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Development of Framework for Improved Sustainability in the Canadian Port Sector

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Abstract: Canada Port Authorities (CPAs) are federal entities responsible for managing Canadian Ports with local, national, and international strategic importance. Despite their connection to the Government of Canada, the CPAs inconsistently report sustainability performance and are absent from Canada's Federal Sustainable Development Strategy (FSDS)—a national strategy to operationalize the United Nation's (UN) Sustainable Development Goals (SDGs). Sustainability initiatives currently used by CPAs only contribute towards attaining 14 of 36 relevant SDG targets, suggesting the need for an additional sustainability framework to achieve the remainder of these targets. This paper proposes a port-specific framework based on disclosures from the Global Reporting Initiative (GRI) to fill performance gaps in current sustainability initiatives. Disclosures were selected in an iterative process based on literature and industry best practices. The framework provides a unified approach for both CPAs and policymakers to attain SDG targets relevant to the Canadian port sector and align sustainability performance with Canada's FSDS.

Keywords: maritime ports; Canadian port sector; sustainability initiatives; sustainability reporting; sustainability framework; sustainability performance; Global Reporting Initiative (GRI); Green Marine (GM); United Nation's Sustainable Development Goals (UN SDGs)

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1. Introduction

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 [1]. The ports of strategic importance, responsible for handling 60% of Canada's cargo tonnage, are managed by the Canada Port Authorities (CPAs) [1,2]. 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 [2]. 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 [3]. 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 [4,5].

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 [6]. 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 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 [5,7–12]. 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.

1.1. 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 [4,13]. Studies by Hossain et al. and Ashrafi et al. reported that most CPAs rely exclusively on the GMEP to improve their environmental performance [5,14]. An analysis of the efficacy of the GMEP by MacNeil found that the GMEP allows CPAs to begin to monitor and improve a very specific set of environmental issues relevant to the port sector [15]. 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 [15]. GMEP does not effectively address significant areas of concern such as the implementation of renewable energy and improved energy efficiency; the implementation of climate change mitigation and adaptation strategies; or social sustainability metrics such as improving engagement with local communities and Indigenous peoples [15].

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 [16]. 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 [15]. 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.

1.2. Global Reporting Initiative

Port authorities (PAs) can become environmental stewards through community management and the adoption of voluntary environmental action beyond their own operational boundaries [17]. Antão et al. 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 [18]. The GRI Standards are often used by organizations because stakeholders can compare reports to evaluate the organizations' year-over-year improvement or to compare their report to those of their competitors [19]. 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 [20]. The GRI offers an integrated solution, providing a unified approach to sustainability reporting using 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 [21]. According to Silvestre et al., the GRI offers an internationally accepted

reporting structure that is adaptable to any business type, dimension, and sector [22]. 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 [22]. 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 [23,24]. 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 [23,25].

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 [26,27]. 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 [25,28]. The GRI Standards are guided by the Reporting Principles, which are integral to a high-quality sustainability report that provides consistent and credible reporting [26]. The Principles ensure that the report content is accurate, balances positive 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 [25].

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 [28,29]. Within the Canadian context, the GRIs are the most widely adopted guideline for sustainability reporting, with 43% of Canadian companies referencing the standards in their sustainability reports [27]. The purpose of disclosing sustainability information is to encourage accountability, identify and mitigate risks, as well as identify new opportunities for the organization [24]. Koseoglu et al. and Karaman et al. 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 [30,31]. 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 [31,32].

In addition to providing a more credible sustainability report, Curtó-Pagès et al. established a positive link between the use of GRI Reporting Standards and SDG reporting [19]. 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 [19]. 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) [33]. 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" [34] (p.5).

The goal of this research is to identify GRI disclosures that can be directly linked to relevant SDG targets, building on previous research that identified performance gaps in the GMEP [15]. The GRI disclosures will provide a foundation upon which a complementary framework can be developed to provide CPAs with an industry-specific set of standards to facilitate decision making and improve sustainability performance through a unified reporting structure. The methods that follow describe how the relevant GRI disclosures were selected for the framework, with the results and discussion detailing how the framework can be used by CPAs to align their sustainability performance with the relevant SDG targets and FSDS.

