Environment and Climate Change Canada, 2020).

There are additional mechanisms in place that provide governance oversight. CPAs are required to document and submit a 5-year business plan to the Minister of Transportation

and are subject to an examination every 5 years to determine if "the port authority's systems and practices provide reasonable assurance that its assets are safeguarded and controlled; its financial, human and physical resources are managed economically and efficiently; and its operations are carried out effectively" (Port of Vancouver, 2020). Each CPA is also responsible for filing an annual, audited financial report. Before beginning new projects (typically capital infrastructure), environmental reviews must occur in compliance with the *Impact Assessment Act, 2019* – the federal government then has the authority to review the project and the decisions made by the port authority (Port of Vancouver, 2020). Understanding the legislation and regulations that CPAs must adhere to provides a baseline for what is required in a framework that would appropriately address port sustainability in Canada.

Table 3. Federal legislation impacting Canada Port Authorities

Federal Agencies Overseeing Legislation and Regulation	**Federal Acts Affecting CPAs**
Canada Border Services Agency	• *Canada Customs Act, 1985*
Fisheries and Oceans Canada (DFO)	• *Fisheries Act, 1985* • *Oceans Act, 1996* • *Canada National Marine Conservation Areas Act, 2002* • *Coastal Fisheries Protection Act, 1985*
Environment and Climate Change Canada (ECCC)	• *Canadian Environmental Protection Act (CEPA), 1999* • *Canada Water Act, 1985* • *Impact Assessment Act, 2019* • *Species at Risk Act (SARA), 2002* • *Canada Wildlife Act, 1985* • *Migratory Birds Convention Act, 1994*
Transport Canada (TC)	• *Canada Marine Act, 1998 (*includes Port Authorities Management Regulations and Port Authorities Operations Regulations) • *Canada Shipping Act, 2001* • *Canada Transportation Act,* • *Canadian Transportation Accident Investigation and Safety Board Act, 1989* • *Coasting Trade Act, 1992* • *Marine Transportation Security Act, 1994* • *Navigable Waters Protection Act, 1985* • *Pilotage Act, 1985* • *Transportation of Dangerous Goods Act, 1992*

2.7. Sustainability Performance in Canadian Ports

A study by Hossain et al. (2019) studied sustainability initiatives in the Canadian Port Sector. They identified 25 sustainability indicators used by the CPAs by reviewing publicly-available port websites, environmental performance results from the Green Marine Environmental Program (GMEP), as well as federal legislation impacting the CPAs. These indicators were used to demonstrate how ports had operationalized sustainability. According to the study, many ports have adopted environmental policies (EPs), EMSs, and other proactive measures to monitor and improve environmental performance. While all CPAs have certification through the GMEP, the authors found that only three CPAs (17%) published annual sustainability reports on their corporate websites, with only two ports using the GRI Standards to prepare their reports (Hossain et al., 2019). In addition to the absence in sustainability reporting, only 2 ports have ISO 14001 certification for their EMSs.

Table 4. Sustainability initiatives in the Canadian Port Sector (adapted from Hossain et al. [2019])

# of Sustainability Indicators	**# of CPAs Adopting Initiatives**
1	6
2	3
3	2
4	1
8	1
14	1
17	2
22	1
23	1

The descriptive statistics of sustainability initiatives are presented in Table 4, with the first column identifying the number of sustainability initiatives adopted and the second column representing the number of ports that adopted those initiatives (Hossain et al., 2019). The authors identified that six CPAs adopted a single sustainability initiative, while four CPAs had adopted 17 or more initiatives (Hossain et al., 2019). Of these high-performers, the Port of Montreal had adopted 23 initiatives and the Port of Vancouver adopted 22 initiatives. The study also analyzed the certification scores CPAs achieved in

the GMEP. Over an eight-year period (2009-2016), the 17 CPAs achieved an average certification score of three or more on a five-point scale (Hossain et al., 2019). According to Walker (2016), the majority of ports that achieved a score greater than three were early adopters, with a possible correlation between lower scores and new participants to the program. These statistics suggest that many CPAs are lagging and have not fully committed to incorporating improved sustainability performance in their strategic goals (Hossain et al., 2019).

2.8. Canada's Federal Sustainable Development Strategy

Canada's Federal Sustainable Development Strategy (FSDS) 2019-2022 is a plan to prioritize the goals and targets of the UN SDGs within the Canadian landscape. The *Federal Sustainable Development Act* was created to provide the legal framework within which the Government of Canada can "promote clean growth, ensure healthy ecosystems and build safe, secure and sustainable communities over a 3-year period" (Environment and Climate Change Canada, 2019a, p. 1). Central to Canada's commitment to implement the UN SDGs, the government continues to develop policies and programs that will focus on reconciliation with Indigenous peoples, reducing poverty, strengthening the middle class, advancing gender equality, justice for all Canadians, and climate action through clean energy and oceans (Environment and Climate Change Canada, 2019). To coordinate efforts in advancing the SDGs, both domestically and internationally, the Government of Canada has dedicated $49.3 million CAD, over 13 years, to create an SDG Unit that will monitor and report activities to Statistics Canada, with an additional $59.8 million CAD to support projects that will advance the SDGs domestically (Environment and Climate Change Canada, 2019).

The FSDS encompasses 13 goals that will allow the government to support international agreements, informed and sustainable decision-making, strong environmental legislation, partnerships with Indigenous peoples, as well as maintaining engagement with Canadians and key stakeholders (Environment and Climate Change Canada, 2019). The goals are outlined in Table 5, including the indicators used to measure progress towards goal completion, whether or not the CPAs are explicitly implicated in the goal, and identifying

if the CPAs should be included. As can been seen in Table 5, the presence of the CPAs in the FSDS is notably absent. The only area of the FSDS where marine shipping is mentioned is the goal for healthy coasts and oceans. The report indicates that marine shipping is continuing to grow which could lead to an increased risk for oil spills; however, other pieces of the report do not discuss the impacts associated with a growing marine industry (Environment and Climate Change Canada, 2019). The FSDS report indicates that, in an effort to reduce marine pollution, the government has adopted a polluter pays approach that holds the shipping industry accountable for any spills that occur, while the CPAs are mentioned in passing, suggesting that they are "also taking action to prevent marine pollution" (Environment and Climate Change Canada, 2019, p. 40).

Many of the priorities outlined in the FSDS have been identified as key environmental priorities in European Ports (Figure 3), with air quality being the top environmental concern for European Ports over the last decade (European Sea Ports Organization, 2019). It is anticipated that air quality will be impacted by increased marine traffic, as well as intermodal transportation moving goods through the hinterland (Council of Canadian Academies, 2017). The FSDS indicates that the growth of cities and increase in transportation and industrial activity will negatively impact air quality; however, the CPAs are not included among the partners working towards this goal. As seen in Table 5, there are eight FSDS Goals that should incorporate CPAs as partners working towards attaining the targets within the goal.

Table 5. Canada's Sustainable Development Strategy Goals and Application to the Canada Port Authorities

FSDS Goals	**Purpose**	**Are CPAs explicitly implicated?**	**Can CPAs have a role?**
1. Effective action on climate change	• Reducing GHG emissions • Zero-emission vehicles	No	Yes

FSDS Goals	Purpose	Are CPAs explicitly implicated?	Can CPAs have a role?
2. Low-carbon government	• Property and Fleet (GHG emission reduction, non-hazardous operational waste, plastic waste, construction and demolition waste, domestic office lease) • Adaptation to climate change • Procurement	No	Yes
3. Clean growth	• Investment in clean energy research • Clean technology exports	No	No
4. Modern and resilient infrastructure	• Investment in green infrastructure	No	Yes
5. Clean energy	• Clean power generation • Energy efficiency	No	Yes
6. Healthy coasts and oceans	• Marine conservation • Sustainable fisheries	No	Yes
7. Pristine lakes and rivers	• Nutrient pollution to lakes and rivers • Lake and river ecosystem protection	No	Yes
8. Sustainably managed lands and forests	• Terrestrial ecosystem conservation • Health of national parks • Sustainable forests	No	No
9. Healthy wildlife population	• Species at risk • Migratory birds	No	Yes
10. Clean drinking water	• Long-term drinking water advisories	No	No
11. Sustainable food	• Sustainable agriculture • Sustainable aquaculture • Agri-food exports	No	No
12. Connecting Canadians with nature	• Visits to parks and participation in biodiversity conservation	No	No
13. Safe and healthy communities	• Air quality • Air pollutant emissions • Chemicals management plan	No	Yes

2.8.1. Transport 2030

In addition to the FSDS, Transportation 2030 is a strategic plan, that was released in 2016, to improve trade and economic growth, a cleaner environment, and the well-being of the middle class (Transport Canada, 2019a). The main components of the plan are to provide travelers with ameliorated, low-cost modes of transportation; a safer more secure transportation system; to reduce air pollution through green and innovative transportation; build competitive marine corridors that are environmentally sustainable; and to improve trade corridors to global markets (Transport Canada 2019a). As part of the strategic plan, the *Transportation Modernization Act* came into effect in 2018. Its

purpose is to begin the implementation of the strategies outlined in Transportation 2030. There is a provision in the act for the CPAs, where they are able to receive loans from Canada's Infrastructure Bank in an effort to finance improvements to equipment and marine infrastructure (Transport Canada, 2019a).

A second outcome of Transport 2030 was the Port Modernization review conducted by Transport Canada to improve "sustainable and inclusive economic growth through effective governance and innovative operations" (Transport Canada, 2018, p. 1). The role of ports cannot be undervalued as they facilitate a growing economy, improve the logistics of bringing goods to market, and are critical components to competitive, safe, and environmentally sustainable marine corridors (Transport Canada, 2018).

The Review has five key objectives:

1. Facilitating the movements of goods and people to keep Canada's economy competitive
2. Strengthen relationships with Indigenous and local communities
3. Improve environmentally sustainable infrastructure and operations
4. Enhance port security and safety
5. Optimize governance and accountability

Upon completing the review, Transport Canada has identified key areas that will require additional research and analysis, including the role of CPAs in Canada's supply chains, innovation and best practices in port operations, competitiveness barriers and opportunities, as well as port governance, financing and service delivery models (Transport Canada, 2018). The intent is to engage with key stakeholders to identify the changes required for the port system to meet the key objectives outlined in the review. Though these are important issues to be addressed, the Review does not provide CPAs with any concrete strategies for completing these objectives. This in combination with the absence of CPAs in the FSDS suggests that there is an immediate need to address whether the current initiatives employed by the Canadian Port Sector are adequately addressing sustainability.

2.9. Next Steps

As federal entities, responsible for serving public interests, the CPAs sustainability performance should be in-line with that of the federal government, especially with respect to the goals of the FSDS. This literature review has provided the foundation for the work that will follow in Chapter 3. The literature review has identified the elements that are required for a port to be considered sustainable; however, there is no literature presently evaluating sustainability initiatives in the Canadian Port Sector, except for the work of Hossain et al. (2019) that identified the initiatives employed by CPAs. Since sustainability initiatives have not been previously evaluated in the Canadian Port Sector, Chapter 3 will identify if initiatives undertaken by the CPAs are effective in addressing sustainability in the Canadian Port Sector.

The GMEP has been widely accepted as the standard for environmental excellence in the North American Maritime Industry, though there are no claims linked to the broader definition of sustainability. Each CPA has obtained certification through the program in an effort to improve environmental performance; however, in most cases, it is the only initiative adopted by CPAs to address sustainability. The reliance on the program necessitates an evaluation to determine if the program adequately addresses goals identified by the UN SDGs and Canada's FSDS. This evaluation will be undertaken in Chapter 3.

CHAPTER 3: EVALUATING THE EFFICACY OF SUSTAINABILITY INITIATIVES IN THE CANADIAN PORT SECTOR

3.1. Introduction

3.1.1. Canadian Port Sector

Canadian ports have a significant impact across all regions and industry sectors in the country, making ports an essential component of Canada's resource-based economy. The role of ports cannot be undervalued as they facilitate a growing economy, improve the logistics of bringing goods to market, and are critical components to competitive, safe, and environmentally sustainable marine corridors (Transport Canada, 2018). According to Transport Canada (2018), in 2017, ports and marine shipping moved 19% ($101 billion CAD) of Canada's exports to global markets and 21% ($116 billion CAD) of Canada's total imports. The Canada Port Authorities (CPAs) also spur economic development by contributing approximately 213,000 direct and indirect jobs, accounting for over $25 billion CAD of Canada's Gross Domestic Product (GDP) (Association of Canadian Port Authorities, 2016).

