Exploring the Capacity of the Extended Producer Responsibility Principle to Incentivize the Collection and Recycling of Plastic Food Packaging Waste

by

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Abstract

Plastic waste mismanagement and pollution have become mounting global concerns that are closely implicated in unsustainable production and consumption paradigms. This research reviews the ecological and socio-economic impacts of plastic waste mismanagement that are currently transboundary in nature and necessitate political interventions to mitigate the multifaceted dilemmas posed by high rates of plastic waste generation. This research examines the Extended Producer Responsibility (EPR) principle as one waste policy for packaging, wherein producers who introduce packaging into the marketplace become mandated to bear the financial and/or operational costs of waste management, incentivizing improved design. This research examines EPR programs for packaging waste in Canada and analyzes potential economic and environmental benefits of implementing such a program in Nova Scotia. This research additionally examines various available methods to achieve reuse-oriented packaging systems within the transition from a disposal-oriented to a reuse-centric economy, requiring collaborative efforts between governments, producers, and consumers.

List of Abbreviations Used

B2B	Business-to-business
B2C	Business-to-consumer
BFFP	Break Free from Plastic
Bt	Billion tonnes
CCME	Canadian Council of Ministers of the Environment
CFIB	Canadian Federation of Independent Businesses
CSSA	Canadian Stewardship Services Alliance
CERI	Canadian Energy Resources Institute
DfE	Design for Environment
ECCC	Environment and Climate Change Canada
ÉEQ	Éco Entreprises Québec
EMF	Ellen MacArthur Foundation
EPR	Extended Producer Responsibility
EPS	Expanded polystyrene
EC	European Commission
EU	European Union
GASC	Great American Shoreline Cleanup
GCSC	Great Canadian Shoreline Cleanup
HDPE	High-density polyethylene
ICC	International Coastal Cleanup
ICI	Institutional, commercial and industrial
IPR	Individual Producer Responsibility
IMO	International Maritime Organization
LDPE	Low-density polyethylene
MAP	Modified atmosphere packaging
MMSM	Multi-Material Stewardship Manitoba
MMSW	Multi-Material Stewardship Western
Mt	Million tonnes
NAICS	North American Industry Classification Standard
NOAA	National Oceanic and Atmospheric Administration
NSFM	Nova Scotia Federation of Municipalities
OECD	Organization for Economic Co-operation and Development
PET	Polyethylene terephthalate
PP	Polypropylene
PPP	Printed paper and packaging
PRO	Producer Responsibility Organization
PVC	Polyvinyl chloride
RCC	Retail Council of Canada
SO	Stewardship Ontario
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development

UNEA	United Nations Environment Assembly
UNEP	United Nations Environment Programme
UNGA	United Nations General Assembly
UPS	United Parcel Service
WEEE	Waste Electrical and Electronic Equipment

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Chapter 1: Introduction

1.1. Context

Plastics have become ubiquitous in the global economy. Synthetic polymers (the foundation of modern plastic materials) are embedded within the current material economy, used in every industrial sector, including building, transportation, electrical equipment, and textiles (Enkvist & Klevnäs, 2018; Geyer, 2020; Geyer, Jambeck & Law, 2017). Total global plastic production reached 368 million tonnes in 2019 (Plastics Europe, 2020). Total estimated production of primary fossil fuel-based plastics reached 9.2 billion metric tonnes (Bt) between 1950 and 2017, and over half of that measured quantity had been produced after 2004 (Geyer, 2020). Many plastic applications are added to long-term stocks, while in comparison, plastic packaging materials have a very short life cycle and are currently discarded as waste in large volumes (Geyer et al., 2017).

Plastics are materials classified as polymers, which are complex molecular structures composed of long, repeated chains of chemical constituents, occurring in many natural sources, including cellulose, silk, rubber, as well as muscle fibre and deoxyribonucleic acid (DNA) (Geyer, 2020). Polymers are formed by long chains of smaller molecular units known as monomers, which are composed of chemical or biological building blocks. Most plastics are composed of chemical monomers, including ethylene, chloride and styrene, which are derived from petroleum, natural gas or coal extraction (Adkins & Moules, 2018; Sicotte, 2020). Polymers may also be produced from non-fossil fuel sources in agricultural crops such as corn, sugarcane, cotton, and cassava; processed biomass or by-products like wood pulp; and fungi, algae, and microbes (Altman, 2021; Casarejos et al., 2018). While bio-based plastics used in packaging are gaining increasing attention as alternatives to fossil fuel-based plastics, this study will be focused on the use and impacts of conventional fossil fuel-based plastics for packaging.

Synthetic polymers are categorized into two main categories of thermoplastics and thermosets. Thermoplastics have a higher molecular weight, and can be heated, melted, and moulded into new polymer applications, while thermoset materials, when produced, form irreversible chemical bonds and are unable to be reconstituted into new materials (Adkins & Moules, 2018). Most plastic packaging products are comprised of thermoplastics, which range from seven types of polymer resins.

It is analytically useful to situate the social, economic and technical elements that have influenced the increase in primary plastics production, contextualized by a postwar economy that invested in new manufacturing industries (George, 2020; Strasser, 1999); an increase in food processing technologies and demand (Hawkins, 2012); socio-cultural perceptions and framings of convenience and hygiene (Lucas, 2002; Oka, 2021); and increasing globalization of trade relations (Gottlieb & Joshi, 2010). While packaging materials have been used as tools to fulfill human needs for food safety, security, and trade for millennia, modern innovations in the food packaging industry have now expanded the range of non-traditional packaging materials for food preservation and have allowed a breadth of food products that would otherwise not be possible to bring to market (Hawkins, 2012; Hine, 1995; Risch, 2009). Amidst these innovations in improved food distribution and safety, the volume of disposable packaging materials used in the food industry has increased exponentially (Twede, 2012).

An influx of disposable food packaging materials into the consumer marketplace has resulted in environmental, social, and economic dilemmas. Growth in the packaging market contributes one of the largest proportions to household waste streams internationally, as packaging waste accounts for an estimated 15-35% of household solid waste around the world (Tencati et al., 2016). Large volumes of primary plastics are produced and discarded within the same year, resulting in millions of tonnes of primary industrial resources that are not recovered and reintegrated back into the economic market (Geyer, 2020). Plastics are a highly mismanaged waste stream due to their complex physical and chemical properties that make their recyclability inconsistent, and often economically prohibitive at current quantities and qualities of waste generated. Driven by the economic state of the global petrochemical industry which favours a high reliance on virgin chemical feedstocks for plastic production, plastic packaging materials have historically lacked strong rooting in circular economic principles driving their production and disposal, thereby further bolstering an extraction-oriented petroleum economy (Sicotte, 2020). Plastic packaging waste has increased substantially over the past 70 years considering these factors – estimates as high as 95% of plastic packaging materials are discarded and are not recycled resulting in them being landfilled, or being mismanaged via burning, or as pollution in the environment (Borrelle et al., 2020; Break Free From Plastic, 2018; EMF, 2017; EMF, 2019; Gabbott et al., 2020; Jambeck et al., 2015; Kaza et al., 2018; Lau et al., 2020).

1.2. Problem Statement

Humanmade waste generation and overproduction is currently considered one of the most significant risks towards global sustainability and resource conservation, closely interconnected with a destabilized global climate and a mounting biodiversity crisis (Andersen, 2021). Current conceptualizations of the circular economy concern the conservation of natural resources and minimization of humanmade wastes, viewing the production and consumption of goods as existing within an industrial metabolism that must maintain a regenerative and cyclical flow of technical and biological nutrients to avoid and prevent waste of natural resources (McDonough & Braungaurt, 2002). The current design of the global material economy operates in a linear momentum, as opposed to a circular, regenerative, or reuse-centric economy.

Waste collection systems struggle to account for increasing volumes of plastic wastes at a local government level, while much municipal waste goes uncollected or informally managed in many regions of the world, particularly across the global South (Bell, 2019; Kaza et al., 2018). Inadequate waste collection systems result in further pathways for post-consumer plastic waste to enter the natural environment. Plastic waste is emitted through a range of sources, thereby complexifying attempts and strategies to limit the entry of plastics into nonhuman habitats on land and at sea (Hurley et al., 2020: Jambeck et al., 2015). Pollution caused by plastics has created myriad risks in the natural environment since their increased production in the 20th century, through both their immediate and accumulative impacts on wildlife and environmental health (Gall & Thompson, 2015; Gregory, 2009). Apart from the direct material risks to wildlife, the overproduction and mismanagement of plastics are closely interwoven with other pressing sustainability issues including sustainable food systems, economic impacts to human livelihoods, and climate change.

Varying levels of political and economic intervention have emerged in attempt to address and mitigate the harmful effects of plastic waste mismanagement (Barrowclough & Birkbeck, 2020; UNEP, 2018). Policymakers responded to waste management dilemmas in new ways, including methods of implicating producers in the waste management process to account for environmental, economic, and social externalities within the design of linear product systems. The Extended Producer Responsibility (EPR) principle is one such instrument that was proposed at the turn of the 21st century, as a waste policy conceptualized to reduce the economic and environmental burdens on citizens and governments in administering recycling programs and undertaking waste diversion, by implicating industry in accounting for the full life cycle impacts of products introduced to the marketplace. In a novel approach to waste policy, Swedish researcher Thomas Lindhqvist (2000) was among some of the first proponents for a model of industrial stewardship that would require producers to be held physically and/or financially responsible for end-of-life management costs for their products. Lindhqvist (2000) articulated the EPR principle as a method of waste management, wherein a producer assumes responsibility in managing their products once their service life has ended, and through that model is theoretically incentivized to invest in product improvements that could minimize the overall costs of waste management. The EPR principle establishes feedback loops between a product and its producer, with the intention to encourage sustainable redesign.