2. Materials and Methods

2.1. Review of Matrix Development

As previously noted, this study builds on the work conducted by MacNeil, who evaluated the efficacy of the GMEP by identifying program performance gaps. Using

the GMEP's 2020 Performance Indicators for Ports & St. Lawrence Seaway Corporations and the UN SDG Indicators, a matrix was created to visually represent the links between the two sets of indicators [15,35,36]. Three types of links exist—direct, indirect, and no link [15]. Table 1 is an adaptation of the matrix that identifies only the direct and indirect links between GMEP PIs and relevant SDG targets [15]. The SDG targets not addressed by GMEP PIs have been compiled in Table 2. The purpose of this study is to select GRI disclosures for a sustainability framework that will create direct links between SDG targets that are either indirectly linked or not linked to the current GMEP PIs. The process for the identification of each type of link is summarized below.

Table 1. SDG targets directly (green) and indirectly (yellow) and not linked (red) to the GMEP (adapted from MacNeil [15]).

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								

Table 2. SDG targets not addressed by GMEP (adapted from MacNeil [15]).

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

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 [35]. 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 . . . " [36]. 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.

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. The SDG targets that had no links to the GMEP were placed in Table 2 to facilitate this evaluation.

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 [37]. Though there are indicators for sectors such as the oil and gas industry or the mining industry, there are no port-specific indicator frameworks available.

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. Puig et al. (2014) used a top-down approach to identify relevant environmental indicators to the port sector—a similar approach was used to identify the disclosures relevant to the CPAs [38]. 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 [38]. The content in the SDG indicators 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 such as work hours, unjust dismissal, minimum wage, and severance pay [39]. Additional systems such as 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 [40]. 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 [39,41]. 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. The framework used in study is based on a critical descriptive assessment of the GMEP (which has been established since 2007), but then compared to other existing frameworks (e.g., the GRI and UN SDGs) to help develop a framework to improve sustainability in the Canadian Port Sector—an initiative which is now a focus of the industry and the environmental performance programs of which CPAs are currently participants.

3. Results

Sustainability Framework

Tables 3–5 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 does not 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 3. GRI economic disclosures directly connected to relevant SDGs [42–45].

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	SDGs 11, 12
Stakeholder Engagement (GRIs 102-42, -43)	Identification of relevant stakeholders, including how and when to engage with stakeholders	SDGs 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	SDGs 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	SDGs 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	SDGs 8, 12, 17

Table 4. GRI environmental disclosures directly connected to relevant SDGs [46–51].

GRI Disclosure	Description	Relevant SDG
Energy Consumption (GRIs 302-1, -2, -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	SDGs 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	SDGs 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)	SDGs 7, 9, 12, 13
Water and Effluents (GRIs 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	SDGs 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	SDGs 6, 12, 14, 15
	Total volume of water reused and recycled by the port	SDGs 6, 12
	Description of minimum standard set for quality of effluent discharged (standards set by the port and sector-specific standards)	SDGs 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	SDGs 3, 6, 12 14, 15
Biodiversity (GRIs 304-1, -2, -3, -4)	Identification of operational sites owned, leased, managed or adjacent to protected areas and areas of high biodiversity value	SDGs 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 such as construction, pollution, invasive species, habitat conversion, and change in ecological processes	SDGs 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	SDGs 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	SDGs 14, 15
Emissions (GRIs 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	SDGs 3, 9, 12, 13, 14
	Reporting significant air emissions in kgs for NO_x, SO_x, POPs, VOCs, HAPs, and PM	SDGs 3, 11

Table 4. *Cont.*

GRI Disclosure	Description	Relevant SDG
Waste (GRIs 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)	SDGs 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	SDGs 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)	SDGs 11, 12, 14
	Total weight of waste disposed (metric tonnes) to landfills, other disposal, or incineration (with and without energy recovery)	SDGs 11, 12, 14
Supplier Environmental Assessment (GRIs 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 5. GRI social disclosures directly connected to relevant SDGs [52–56].