The CPAs were created under the 1998 *Canada Marine Act* in an effort to transfer the cost of port operations from taxpayers to users (Transport Canada 2018). Seventeen ports were designated as CPAs due to their local, regional, national, and international strategic importance (Government of Canada, 2019a). The CPAs operate at arm's length from the federal government as "federally incorporated, autonomous, non-share corporations" (Government of Canada, 2019a, para. 5). Though they are financially self-sufficient, they are responsible for fulfilling public policy objectives and regulatory requirements, creating a balance between commercial autonomy and the accountability required for the use of public assets (Government of Canada, 2019a). The Minister of Transport creates the Letters Patent, which outline how CPAs are governed, as well as their major activities and powers, and the lands and waters under their management (Government of Canada, 2019a).

In addition to their economic impact, the CPAs have an important role in communities, by managing lands and building partnerships with local and Indigenous community groups (Transport Canada, 2018). Despite their economic and social importance, ports have had negative impacts locally, particularly with respect to local environments. Ports are complex systems whose existence, and continued expansion to accommodate economic growth, inevitably lead to environmental impacts such as habitat loss, wastewater, air emissions, dust generation and the release of fine particulate matter (PM) in the air; light and noise pollution; dredging and sediment contamination; the accidental release of ballast water and fuel oil residues from ships; as well as marine debris from land-based activities (Darbra et al., 2004; Merk, 2014; Council of Canadian Academies, 2017; Lam & Notteboom, 2014; Walker et al, 2019; Hossain et al., 2021). Knowing the potential environmental and social impacts to local communities, the CPAs must balance the port's role as a catalyst of economic growth with the increased negative environmental impacts at the local level. These externalities related to an evolving marine industry must be carefully managed and CPAs require sector-specific tools to improve their sustainability performance.

3.1.2. Canada's Commitment to Sustainable Development

Canada's Federal Sustainable Development Strategy (FSDS) 2019-2022 prioritizes the goals and targets of the United Nations (UN) Sustainable Development Goals (SDGs) within the Canadian landscape. Central to Canada's commitment to implementing the UN SDGs, the government continues to develop policies and programs that will focus on reconciliation with Indigenous peoples, reducing poverty, strengthening the middle class, advancing gender equality, justice for all Canadians, and climate action through clean energy and oceans (Environment and Climate Change Canada, 2019). The FSDS encompasses 13 goals that will allow the government to support international agreements, informed and sustainable decision-making, strong environmental legislation, partnerships with Indigenous peoples, as well as maintaining engagement with Canadians and key stakeholders (Environment and Climate Change Canada, 2019).

In addition to the FSDS, Transportation 2030, released in 2016, is a strategic plan to improve trade and economic growth, create a cleaner environment, and improve the well-being of the middle class (Transport Canada, 2019a). The main components of the plan are to provide travelers with ameliorated, low-cost modes of transportation; a safer more secure transportation system; to reduce air pollution through green and innovative transportation; build competitive marine corridors that are environmentally sustainable; and to improve trade corridors to global markets (Transport Canada 2019a). An outcome of Transport 2030 was the Port Modernization Review conducted by Transport Canada in 2016 to improve "sustainable and inclusive economic growth through effective governance and innovative operations" (Transport Canada, 2018, p. 1).

The Review has five key objectives:

1. Facilitating the movements of goods and people to keep Canada's economy competitive
2. Strengthen relationships with Indigenous and local communities
3. Improve environmentally sustainable infrastructure and operations
4. Enhance port security and safety
5. Optimize governance and accountability

Upon completing the review, Transport Canada identified key areas requiring additional research and analysis, including the role of CPAs in Canada's supply chains, innovation and best practices in port operations, competitiveness barriers and opportunities, as well as port governance, financing and service delivery models (Transport Canada, 2018). The intent is to engage with key stakeholders to identify the changes required for the port system to meet the key objectives outlined in the review.

3.1.3. Overview of Sustainability in the Canadian Port Sector

Despite being federal entities, the CPAs do not meet the same governance reporting standards that are required in Canada's private sector, inconsistently reporting financial, social, and environmental performance (Brooks, 2018). Although some CPAs meet, and often exceed, these reporting standards, this inconsistency in reporting across the sector suggests that there is significant room for improvement. This is an opportunity for the

Government of Canada, as well as the CPAs themselves, to implement mechanisms to ensure that sustainability performance is focused on continuous improvement, above and beyond regulatory compliance. Unfortunately, while CPAs are extensions of the federal government, they do not appear as partners in the FSDS goals (Table 6). This is concerning as the CPAs could play a significant role in achieving these goals.

Table 6. Relevance of Canada's Federal Sustainable Development Strategy Goals to CPAs

FSDS Goals	Are CPAs explicitly implicated?	Do CPAs have a role?
1. Effective action on climate change	No	Yes
2. Low-carbon government	No	Yes
3. Clean growth	No	No
4. Modern and resilient infrastructure	No	Yes
5. Clean energy	No	Yes
6. Healthy coasts and oceans	No	Yes
7. Pristine lakes and rivers	No	Yes
8. Sustainably managed lands and forests	No	No
9. Healthy wildlife population	No	Yes
10. Clean drinking water	No	No
11. Sustainable food	No	No
12. Connecting Canadians with nature	No	No
13. Safe and healthy communities	No	Yes

In a survey of Canadian and US ports, Ashrafi et al. (2019) found that only 29% of respondents disclosed their sustainability performance using a standalone sustainability report. The survey also identified that 65% of respondent ports had adopted a sustainability initiative of some sort, with the Green Marine Environmental Program (GMEP) being the most common initiative (Ashrafi et al., 2019). A previous study by Hossain et al. (2019) also identified sustainability initiatives employed by the CPAs to improve sustainability performance; these included the GMEP, ISO 14001, the Global Reporting Initiative (GRI), as well as initiatives by individual ports based on industry best practices.

While the GMEP has been widely accepted as the standard for environmental excellence in the North American Maritime Industry, there are no claims linked to the broader definitions of sustainability. Each CPA has obtained certification through the program in

an effort to improve environmental performance; however, in most cases, it is the only initiative adopted by CPAs to address sustainability. The reliance on the program necessitates an evaluation to determine if the program adequately addresses goals identified by the UN SDGs and Canada's FSDS. The methods below demonstrate how the program was evaluated and how performance gaps were identified. A discussion follows regarding the merits of the program and what areas could be improved, based on the elements of port sustainability identified throughout the literature (previously discussed in Chapter 2).

3.2. Methods

3.2.2. Identification of Relevant Sustainability Initiatives

Hossain et al. (2019) previously identified the sustainability initiatives employed by CPAs to improve sustainability performance, including the GMEP, ISO 14001, the GRI, and specific internal initiatives by individual ports based on industry best practices. To identify if any initiatives had been adopted or discarded, the CPA websites and publicly-available sustainability reports were reviewed. Table 7 identifies each CPA and the current initiatives they employ to provide a benchmark for further evaluation of the efficacy of the sustainability initiatives employed by CPAs in addressing both environmental and social pillars of sustainability.

The Port of Vancouver had previously published a sustainability report using GRI standards in 2018; however, there has not been a more recent report published (Port of Vancouver, 2018). The GRI standards were excluded from this analysis because no CPAs currently publish sustainability reports using these standards. There were two ports (Port of Halifax and Port of Montreal) that obtained ISO 14001 certification; however, ISO 14001 was excluded from this analysis because it is a set of process standards that allow organizations to identify the environmental aspects unique to the organization, guiding the implementation of an EMS (ISO, 2015; Port of Halifax, 2020; Port of Montreal, 2020). Though a component of ISO 14001 is continuous improvement, the program does not identify what level of environmental performance must be achieved; instead it assumes that improved environmental management will lead to improved environmental

performance (Vastag, 2009; Johnstone, 2020). Additionally, there is evidence to suggest that the adoption of ISO 14001 often has short-term effects on improved environmental performance instead of long-term improvement because organizations often implement the standard as a reactive response to external pressures instead of a proactive strategy to improve environmental performance (Testa et al., 2014).

The GMEP remains the only initiative employed by each CPA to improve their sustainability performance (Table 7). As all 17 CPAs have achieved certification through the program, this study will focus on evaluating the GMEP to determine if it is effectively addressing sustainability in the Canadian Port Sector. The section that follows will provide an overview of the GMEP and its performance indicators (PIs).

Table 7. Sustainability Initiatives in Canada Port Authorities (adapted from Hossain et al. [2019])

Canada Port Authority (CPA)	**Sustainability Initiatives**		
	GMEP	**EMS**	**ISO 14001**
Belledune	X	X	
Halifax	X	X	X
Hamilton-Oshawa	X		
Montreal	X	X	X
Nanaimo	X		
Port Alberni	X		
Prince Rupert	X		
Quebec	X		
Saguenay	X	X	
Saint John	X		
Sept-Îles	X		
St. John's	X		
Thunder Bay	X		
Toronto	X		
Trois-Rivieres	X	X	
Vancouver	X		
Windsor	X		

3.2.3. Description of Green Marine Environmental Program

The GMEP was established in 2007 to mitigate the potential environmental impacts caused by the maritime industry. The GMEP is a certification program that offers "a detailed framework for maritime companies to first establish and then reduce their

environmental footprint" (Green Marine Management Corporation, 2020a). The program's main goals are to facilitate the marine industry in strengthening its environmental performance, moving beyond regulatory compliance, and establishing strong relationships with stakeholders (Walker, 2016; Green Marine, 2017). The program is voluntary, with a transparent and rigorous certification process. Participants – ship owners, port authorities, seaway companies, terminal facilities, and shipyards – must benchmark their environmental performance using Green Marine's Self-Evaluation Framework.

The Self-Evaluation Framework is used to evaluate each environmental performance indicator (PI) on a five-point scale, ranging from regulatory compliance to industry leadership (Green Marine Management Corporation, 2020a). As of 2020, when research was completed, the GMEP used 13 PIs to address important environmental issues related to air, land, and water, at both the regional and international level (Green Marine Management Corporation, 2020a). To ensure transparency, participants must submit results for third-party verification every two years, using accredited verifiers who verify the documented proof and justification used in the Self-Evaluation Framework (Green Marine Management Corporation, 2020c). To remain certified, participants must show year-over-year improvement and agree to publish their results in Green Marine's Annual report (Green Marine Management Corporation, 2020c).

The criteria under each performance indicator are reportedly updated regularly to ensure that they are "sufficiently demanding" with respect to current regulations, available technology, and best management practices (Green Marine, 2018a). There were seven port-specific PIs that ports were required to document their performance in using the *Performance Indicators for Ports & St. Lawrence Seaway Corporations 2020 Self-Evaluation Framework*, including Greenhouse Gases and Air Pollutants, Spill Prevention, Dry Bulk Handling and Storage, Community Impacts, Environmental Leadership, Waste Management, and Underwater Noise (Green Marine Management Corporation, 2020d). Ports are not yet required to document their performance for the Aquatic Invasive Species (AIS) criteria that were introduced in 2020 but will be required to do so if it is developed

into a complete PI in the future (Green Marine Management Corporation, 2020d). The objectives of each PI can be found in Table 8.

Table 8. GMEP PIs and their objectives for ports and seaways (Green Marine Management Corporation, 2020d)

PI#	PI for Ports	Objective
	Aquatic Invasive Species*	Reduce the risk of introducing and propagating aquatic invasive organisms and pathogens associated with ballast water discharges and biofouling
1.	Greenhouse Gases and Air Pollutants	Reduce GHGs and air pollutant emissions
2.	Spill Prevention	Minimize spills and leakages of pollutants into the environment (water, land)
3.	Dry Bulk Handing and Storage	Reduce cargo losses and dust generated during handling, transportation and storage of dry bulk
4.	Community Impacts	Reduce the amount of noise, dust, odour and light to which people residing close to port facilities are exposed
5.	Environmental Leadership	Recognize the significant influence of port authorities and Seaway corporations as land owners and/or managers over the environmental practices of their tenants and/or users
6.	Waste Management	Increase waste diversion and reduce at source the waste arising from administrative activities and site operations
7.	Underwater Noise	Manage underwater noise sources during ongoing activities, development/construction, and/or port maintenance activities to reduce impacts to marine mammals

*Note: The *Performance Indicators for Ports & St. Lawrence Seaway Corporations 2020* included Aquatic Invasive Species criteria for ports with the intent to develop a complete PI for 2021; however, it cannot currently be classified as a PI (Green Marine Management Corporation, 2020d).