By 2021, the EPR principle has been implemented internationally for many different recyclable waste streams, and its potential to reduce resource loss and result in more sustainable production and consumption systems has been embraced by many jurisdictions around the world (Filho et al., 2019; Kaffine & O'Reilly, 2013). The EPR principle has been implemented for the packaging waste stream in many nations, which has led to improved waste collection systems and mandatory recycling targets for packaging materials.

The urgency to address the global plastic waste crisis is felt by governments and citizens, and multifaceted solutions are essential to ameliorate the challenges across the entire life cycle of plastic. EPR programs for packaging waste lessen the burdens of managing waste on local governments. Through a combination of efforts to prevent and manage high volumes of disposable plastic materials, EPR policies represent a key opportunity to limit the pathways of plastic pollution in the natural environment (EMF, 2020; Kaza et al., 2018). EPR programs have the capacity to make meaningful strides in better waste management practices to contain plastic waste on land, while simultaneously undertaking efforts to limit the production and consumption of plastic materials overall (Filho et al., 2019; Lindhqvist, 2000).

Improvements to food packaging materials may use various waste policy instruments ranging from restrictive regulatory measures, increasing product recyclability, and improving the material composition of products. Progressing away from a disposal-oriented system, it is possible to envision a circular economic system that could revitalize past systems of a reuse-oriented economy for food products and consumer goods (Coelho et al., 2020; Muranko et al., 2021). Disposable plastic packaging materials currently pose complex sustainability issues that now demand global efforts to grapple with its risks, mobilizing humans in new efforts to both mitigate negative aspects of its use and to reconceptualize alternative methods of consumption (Brembeck, Cochoy & Hawkins, 2021).

The research questions that will be addressed throughout this thesis are as follows:

1. How is the global food and beverage industry contributing to increasing plastic waste from packaging materials?
2. How can the EPR principle incentivize the collection of food packaging waste in municipal recycling programs?
3. How is the EPR principle for packaging waste implicating industry in Canada, and how would industry be implicated in Nova Scotia?
4. How can EPR instruments provide the opportunity to design reuse-oriented systems and networks for food and beverage distribution?

1.3. Structure of Thesis

This thesis consists of a total of four chapters. Chapter 2 will examine the industrial and social changes that took place in industrialized regions, which significantly altered preceding human habits in waste and consumption practices. Changing consumption practices towards the increased production and use of disposable food packaging materials underlays the expansion of the plastic packaging industry. The factors influencing the emergence of plastic materials will be discussed, focusing on the impacts of the Second World War in igniting global investments in plastic applications and their continued expansion within consumer markets through the second half of the 20th century.

In Chapter 3, the impacts of plastic overproduction and mismanagement will be reviewed, focusing on the detrimental impacts of plastic waste in aquatic and terrestrial ecosystems, as well as on human livelihoods around the world. Plastics have warranted new forms of political intervention and governance to address the impacts of pollution, which have placed administrative and financial responsibility on the public. Various regulatory approaches to address disparate aspects of the life cycle of plastics will be explored, pivoting to the role of industry through the development of the Extended Producer Responsibility principle.

Chapter 4 will examine five EPR programs for packaging waste that have been implemented in Canada and will analyze program design across the country as well as the industrial stewards currently contributing to recycling programs in the country. A localized case study explores the potential implementation of an EPR program for packaging in the province of Nova Scotia, Canada. This case study highlights the opportunities to reduce the burden of recycling programs on communities, and to achieve more sustainable product systems for packaging materials.

Chapter 5 examines the use of packaging reuse systems from a logistical perspective to identify current trends underway in reuse-oriented packaging systems for food distribution, and reverse logistics models that are available to businesses to undertake a shift towards closed-loop operations. From contemporary examples, this concluding chapter examines operational elements of various reuse models available to businesses.

Chapter 2: Developments in Food Packaging and Emergence of a Disposability Paradigm

Design for disposability is currently embedded into the global material economy for the production of consumer goods, which has revolutionized the manner in which primary resources are employed and dispersed for human consumption. Yaeger (2008) describes the cultural transformations approaching production and consumption at the end of the Second World War, articulating these transformations as “the postwar shift from a culture of maintenance to one of discards and (planned) obsolescence” (Bell, 2019, p. 99). This examination fundamentally describes the model by which contemporary industrial production has escalated and by which consumption patterns have resulted, which has forged the pathways of a linear economy that manufactures and discards large volumes of primary materials with very short usage or service phases (Geyer, 2020; Lindhqvist, 2000).

Generation and management of human solid wastes became actively reconfigured by the emergence of industrial mechanization which caused increases in material output from manufacturing industries and allowed for rapid distribution of consumer goods (Hawkins, 2012). Fluctuating social ideals towards convenience and cleanliness emerged throughout the period of Western industrialization in Europe and arose within home economics. Strasser (1999) describes the impacts of technological transformations and electronic advancements that were underway at the turn of the 20th century within the sphere of the household, which began to upend previously innate habits of reuse and prompted new activities and social arrangements:

> “New utilities fostered new trash and encouraged new attitudes about throwing things away. Technological obsolescence, still a relatively new idea even in most industries, now came to the household as modern appliances replaced old stoves and fireplace equipment, and aluminum and enameled steel pots and pans supplanted iron ones. Used paper, kitchen waste, packaging, and scraps of wood could not be burned as fuel in radiators or central gas furnaces, as they could in fireplaces or cast iron stoves. Used

> lightbulbs did not simply burn up, like kerosene and its wicks or gas and its incandescent filament mantles. In the trash, they joined the other refuse of a developing ethos of disposability; chewing gum, cigarette butts, razor blades, and paper products." (p.172-173).

A linear flow of newly introduced consumer commodities demanded new household practices and actions to integrate them into household applications, replacing preceding habits that relied on upkeep and recirculation. Socio-cultural attitudes towards convenience, ideals of cleanliness and hygiene, and material ephemerality increased with the rise of consumerism in the postwar period (Strasser, 1999). Disposable materials supplanted the need for more onerous or time-consuming activities, materiality, and in some ways, human relations (Hine, 1995; Sattlegger, 2021; Vaughn, Cook & Trawick, 2007). This transition has arguably altered social practices around individual eating and drinking habits, household economics, and grocery shopping. Household discard patterns have increased substantially over the past century, and particularly in the consumption and discard of packaging materials.

2.1. Early Approaches to Waste Management

In pre-industrial times, rural household solid wastes had been managed through informal means through decentralized methods of dumping and burning, undertaken by individual family households and small communities. In a North American and European context, common household discards consisted of large volumes of organic matter like food waste from fruits and vegetables, rags, and bones, which were managed through a cascade of secondary applications within the household, all leading towards eventual household repurpose: employing food scraps for animal feed and agricultural input; use of dilapidated garments and fabrics for rags, rug-making and quilt-making; and use of animal fats for soap-making and candle-making (Lucas, 2002; Strasser, 1999). While reuse practices were fundamental to the conservation of resources during a period of material scarcity among human societies, as documented in early accounts of household hygiene and upkeep, great care was taken to ensure that waste was contained in outdoor receptacles in a hygienic manner exterior to the house to not attract animals and pests (Elliott, 1911). Meanwhile, inorganic waste materials created within the household held inherent value for remanufacturing industries, operating on a reverse flow of goods between households and factories. The overarching material economy shaped household waste generating habits, and the flow of goods between the private and the public spheres.

The concept of waste recycling emerged early in human history as a form of resource management and conservation, that was predicated upon the recovery of valuable manmade materials like pottery, glassware and various metals that retained their value through a web of recirculation flowing between rural households, peddlers, scrap traders, and factories located in urbanized locations (Rathje & Murphy, 2001; Strasser, 1999). The process of material collection and transportation was partially undertaken by an informal network of peddlers in North America, who acted as both bartering salesmen and material traders with distant households, mediating the flow of new and unused commodities in and out of the household while concurrently collecting valuable household salvage for use in urban remanufacturing factories (Lucas, 2002; Strasser, 1999). Textile products, metals like copper, iron and tin, and some kitchen wastes retained their value as feedstock into the production of new commodities and industrial applications. The international trade in waste rags had been established as a lucrative business extracting secondary value from discarded textiles to produce paper products, and scrap metals were in high demand for many industrial applications (Rathje & Murphy, 2001; Strasser, 1999). Waste collection was driven most by a context of material scarcity and technological limitation, where lacking access to raw material reserves in a pre-mechanical society demanded the recovery of valuable resources to reintegrate into new industrial processes (Busch, 1987). These informal waste management approaches created material recovery markets that predate the formalized collection and recycling infrastructure known today.