GRI Disclosure	Description	SDG Addressed
Training and Education (GRIs 404-1, -2)	Average hours of training that the port's employees have undertaken, reported by gender and employee category	SDGs 5, 8
	Type and scope of programs implemented, and assistance provided to upgrade employee skills	SDG 8
Diversity and Equal Opportunity (GRIs 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	SDGs 5, 8
	Ratio of the basic salary and remuneration of women to men from each employee category by operation	SDGs 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 (GRIs 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	SDGs 3, 12, 17

Table 5. *Cont.*

GRI Disclosure	Description	SDG Addressed
	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	SDGs 3, 6, 8, 9, 11, 12, 14, 15, 17

4. Discussion

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 [15]. 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 [15].

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 [49]. 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 4) [46,49]. 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 [12,49]. 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 [57].

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 [35]. 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 4) [47]. 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 [47]. These additional measures outlined in the GRIs would create direct links to SDGs 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 4). These actions would ensure that the CPAs 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 [50]. 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 [58]. 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 [59,60]. 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 by MacNeil because it offers CPAs a choice, with considerable disparity in the rigour of criteria used to attain level-five certification [15]. 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.

4.2. 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—energy, climate change adaptation, and collaboration with Indigenous Peoples and local communities. Each indicator set is described in detail below.

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 4) [46]. In addition to quantifying their energy use, the CPAs would also be required to identify the amount of reduction in energy consumption directly related to conservation and energy initiatives [46]. This includes conversion and retrofitting equipment, operational changes to increase energy efficiency, changes in individual employee behaviour, and process redesign [46]. 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 [61,62]. 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 [63–65]. These types of changes create direct links between SDG 7, specifically the increase in renewable energy and increased energy efficiency.

Ports are often located in areas that would be suitable for power generation from renewable sources, such as wind, wave, tidal, and geothermal energy, as well as having infrastructure that could be outfitted with solar panels [66]. 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 [66,67]. 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 [68,69]. These changes are also critical for building the capacity required to adapt to climate change (SDG 13).

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 [70]. Climate change adaptation requires that ports build adaptive capacity to deal with these changes through policy planning and operational changes [71]. Becker et al. argue that many of these long-term changes resulting from climate change have not been accounted for in port planning [70]. Monios and Wilmsmeier 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 [72]. 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 [73].

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 [44] (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 3) [44]. 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 [6]. The GRI Standards require that CPAs conduct environmental assessments of their suppliers (Table 4) 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 [45,51].

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 [1]. 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 [55]. 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 5) [55]. 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 SDGs 3, 6, 8, 9, 11, 12, 14, 15, and 17 (Table 5).

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 [74]. 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 [75]. CPAs would be required to apply UNDRIP's framework to its policy and operational activities involving Indigenous Peoples, their lands, and resources [75]. Following *GRI 411: Indigenous Peoples* can begin to address the impact that the CPAs have on local Indigenous Peoples (Table 5); 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 [54,75].

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 6). The FSDS will be reviewed and renewed after 2022, as the goals required to meet the 2030 Agenda for Sustainable Development continue to evolve [6]. 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 6. 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	GRIs 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	GRIs 303, 304, 305, 306
7. Pristine lakes and rivers	- Nutrient pollution to lakes and rivers - Lake and river ecosystem protection	GRIs 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	GRIs 303, 305, 306

5. Conclusions

The reliance on the GMEP was previously 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 using 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 Scopes 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 mon-

itoring 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 this 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 socially focused SDGs are now directly linked to the disclosures in Table 5 of the sustainability framework, providing CPAs with guidance on how to incorporate social sustainability into port governance and operations. 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 [13]. Should program participants push for the development of holistic sustainability metrics, it is possible that the GMEP may expand to include social sustainability metrics, rather than focusing primarily on environmental performance [76].

This work contributes to a limited body of academic literature pertaining to sustainability performance in Canada's Port Sector. Previous work has identified sustainability initiatives employed by CPAs; however, the efficacy of these initiatives has not been evaluated for performance gaps and proposed alternatives to fill these gaps have not yet been proposed. This study offers both an examination of the efficacy of sustainability initiatives in the Canadian Port Sector as well as an alternative framework for evaluating sustainability performance. 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 sustainability framework offers a unified approach for CPAs to improve sustainability performance by using GRI disclosures that are directly linked to attaining relevant SDG targets. 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.

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