The GMEP provides several benefits to participants including the use of the certified logo, tools to strengthen environmental performance, knowledge sharing among the maritime community, involvement in program development, gaining national and international recognition for sustainability efforts, as well as protecting their social license to operate (Green Marine Management Corporation, 2020a). The program has seen continuous growth over the last 12 years, with an 85% retention rate for participants (Green Marine, 2018b). As reported by Walker (2016), new participants enter at a lower certification level, which has had an impact on the overall program average. The program average dropped from 3.1 in 2017 to 2.9 in 2018, with the addition of new participants

and the introduction of new PIs being the most likely cause for this decrease (Green Marine, 2018b). The port sector saw the most significant progress, with participants moving up 38 levels from 2017 to 2018 (Green Marine, 2018b).

3.2.3 Identifying Sustainable Development Goals Relevant to Canadian Port Authorities

The UN SDGs provide a blueprint for improving sustainability by addressing current challenges pertaining to poverty, inequality, climate, environmental degradation, prosperity, peace and justice (United Nations, 2019). The Inter-Agency and Expert Group (IAEG) on SDG Indicators developed an indicator framework that allows countries and other organizations to measure their sustainable development (United Nation's Statistics Division, 2030). The goals were created to allow for flexibility, such that governments can set their own targets and incorporate them into national policies and strategies (Cormier & Elliott, 2017).

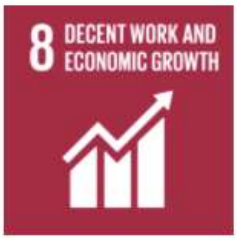
The indicators developed by the UN are intended to be used as a baseline for sustainability measurement in this study. Ports in other jurisdictions have been focused on improving sustainability performance that meets the goals outlined in the UN SDGs rather than domestic government initiatives like Canada's FSDS (Environment and Climate Change Canada, 2019; WPSP, 2020). This work focuses on assessing the GMEP within a Canadian context; however, in using the UN SDG indicators, the intention is to ensure its application within jurisdictions outside of Canada. Despite the WPSP stating that all SDGs are relevant to the port sector, they have classified the SDGs based on their priority. The SDGs related to reducing poverty, hunger, and inequalities were rated as low priorities for ports globally (World Ports Sustainability Program, 2020). In the Canadian context, it is also important to consider the CPAs sphere of influence when identifying which SDGs are relevant to the Canadian Port Sector.

For this research, the indicators for each SDG were reviewed; only those that were directly applicable to CPA governance and operations were selected. The *CMA* outlines the capacity and powers of the CPAs as "port activities related to shipping, navigation,

transportation of passengers and goods, handling of goods and storage of goods" and other activities "necessary to support port operations" (Government of Canada, 2020, p. 4). The indicators for SDGs 1, 2, 4, 10, and 16 were eliminated from this study because addressing issues related to poverty, food security, literacy and education, inequality among countries, and issues related to the rule of law are not under the jurisdiction of CPAs (United Nation's Statistics Division, 2030). The indicators for each of the remaining SDGs were systematically reviewed. Indicators were eliminated in an iterative process, first removing those that were related to sustainable development in jurisdictions outside of Canada (developing nations), then removing additional indicators when the CPA could not have a direct influence over that the actions in that indicator. The relevant SDG targets and indicators are presented in Table 9.

Table 9. UN SDGs applicable to the Canadian Port Authorities

Sustainable Development Goal	**Targets and Indicators***
	(3.6) Decrease the number of deaths and injuries from road traffic accidents (3.9) Reduce the number of deaths and illnesses from hazardous chemicals, as well as air, water and soil pollution and contamination
	(5.5) Ensure women have equal opportunities for leadership at all levels of decision-making in the organization (i.e., the proportion of women in managerial positions at the CPA)

Sustainable Development Goal	Targets and Indicators*
	(6.3) Improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally • (6.3.1) Proportion of wastewater safely treated • (6.3.2) Proportion of bodies of water with good ambient water quality (6.4) Substantially increase water usage efficiency and ensure sustainable withdrawals and supply of freshwater • (6.4.1) Change in water-use efficiency over time • (6.4.2) Level of water stress: freshwater withdrawal as a proportion of available freshwater resources (6.5.) By 2030, implement integrated water resource management (6.6) Protect and restore water-related ecosystems including mountains, forests, wetlands, rivers, aquifers and lakes
	(7.2) Increase substantially the share of renewable energy in the global energy mix (7.3.) Double the global rate of improvement in energy efficiency • (7.3.1) Energy intensity measured in terms of primary energy and GDP
	(8.3) Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium enterprises (8.5) Achieve full and productive employment and decent work for all, including equal pay for work of equal value (8.8) Protect labour rights and promote safe and secure working environments for all workers • 8.8.1 Decrease frequency of fatal and non-fatal occupational injuries
	(9.1) Develop quality, reliable, sustainable and resilient infrastructure, to support economic development and human well-being (9.4) Upgrade infrastructure and retrofits to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and processes • (9.4.1) CO2 emission per unit of value added (9.5) Enhance scientific research, upgrade technological capabilities, including encouraging innovation and increasing the number of research and development workers, and research and development spending

Sustainable Development Goal	Targets and Indicators*
	(11.2) Provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety (11.5) Reduce the number of deaths and the number of people affected by direct economic losses caused by disasters, including water-related disasters that damage critical infrastructure and create service disruptions to basic services (11.6) Reduce the adverse per capita environmental impact of cities (special attention to air quality [annual mean levels of fine particulate matter reduced] and waste management) (11.a) Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening development planning
	(12.2) Achieve the sustainable management and efficient use of natural resources • (12.2.1) Material footprint • (12.2.2) Material consumption (12.4) Achieve the environmentally sound management of chemicals and all wastes through their life cycle, and significantly reduce their release to air, water, and soil (12.5) Significantly reduce waste generation through prevention, reduction, recycling, and reuse (12.6) Adopt sustainable practices and integrate sustainability information in the reporting cycle • (12.6.1) Publishing sustainability reports (12.7) Promote public procurement practices that are sustainable, in accordance with national policies and priorities
	(13.1) Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters • (13.1.2) Adopt and implement disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction (13.2) Integrate climate change measures into policies, strategies, and planning • (13.2.1) Establish and operationalize integrated policies/strategies/plans that increase the ability of the port to adapt to the adverse impacts of climate change and foster climate resilience and low GHG emissions (13.3) Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning within port operations • (13.3.2) Strengthening capacity-building to implement adaptation, mitigation and technology transfer, and development

Sustainable Development Goal	Targets and Indicators*
	(14.1) Prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution • (14.1.1) Index of coastal eutrophication and floating plastic debris density (14.2) Sustainably manage and protect marine and coastal ecosystems to avoid adverse impacts, including by strengthening their resilience and taking action for their restoration in order to achieve healthy and productive oceans (14.3) Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation
	(15.5) Act to reduce the degradation of natural habitats, halt the loss of biodiversity, and protect and prevent the extinction of threatened species (15.8) Introduce measures to prevent the introduction and the impact of invasive alien species on land and water ecosystems (15.9) Integrate ecosystem and biodiversity values into port planning and policies
	(17.6) Improve access to science, technology and innovation and enhance knowledge sharing (17.17) Encourage and promote effective public, public-private and civil society partnerships, building on the experience and resourcing strategies of partnerships

*Note: Second column presents the specific targets and indicators relevant to CPAs, as not all are applicable. Indicators have been adapted to use language relevant to the port, where applicable (United Nations' Statistics Division, 2020).

3.2.4. Evaluation Criteria

All 17 CPAs have obtained GMEP certification, to varying degrees; however, the GMEP is often the only initiative adopted by CPAs to address sustainability (Table 7). The reliance on the GMEP necessitates an evaluation to determine if the program adequately addresses targets identified in the UN SDGs.

The evaluation required the development of a matrix to demonstrate the links between the GMEP PIs and SDG indicators. The relevant SDG targets and indicators are outlined in Table 9 and are presented on the vertical axis of the matrix. The GMEP PIs are along the horizontal axis of the matrix. The primary objectives of each GMEP PI were previously identified in Table 8 and will not be repeated here. The matrix provides a visual representation of the gaps that exist in the GMEP when compared to the SDGs that can and should be addressed by the port sector if a more fulsome view of sustainability was applied. As there are multiple levels of certification for each indicator in the GMEP (one through five), it is assumed that a level five certification has been obtained, so as to demonstrate the most rigorous standard that could be achieved from using the GMEP as a performance metric. The links between GMEP PIs and the SDGs are classified as direct, indirect, or no link. Direct links are represented in green; indirect links in yellow; and no link in red.

A direct link is classified when the indicator in the GMEP directly contributed to achieving the SDG target for the specified goal. For example, GMEP's PI for Spill Prevention focuses on minimizing spills and leakages of pollutants – both on land and in water. The Spill Prevention PI includes collecting and treating "storm water via an appropriate storm water treatment device, process or procedure" (p. 6), as well as sampling and analyzing stormwater to ensure that the systems in place are operating properly (Green Marine Management Corporation, 2020d). This PI is directly linked to SDG 6, specifically target 6.3 which focuses on improving "water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater…" (United Nations Statistics Division, 2020, p. 7). As such, the link is denoted by a green box in the matrix.

An indirect link is classified when a GMEP PI can have an indirect impact on achieving a target outlined in the SDG indicators. To avoid ambiguous connections, the action of obtaining the specified GMEP indicator had to be one-step removed from the desired impact of the specified SDG indicator. The Greenhouse Gases and Air Pollutants PI for GMEP has an objective of reducing GHG and air pollutant emissions. The reduction in

GHG and air pollutants has an indirect impact on SDG 3, specifically the indicator focused on reducing "the number of deaths and illnesses from hazardous chemicals, as well as air, water and soil pollution and contamination" (United Nations Statistics Division, 2020, p. 4). The intent of the GMEP PI is simply to reduce emissions; however, this could have an indirect impact on reducing illnesses related to poor air quality resulting from the release of air pollutants. For this reason, the link is denoted as an indirect link in yellow in the matrix.

There are two distinct instances where a GMEP PI was classified as having no link to the SDG indicators. The first is where the PI does not contribute in any obvious way to the SDG target for a specified goal. For example, the GMEP's GHG and Air Pollutants PI cannot be linked in any obvious way to SDG 5's target of achieving gender equality in the workplace. Additionally, the no link is also used when the GMEP PI and SDG indicator are several steps removed from each other, creating too many contingencies to guarantee that there could be an impact on the SDG indicator. For example, if a CPA lowers GHG emissions by reducing fossil fuel use and increases their use of renewable energy, this could potentially impact SDG 7 by increasing the share of renewable energy in the global mix; however, there is no guarantee that the CPA would take this route to lower emissions. For this reason, it must be classified as no link.

Table 10 is a visual representation of the outcome of this analysis, which will be discussed further in the section that follows. Links between the GMEP PIs and SDG targets are identified using colour-coded cells.

Table 10. Links between GMEP PIs and the SDGs relevant to CPAs (direct links = green; indirect = yellow; no link = red)

SDG	SDG Indicator	Green Marine Indicators							
		Aquatic Invasive Species	GHGs and Air Pollutants	Spill Prevention	Dry Bulk Handling	Community Impacts	Waste Management	Environmental Leadership	Underwater Noise
3	Decrease # of deaths/injuries from road traffic accidents								
	Reduce # of deaths/illnesses from air, water and soil pollution/contamination								
5	Increase # of women in managerial positions								
6	Improve water quality (reduce pollution/release of hazardous chemicals, eliminate dumping)								
	Increase proportion of treated wastewater from operations								
	Improve water-use efficiency over time								
	Protect/restore water-related ecosystems impacted by port activities								
7	Increase share of renewable energy in the global energy mix								
	Improve energy efficiency								
8	Policies that support productive activities, job creation, etc., in growth of SMEs								
	Productive employment for all, with equal pay for work of equal value								
	Decrease frequency of occupational injuries								

SDG	SDG Indicator	Green Marine Indicators							
		Aquatic Invasive Species	GHGs and Air Pollutants	Spill Prevention	Dry Bulk Handling	Community Impacts	Waste Management	Environmental Leadership	Underwater Noise
9	Sustainable and resilient infractructure to support economic development								
	Upgrade infrastructure to increase resource efficiency and adopt clean tech								
	Enhance research, upgrade tech including increased spending on R&D								
11	Reduce losses related to natural disasters (damage to infrastructure and service disruptions)								
	Reduce adverse environmental impact of cities - increase waste diversion								
	Reduce adverse environmental impact of cities - decrease levels of fine particulate matter								
	Positive economic/social/environmental links between urban/peri-urban/rural areas								
12	Sustainable management of natural resources - reduce material footprint								
	Sustainable management of natural resources - reduce material consumption								
	Manage chemicals through their lifecycle and reduce release into water/air/soil								
	Reduce waste generation through prevention, reduction, recycling, and reuse								
	Adopt sustainable practices and integrate sustainability ireporting in financial cycle								
	Promote sustainable public procurement practices								
13	Adopt and implement disaster risk reduction strategies in line with Sendai Framework								
	Integrate climate change measures into policies, strategies, and planning								
	mitigation, adaptation, impact reduction and ealy warning								

SDG	SDG Indicator	Green Marine Indicators							
		Aquatic Invasive Species	GHGs and Air Pollutants	Spill Prevention	Dry Bulk Handling	Community Impacts	Waste Management	Environmental Leadership	Underwater Noise
14	Prevent marine pollution from land-based activities (marine debris and nutrient pollution)								
	Sustainably manage and protect marine and coastal ecosystems to avoid adverse impacts								
	Minimize the impacts of ocean acidification								
15	Reduce degradation of natural habitats, halt loss of biodiversity, protect threatened species								
	Measures to prevent the introduction/impact of invasive alien species to land/water ecosystems								
	Integrate ecosytem and biodiversity values into port planning and policies								
17	Improve access to science, technology, and innovation, plus enhance knowledge sharing								
	Promote effective public, public-private, civil society partnerships								

3.3. Evaluating the Green Marine Environmental Program

The GMEP is primarily focused on improving *environmental performance* in the maritime industry. The program only addresses social dimensions of sustainability with its consideration of community impacts; however, the objective of that PI is to "reduce the amount of noise, dust, odour and light to which people residing close to port facilities are exposed" (Green Marine Management Corporation, 2020d, p. 9). The program does not currently address social issues like relationships with local communities, relationships with Indigenous peoples, workplace safety, or workplace diversity and equity. Each section below provides examples of the manner in which GMEP PIs address specific SDG targets.