Waste salvaging has historically served an important function in increasing recycling rates and waste trade within a country. These activities have offered informal employment and a source of income through the collection of high-value materials in centralized dumpsites and informally managed landfills. Historical analysis in human discard studies finds that the early work of recycling through both scavenging and networks of peddler systems predates the formalization of waste management in sanitary landfills and municipally organized waste collection undertaken by local governments (Moore, 2015). Both deregulated and organized waste work continue to act as an important backbone of local waste infrastructures, as they may supplement low rates of government waste collection, and also support functioning recycling markets in many regions around the world, ranging from individual collection work to larger commercial and corporate scavenging organized by trade associations (Johannes et al., 2021; Rathje & Murphy, 2001). While informal waste work is recognized as contributing to increased recycling rates, such work has historically been driven more by economic determinants and incentives for recovering the most valuable materials based on current market conditions, than it has been by the imperative for resource conservation (Johannes et al., 2021). Importantly, the economic value of waste materials shapes how public spending is allocated to its management and recovery.

Urban populations in North American and European cities were increasing rapidly during Western industrialization, which necessitated the organization of urban sanitation programs and the formation of designated waste authorities to undertake waste collection (Burcea, 2015). Until that point, much solid waste in urban environments had been informally discarded outside of homes, accumulating in streetways and near human dwellings. During the turn of the 20th century, the first modernized sanitary landfill was developed in New York City (Rathje & Murphy, 2001). Importantly, over time the physical and chemical composition of household waste streams grew more complex, growing in both volume and in the rate of disposal, which demanded more wide-scale intervention by citizens and government.

Consumption patterns were shifting rapidly in urban environments after the industrial revolution's socio-economic impacts. In the same way peddlers mediated the flow of materials through distant households, Hine (1995) analyzes their role in introducing modern consumption practices to the wider population during the dawn of a packaging revolution. Such significant changes symptomized the growth of mass marketing, new production industries, and widening networks of trade. Describing the beginning of both an industrial and consumption revolution, the impacts of rural depopulation creating urban communities altered social arrangements and lifestyles in profound ways:

> "Railroads made it possible to move bulky items rapidly and cheaply. Urbanization broke ties of family and community, making it necessary for people to trust strangers and to be susceptible to advertising in new, populist communications media. The move from subsistence living to wage-earning jobs allowed little time for people to make things for themselves and transformed necessities into consumables" (Hine, 1995, p.55).

While avoiding a simplification of significant socio-economic changes caused by industrialization, these changes may be understood as having an important influence in the daily lives of citizens and in their consumption practices. The creation of new purchasing and material habits contributed significantly to a change in household waste generation, where increasingly more disposal-oriented materials were acquired and discarded. As existing household practices had employed wastes as raw material inputs used towards new applications in the household, Lucas (2002) examines the conflicting messages in household economic manuals that urged the habitual adoption of new disposal-oriented household practices in the late 19th and early 20th centuries, illuminating how "disposability came to have both negative and positive connotations as it became entangled in the two moral systems of hygiene and thrift and which articulated the modern domestic economy in places such as North America and Britain" (p. 7).

2.2. Expansion of Packaging Materials for Food and Beverages

Reusable glass bottles, ceramic jars, barrels, sacks, and wooden crates were a functional choice for which to circulate, store, and sell foodstuffs and essential household materials for centuries – such forms of storage have been gradually downgraded for a lower-cost method of food distribution, simultaneously reducing household workloads (Hine, 1995; Leighton, 2010). The development of one-way, nonreturnable packaging materials unravelled existing reverse supply chains for returnable and reusable packaging that had been well-established for many food products in the past. Packaging's function has grown more complex in the modern marketplace. It functions to preserve food and reduce wastage; to build advertising and brand loyalty (Hine, 1995); to ensure and guarantee safety to the consumer, by preventing contamination and tampering (Risch, 2009); and to allow for information flow using barcodes and digital markers for shopkeepers and employees in a retail store (Sattlegger, 2021b).

The use of food packaging arose from the human need to preserve, transport, and identify foods. Early packaging devices consisted of leaves, vegetable material and animal matter for short-term transportation and storage of food and drink (Varghese et al., 2020). After the evolutionary shift from nomadic life to use of permanent shelter and settlement, long-term food storage in permanent containers was required (Risch, 2009). Findings of food jars and vessels dating back to ancient civilizations and trading posts throughout Greece, the Middle East, and Mesoamerica were employed for storage and transport of wines, oils and water, in addition to medicinal and ritualistic purposes (Hine, 1995). Wooden barrels and ceramic containers remained the main source of food storage throughout human societies for many centuries (Hine, 1995; Twede, 2012).

Packaging use for food gained significant technological progress beginning in the 17th century, largely in Western Europe, when paper, glass and tinplate methods emerged but were restricted by costliness, manual production techniques and scarcity of materials (Twede, 2012). Food preservation techniques were scientifically advanced during the early 19th century when French chef and distiller Nicolas Appert was awarded by the French government for his method of boiling glass bottles at high temperature to seal and preserve a range of dairy products, fruits and vegetables, meat, and syrups, an innovation which was employed to supply prepared meals and foodstuffs for the French army on long voyages (Encyclopedia Brittanica, n.d.). Over the period of industrialization, hollow glass containers and tin cans were in demand for long-term storage of various processed foods made possible by Appert's methods. Canning technology created new products and food markets for otherwise perishable items like canned milk, and processed vegetable and fruit products (Hine, 1995).

Individually packaged processed foods began to enter the retail environment towards the late 19th century. In the 1890s, some of the first packaged ready-to-eat cookies were produced by the National Biscuit Company (NABISCO) in the In-Er-Seal carton comprised of cardboard and a waxed paper coating (Risch, 2009; Strasser, 1999). A method of individually wrapping and portioning processed foods like baked goods and other pantry foodstuffs marked an important step in food packaging innovation and demand to maintain quality, freshness and safety from the surrounding retail environment. Risch (2009) describes how retail environments were changing shopkeeper and customer relations, where biscuits and dry foods were stored in large barrels that would sit open at the market or at grocery stores, from which customers would be required to pick out the quantity of product that they desired and place it within a paper bag or other container to transport home. A newfound capacity of packaging communicated to customers assured hygiene and perceived product purity that reconfigured expectations about a package's function. This marked an important opportunity for food producers that were seeking to broaden their consumer base by using increased packaging materials, and to make their selection available in a format that could enhance brand loyalty.

2.2.1. Emergence of Packaging Design Industry

Package design includes two components: graphics and structure (Hine, 1995). The physical form of the package concerns shape, tactile features, and the materiality of the product, while brand identity is dictated and reinforced by the graphic component of a package. While colour, imagery, and text communicate different messages on the surface of a container, a package's shape plays a particularly sentient role in communicating ideals, values, and emotional associations, while shaping product expectations for the customer (Wagner, 2015). As a result of technological innovation in packaging, many complex and multi-material packages using complex graphic design techniques have allowed brands to assume a distinct shelf presence from others, distinguished by such simple factors as tactility, form, size, and semiotic language. As Hawkins (2012) describes, "the growth of packaging has also made it possible (and, in fact, necessary) to invent and highlight product differences: this necessity has fuelled the expansion of branding and brand strategies, with the package providing a crucial surface for establishing the symbolic qualities of the product" (p. 71). Thus, such an analysis suggests packaging development has undergone an amplification driven more by conceptual design motivations for branding strategy, than by material constraints.

Packaging design has evolved into a discrete industry governed by advertisers, marketers, psychological consultants, and industrial designers. Package development is infused with many socio-cultural and economic factors enabled by innovations in the packaging industry. Package designers share long checklists of up to 300 questions to assist companies in defining their goals and standards in developing a package – often, this stage also includes a close analysis of the graphics and structure of competing products within the same market, to decide if a packaged product should resemble or contrast from other existing designs (Hine, 1995). While packaging manufacturers generally operate as an independent industry from package designers, they control the necessary feedstock and manufacturing technologies that shape the availability of diverse packaging materials, thus maintaining significant influence on the packaging market.

2.3. Applications of Plastic Materials

Since its inception, plastic materials were conceptualized in relation to other well-established traditional materials like glass, paper, rubber, and metals. A range of technological developments in humanmade polymers led to the creation of a cellulose-based polymer termed Parkesine in the 1850s, and later the first completely synthetic polymer known as Bakelite, a phenol formaldehyde thermoset in 1907, coined by Belgian chemist Leo Hendrik Baekeland who is now considered the father of modern plastics (Crespy, Bozonnet & Meier, 2008). Bakelite was employed for its rigid properties in various applications, including clocks, radios, as well as eyeglass frames (Geyer, 2020).

Through this period and the early 20th century, material reclamation became an important normalized civic habit which was influenced by driving factors of material scarcity and value recovery. Riley (2008) describes how salvage patterns had been mandated by governments throughout Western Europe during the Second World War, when citizens were encouraged to stockpile the scrap metals, discarded bones, and paper in their homes in large quantities and provide them to state-sponsored manufacturing efforts. Material recycling became framed as civic duty during periods of material scarcity to supply the industries that were tasked with manufacturing transportation equipment for military operations and apparel for soldiers (George, 2020).

Much technological advancement throughout human history has been catapulted through militaristic and wartime demands, especially to fulfill dire needs for soldiers (Hine, 1995). Military applications of plastics for food storage were driven by the need to feed soldiers in a manner that was hygienic, safe, and sturdy to allow travel over long distances in environments without access to heating or cooling technologies (Hine, 1995). Much of the knowledge that had been funnelled towards military needs were then, upon the end of the war, useful and available for various consumer applications to the public.