3.3.1. Aquatic Invasive Species

The GMEP PI guide for 2020 included Aquatic Invasive Species (AIS) criteria for ports with the intent to develop a complete PI for 2021 (Green Marine Management Corporation, 2020d). When this PI is fully incorporated into the program, a direct impact could be associated with target 15.8 which focuses on preventing the introduction of invasive species to land and water-based ecosystems (United Nations Statistics Division, 2020). It could also be indirectly linked to SDG 17 – a commitment to cooperation among industry, research and government – because it encourages CPAs to work with the scientific community and government organizations (Green Marine Management Corporation, 2020d).

3.3.2. Greenhouse Gases and Air Pollutants

The GMEP's GHG and Air Pollutants PI can only be directly linked to SDG 11, specifically the indicator for reducing annual mean levels of fine PM in an effort to reduce the adverse environmental impacts of cities (United Nations Statistics Division, 2020). GMEP participants have the *choice* to transition to lower emission equipment that uses cleaner fuels and engine repowers (Green Marine Management Corporation, 2020d). As this is a choice and not a mandatory requirement to obtain Level 5 certification, the link with SDG 9 to adopt cleaner technology and retrofits to reduce CO2 emissions can

only be classified as indirect (Table 11). The link to SDG 3 is also considered indirect because the intent of the PI is to reduce GHG emissions and air pollutants; a reduction in illness related to poor air quality could result but is not the intention of the PI's implementation.

Table 11. Certification levels for the GHG and air pollutants PI (Green Marine Management Corporation, 2020d)

Certification Level	Performance Indicators
Level 1	• Monitoring of regulations
Level 2	• Discourage idling of internal combustion engines • Promote sustainable transport • Reduce traffic congestion • Issue warnings to ships emitting excess smoke
Level 3	• Annual report on GHG emissions AND • Detailed inventory of port fleet OR • Program to transition to lower emissions through equipment retrofits
Level 4	• Port-wide GHG and air emission inventory from all sectors • Performance plan to define reduction measures and targets for port participants
Level 5	• Public disclosure of GHG and air pollutants reduction targets and timeframe, continued decrease in GHG emissions (intensity) • Achieve annual average reduction in GHG intensity of at least 1% (optional)

3.3.3. Spill Prevention

The objective of the Spill Prevention PI is to "reduce spills and leakages of pollutants into the environment" (Green Marine Management Corporation, 2020d, p. 5). This objective can be directly linked to SDG 6 through the proportion of wastewater being treated, as the PI requires that storm water be collected, treated, sampled, and analyzed before it can be released into the environment (Green Marine Management Corporation, 2020d). There are also direct links between SDG 12 through the reduction of chemical releases into water and soil; as well as SDG 14 through the prevention of marine pollution through land-based activities. The link to SDG 3 is indirect because the intent of the PI is to reduce spills into local environments, which could potentially result in a reduction in illness related to soil and water contamination.

3.3.4. Dry Bulk Handling and Storage

Dry bulk handling and storage can cause a significant amount of dust during its handling, transportation and storage (Green Marine Management Corporation, 2020d). This PI is only used for PAs who operate dry bulk terminals. The dust can have an adverse impact on individuals with respiratory issues living near or working in the port area (Council of Canadian Academies, 2017). The measures taken to reduce dust, therefore, contribute directly to SDG 11, by decreasing the levels of fine PM that impact cities, as well as SDG 14 by preventing marine pollution caused by land-based activities. There is an indirect link to SDG 3 and 6 because the intent of the indicator is to "reduce cargo losses and dust generated during the handling of dry bulk", which again, can potentially reduce the illness related to increased fine PM in the air (SDG 3), as well as improved water quality by reducing pollution (Green Marine Management Corporation 2020d).

3.3.5. Community Impacts

The indicator for community impacts focuses on reducing the noise, dust, odour, and light that impact communities living close to the port and its facilities (Green Marine Management Corporation, 2020d). Ports can be exempt from this PI if they can prove that there are no local communities impacted by their operations. The PI touches briefly on the importance of community engagement and building positive relationships with local communities, though strategies like having a complaint line are more reactive than proactive. There is only a direct link between this PI and SDG 11, as its primary focus is to reduce the adverse impact of the port to the surrounding community. There is an overlap with the measures taken in the Dry Bulk Handling and Storage PI to reduce dust; therefore, there are indirect links to SDG 3 and 6 for the same reasons mentioned above.

3.3.6. Environmental Leadership

The purpose of this PI is to demonstrate how PAs have the ability to influence their tenants to improve their own environmental practices/performance (Green Marine Management Corporation, 2020d). No direct or indirect links were identified between this PI and the SDG targets. To obtain a level four certification in this PI, ports must

complete four of 12 listed criteria; completing two additional criteria will provide level five certification. The criteria differ significantly; there are easily attainable objectives that require few resources and others that require a proactive approach to environmental management with more significant time and cost commitments. For example, a port may choose to simply donate revenue to environmental or social projects to offset their footprint (Green Marine Management Corporation, 2020d); this contributes little to port sustainability. As there is no guarantee that a port will select the more challenging criteria to attain certification, the connections to the SDGs can only be evaluated using the six criteria with the least meaningful impacts, resulting in no clearly identified linkages.

3.3.7. Waste Management

This PI's purpose is to reduce waste in administrative and operational activities and encourage waste diversion (Green Marine Management Corporation, 2020d). This directly links to SDG 11 and 12; the port is reducing its environmental impact through waste reduction and diversion by recycling and reusing, thus decreasing the amount of urban solid waste collected by the city (United Nations' Statistics Department, 2020). Diverting waste and performing waste audits could potentially allow ports to reduce their material footprint and improve resource efficiency, particularly if they focus on waste valorization, thus creating an indirect link to SDG 12. The PI also encourages practices like the promotion of an environmental purchasing policy and sustainable purchasing practices, creating a second indirect link to SDG 12.

3.3.8. Underwater Noise

The underwater noise from construction/development and from ships entering and leaving the port can disrupt communication and migration of marine mammals (Council of Canadian Academies, 2017; Green Marine Management Corporation, 2020d). The purpose of this indicator is to reduce the impact on these mammals; however, it also acknowledges that other species may be impacted by underwater noise and this will be a future area of study (Green Marine Management Corporation, 2020d). There are indirect links between this PI and SDGs 15 and 17. Monitoring and reducing underwater noise could potentially halt the loss of biodiversity and degradation to natural habitats, though

this is not the PI's intent. As the PI encourages collaboration between the port and scientific community, to build relationships and share knowledge, there is also an indirect link to SDG 17 (Green Marine Management Corporation, 2020d).

3.4. Discussion

The GMEP is touted as the premier environmental program in North America (Walker, 2016; Hossain et al., 2019). In many instances, the program is beneficial in its ability to facilitate improved environmental performance in the port sector; however, the program focuses primarily on pollution prevention and is limited in its capacity to address the SDGs relevant to the Canadian Port Sector (Chapter 2). In Table 10, these 12 SDGs were identified, along with the 36 SDG targets that could be measured by the CPAs. Of these 36 SDG targets, only seven were directly linked to the PIs used by the GMEP. There were an additional seven targets with indirect links, suggesting that changes to objectives and criteria in the relevant GMEP PIs could lead to more direct links between the program and achievement of the SDG targets. The matrix provides a stark visual representation of GMEP's efficacy in addressing the SDG targets relevant to the port sector. The following discussion highlights the areas of focus that could be used to improve the efficacy of the GMEP, strengthening or creating links between their PIs and the SDG targets should the program wish to address sustainability in its broader context.

The GHG and Air Pollutants PI encourages CPAs to reduce their emissions; however, its primary focus is to reduce source pollution. The GMEP does suggest the use of the Greenhouse Gas Protocol – an accounting and reporting standard that provides sector guidance, calculation tools, and training for both businesses and government (World Resource Institute, 2020). It facilitates the accounting and reporting of the GHGs listed in the Kyoto Protocol (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride) for both direct and indirect emissions (Greenhouse Gas Protocol, 2020). The emission scopes for the GHG Protocol are found in Figure 6.

As noted, the PI for GHG and Air Pollutants focuses primarily on Scope 1 emissions, those caused directly by the CPA. It does not account for indirect emissions, like the purchase of electricity for their operations (Scope 2) or the indirect emissions related to the products used, waste disposal, and outsourced activities (Scope 3). If CPAs focused on indirect, as well as direct emissions, it could lead to proactive strategies to reduce emissions rather than reactionary strategies developed in response to regulatory and legislative pressure. To create direct links to the SDGs, the GMEP would have to move beyond GHG reporting to encouraging CPAs to adopt technology and practices that would continually reduce GHG emissions, whether that be through shifting to renewable energy or retrofitting infrastructure. Additionally, with oceans absorbing 23% of annual anthropogenic CO_2 emissions from the atmosphere, the active reduction in GHG emissions by the CPAs can also ensure that ports are not a significant contributor to the decreasing pH levels that cause ocean acidification (United Nations' Department of Economic and Social Affairs, 2020).

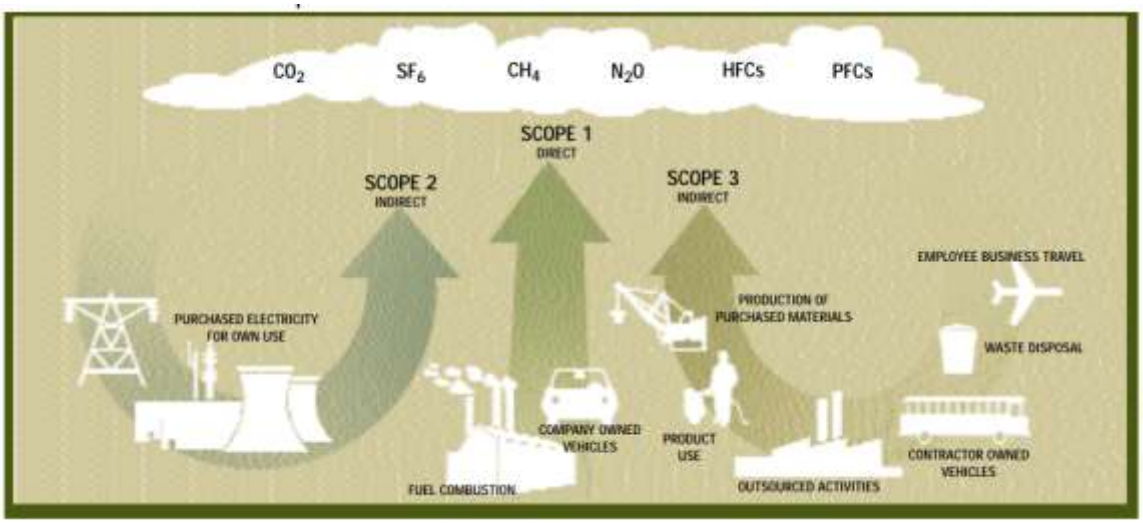


Figure 6. The three scopes used to inventory GHGs using the GHG Protocol (2020)

A review of port literature reveals that PAs, especially in Europe, have been focused on adopting green energy (Puig et al., 2021). Ports are often located in areas that would be suitable for power generation from renewable sources, like wind, wave, tidal, and geothermal energy, as well as having infrastructure that could be outfitted with solar

panels (Acciaro et al., 2014). In addition to focusing on electric vehicles, battery power on ships, and investing in their own electrical grids, many PAs have adopted onshore power that allows vessels to be powered through on-grid electricity while docked at the port, reducing the combustion of fuels on ships, and thereby, reducing emissions locally (Acciaro et al., 2014; Krämer and Czermanski, 2020). There can be barriers to this installation, however, and it may not always be a better source of power generation depending on the port's primary source of electricity. Energy has continually been an environmental concern identified by EcoPorts, with ESPO's Annual Report for 2019 stating that half of the ports belonging to the EcoPorts program had developed on-shore power supplies for ships at port (European Sea Port's Organization, 2020). The GMEP could benefit from the development of an energy indicator, as this would address SDGs 7, 9, 11, and 12 more effectively.

Despite the focus on reduction in air emissions, there are no additional measures in the GMEP to prepare PAs for climate change. The EcoPorts SDM asks ports to consider if there would be operational challenges that could be related to climate change and what steps the port has taken to strengthen resilience for their current infrastructure (European Sea Ports Organization, 2019). Becker et al. (2018) suggest that port infrastructure, operations, and supply chains will all become vulnerable to oceanic and atmospheric changes that will lead to more frequent and intense storms, as well as flooding related to sea-level rise. Failing to prepare for the changes associated with climate change can result in significant economic costs. Providing indicators that ensure that ports are preparing for these changes would contribute to the capacity building required to meet targets in SDG 13.

Improving efficiencies in resource consumption is also an area that could be addressed by the GMEP. Presently, the program addresses SDG 6 and 12 by encouraging PAs to implement wastewater treatment, prevent the release of hazardous chemicals, as well as diverting waste. The GMEP could expand their indicators to further address issues like water use efficiency, providing waste disposal for ships entering port and other port users, as well as encouraging CPA's to focus on green procurement in their PIs. For

example, though the reduction of PM is important, the use of a fine-mist spray to limit cargo residues during the unloading and loading of dry bulk cargo leads to an increased consumption of freshwater resources, which could be problematic in areas with high water stress (Green Marine Management Corporation, 2020d). In an effort to reduce marine pollution, the EU Directive on Port Reception Facilities requires that ships traveling between ports dispose of their waste at port reception facilities (European Commission, 2019). There could also be a more significant portion of the program that focuses on green procurement and investment – both of which are outlined in Canada's FSDS. The GMEP requires PAs to adopt an environmentally preferable purchasing policy in upper levels of certification; however, it specifies that this should be related to the purchase of products with less packaging or derived from recycled content (Green Marine Management Corporation, 2020d). Though this type of circular thinking is important, it should include all materials used for all port operations rather than just administrative operations.

There is very little attention given to PIs that support improvement of the socially-focused SDGs. Canada's Port Modernization Review suggested that CPAs should build relationships with Indigenous peoples and local communities by developing partnerships, hosting open houses, starting good neighbour committees and engaging with the public on social media (Transport Canada, 2018). There are measures in the GMEP to engage with the public, but it is primarily intended to manage complaints from the community. In the higher levels of certification, the GMEP requires CPAs to be involved in community organizations (not just paying dues), though this requirement appears to be more focused on public relations than efforts to build relationships with surrounding communities.

The Environmental Leadership PI is problematic because it offers CPAs a choice, with considerable disparity in the rigour of criteria used to attain level five certification. For example, one option is to submit a sustainability report using recognized standards (GRI); however, at present, there are no CPAs who publish sustainability reports using the GRI standards. An alternative option is to simply donate time and financial aid to green causes, which could be considered a superficial solution known as greenwashing. There

is a heavy focus on CPAs ensuring that tenants and terminal operators within the port area become members of GMEP, as well as communicating their own involvement with the program publicly. At its core, this is simply just advertisement and expansion for the program rather than a focus on improved performance. To be an environmental leader, an organization should be among the first adopters of industry best practices related to environmental performance, rather than selectively choosing from a list of criteria of varying impact, to demonstrate commitment to environmental performance.

3.5. Conclusion

Green Marine is effective in doing what it sets out to do – to help ports address a very specific set of environmental issues relevant to the port sector. Unfortunately, most CPAs rely exclusively on this program to improve sustainability performance, and the GMEP does not effectively address the bulk of SDGs relevant to the Canadian Port Sector. Despite offering several benefits to participants – the use of certified logo, involvement in program development, enhancing social license to operate – the program is limited in its ability to affect meaningful change in the overall sustainability of CPAs (Green Marine, 2018b). This finding necessitates the development of an additional framework that can be used by CPAs to bridge the gaps between the GMEP and the SDG targets applicable to their operations.

Despite being federal agencies, CPAs are absent from the FSDS, which could suggest that their goals are not currently aligned with those of the federal government. CPAs could be contributing to the FSDS goals of Clean Growth, Modern and Resilient Infrastructure, and Clean Energy with the addition of new indicators in a sustainability framework. Through investments in clean energy, green infrastructure, clean power and energy efficiency, the CPAs could help Canada reach its commitments to the UN 2030 Agenda for Sustainable Development.

There is currently no framework that exists that would provide CPAs with a comprehensive list of indicators to fulfill these targets/goals. The GMEP provides a good opportunity for CPAs to begin to monitor and improve their environmental performance.

Further work is necessary to develop a framework that incorporates metrics from globally-recognized sustainability standards to provide CPAs with the indicators needed to improve both environmental and social sustainability performance. This will be discussed in the Chapter 4.

CHAPTER 4: DEVELOPING A FRAMEWORK FOR IMPROVED SUSTAINABILITY IN THE CANADIAN PORT SECTOR

4.1. Introduction

4.1.1. Context

Canadian ports are critical to the nation's growing, resource-based economy. They improve the logistics of bringing goods to market and are critical components of competitive, safe, and environmentally sustainable marine corridors (Transport Canada, 2018). The ports of strategic importance, responsible for handling 60% of Canada's cargo tonnage, are managed by the CPAs (Transport Canada, 2018; Government of Canada, 2019a). The CPAs operate at arm's length from the federal government. Though they are financially self-sufficient, they are responsible for fulfilling public policy objectives and regulatory requirements, creating a balance between commercial autonomy and the accountability required for the use of public assets (Government of Canada, 2019a). Despite being federal entities, the CPAs do not meet the same governance reporting standards that are required in Canada's private sector, inconsistently reporting financial, social, and environmental performance (Brooks, 2018). Though some CPAs meet, and often exceed, these reporting standards, the inconsistency in reporting across the sector suggests that there is a need for a unified reporting system (Walker, 2016; Hossain et al., 2019).

The Government of Canada has committed to the United Nation's (UN) 2030 Agenda for Sustainable Development through the operationalization of the UN Sustainable Development Goals (SDGs) in the Federal Sustainable Development Strategy (FSDS). Though CPAs are extensions of the federal government, they are absent from this national strategy, which could suggest that their sustainability goals are not currently aligned with those of the federal government (Environment and Climate Change Canada, 2019). As international trade agreements are signed, and globalization propels the Canadian economy forward, there will be an inevitable expansion of the port system. Ports are complex systems, whose existence and continued expansion inevitably lead to environmental impacts such as habitat loss, waste water, air emissions, dust generation

and the release of fine particulate matter (PM) in the air; light and noise pollution; dredging and sediment contamination, the accidental release of ballast water and fuel oil residues from ships; as well as marine debris from land-based activities (Darbra et al., 2004; Merk, 2014; Council of Canadian Academies, 2017; Lam & Notteboom, 2014; Walker et al, 2019; Hossain et al., 2019; Hossain et al., 2021). The CPAs must balance the port's role as catalysts of economic growth with the increased negative environmental impacts at the local level. These externalities related to an evolving marine industry must be carefully managed and CPAs require sector-specific tools to improve their sustainability performance.

4.1.2. Evaluation of the Green Marine Environmental Program

The primary framework for improving environmental performance in Canadian Ports is the Green Marine Environmental Program (GMEP). The GMEP allows maritime companies to reduce their environmental footprint by benchmarking their environmental performance using established performance indicators (PIs) in their Self-Evaluation Framework (Walker, 2016; Green Marine Management Corporation, 2020a). Studies by Hossain et al. (2019) and Ashrafi et al. (2019) reported that most CPAs rely exclusively on the GMEP to improve their environmental performance. An analysis of the efficacy of the GMEP in Chapter 3 found that the GMEP allows CPAs to begin to monitor and improve a very specific set of environmental issues relevant to the port sector. The program does not effectively address the bulk of SDGS relevant to the Canadian Port Sector, with only 14 of 36 relevant SDG targets directly linked to the program (Table 12).

Despite offering several benefits to participants – the use of their certified logo, involvement in program development, enhancing social license to operate – the program is limited in its ability to affect meaningful change in the overall sustainability of CPAs (Green Marine, 2018b). The absence of the CPAs from the FSDS is also concerning, as a shift to focus on investments in clean energy, green infrastructure, clean power and energy efficiency would allow the CPAs to contribute to the success of the strategy and Canada's commitment to the UN 2030 Agenda for Sustainable Development. These findings necessitate either an expansion of the GMEP to incorporate these broader

sustainability goals, or the development and inclusion of an additional framework that can be used by CPAs to bridge the gaps between the GMEP and the SDG targets applicable to their operations (Chapter 3). To address these gaps, the present study will develop a framework using disclosures from the Global Reporting Initiative's (GRI) Sustainability Reporting Standards to provide CPAs with a robust set of metrics to improve environmental and social sustainability performance.

4.1.3. Global Reporting Initiative

Port authorities (PAs) have the ability to become environmental stewards through community management and the adoption of voluntary environmental action beyond their own operational boundaries (Poulsen et al., 2018). Antão et al. (2016) advocate for the use of indicators by PAs to facilitate compliance with legislation and environmental protection, because indicators allow the PA to monitor performance trends and improve performance over time. The GRI Standards are often used by organizations because stakeholders are able to compare reports to evaluate the organizations' year-over-year improvement or to compare their report to those of their competitors (Curtó-Pagès et al., 2021). Despite various programs focused on elements of sustainability, the port sector does not have an integrative initiative that incorporates the three dimensions of sustainability (economic, social, and environmental) that is often seen in other industries (Langenus & Dooms, 2018). The GRI offers an integrated solution, providing a unified approach to sustainability reporting through the use of economic, environmental, and social metrics.

The GRI was initially based on the US financial reporting system, with the intent being to expand their global reach, scope and stakeholder base, to facilitate a participatory discussion regarding what sustainability performance should look like in different business sectors (Szejnwald Brown et al., 2009). According to Silvestre et al. (2015), the GRI offers an internationally accepted reporting structure that is adaptable to any business type, dimension, and sector. The disclosures are representative of the triple-bottom-line approach to sustainability, with its reporting structure focused on transparency, as they allow stakeholders to review and propose changes to the

organization's reporting structure (Silvestre et al., 2015). The GRI Standards offer *core* and *comprehensive* options for sustainability reporting. The *core* option is the minimum amount of information about an organization's material topics, related impacts and how they are managed, that is required to say the report was published using GRI Standards (Prakash Sethi et al., 2017; GRI 2018a). The *comprehensive* disclosures move beyond the minimum to include disclosures for the organizations' ethics and integrity, strategy, and governance; as well as extensive reporting on its impacts in all topic-specific disclosures (Prakash et al., 2017; GRI, 2020c).

The GRI Standards offer a "modular, interrelated structure" that provides fewer distractions and is a clearer framework for organizations choosing to publish a sustainability report (GRI, 2020b; Cho et al., 2020). The GRI Standards require organizations to report both their positive and negative economic, environmental, and social impacts, as well as how these impacts are managed (GRI, 2020c; Rodrigues et al., 2021). The GRI Standards are guided by the Reporting Principles, which are integral to a high-quality sustainability report that provides consistent and credible reporting (GRI, 2020b). The Principles ensure that the report content is accurate, balances positives and negative aspects of performance; is accessible to all stakeholders and is reported consistently so that performance can be evaluated over time and relative to other companies (GRI, 2020c).