Owing to industrial associations emerging in the plastics industry in the mid-20th century, plastics had been centred during World War II as an innovative and practical substitute for scarce natural materials, but its versatility and use for commercial functions beyond military application made it a preferable substitute making long-term advances within the consumer goods industry (Hine, 1995). Plastic justified itself as a viable solution to natural resource shortages during the wartime and the ensuing economic recovery. Upon the end of the war, “the increase of plastic packaging continued at a brisk, steady pace, not because consumers were demanding it but because it was very functional for producers, transporters and retailers. [...] such financial and operational virtues as light weight and shatter resistance are the real reasons plastic packages are everywhere” (Hine, 1995, p. 145).

2.4. Traditional Packaging Materials and the Introduction of Plastics

Traditional materials like glass and metals were well-established for food storage and were widely recycled, holding a steady demand for many commercial applications. Whereas the popularization of lightweight and disposable packaging materials had begun to take root, up until the early 20th century most packages were still distributed with the intention and expectation that they would be reused and returned by customers to the point of sale when emptied (Lucas, 2002). Busch (1987) traces the history of glass bottle reuse in the United States throughout the 18th to 20th centuries and finds that between brewers, manufacturers and consumers, there were great incentives for all bottle-users to keep bottles in circulation due to their limited availability and production methods. Since the demand for glass bottles was greater than the supply available, the impetus for maintaining reuse networks for glass bottles was great, which also motivated industrial investments in bottle-making processes and technologies to produce more volume at a quicker pace (Busch, 1987).

A wide variety of packaging materials have been added to the packaging industry since the introduction of non-traditional, synthetic materials (Varghese et al., 2020). Availability of low-cost chemical feedstock from the petroleum industry created a flexible new environment to innovate and develop alternative materials that mimicked and enhanced the properties of glass and metal materials, through wider availability of lower-cost petrochemical feedstock compared to mineral and metallic feedstocks for glass and metal production, respectively. Plastics offered a novel capacity to protect perishable contents from spoilage induced by oxidation, moisture, UV light, and microbial contaminants via lightweight and flexible materials, that led brands to make investments in plastic packaging options, offering unprecedented affordable solutions to the food industry (Wikström et al., 2019).

The introduction of plastic to the packaging industry interrupted long-term trends in existing material markets. Plastic materials were able to fulfil functional criteria that traditional packaging materials such as metal and glass had not been able to meet. In particular, glass was limited by its physical fragility, transport weight, temperature sensitivity, and energy intensive manufacturing processes, while cardboard and paper products had low barrier to moisture which required coatings like aluminum and waxes to resist moisture in food storage (Varghese et al., 2020). Plastic's versatility also allowed it to merge with traditional packaging materials as coatings to increase durability, and as auxiliary additions like labels and closures. Versatile chemical and physical properties of plastics could be exploited to decrease food loss, increase shelf life, and decrease transportation costs through lowered package weight, thereby expanding markets for processed and preserved foods.

Currently, the food packaging market is occupied by a range of materials that offer a wide variety of applications. Table 2.1 lists the variety of food packaging materials that are conventionally employed, and which fulfill numerous criteria for a range of food categories.

Table 2.1: *Traditional and Non-traditional Food Packaging Materials.*

Materials	Packaging Product	Common Packaging Function
Paper	Paper, cardboard, and carton	- Trays and cups - Flexible packaging - Folding boxes
Glass		- Bottles - Jars - Cups
Metal	Tinplate	- Trays and cups - Cans
	Aluminum	- Trays and cups - Flexible packaging - Tubes - Cans
Plastic	Polyethylene terephthalate (PET)	- Bottles and containers for use in water and soft drinks - Sealed jars - Trays for sealed, processed foods - Tubs for frozen and refrigerated foods
	High density polyethylene (HDPE)	- Bottles for milk and juice
	Polyvinyl chloride (PVC)	- Cling wrap
	Low-density polyethylene (LDPE)	- Squeezable food bottles - Cling wrap and garbage bags
	Polypropylene (PP)	- Bottles - Tubs for frozen and refrigerated foods - Trays and cups - Flexible packaging - Squeezable tubes
	Polystyrene and expanded polystyrene (PS and EPS)	- Disposable cutlery and cups - Clamshell packages - Trays for meat
	Other	- Multi-material and flexible packaging and film

Sources: Ellen MacArthur Foundation (2017); Gürlich & Kladnik (2021).

2.5. Transformation of Food Supply Chains

The prevalence of plastic packaging in the food supply chain has become interwoven with an expansion of supermarkets, modernized approaches to food processing, and the growth of multinational food firms throughout the 20th and 21st centuries (Beitzen-Heineke, Balta-Ozkan & Reefke, 2017). Hawkins (2012) describes "...changes in agriculture, the shift to regional and global supply chains, the rise of supermarkets, the blurring of seasons, and the development of fast foods" in altering food consumption patterns as well as the increased demand for packaging materials (p. 68). Such interconnected agricultural and economic factors define the current landscape of food supply, driving the pace and scale of the globalized agricultural economy. Gottlieb & Joshi (2010) note that each sector in the food supply chain was influenced by corporate globalization in a postwar economy, leading to an increase of international corporate investments in food and agriculture; transportation and supply chains stretched over wider geographic distance; the spread of industrial agriculture; the increase in multinational food retailers; and increase of processed food consumption. Particularly, the spread of earlier food preservation techniques had allowed for the availability of processed food products to emerge like bottled and canned fruits and vegetables, fish, meats, as well as breads and cheeses (Monteiro et al., 2019). Building on basic food preservation techniques, industrial food production processes allowed for ultra-processed foods, consisting of high-sugar and ready-to-eat food products, ranging from carbonated and sugary beverages, confectionary, and snack foods, as well as baked goods, processed meat products, and instant soups (Monteiro et al., 2019).

2.5.1. Growth of the Supermarket and Changing Food Habits

Modern packaging design allows products to market themselves through their visual and structural features. The autonomy of a packaged product is distinct from a service-oriented relationship that once existed between the consumer, the shop counter, and grocers and shopkeepers. Traditionally, a grocer acted as an intermediary and was responsible for dispensing a customer's requested items from a bulk stock of goods stored behind a shop's counter, out of customer reach (Hine, 1995). Customers depended on the grocer as an advisor who facilitated their shopping experiences, creating a dependency for the shopper in the procurement of foodstuffs and other household goods (Hine, 1995). The emergence of packaged goods and pre-portioned food products removed some interdependency between the customer and the grocer or shopkeeper, thereby slowly restructuring the nature of food supply and access. Sattlegger (2021b) argues that food packaging has now become entangled with the organization and work practices within supermarkets, shaping product presentation, product assessment by the consumer, and supermarket representation in food supply. From an operational and consumption point of view, packaging materials have reorganized the stock and flow of food from distribution channels into the marketplace and is deemed essential in providing nutritional and source information about food products to the consumer.

Small and locally owned grocery stores grew as fixtures in neighbourhoods and supplied limited stocks of fresh and packaged foods. The development of the small, full-service grocery store in the 1920s and 1930s was supplanted by mergers of small grocery stores into national retail chains throughout North America and in Europe (Gottlieb & Joshi, 2010). Amidst trends of consolidation and market concentration within the food system, and throughout the food retail industry, supermarkets emerged as many consumers' main source of food. Large supermarkets expanded the selection of fresh, processed, and frozen food products available to consumers, less restricted by seasonal variation. Gottlieb & Joshi (2010) state that increasing quantities of food preservation and packaging were facilitated by the increasing market concentrations controlling food trade and supply: "No longer keyed to local-regional food growing and production patterns, the supermarkets have helped consolidate the trend toward standardization and the branding of food products" (p. 45).

Due to increased globalization within the food supply chain, multinational food producers have emerged to occupy a large proportion of the overall food market and have forged mass markets for many processed and preserved food products offered in a consumption-ready state (Hawkins, 2017). Resultantly, the food supply chain has been shaped by food brand consolidation and globalization. In a scan of American grocery stores, a joint study by *The Guardian* and Food & Water Watch found that a large selection of food items on the market are controlled by a small range of multinational firms that dominate different niches of the global food market, ranging from vegetables, fruits, and grains; beverages; prepared foods; snacks and condiments, and animal products (Lakhani, Uteuova & Chang, 2021). Moreover, packaging has played a part in this growth as producers compete for space, time, and consumer attention on retail shelves through these distinct modes of communication (Hine, 1995). Current estimates suggest 15 cents for every dollar spent in the American supermarket is allocated to farmers, while the remaining quantity is allocated to food processing and marketing food (Lakhani, Uteuova & Chang, 2021). Thus, the means of growing and producing food is merely one devalued component of the distribution and sale of food products, and the use of food packaging is a crucial mediation in the food market.