The GRI Standards have become the global standard for voluntary sustainability reporting, with a 75% adoption rate for companies listed in the Fortune 500's G250 (Dennis et al., 2015; Rodrigues et al., 2021). Within the Canadian context, the GRIs are the most widely adopted guideline for sustainability reporting, with 43% of Canadian companies referencing the guidelines in their sustainability reports (Cho et al., 2020). The purpose of disclosing sustainability information is to encourage accountability, identify and mitigate risks, as well as identify new opportunities for the organization (GRI, 2020a). Koseoglu et al. (2021) and Karaman et al. (2021) found that organizations who used the GRI framework for their sustainability reports were also more likely to seek external assurance for their reports to strengthen the credibility and reliability of the information disclosed. The external assurance of sustainability reports by auditing

professionals enhances the credibility of the report, and the quality of the report can be significantly improved if the auditors systematically apply the GRI principles in their review (Boiral et al., 2019; Karaman et al., 2021).

In addition to providing a more credible sustainability report, Curtó-Pagès et al. (2021) established a positive link between the use of GRI Reporting Standards and SDG reporting. They found that organizations who published a sustainability report using these standards were more likely to consider the SDGs in their disclosures than organization's who used their own independent reporting standards (Curtó-Pagès et al., 2021). An additional link between the GRI and SDGs is the partnership between the GRI, UN Global Compact and the World Business Council for Sustainable Development (WBCSD) (Dalton, 2020). These organizations partnered to develop the SDG Compass – a guide for businesses to "align their strategies as well as measure and manage their contribution to the SDGs" (GRI et al., 2015a, p. 5).

With the identification of performance gaps in the GMEP identified in Chapter 3, the GRI Standards provide a foundation upon which a complementary framework can be developed to ensure that CPAs are meeting all relevant SDG targets. The methods that follow have identified how the relevant GRI Standards have been identified to bridge the gap between the SDGs addressed by the GMEP and those that are not.

Table 12. SDG targets directly (green) and indirectly (yellow) linked to the GMEP (adapted from Figure 8)

SDG	SDG Indicator	Green Marine Indicators							
		Aquatic Invasive Species	GHGs and Air Pollutants	Spill Prevention	Dry Bulk Handling	Community Impacts	Waste Management	Environmental Leadership	Underwater Noise
3	Reduce # of deaths/illnesses from air, water and soil pollution/contamination								
6	Improve water quality (reduce pollution/release of hazardous chemicals, eliminate dumping)								
	Increase proportion of treated wastewater from operations								
9	Upgrade infrastructure to increase resource efficiency and adopt clean tech								
11	Reduce adverse environmental impact of cities - increase waste diversion								
	Reduce adverse environmental impact of cities - decrease levels of fine particulate matter								
12	Sustainable management of natural resources - reduce material consumption								
	Manage chemicals through their lifecycle and reduce release into water/air/soil								
	Reduce waste generation through prevention, reduction, recycling, and reuse								
	Promote sustainable public procurement practices								
14	Prevent marine pollution from land-based activities (marine debris and nutrient pollution)								
15	Reduce degradation of natural habitats, halt loss of biodiversity, protect threatened species								
	Measures to prevent the introduction/impact of invasive alien species to land/water ecosystems								
17	Improve access to science, technology, and innovation, plus enhance knowledge sharing								

4.2. Methods

4.2.1. Review of Matrix Development

The GMEP performance gaps were identified and analyzed in Chapter 3. The links between the GMEP PIs and SDG targets were previously noted in Table 10 and were condensed in Table 12 to explicitly identify the PIs that had direct or indirect connections to relevant SDG targets. The purpose of this research is to develop a sustainability framework to address the performance gaps that result in indirect or no links to relevant SDG targets. The rationale for direct, indirect, and no link is summarized below.

A direct link was classified when the GMEP PI directly contributed to achieving the SDG target for the specified goal. For example, GMEP's PI for Spill Prevention focuses on minimizing spills and leakages of pollutants – both on land and in water (Green Marine Management Corporation, 2020d). This PI was directly linked to SDG 6, specifically target 6.3 focusing on improving "water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater…" (United Nations Statistics Division, 2020, p. 7). The link was, therefore, denoted by a green box in the matrix.

An indirect link was classified when a GMEP PI could have an indirect impact on achieving a target outlined in the SDG indicators. To avoid ambiguous connections, the action of obtaining the specified GMEP PI had to be one-step removed from the desired impact of the specified SDG indicator. For example, though the GMEP PI for GHGs and Air Pollutants has an objective of reducing these emissions, a reduction in these emissions can also have an indirect impact on SDG 3 (reducing illness related to hazardous chemicals released into air, water and soil). For this reason, the link is denoted as an indirect link in yellow in the matrix.

The remainder of the SDG targets that had no links to the GMEP were placed in Table 13 to facilitate this evaluation. There were two distinct instances where a GMEP PI was classified as having no link to the SDG indicators. The first was when the PI did not

contribute in any obvious way to the SDG target for a specified goal. Additionally, the no link was also used when the GMEP PI and SDG indicator were several steps removed from each other, creating too many contingencies to guarantee that there could be an impact on the SDG indicator.

Table 13. SDG targets not addressed by GMEP (adapted from Table 10)

SDG	Target
3	Decrease # of deaths/injuries from road traffic accidents
5	Increase # of women in managerial positions
6	Improve water-use efficiency over time
	Protect/restore water-related ecosystems impacted by port activities
7	Increase share of renewable energy in the global energy mix
	Improve energy efficiency
8	Policies that support productive activities, and job creation in growth of SMEs
	Productive employment for all, with equal pay for work of equal value
	Decrease frequency of occupational injuries
9	Sustainable and resilient infrastructure to support economic development
	Enhance research, upgrade tech including increased spending on R&D
11	Reduce losses related to natural disasters (damage to infrastructure and service disruptions)
	Positive economic/social/environmental links between urban/peri-urban/rural areas
12	Sustainable management of natural resources - reduce material footprint
	Adopt sustainable practices and integrate sustainability reporting in financial cycle
13	Adopt and implement disaster risk reduction strategies in line with Sendai Framework
	Integrate climate change measures into policies, strategies, and planning
	Capacity-building for climate change mitigation, adaptation, impact reduction and early warning
14	Sustainably manage and protect marine and coastal ecosystems to avoid adverse impacts
	Minimize the impacts of ocean acidification
15	Integrate ecosystem and biodiversity values into port planning and policies
17	Promote effective public, public-private, civil society partnerships

4.2.2. Development of Port Sustainability Framework

The GRI Standards were chosen as a metric to supplement the GMEP PIs because they offer a robust framework for reporting, and improving on, sustainability performance. They are also closely affiliated with the SDGs; a partnership between the GRI, UN Global Compact, and WBCSD led to the development of the SDG Compass which provides sector-specific business indicators using GRI Standards to meet SDG targets

(GRI et al., 2015b). Though there are indicators for sectors like the oil and gas industry or the mining industry, there are no port-specific indicator frameworks available. This

The GRI offers three distinct topic-specific standards: economic, environmental, and social. Three separate tables were created to clearly delineate the disclosures based on topic. The economic indicators reflect the need to identify policies and procedures to address sustainability with respect to the positive and negative impacts to key stakeholders, planning for climate change adaptation, as well as green procurement practices. The environmental disclosures are related to the direct and indirect actions of the port and their impact on energy consumption, air emissions, water usage and effluent discharge, biodiversity loss, and solid waste management. Finally, the social indicators focus on improving diversity and equity in the workplace, incorporating the rights of Indigenous Peoples into port policies and planning, as well as building relationships with local communities through the identification and mitigation of harmful port activities.

Using the table of SDG targets with no direct links to the GMEP PIs, a systematic review was conducted with the goal of filling program gaps with suitable metrics from the GRI Standards. Similar to Puig et al. (2014), a top-down approach was used to identify the disclosures relevant to the CPAs. A top-down approach identifies indicators of relevance based on findings from the literature and narrows these down to a suitable set of indicators, using specified criteria (Puig et all., 2014). The content in the SDG indicators were acted as selection criteria, because each GRI disclosure had to directly contribute to achieving a specified target to be included in the framework.

GRI disclosures were initially reviewed and were excluded when pre-existing legislation and regulations pertaining to accountability, transparency, economic reporting, labour rights, and human rights that were identified in the literature rendered the use of these disclosures redundant in the Canadian context. For example, the Canada Labour Code covers industrial relations (certification of unions, labour-management relations, collective bargaining, unfair labour practices); workplace health and safety, as well as employment standards that include issues like work hours, unjust dismissal, minimum

wage, and severance pay (Government of Canada, 2018). Additional systems like the Workplace Hazardous Materials Information System (WHMIS) and *Canada Occupational Health and Safety Regulations* require safe working environments and training for all employees of the CPAs (Government of Canada, 2021a). The *Canadian Human Rights Act* also ensures that Canadians are protected from discrimination in the workplace when they are employed by the federal government or companies that they regulate; the failure to comply with Canada's Labour Code results in administrative monetary penalties (Government of Canada, 2018; Government of Canada, 2021b). This resulted in several social standards being eliminated from the list of disclosures to ensure that the framework would only address areas of significant concern.

Once these GRI standards were excluded, the content of each of the remaining GRI standards were reviewed alongside the SDG indicators. Using an iterative process, each GRI disclosure was compared to each SDG target to identify if its use would directly contribute to achieving that target. The use of a binary, yes-no approach was used for the inclusion and exclusion of each of the remaining GRI disclosures. For each disclosure asking if the actions undertaken in this disclosure directly contributed to the SDG target resulted in a "yes" or "no" response. Only disclosures with a "yes" response were included in the sustainability framework.

The tables in the framework identify each applicable GRI disclosure, identified by their respective numbers. The second column of the table provides an overview of the information that must be disclosed by the CPA to fulfill that disclosure's requirements. This overview was adapted to identify specific port activities that should be described, to remove ambiguity in the interpretation of what CPAs were required to disclose. The final column of the table identifies the SDGs that could be directly linked to the changes in performance outlined in the disclosures. The list of SDG targets that were not linked to the GMEP were reviewed and direct links were identified using the same methodology noted above – a direct link to the SDG meant that the activity in the GRI disclosure could directly impact that SDG. The list of SDG targets with indirect links to GMEP PIs were

also reviewed to identify if the addition of metrics in the GRI disclosures could shift those links from indirect to direct links.

4.3. Sustainability Framework

The three tables below provide a detailed framework for CPAs to use either independently, or in conjunction with the GMEP, to address the broader sustainability concerns that the program fails to address. The first table identifies the economic disclosures; the second identifies the environmental disclosures; and the third identifies the social disclosures. Each SDG with direct links to the metrics in the disclosure are identified in the third column.

Table 14. GRI economic disclosures directly connected to relevant SDGs

GRI Disclosure	Description	SDG Addressed
Identification of economic, environmental and social impacts (GRI 102.15)	Description of the significant economic, environmental and social impacts, and associated challenges and opportunities of the port. This includes the effects that these impacts have on key stakeholders	SDG 11, 12
Stakeholder Engagement (GRI 102-42, -43)	Identification of relevant stakeholders, including how and when to engage with stakeholders	SDG 11, 17
Economic Performance (GRI 201-2)	Risks and opportunities posed by climate change that have the potential to generate substantive changes in operations, revenues, expenditures, including: description of risk/opportunity; classification (physical [weather events and infrastructure] or regulatory); associated impacts; financial implications, and methods of management	SDG 9, 11, 12, 13, 15
Indirect Economic Impacts (GRI 203-1)	Extent of development of significant infrastructure investments and services supported. Current or expected impacts on communities and local economies, including positive and negative impacts where relevant	SDG 9, 11, 12, 13
Green Procurement (GRI 204-1)	Describe actions taken to identify and adjust the organization's procurement practices that cause or contribute to negative impacts in the supply chain Describe policies and practices used to select locally-based suppliers, including proportion of spending on local suppliers	SDG 8, 12, 17

Table 15. GRI environmental disclosures directly connected to relevant SDGs

GRI Disclosure	Description	Relevant SDG
Energy Consumption (GRI 302-1) (GRI 302-2) (GRI 302-4)	Total energy consumption within the port including non-renewable sources (1a), renewable sources (1b); electricity, heating, cooling, and steam purchased for consumption, self-generated, and sold by the port	SDG 7, 13
	Energy consumption outside of the port (upstream and downstream) • Upstream: purchased goods and services, capital goods, upstream transportation and distribution, waste generated in operations, business travel, employee commuting • Downstream: transportation of goods, processing of sold products, use of sold products, end-of-life treatment of sold products, downstream leased assets, investments	SDG 7, 13
	Amount of reduction in energy consumption achieved as a direct result of conservation and efficiency initiatives (includes process redesign, conversion and retrofitting equipment, changes in behaviour, operational changes)	SDG 7, 9, 12, 13
Water and Effluents (GRI 303-1, -2, -3, -4)	Total volume of water withdrawn from surface water (wetlands, rivers, lakes, and oceans); ground water, seawater, produced water (wastewater, recycled, rainwater), and third-party water (municipal or private supply) *Note collections from areas of water stress should be identified separately	SDG 6, 12
	Identification of water sources impacted by withdrawal, including whether it's nationally protected, has biodiversity value, and its value to local communities and Indigenous peoples	SDG 6, 12, 14, 15
	Total volume of water reused and recycled by the port	SDG 6, 12
	Description of minimum standard set for quality of effluent discharged (standards set by the port and sector-specific standards)	SDG 3, 6, 12, 14, 15
	Total wastewater discharge to surface water, groundwater, seawater, and third-party water *Includes identification of priority substances (cause irreversible harm to waterbodies, ecosystems, human health) of concern and how they're handled	SDG 3, 6, 12 14, 15

GRI Disclosure	Description	Relevant SDG
Biodiversity (GRI 304-1, -2, -3, -4)	Identification of operational sites owned, leased, managed or adjacent to protected areas and areas of high biodiversity value	SDG 6, 14, 15
	Reporting positive and negative direct or indirect impacts on biodiversity, including the affected species, extent of area impacted, duration, and reversibility/irreversibility *Note related to port activities like construction, pollution, invasive species, habitat conversion, and change in ecological processes	SDG 6, 14, 15
	Reporting size and location of habitats protected or restored by the port, and whether this was done through partnerships with local groups	SDG 6, 14, 15
	Reporting number of IUCN Red List species and national conservation list species (by level of extinction) in areas affected by port operations	SDG 14, 15
Emissions (GRI 305-1, -2, -3, -4)	Reporting direct Scope 1 emissions (metric tons of CO_2 equivalent and other GHGs). Includes • Generation of electricity, heating, cooling and steam • Physical or chemical processing • Transportation of materials, products, waste, workers, and passengers • Fugitive emissions (intentional or unintentional leaks of GHGs, including equipment leaks, methane emissions, venting, HFC emissions from air conditioning)	SDG 12
	Reporting energy indirect GHG emissions (Scope 2) in metric tons of CO_2. This includes the purchase or acquired electricity, heating, cooling, and steam consumed by the port	SDG 12
	Reporting other indirect GHG emissions (Scope 3) in metric tons of CO_2. This includes upstream and downstream activities that contribute significantly to the ports' total emissions *(see **Energy**)	SDG 12
	Reporting reduction in GHG emissions (metric tonnes CO_2 equivalents) as a direct result of reduction initiatives, including process redesign, conversion/retrofitting equipment, fuel switching, changes in behaviour, and offsets	SDG 3, 9, 12, 13, 14
	Reporting significant air emissions in kgs for NO_x, SO_x, POPs, VOCs, HAPs, and PM	SDG 3, 11

GRI Disclosure	Description	Relevant SDG
Waste (GRI 306-1, -2, -3, -4, -5)	Reporting the inputs, activities, and outputs that could lead to actual or potential waste-related impacts. *Note: Can be related to direct operations of the port or to upstream/downstream activities in the value chain (see **Energy**) Identification of all waste streams for the port, with waste generated reported in metric tonnes (can include administrative waste, biomass waste)	SDG 3, 6, 12
	Circularity measure taken to prevent waste generation in the port's activities (upstream/downstream activities in value chain) and how impacts are managed • Improving material selection by considering longevity/durability, reparability, modularity/disassembly, and recyclability • Reducing use of raw materials by procuring secondary materials • Substituting hazardous for non-hazardous materials • Recovering products/materials through preparation for re-use and recycling • Collaboration in the value chain, including industrial symbiosis (by-product valorization) • Third-party waste management reviewed for adherence to legislation/regulation	SDG 9, 12, 14
	Total weight of waste diverted from disposal in metric tonnes (categorized by waste stream). Include both hazardous and non-hazardous waste, and how the waste was diverted (preparation for reuse; recycling, other recovery)	SDG 11, 12, 14
	Total weight of waste disposed (metric tonnes) to landfills, other disposal, or incineration (with and without energy recovery)	SDG 11, 12, 14
Supplier Environmental Assessment (GRI 308-1, -2)	Reporting approach for conducting environmental assessments of suppliers (screening, assessment of potential negative impacts of supply chain, grievance mechanisms)	SDG 12
	Identification of the number of suppliers assessed, including the number identified as having an actual potential negative impact	SDG 12

Table 16. GRI social disclosures directly connected to relevant SDGs

GRI Indicator/ Disclosure	Description	SDG Addressed
Training and Education (GRI 404-1, -2)	Average hours of training that the port's employees have undertaken, reported by gender and employee category	SDG 5, 8
	Type and scope of programs implemented, and assistance provided to upgrade employee skills	SDG 8
Diversity and Equal Opportunity (GRI 405-1, -2)	Percentage of individuals within the port's governance bodies based on gender; age group (<30; 30-50; >50), and other indicators of diversity	SDG 5, 8
	Ratio of the basic salary and remuneration of women to men from each employee category by operation	SDG 5, 8
Security Practices (GRI 410-1)	Percentage of security personnel who have received formal training in the port's human rights policies/procedures	SDG 8
Rights of Indigenous Peoples (GRI 411-1)	Total number of incidents (legal action or complaint) of violations involving the rights of Indigenous peoples. Actions taken must include: incident review, remediation plans implemented and results of remediation Grievance mechanisms for reporting incidents must be implemented/reviewed	No direct link to SDGs
Local Communities (GRI 413-1, -2)	Percentage of operations with implemented local community engagement, impact assessments, and/or development programs, including: • Social/environmental impact assessments, ongoing monitoring, and public disclosure of results • Local community development programs based on community needs • Stakeholder engagement plans based on stakeholder mapping • Local community consultation committees (including vulnerable groups) • Formal local community grievance process	SDG 3, 12, 17
	Reporting operations with significant actual and potential negative impacts on local communities including: • Vulnerability and risk of physical/economic isolation, proximity to operations • Exposures to local communities including use of hazardous substances that impact health; volume/type of pollution released; status as major employer in local community, land conversion and resettlement, natural resource consumption For each potential negative impact, the intensity/severity, duration, reversibility, and scale of the impact should be assessed	SDG 3, 6, 8, 9, 11, 12, 14, 15, 17

4.4. Discussion

4.4.1. Strengthening the Green Marine Environmental Program

The GMEP is beneficial in its ability to facilitate improved environmental performance in the port sector; however, the program is limited in its capacity to address all SDGs relevant to the Canadian Port Sector. Of the 36 SDG targets, only seven were directly linked to the PIs used by the GMEP (Chapter 3). There were an additional seven targets with indirect links, suggesting that changes to objectives and criteria in the GMEP PIs could lead to more direct links between the program and achievement of the SDG targets.

The adoption of the GRI disclosures in the *Emissions* Standard would allow the GMEP to shift their indirect links to SDG targets to direct links. *GRI 305: Emissions* focuses on reporting Scopes 1, 2, and 3 of the GHG Protocol, as well as the identification and implementation of reduction strategies used to improve efficiencies and reduce emissions (GRI, 2020k). Moving beyond simply quantifying and reporting direct emissions from port activities, the GRI asks that CPAs report emissions related to the purchase of electricity and the emissions related to upstream and downstream activities such as purchased goods and services, capital goods, and investments (Table 15) (GRI, 2020h; 2020k). The adoption of clean technology, shifting to renewable energy, retrofitting infrastructure, fuel switching, changes in behaviour, and offsets are all methods that can be used by CPAs to reduce their emission levels (GRI 2020k; Hossain et al, 2021). Being proactive in reducing emissions may have more upfront costs; however, it ensures that the port is prepared for future regulatory changes, including carbon taxes (Papaefthimiou et al., 2017).

The GMEP PI for Spill Prevention is effective at addressing the accidental release of hazardous chemicals/materials into land and water-based ecosystems, as well as stormwater treatment (Green Marine Management Corporation, 2020d). The GRI Standard for *Water and Effluents* also ensures that all water withdrawal is recorded and that the impacts to the water sources are identified and monitored, paying special attention to areas of water stress (Table 15) (GRI, 2020i). The Standard also includes a description of the minimum standard for the quality of effluent discharge set by the port, as well as local and national standards, and the identification of priority substances in wastewater that can cause irreversible harm (GRI, 2020i). These additional measures

outlined in the GRIs would create direct links to SDG 3, 6, 12, 14, and 15 because these measures require that port policies are created to include an assessment of how their operations will impact local communities and biodiversity.

Many of the disclosures in *GRI 304: Biodiversity* Standard are connected to federal legislation in Canada. The *Fisheries Act, National Marine Conservation Act, Coastal Fisheries Protection Act, Species at Risk Act, Canada Wildlife Act,* and *Migratory Birds Convention Act* protect biodiversity and must be adhered to by the CPAs. As it can be difficult to navigate the legal jargon in legislative acts, CPAs should proceed with caution and identify the impacts that their operations have on biodiversity, recording species at risk located in areas affected by the port, and detailing how they have worked on projects to protect or restore habitats that were previously impacted by port activities (Table 15). These actions would ensure that the CPA's could directly link performance to SDGs 6, 14, and 15.

The Waste Prevention PI in the GMEP could become more robust through the adoption of disclosures in the *GRI 306: Waste* standard. CPAs would be required to characterize all waste streams of direct operations and upstream/downstream activities, including the potential impacts for each (GRI, 2020l). Additionally, the standard encourages CPAs to adopt circular thinking with waste generation and diversion. The creation of value through the efficient reuse of natural capital can also provide cost-saving and revenue-generating measures to CPAs (Ashrafi et al., 2021). Monitoring and reducing waste levels has been an area of focus for European ports since 2013; however, the 2019 EU directive requiring ports to have waste disposal facilities for ships entering port has led to this becoming one of the top environmental priorities for ports in recent years (European Commission, 2019; Puig et a., 2021). This legislation does not currently exist within the Canadian context; however, rather than lagging in performance, CPAs could become industry leaders and offer this service to ships entering port before this becomes an enforceable regulation in Canada.

The GRI Standards do not simply require CPAs to report their performance; they are also required to identify all positive and negative impacts of their activities and how these impact local communities. By taking this approach in the GMEP, CPAs would shift from focusing primarily on environmental performance to ensuring that their actions have limited adverse impacts on local communities and ecosystems. This would make CPAs true environmental leaders; an area of concern in the GMEP PIs. The Environmental Leadership PI was previously identified as being problematic because it offers CPAs a choice, with considerable disparity in the rigour of criteria used to attain level five certification. To be an environmental leader, a CPA should be an early adopter of best practices related to sustainability performance in the port sector, rather than selectively choosing from a list of criteria of varying impact to demonstrate their environmental leadership. The GMEP could provide participants with a higher level of certification if they publish a sustainability report following the GRI Core Standards.

4.4.2. Creating New Indicators for Port Sustainability

The development of the sustainability framework identified three primary indicator sets that should be incorporated into CPA planning and operations, including Energy, Climate Change Adaptation, and Collaboration with Indigenous Peoples and Local Communities. Each indicator set is described in detail below.

4.4.2.1. Energy

The GRI Standard requires that CPAs calculate their total energy consumption including all forms of renewable and non-renewable energy related to direct port activities and the purchase of electricity, as well as consumption outside the port, including all upstream and downstream activities (Table 15) (GRI, 2020h). In addition to quantifying their energy use, the CPAs would also be required to identify the amount of reduction of energy consumption directly related to conservation and energy initiatives (GRI, 2020h). This includes conversion and retrofitting equipment, operational changes to increase energy efficiency, changes in individual employee behaviour, and process redesign (GRI, 2020h). Automation of services and operations has also been linked to increased efficiency; specifically, automatic mooring systems used to berth ships, which can reduce

the berthing time by over an hour (Díaz-Ruiz-Navamuel et al., 2018; Sifakis & Tsoutsos, 2021). The use of new lighting technologies and implementation of motion sensors are also leading to reduced energy consumption, as 5% of energy consumption in ports is caused by lighting (Van Duin et al., 2017; Iris & Lam, 2019; Chen et al, 2019). These types of changes create direct links between SDG 7, specifically the increase of renewable energy and increased energy efficiency.

Ports are often located in areas that would be suitable for power generation from renewable sources, like wind, wave, tidal, and geothermal energy, as well as having infrastructure that could be outfitted with solar panels (Acciaro et al., 2014). In addition to focusing on electric vehicles, battery power on ships, and investing in their own electrical grids, many PAs have also adopted onshore power that allows vessels to be powered through on-grid electricity while docked at the port, reducing the combustion of fuels on ships, and thereby, reducing emissions locally (Acciaro et al., 2014; Krämer and Czermanski, 2020). The caveat with onshore power is that if electricity is not derived from renewable sources, its use may have a net zero impact, and the high cost of implementation is often a barrier for many ports (Coppola et al, 2016; Gutierrez-Romero et al., 2019). These changes are also critical for building the capacity required to adapt to climate change (SDG 13).