Plastic packaging has also impacted and eased the provision of fresh fruits, vegetables, fish, and chilled meats in retail. Similar to the expansion of prepared and consumption-ready foods, high volumes of plastic packaging are used to transport and store fresh agricultural foods after harvest. Synthetic packaging materials have been harnessed to prolong the freshness of agricultural products and delay their degradation and spoilage caused by oxidation and respiration throughout long-distance transportation from farms to retail environments (Zhuang, Barth & Cisneros-Zevallos, 2014). Innovations in food packaging technologies have facilitated greater protection of produce over increased global distribution chains in agriculture, particularly through the development of modified atmospheric packaging (MAP) materials, which slow the biological degradation of produce and meat products and act as a gas barrier between the packaged contents and the surrounding atmosphere (Wilson et al., 2017). When combined with refrigeration, MAP materials control the biochemical metabolism of their food contents by altering the chemical atmosphere within a packaged food product, through the addition of various gases like nitrogen and carbon dioxide to mediate the internal presence of oxygen, therefore prolonging shelf life (Han, 2014). Such achievements in material innovations have greatly impacted the availability of the food as well as the format in which it has been made available to consumers. Sattlegger (2021a) illustrates that these achievements in food preparation have greatly reshaped the provisioning of food and have resulted in multifaceted changes in food consumption patterns. One way this can be exemplified is through the development of both mobile eating, and a rising reliance on the provision of processed, sealed foods as well as ready-made meal services from cafes, restaurants, and grocery stores in daily life. Alternately, new packaging materials have also requalified human access to essential services.

2.5.2. Mobile Eating and Implications for Food Packaging Waste

Several social historians, including Hawkins (2012; 2017; 2018) and Hine (1995), have both described how the availability of lightweight, lower-cost packages compared to glass, metal, and paper impacted consumer practices and transformed food supply and variety. Modern packages did not simply replace older forms of packaging, but it allowed for the creation of new processed food and beverage products, which have had a significant impact on consumer practices. Innovations in packaging materials have permitted the introduction of new categories of food within retail environments, allowing many prepared, sealed meals and foodstuffs suited for mobile eating, including snack foods in individually sealed wrapping, microwaveable dinners, and resealable water bottles.

The growth in food packaging technologies has impacted food preparation and availability greatly, which in turn has shaped many aspects of consumption and has given rise to the concept and practice of mobile eating (Hawkins, 2012). As Goldstein (2012) suggests, "...commutes between home, work, amusement, etc. almost necessitate our using disposable items [and] disposability is a function of speed" (p. 336). Increased meals outside of the home have had many profound effects on waste generation. In the UK alone, an estimated 10.7 billion food packaging items were found to have been discarded each year from fast food meals and prepared lunch items purchased during the workday (Hubbub, 2019; Smithers, 2019). In 2017, an estimated 60 million food boxes were used and disposed each day in China (Yang et al., 2021).

2.5.3. Bottled Water and Implications for Drinking Water

Drinking water at its most basic level is recognized as a necessity and a public good; however, access to and confidence in safe tap water supply globally has decreased due to environmental challenges and chemical concerns, especially in the global South (Greene, 2018). Bottled water has flourished in response to gaps that arose in publicly accessible infrastructure to provide public sources of safe and drinkable water (Villanueva et al., 2021). Attempts to privatize provisioning of water to the public have resulted in increased private sector engagement, constructing drinkable water as a commodity over the 20th and 21st centuries (Bakker, 2007).

A centuries-old practice of glass bottle reuse has been gradually supplanted by the availability of low-cost and lightweight PET-based bottles, which was hastened with the emergence and popularity of bottled mineral water throughout urban centres in Europe, first as a perceived luxury item and later as a supplementary product to tap water (Marty, 2021). Hawkins (2012) has extensively analyzed the growth of the global bottled water market, describing the surge of PET-bottled water production as "the requalification of water and the normalization of disposability" (p. 73-74). Bottled water's rapid integration into the beverage market was driven by perceived hygiene and concepts of purity, further normalizing its usage. PET-bottled water is now recorded as one of the fastest growing markets in the world, valued at an estimated USD 299.6B in 2021 (Statista, 2021).

The World Health Organization & United Nations Children's Fund (2021) measure that 2 billion people lacked access to safely managed drinking water services in 2020. Packaged or bottled water is currently recognized as one key facilitator of improved access to drinking water in water insecure regions (World Health Organization & United Nations Children's Fund, 2021). Increasingly, access to safe and accessible drinking water supply remains a global concern, especially in nations in the Global South, as tap water provision is severely limited due to contamination and lacking public infrastructure (dos Santos et al., 2017). While bottled water has become a significant sector of the beverage market worldwide, it provides essential functions in provisioning safe drinking water to a large segment of the global population.

2.6. Conclusion

The normalization of disposability has transformed the way in which food is marketed and how packaging materials are produced. Plastic has become deeply embedded within the functioning of the global distribution of food. Through this examination of the growth in food packaging, its implications have been significant on the design of an increasingly global food chain. Additionally, the growth of disposable plastic packaging materials has altered the nature of food access and consumption between consumers and producers. This reality has had significant effects on generation of household waste. In the next chapter, aspects of plastic's production and disposal will be discussed to contextualize its volume and scale both within the global economy, as a material that now demands new political and social interventions to mitigate its risks throughout the natural world.

The improper management of waste packaging materials is an increasingly burdensome task for communities and citizens to address. The material complexity of the packaging waste stream restricts the efficient functioning of secondary recycling markets. The pace and scale of primary plastics production has downcast the capacity of recycling industries to produce substantial feedstock to a quality and scale necessary to compete with virgin plastics, inhibiting a thriving secondary market for plastic packaging. Furthermore, inadequate plastic recycling has caused the leakage of land-based plastic waste into terrestrial and aquatic environments through insufficient and lacking waste management practices. Since the introduction of plastic material to the consumer market, a burgeoning plastic pollution crisis has been increasing on land and at sea.

Chapter 3: Environmental and Economic Impacts of Mismanaged Plastics, and Measures for Mitigation

The mismanagement of plastic materials has grown to become a mounting global pollution concern that is closely implicated in unsustainable production and consumption paradigms. The ecological, social, and economic impacts of plastic waste mismanagement are currently transboundary in nature and have necessitated numerous methods of government intervention to address and mitigate the globalized and multifaceted dilemmas posed by high rates and volumes of plastic waste generation. This review examines the current landscape of a plastics economy which has operated with a linear momentum, employing large quantities of primary resources and disincentivizing the functioning of a robust recycling market for collecting plastic waste and reintegrating it into the consumer market. This contextualizes an increasing plastic pollution crisis that has required global efforts to address and mitigate the ecological risks and socio-economic challenges of mismanaged plastic waste. A timeline of government interventions regarding plastic pollution is described, including numerous international, regional, and local actions to combat plastic waste, and this is followed by an examination of the relevance of the Extended Producer Responsibility principle to improve plastic waste management and obligate industry to assume responsibility in waste collection and recycling (see Appendix B).

3.1. Impacts of Plastic Production

The global value chain for plastics spans numerous industries and complexifies the total life cycle of plastics production, use, and disposal. The value chain consists of a complex network of stakeholders operating in the following industrial sectors described by Barrowclough & Birkbeck (2020):

1. Raw material extraction and provision of material feedstocks;
2. Refining raw inputs to produce feedstock for production of plastics;
3. Converting plastics into plastic resins or fibres;

4. Manufacturing intermediate and final plastic products;
5. Plastic use by all final consumers including brands, institutions, retailers, and distributors;
6. Collection, sorting and transportation of plastic waste;
7. Plastic waste treatment in landfill, incineration, recycling or dumping; and
8. Plastic reuse as secondary materials or in waste-to-energy approaches.

According to the International Energy Agency, the production of virgin plastics has increased over tenfold globally since 1970 and has exceeded the growth of any other group of bulk materials produced from the chemical sector, including steel, cement, aluminum, and ammonia (Pales & Levi, 2018). According to estimates by the EMF (2017), plastic consumes between 4-8% of global oil production, equal to the oil consumed by the global aviation industry. Oil demand for plastic production is expected to outpace that for road passenger transport by 2050, and the projected combined CO_2 emissions from both production and embedded carbon amounts to 287 billion metric tonnes (Bt) annually by the end of this century, comprising more than one-third of the allotted carbon budget under a 2°C climate warming scenario (Pales & Levi, 2018). The production of plastics has grown at an exponential rate permitted by a highly government subsidized petroleum industry since the mid-20th century.

Plastic dominates consumption choices and prevails across the global supply chain (Geyer, 2020; Pales & Levi, 2018). In response to the currently decreasing demand for oil and gas for energy for transportation as well as the decarbonization of electricity generation, the fossil fuel industry has been expanding investments in plastic production (Charles, Kimman & Saran, 2021; Vallette, 2021). Investments in new refineries and ethane-cracking facilities are now on the rise across the United States to increase its domestic capacity to produce chemical feedstock for production of plastic materials (Sicotte, 2020; Vallette, 2021). The United States currently holds approximately 40% of the global capacity to produce ethane-based petrochemicals, and its market share of steam cracking facilities is projected to rise to 22% by 2025 (20% higher than 2017 levels) (Pales & Levi, 2018). Ethane is considered a preferable lower-cost domestic alternative to other plastic feedstocks such as naptha, originally accessed from stocks in India and China (Sicotte, 2020). These facilities are known to emit high levels of CO_2 in their production of plastic feedstock and are of concern for public health regarding air quality, water contamination, and environmental degradation surrounding production facilities (Azoulay et al., 2019; Vallette, 2021). Virgin plastics production is thus projected to rise amidst a backdrop of a plastic mismanagement crisis.

An estimated 9.2 Bt of virgin plastic was produced between 1950 and 2017, and an estimated mere 9% of that quantity produced is measured to have been recycled within that time period, leading to a crisis of overproduction as well as of resource loss and waste mismanagement (Geyer, 2020). Based on global estimates from Geyer (2020), around 36% of plastics production are employed for packaging, accounting for 158 million metric tonnes (Mt) of the total 348 Mt of plastic resin produced in 2017. The production rates of plastic resins in 2017 are shown in Table 3.1 based on analysis by Geyer (2020).

Table 3.1: *Estimated Primary Plastic Production in 2017 by Resin Type.*

Polymer Resin Type	Estimated Primary Plastic Production in 2017 (%)
#1 PET Polyethylene terephthalate	8%
#2 HDPE High density polyethylene	13%
#3 PVC Polyvinyl chloride	9%
#4 LDPE Low density polyethylene	16%
#5 PP Polypropylene	17%
#6 PS Polystyrene	6%
Other plastics	31%

Source: Geyer (2020).

Alongside the 158 Mt produced in 2017, a total of 152 Mt or 46% of plastic waste generated during the same year was packaging (Geyer, 2020). Plastic production reached a total of 368 Mt in 2019 (Plastics Europe, 2020) and production rates have increased annually. Rates of plastic waste generation are projected to continue to increase during the next decades due to projected growth in plastic production, in human population, and in plastic consumption, but they are also dependent on global waste generation rates, improvements in overall waste management, recycling technology and governance, material reduction and substitution, and progress towards circular economy goals for plastic materials (Borrelle et al., 2020; Lau et al., 2020). Currently, the high rates of virgin plastic production have outpaced development of adequate recycling infrastructure and technologies, which are out of pace with increasing demands for plastic packaging.

3.2. The Reality of Plastic Recycling

The origins of the term and concept of recycling are rooted within the oil processing industry, to describe the process of re-refining partially processed petroleum materials to reduce the quantity of waste (Strasser, 1999). Once the term was popularly reemployed in the 1960s and 1970s, the term became a descriptor for general material reuse and reclamation, and eventually became a commonplace for the collection of separated trash streams to minimize useful materials in household waste entering landfill (Strasser, 1999).

The packaging industry is dependent on extractive industries to produce steel, aluminum, glass, paper and cardboard, and plastic. Metal and glass packaging materials often do not require the addition of primary materials into their recycling processes, and are therefore suitable for repeated recycling that retains the original material properties intact, while plastic packaging recycling processes usually require the inclusion of additional primary materials to produce secondary materials (Food

Packaging Forum, n.d.). While recycling technologies have been developed to decrease the quantity of virgin resources necessary to produce packaging materials, current economic and technical dynamics are significant in shaping resource flows within the packaging industry.

Currently, the goal of plastic recycling is to reduce the need for primary plastic production, as well as to recover the value in materials that have fulfilled their functional purpose. The variety of many plastic types makes recycling difficult, largely due to multi-material configurations. Recyclability can be restricted by a range of product features which include product format, material, size, colour, transparency, as well as surface presence of inks, adhesives and labels (OECD, 2021a; Gürlich & Kladnik, 2021). Due to their perceived low or inconsistent quality, recycled plastics can trade at discounts of up to 50% lower than the price of some corresponding primary plastics categories (Enkvist & Klevnäs, 2018). The myriad quantity of plastics on the market with a range of chemical and physical properties inhibits the functioning of efficient plastic recycling. Additionally, recycled plastics are continually in economic competition with the virgin plastics market, which has a higher relative material efficiency compared with secondary plastic production due to the ongoing availability of lower-cost feedstock (OECD, 2018). Enkvist and Klevnäs (2018) describe the contradiction at play in improving secondary plastics where "a fragmented and small-scale recycling industry cannot produce the consistent quality and volumes required for large-scale use, even as lack of demand holds back the investment that would enable such production in the first place" (p. 84).

Various methods are used to treat plastic waste. Two main methods of recycling are available in mechanical and chemical form. Mechanical recycling, also termed back-to-polymer recycling, allows for the recovered material to be remanufactured or downgraded into a new product with a different function. Chemical recycling, also termed back-to-monomer recycling, concerns the recovery of a product into its chemical constituents, permitting closed-loop recycling that maintains a material's original quality. Closed-loop recycling is possible when a resin "is returned at the end of its initial lifetime in a fit state to fulfill the service for which it was originally produced" (Pales & Levi, 2018, p. 23). Open-loop recycling, by contrast, remanufactures a product with a loss in physical quality and properties (Pales & Levi, 2018; Kunz et al., 2018). Various recycling options available for plastics are otherwise categorized into primary, secondary, tertiary, and quaternary recycling by Bocken et al. (2016), and are further described in Table 3.2.

Table 3.2: *Overview of Plastic Recycling Methods.*

Recycling	Description
Primary recycling (mechanical recycling)	- Employs the mechanical recycling process to retain original quality of material properties for use in similar applications - Known as closed-loop recycling within a circular economy
Secondary recycling (mechanical recycling)	- Employs the mechanical recycling process resulting in lower-quality material properties for use in alternative applications - Known as downgrading within a circular economy
Tertiary recycling (chemical recycling)	- Employs the chemical recycling process to the material's chemical constituents to retain original chemical properties - Known as depolymerization & repolymerization in a circular economy
Quaternary recycling (energy recovery and incineration)	- Employs thermal recycling and energy recovery through incineration of materials - Not always considered recycling in a circular economy - Energy recovery for production of fuel may be considered within a circular economy (Al Rayaan, 2021)

Source: Adapted from Bocken et al. (2016).

The OECD (2021a) distinguishes between two important factors that are relevant in defining recycling capacity, clarifying further the discrepancy between perceived and actual recyclability. A material's technical recyclability is based on the currently existing recycling technologies available, while practical recyclability is subject to greater regional differences across the world, given that each country has access to different recycling and waste management infrastructure largely shaped by available public funds, market conditions and socio-economic determinants (OECD, 2021a).

Cognizant of the many factors hindering recovery of plastics and production of secondary plastics, it has been recognized that plastic recycling produces the lowest CO_2 emissions compared to other methods of plastic production. Globally, mechanical recycling is the most available method of plastic recovery, and chemical recycling rates still remain quite low (Geyer, 2020). Enkvist and Klevnäs (2018) determined that current primary plastic production produces 5.1 tonnes of CO_2 per 1 tonne of primary plastic (both in production and embedded carbon use), compared to the production of secondary plastics via mechanical recycling, which produces 1.4 tonnes of CO_2 emissions per 1 tonne of recycled plastic. Additionally, looking forward, they projected that mechanical recycling would produce only 0.1 tonnes of CO_2 emissions per 1 tonne of secondary plastic produced, based on projections for 2050 regarding increased decarbonization in recycling technology (Enkvist & Klevnäs, 2018). From a material efficiency standpoint, plastics recycling is deemed a valuable manufacturing option, while being fraught with barriers to achieving circularity for plastics.

Currently, recycling is not functioning at the scale that is necessary to adequately process the quantity of plastic waste that is currently discarded globally. Therefore, the production of plastic resin is not aligned with the realistic capacities of recycling infrastructure. Contextualizing this challenge, Gordon (2021) states "the benefits of recycling [...] are based on a series of assumptions that may not match the reality of how these systems operate and the impacts of the materials that flow through them" (p. 28).

3.2.1. Plastic Waste Exports

Due to inhibitive technical and economic barriers impacting plastic recycling, recycling has become a substantial economic and technical matter of resource management through the 20th and 21st centuries. The economic and technological barriers currently restricting closed-loop recovery of plastic waste have placed a burden on municipal waste programs that has left communities struggling to address stockpiles of solid waste in recycling bins, due to a lack of stable and long-term end-markets for recycling, as well as domestic capacity to process waste locally. As a remedy to combat a domestic issue of increased recyclable waste, many countries across the world have facilitated an international trade in plastic waste amounting to a total of USD 3.3B in trade value according to the United Nations Conference on Trade and Development (UNCTAD) (Barrowclough, Birkbeck & Christen, 2020).

For many years, the recycling trade in global scrap plastic materials predominated in China, later sweeping across the globe to other markets that would accept designated materials (Secretariat of the Basel Convention, 2020; Lerner, 2019). East Asian and Pacific countries imported the vast majority of plastic waste between 1988 and 2016, accounting for 75% of total imports (Brooks, Wang & Jambeck, 2018). Until the Chinese government restricted plastic scrap imports in the early part of 2018, many recycling programs relied on exports to the Chinese recycling market (Liu, Adams & Walker, 2018). Through its National Sword policy, China shed its previous role as the world's largest importer of recyclable waste by banning 24 different types of materials from foreign shipments, thereby eradicating many nations' main export market for their recyclable materials (Franklin-Wallis, 2019; Liu et al., 2018; Walker, 2018). Smaller recycling markets in south-east Asia attempted to fill the void left by China and began importing larger quantities of plastics and other recyclable materials to fulfill the overseas demand, and countries including Malaysia, Thailand, and Turkey were soon inundated by waste materials (Giuffrida, 2020; OECD, 2018). Brooks et al. (2018)

estimated that the trade implications of China's restrictions will displace a total of 111 Mt of plastic waste by 2030.