4.4.2.2. Climate Change Adaptation and Mitigation

Port infrastructure, operations, and supply chains will all become vulnerable to oceanic and atmospheric changes that will lead to frequent and intense storms, as well as flooding related to sea-level rise (Becker et al., 2018). Climate change adaptation requires that ports build adaptive capacity to deal with these changes through policy planning and operational changes (Chhetri et al., 2020). Becker et al. (2018) argue that many of these long-term changes resulting from climate change have not been accounted for in port planning. Monios and Wilmsmeier (2020) also suggest that the continued forecasting for uninterrupted growth in the port sector is inaccurate, and the continued minor incremental changes in policy are not sufficient for climate change mitigation and adaptation. The plan to increase port capacity related to this growth must be carefully balanced with

infrastructure upgrades to maintain current levels of operation in the face of sea-level rise (Hanson & Nicholls, 2020).

The *GRI 203: Indirect Economic Impacts* Standard asks that CPAs identify all risks and opportunities posed by climate change that "have the potential to generate substantive changes in operations, revenues, expenditures" and the plans they have created to mitigate these impacts (GRI, 2020, p. 9). The GRI Standard for *Indirect Economic Impacts* also ensures that any type of infrastructure development and investment undertaken to build these capacities does not have any adverse impacts on local communities and ecosystems (Table 14). This type of capacity building can ensure that ports are preparing for climate-related changes and meeting the targets outlined in SDG 13. Green procurement and supporting local suppliers are a priority in Canada's FSDS, with all government departments required to evaluate how the goods and services they procure address carbon reductions, increase sustainable plastics, and address broader environmental concerns (Environment and Climate Change Canada, 2019). The GRI Standards require that CPAs conduct environmental assessments of their suppliers (Table 15) and demonstrate how they have changed procurement practices to shift away from suppliers who cause negative impacts, providing a more holistic approach to that in the FSDS and linking directly to SDG 12 (GRI, 2020g; 2020m).

4.4.2.3. Collaboration with Indigenous Peoples and Local Communities

There is very little attention given to PIs that support improvement of the socially-focused SDGs. Canada's Port Modernization Review suggested that CPAs should build relationships with Indigenous peoples and local communities by developing partnerships, hosting open houses, starting good neighbour committees and engaging with the public on social media (Transport Canada, 2018). The GRI Standards require CPAs to perform stakeholder mapping to identify their key stakeholders and proceed to develop mechanisms for community engagement, as well as impact assessments and program development (GRI, 2020q). The CPAs would also be required to identify the operations that have potential or actual negative impacts on local communities, including the intensity and severity, duration, reversibility, and scale of the impact (Table 16) (GRI,

2020q). This would mean that CPAs are proactively addressing their impact on local communities rather than focusing on community impacts through a reactive lens. By incorporating these elements into their planning, CPAs would directly contribute to achieving SDG targets in goals 3, 6, 8, 9, 11, 12, 14, 15, and 17 (Table 16).

The Government of Canada continues to work towards the 94 calls to action identified by the Truth and Reconciliation Commission (TRC) to begin the process of reconciliation with Indigenous peoples (Government of Canada, 2019b). The TRC called on the corporate sector in Canada to adopt the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) as a reconciliation framework (Government of Canada, 2019c). CPAs would be required to apply UNDRIP's framework to its policy and operational activities involving Indigenous peoples, their lands, and resources (Government of Canada, 2019c). Following *GRI 411: Indigenous Peoples* can begin to address the impact that the CPAs have on local Indigenous Peoples (Table 16); however, further actions to ensure meaningful consultation, building respectful relationships, obtaining informed consent before development projects, and providing equitable access to jobs would demonstrate a higher level of commitment to reconciliation that would make CPAs good corporate citizens (Government of Canada, 2019c; GRI 2020p).

4.4.3. Links to Canada's Federal Sustainable Development Strategy

The CPAs are federal entities and yet their absence from the FSDS could suggest that their sustainability goals are not aligned with those of the Government of Canada. Though this research focused primarily on the achievement of SDG targets through the GRI metrics, these same metrics can be applied to the goals outlined in Canada's FSDS (Table 17). The FSDS will be reviewed and renewed after 2022, as the goals required to meet the 2030 Agenda for Sustainable Development continue to evolve (Environment and Climate Change Canada, 2019). This research demonstrates the role that CPAs have in achieving targets outlined in the SDGs and, in turn, the FSDS. Though the implications of this study are related to the CPAs, these measures could be applied to other federal entities to ensure that there is a unified approach to sustainable development in Canada.

Table 17. FSDS Goals applicable to CPAs and GRI metrics to attain goals

FSDS Goals	Purpose	Metric
1. Effective action on climate change	• Reducing GHG emissions • Zero-emission vehicles	GRI 305
2. Low-carbon government	• Property and Fleet (GHG emission reduction, non-hazardous operational waste, plastic waste, construction and demolition waste, domestic office lease) • Adaptation to climate change • Procurement	GRI 201, 202, 204, 305, 306, 308
4. Modern and resilient infrastructure	• Investment in green infrastructure	GRI 203
5. Clean energy	• Clean power generation • Energy efficiency	GRI 302
6. Healthy coasts and oceans	• Marine conservation • Sustainable fisheries	GRI 303, 304, 305, 306
7. Pristine lakes and rivers	• Nutrient pollution to lakes and rivers • Lake and river ecosystem protection	GRI 303, 304
9. Healthy wildlife population	• Species at risk • Migratory birds	GRI 304
13. Safe and healthy communities	• Air quality • Air pollutant emissions • Chemicals management plan	GRI 303, 305, 306

4.5. Conclusion

The reliance on the GMEP had previously been identified as problematic because the program does not effectively address the bulk of SDGs relevant to the CPAs. This finding necessitated the development and inclusion of an additional framework that could be used by CPAs to bridge the gaps between the GMEP PIs and the SDG targets applicable to their operations. The GRI Standards were identified as an integrated solution that provide a unified approach to sustainability reporting through the use of economic, environmental, and social standards. The GRI Standards provided the foundation upon which this complementary framework was developed to ensure that CPAs are meeting all relevant SDG targets.

The GMEP could become more robust with the addition of metrics from select GRI standards. The addition of Scope 1-3 of the GHG protocol and a metric for emissions reductions through efficiencies and new technology could strengthen the GMEP's GHG

Emission and Air Pollutants PI. The Spill Prevention PI could shift to a more holistic approach that considers the prevention of spills as well as GRI disclosures focused on monitoring water withdrawal, water efficiency measures, and effluent standards. The focus of waste prevention should also shift from an administrative waste diversion approach to one that encourages circular thinking in waste diversion through all activities in the port. These simple changes would create direct links between the GMEP and 18 of 36 SDG targets.

The use of the sustainability framework creates direct links between CPA performance and each of the 36 SDGs relevant to the Canadian Port Sector. The sustainability framework provides a list of disclosures that can be used by CPAs to improve their sustainability performance through the identification of their positive and negative environmental and social impacts, as well as how these impacts can be mitigated. The social metrics for port sustainability in Canada were not previously addressed in the GMEP, though the program only claims to help the maritime industry improve their environmental footprint (Green Marine Management Corp, 2020a). The socially-focused SDGs are now directly linked to the disclosures in Table 16 of the sustainability framework, providing CPAs with guidance on how to incorporate social sustainability into port governance and operations.

The goal of this research was to provide a framework that would ultimately address all elements of environmental and social sustainability in the Canadian Port Sector. The onus to improve sustainability performance will continue to remain with CPAs, though the identification of impacts, monitoring of performance, and continuous improvement in performance can be achieved by adhering to this sustainability framework. The Government of Canada should also incorporate the CPAs in their renewed FSDS to ensure there is a unified approach to attaining the 2030 Agenda for Sustainable Development.

CHAPTER 5: CONCLUSION

5.1. Final Conclusions and Recommendations

This thesis evaluated the efficacy of sustainability initiatives in the Canadian Port Sector and developed a framework to address performance gaps in existing initiatives. The first objective of this thesis was to review the academic literature to provide a holistic view of what is expected of a sustainable port. The World Ports Sustainability Program (WPSP) and ports in other jurisdictions have been focused on aligning their sustainability performance with the United Nations (UN) Sustainable Development Goals (SDG) targets. Though the bulk of the literature focuses on environmental performance in ports, there has been a shift more recently to focus on the social and community-level impacts of port activities.

The second research objective was to review the efficacy of sustainability initiatives employed by the Canada Port Authorities (CPAs). The Green Marine Environmental Program (GMEP) was identified as the primary initiative used by the CPAs to improve their sustainability performance, with each CPA certified by the program to varying degrees. The reliance on this program necessitated an evaluation of its efficacy in addressing sustainability in its broader context as this had not been previously reviewed in the academic literature. The research conducted found that the GMEP is effective in doing what it sets out to do – to help ports address a very specific set of environmental issues relevant to the port sector. Though it provides a good opportunity for CPAs to begin to monitor and improve their environmental performance, it does not address the bulk of SDGs that are relevant to the Canadian Port Sector, with only 14 of 36 SDG targets linked to the GMEP performance indicators (PIs). The identification of these performance gaps led to the development of a framework that could be used by CPAs to bridge the gaps between the GMEP PIs and the SDG targets applicable to their operations.

The third research objective of this thesis was the development of a holistic sustainability framework that addressed the performance gaps in the GMEP. The Global Reporting

Initiative (GRI) Standards were identified as an integrated solution that provide a unified approach to sustainability reporting through the use of economic, environmental, and social standards. The GRI Standards provided the foundation upon which this complementary framework was created. The framework provides a list of disclosures that can be used by CPAs to improve their sustainability performance through the identification of their positive and negative environmental and social impacts, as well as how these impacts can be mitigated. The use of this framework creates direct links between CPA performance and each of the 36 SDGs relevant to the Canadian Port Sector. Ultimately, this could also be achieved with the addition of metrics to the exiting GMEP PIs and the inclusion of additional PIs like Energy, Climate Change Adaptation, and Collaboration with Indigenous Peoples and Local Communities, should the program see an opportunity in shifting the program's focus from environmental performance to address broader sustainability issues related to the maritime sector.

The overall findings of the research indicate that the CPAs require a unified approach to improving their sustainability performance. As they are federal entities, the Government of Canada has an obligation to outline the sustainability standards that the CPAs are required to meet. The following list of recommendations can be used by CPAs, the GMEP, and the Government of Canada in future evidence-based policy development:

- To address shortcomings identified in the Port Modernization Review, the CPAs should be fully integrated into the renewal of Canada's FSDS in 2022
- The sustainability goals of CPAs should be clearly aligned with those of the federal government.
- The Government of Canada should create regulations to standardize sustainability reporting among CPAs and provide them with their own sustainability framework (Chapter 4) rather than relying on a third-party certification program
- The marine industry continues to focus on improving sustainability performance in alignment with the targets outlined in the SDGs. The GMEP caters to the marine industry and should focus on integrating these targets into the development of their PIs

- The GMEP could expand to include additional metrics from the framework outlined in Tables 14, 15, and 16, as well as the addition of new PIs (Energy, Climate Change Adaptation, and Collaboration with Indigenous Peoples and Local Communities) to ensure the program is directly contributing to all relevant SDG targets
- The GMEP must consider the mandatory inclusion of a sustainability report using GRI Standards to achieve the highest certification level in the Environmental leadership PI

The onus to improve sustainability performance will continue to remain with CPAs; however, the identification of impacts, monitoring of performance, and continuous improvement in performance can be achieved by adhering to the sustainability framework. As noted in the recommendations, the GMEP could improve the robustness of their program by considering the addition of metrics to their existing indicators, as well as the addition of new PIs that would address sustainability in its broader sense. The methods outlined in this research can also be replicated by other sustainability initiatives in the port sector to create direct links between their own programs and the targets outlined in the SDGs. Though the research focuses primarily on the Canadian context, the sustainability framework and policy recommendations can be applied and adapted to jurisdictions globally.

5.2. Next Steps

The research and methodology in this thesis were presented through an evidentiary lens. With future research, the external validity of the methodology could be improved by incorporating input from key stakeholders in the development of a framework. Due to the original scoping of the research, surveys or interviews could not be conducted with CPAs to obtain bottom-up input on how sustainability can be operationalized into port performance. To ensure that the sustainability framework is aligned with the Government of Canada's FSDS, future consultation with committees in Transport Canada and Environment and Climate Change Canada responsible for SDG policy development could provide additional support of these findings.

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