Pacini et al. (2021) examined the import and export patterns of styrene, ethylene, PVC, and mixed plastics waste within the global plastic scrap trade network during 2018, which amounted to a total quantity of 2,738 declared inter- and transcontinental transactions between a network of 111 countries. The global plastic scrap trade in 2018 dramatically declined 45.5% from years prior to the Chinese import ban, as many countries involved in plastic waste exports in the past turned to stockpiling their high volumes of plastic waste locally, increasing landfill usage (Wen et al., 2021). Waste recycling capacity is lacking in many importing countries, and landfill methods are the more common waste management approach in recycling markets located in Malaysia (Kaza et al., 2018; Wen et al., 2021). Ratifications to the international Basel Convention under the United Nations Environment Programme, which regulates the transboundary shipment of hazardous wastes between countries, have attempted to limit the shipment of plastic waste overseas to countries lacking environmental protocols for effective recycling or safe operational conditions in recycling facilities (Secretariat of the Basel Convention, 2020). Within this reality, transplanting recycling challenges by the transboundary shipment of wastes to emerging economies and recycling markets with low or inadequate access to recycling infrastructure creates ongoing social and ecological risks.

The global waste trade has resulted in profound inequities through the transfer of stockpiled plastic scrap waste from the Global North to Asian, African, and Latin American nations (UNEP, 2021b). Many regions of the Global South do not have access to even the most basic waste collection services, especially in rural regions, creating large quantities of waste plastic that are not formally collected and managed before foreign waste imports add to an existing stockpile (Bell, 2019; Liamson et al., 2021; OECD, 2018). The work of informal waste workers and cooperatives around the world has contributed to localized waste management, recycling, and litter reduction in substantial ways in the face of lacking waste infrastructure (Bell, 2019; Miranda et al., 2020; Platform for Accelerating the Circular Economy (PACE); 2021). Informal waste work in collection, handling, and recycling employs an estimated 15 to 20 million people globally, predominantly workers who are women, children, elderly, or migrants (Kaza et al., 2018; Lerpiniere et al., 2015; Medina, 2010). Informal waste work has been on the frontlines of the plastic pollution crisis since its origins. Particularly for packaging waste, informal waste-workers can play a crucial role in mitigating plastic waste emissions into terrestrial and marine environments (PACE, 2021). Given these challenges, the current state of waste generation and recycling is hindering the operation of a circular economy for plastics.

3.3. Plastic Leakage into Marine and Terrestrial Environments

Discarded plastic materials created a burgeoning pollution crisis in ecological systems soon after the production of consumer plastics began. Thompson et al. (2004) examined plankton samples that were collected regularly from various points along coastlines of the UK and Iceland dating back to the 1960s, and among the collected plankton samples found various polymers with increasing abundance over time. Among the earliest scientific accounts of a burgeoning pollution issue that would later be known to impact birds, fish, and other wildlife was that from two American marine biologists in 1972 (Carpenter & Smith, 1972), who documented findings of plastic in the Sargasso Sea in concentrations of approximately 3,500 particles and fragments per square kilometer (km^2). Since then, studies have documented the presence of plastic debris from some of the highest points on earth – the surface of Mount Everest at the China-Nepal border (Napper et al., 2020) – and at the lowest – within oceanic trenches (Jamieson et al., 2019; Morelle, 2019).

About forty years after Carpenter and Smith's findings, Eriksen et al. (2014) published an oceanic survey that estimated that 5.25 trillion plastic particles, weighing an estimated 268,940 tonnes, were floating as debris in the world's oceans, ranging from 0.33 millimeters (mm) to above 200 mm in size. Their expedition surveys spanned five subtropical gyres as well as several smaller waterbodies and coastlines around the world, and their findings estimated plastic particle densities ranged between 1,000 to 100,000 particles per km^2, reaching up to 890,000 particles per square km^2 in the Mediterranean Sea (Eriksen et al., 2014). In the same region as Carpenter and Smith's study, plastic particle densities were most prevalent as small and large microplastics and based on the density estimates made by Eriksen et al., floating plastic debris had increased substantially. One year later, in 2015, a study estimated a much higher quantity of plastic debris present in the world's oceans, ranging from 15 to 51 trillion plastic particles on the ocean's surface, weighing between 93,000 to 236,000 metric tonnes (van Sebille et al., 2015). While further studies have proposed increasing estimates and various methodologies for measuring the amount of plastic debris in the oceans, these two examples exemplify the challenge and diverging methods used in quantifying the presence of plastic pollution in the marine environment, using different volume and density metrics to capture the scale and character of marine plastic debris.

There is now a vast and growing body of literature documenting the ecological, social, and human health effects of litter and debris caused by mismanaged plastic waste leaking into the biosphere (Fossi et al., 2018; Geyer et al., 2017; Lavers & Bond, 2017; Rochman, 2018). Pathways of plastic pollution emerge from various sources on land and at sea (Goodman et al., 2020; Jambeck et al., 2015). Sea-based sources of marine pollution emerge from commercial fishing industries through both active fishing gear, and abandoned and derelict fishing gear, caused by a lack of adequate collection and on-land disposal protocols to retrieve gear, that may continue to catch unintended species on land and at sea, entangle marine mammals, prevent mobility, and shed fragments over time through degradation (Goodman et al., 2019; Goodman et al., 2021;

Gregory, 2009). Abandoned, lost, and discarded fishing gear can cause the by-catch of unintended aquatic species when not retrieved, including aquatic species at risk (Goodman et al., 2021). Estimates of land-based pollution have stated that plastics are also emitted in much greater volumes from mismanaged waste in inadequately functioning waste disposal sites, as well as via informal and uncontained dump sites. It is estimated that the most significant entry points for plastic entering waterways emerge in coastal cities and towns that are lacking in waste infrastructure or regular waste collection services, emitting an estimated 8 Mt of plastic waste into marine environments annually (Jambeck et al., 2015). If current rates of plastic production, consumption and disposal are maintained, Borrelle et al. (2020) predict that the global quantity of plastic waste entering aquatic ecosystems could reach up to 90 Mt annually by 2030, with the highest rates from upper middle-income and middle-income countries.

Plastics can become environmental pollutants in fragmented form, and as larger and intact plastic litter known as macroplastics (Eriksen et al., 2014). Plastic fragments in their smallest forms are classified into the two main categories of primary and secondary microplastics. Primary microplastics occur either as manufactured nurdles, which are small-scale plastics used as feedstock for commercial plastic production, or as microbeads for use as rinseable exfoliants and abrasives in cosmetic products; the use of the latter has now been banned in many countries, first in the Netherlands in 2014, and later including Canada, the US, and the UK, due to a lack of catchment filters in wastewater treatment operations (Gabbott et al., 2020; Pettipas et al., 2016; Schnurr et al., 2018; Xanthos & Walker, 2017). Secondary microplastics, by comparison, are produced by the breakdown of larger intact plastics that gradually fragment. Secondary microplastics fragment from exposure to environmental weathering, sunlight, and wave movements, leading to dispersal both upon surface water and throughout the water column (Hurley et al., 2020).

As of 2021, it is estimated that there have been over 100,000 studies produced analyzing the impacts of marine litter on each level of the ecological web (UNEP, 2021a). By 2018, over 1,400 species of marine fauna have been documented to have been negatively impacted by plastic debris (Fossi et al., 2018). In aquatic environments and on shorelines, plastics expose many mammals, fish, birds, reptiles, and plants to risks from entanglement, collision, and/or ingestion of debris (Campani et al, 2013; Gregory, 2009; UNEP, 2021a). Plastic entanglement can lead to decreased mobility for wildlife, increased vulnerability to striking by ship traffic, external abrasions, and fatal constriction or choking (UNEP, 2021a). Ingestion of plastics poses a range of potential risks to organisms, leading to digestive blockages that may lead to starvation, prevent regular nutrition, and lower food stimulus (Campani et al., 2013; Fossi et al., 2018). Plastic debris is known to act as a vector and a sink for persistent chemicals upon surface areas, including chemical compounds such as plastic additives and brominated flame retardants, in addition to other industrial and microbial contaminants in the surrounding marine environment including heavy metals, polycyclic aromatic hydrocarbons, polychlorinated biphenyls, polybrominated diphenyl ethers, antibiotics, and endocrine-disrupting chemical compounds, which when ingested can result in sorption of persistent toxins into the organs and tissues of marine life (De Frond et al., 2019; Rochman et al., 2013; Wang et al., 2021). Plastic debris has also been found to act as an aquatic raft that allows for the transportation of biota, microbes and chemical contaminants from one ecosystem to another, due to their properties as vectors and their rougher surface area which accommodates a higher volume of matter, compared to other natural aquatic rafts like wood and microalgae (Cook & Halden, 2020). These properties have potentially detrimental impacts via the more frequent migration of invasive species, or ‘colonizers’, from one region to another via aquatic transport (Gregory, 2009; Rech, Pichs & García-Vazquez, 2018), contributing to the widespread formation of microbial assemblages on plastic debris which has led to what has been termed the ‘Plastisphere’ (Wright, Langille & Walker, 2021; Zettler, Mincer & Amaral-Zettler, 2013). Some microplastic debris has greater buoyancy and is transported along the surface water via wind and oceanic currents, whereas plastic with greater weight may descend deeper into the water column (Eriksen et al., 2014). This leads to potentially compounding effects on species throughout the marine environment, infiltrating the marine food chain. Plastic movements throughout the water column can be further facilitated by deposition on the seabed by organisms that have ingested and excreted plastic particles, resulting in increasing quantities of microplastics that may accumulate deeper in the water column and within aquatic sediment (Coppock et al., 2021; Eriksen et al., 2014; Thompson et al., 2004).

All known species of sea turtle have been documented to have ingested plastic sheets and films, due to their dietary patterns and susceptibility to mistaking plastic debris for a variety of regular marine prey (Campani et al., 2013). Fish species in freshwater, estuarine and marine ecosystems have had documented interaction with plastics. Based on a review of 108 studies surveying interactions between fish and plastics, Azevedo-Santos et al. (2019) determined that at least 427 fish species have been documented to ingest plastic particles. Plastic ingestion has been globally documented among mussels, oysters, clams, shrimps, lobsters, squid, and many fish species, with potentially dangerous implications for commercial fisheries (Markic et al., 2019) as well as human consumption of seafood species that have ingested marine plastic particles (Karbalaei et al., 2019).

Bird species in both marine and terrestrial environments have been documented to interact with plastic debris in each hemisphere, causing a range of potential physical and toxicological risks (Wang et al., 2021). Seabirds have been some of the species most impacted by marine plastic debris, especially those in the petrel and shearwater families (Carey, 2011) which ingest large quantities of surface debris mistaken for their regular diet of plant matter and fish eggs. Seabirds have thus been characterized as a sentinel species for exposure to marine plastic pollution, due to their long migration paths and feeding habits across numerous marine environments throughout their lifetimes

(Borrelle, Provencher & Ngata, 2021; Fossi et al., 2018). Intergenerational transfer of plastic particles has been documented from adult seabirds to their nestling chicks via regurgitation, resulting in plastic accumulation in the gut of immature seabirds that may cause intestinal blockage, perforations, and ulcerations inhibiting growth and feeding (Bond, Hutton & Lavers, 2021; Carey, 2011). Due to current rates of plastic ingestion and increased exposure pathways, as well as the expected continued increase in plastic production, Wilcox, van Sebille and Hardesty (2015) project that 95% of all seabird species will have ingested plastic debris by the year 2050. Meanwhile, terrestrial bird species are relatively understudied compared to seabird species. Some birds of prey, including some species of hawk and vulture, have been documented to ingest macroplastics and microplastics, both from their prey and scavenging practices surrounding waste disposal sites, but little knowledge has been documented about interactions of smaller terrestrial birds with plastic debris (Wang et al., 2021).

While land-based pollution has received attention as providing pathways towards marine plastic pollution, it is noted that the study and analysis of the ecological impacts of plastic pollution within terrestrial and freshwater ecosystems is lacking (Blettler & Mitchell, 2021; Malizia & Monmany-Garzia, 2019). Macroplastic debris enters the terrestrial environment as litter and is most abundant in areas lacking adequate solid waste management; when subject to environmental variables, it can enter other environmental pathways towards rivers and coastlines. Macroplastic debris is intact plastic material less subject to the same degradation as within marine environments (Gregory, 2009). Wildlife interactions with macroplastic debris can include low-risk, benign or potentially beneficial encounters, as some wildlife employ fragments or intact plastic materials for nesting and makeshift shelter, including various mammal and bird species (Blettler & Mitchell, 2021). More dangerous or fatal interactions can take place via entanglement and ingestion, depending on the nature and condition of the debris and its impact on wildlife habitat and health (Hurley et al., 2020). Terrestrial plastic debris also impacts agricultural livelihoods and the health of livestock. This has been documented within Western Africa and central Asia, where plastic bags are commonly ingested by roaming cows and goats, and plastic materials are commonly found in the manure and remains of sheep, poultry, and cows (Adam et al., 2020; Lange et al., 2018; UNEP, 2021).

3.3.1. Economic Costs of Plastic Pollution

Costs of marine plastic pollution are multifold, causing an estimated annual economic loss between USD 6-19B to 87 coastal countries around the world whose economies depend on fisheries and tourism industries (Vlool et al., 2019). Since the costs required for organizing and funding formal waste management systems require large economic investment in infrastructure (in recycling facilities and sanitary landfills), public information, transportation, and human resources, it has been unfeasible for many local governments in low-income countries to make these investments, and thus they are forced to grapple with the other social and economic costs of mismanaged household waste (Johannes et al., 2021; Kaza et al., 2018). The economic repercussions of plastic pollution create pressures that are both direct and indirect in nature, spanning loss to tourism revenues, impacts on fisheries and aquaculture stocks, increased demand for government expenditure on litter cleanup efforts, as well as indirect impacts to aspects of public health (Vlool et al., 2019).

3.4. Public Responses and Political Action

Public and political concern has increased towards the plastics industry due to perception and recognition of the harmful impacts of plastic waste. The perception and critical responses to plastics and their implication in environmental damage can be traced back to the origins of some of the first disposable plastic packaging materials. Beginning in the 1970s, pollution caused by plastic products was being increasingly documented by scientific researchers and vocalized in the media as an ecological threat to marine life (Kinkela, 2017). In particular, Kinkela (2017) traces the introduction of the polyethylene six-pack plastic beverage ring, developed in 1959 by an American manufacturer, used for the sale of aluminum beverage containers sold in multipacks. The six-pack beverage ring emerged as one of the first packaging materials of synthetic origin deemed problematic by the American public, due to increasing evidence and media coverage displaying littered American waterways, and the entanglement of fish, birds and sea lions (O'Hara, Iudicello & Bierce, 1988). This dialogue garnered increasing public attention towards the plastics industry, as well as political interventions calling for increased regulation of plastic manufacturers.

Industry responses to public concern about mounting environmental litter caused by plastic packaging have promoted a consumer-centred structure of accountability in managing and reducing plastic pollution, which has normalized an approach of individual responsibility and community cleanups. Both Kinkela (2017) and Lerner (2019) have investigated the emergence of industry-sponsored public campaigns such as the "Keep America Beautiful" campaign developed in 1953, to encourage citizen engagement as the most effective means of improving recycling rates and ensuring litter prevention (Keep America Beautiful, n.d.; Lerner, 2019; Strand, n.d.). Such campaigns have been critiqued by environmental groups, as these framings of plastic consumption and litter have attempted to position consumers as the actors best suited to prevent a continuing pollution crisis (Break Free from Plastic, 2018).

3.4.1. Role of Citizen Science Cleanups

Worldwide beach cleanups undertaken by citizens and environmental organizations have contributed to public and political understandings of marine debris by quantifying and characterizing the presence of plastic pollution in the natural environment, empowering citizens to engage in environmental stewardship and contribute to immediate efforts to reduce environmental pollution (O'Hara, Iudicello &

Bierce, 1988; Phillips, 2017; UNEP, 2018). De Frond et al. (2019) posit that by preventing the entry of plastic debris into oceans, coastal cleanups simultaneously function as effective chemical pollution prevention measures by reducing the introduction of chemicals embedded within plastic products into the marine environment. Such citizen-led efforts also critically contribute to citizen science efforts to identify and record litter and debris in the environment, characterizing the scale of terrestrial pollution which is not possible to the same extent once litter becomes mobilized by wind or aquatic forces. Hidalgo-Ruz & Thiel (2015) examine how citizen science studies have contributed to scientific understandings of marine litter, which have focused most on the distribution and composition of marine litter, as well as on interpretations of marine litter's interactions with marine biota and its toxic effects, transport, and degradation. Citizen cleanups are thus important components of risk identification, as well as a crucial step in preventing the entry of litter to ecosystems.

Coordinated efforts to manage litter through citizen-led cleanup activities have become well-established intervention methods. Current shoreline cleanup programs include the Ocean Conservancy's International Coastal Cleanup (ICC), Ocean Wise and the World Wildlife Fund's Great Canadian Shoreline Cleanup (GCSC), the Great American Shoreline Cleanup (GASC), and Break Free from Plastic (BFFP) that mobilize and equip volunteers to collect data and information about plastic debris. Data collection on the composition and quantity of litter provides valuable information on the most prevalent and mismanaged materials that are escaping waste collection systems and entering the environment as debris. Annually released data from the ICC's cleanups document that seven of the ten most collected litter categories are food packaging materials (ICC, 2021). Similarly, the GCSC (2021) also compiles the most common litter items collected across Canadian cleanups and records that food packaging materials constitute over half of the materials collected, including food wrappers, bottle caps, beverage cans, plastic bottles, plastic bags, and other packaging. Additionally, various methods to identify the primary industrial sources of plastic pollution have increased in popularity and in turn have popularized the use of brand audit methodologies, in which cleanup volunteers identify and record the producers of the most prevalent littered items to create an ethic of corporate accountability within cleanup efforts. Since 2017, brand audits undertaken by groups like BFFP around the world have found consistent proof that a defined group of global consumer brands contribute to plastic pollution on a large scale, which motivates efforts to assign correct accountability to actors along the plastic packaging value chain (BFFP, 2018; UNEP, 2021b).

> "For years, the messaging around plastic pollution and litter has been focused on community cleanups and individual responsibility for managing waste. Yet in this latest effort to add brand audits to cleanups, we are seeing a shift in the way consumers are thinking about waste. People are beginning to see the connection between plastic pollution on the ground and the corporations that overpackage food and healthcare products" (BFFP, 2018, p. 23).

Audits are undertaken regularly in volunteer-led cleanup initiatives, and findings identify the materials that are contributing to increased marine pollution and are continuously escaping waste collection systems or bypassing waste management entirely as litter. Citizen science outcomes have effectively influenced and informed government policy for plastic pollution around the world (Ambrose et al., 2019; Environment and Climate Change Canada, 2019; European Commission, 2019). While citizen-led efforts have proven to be central in managing and characterizing pollution caused by mismanaged plastic materials, the pace and scale of plastic pollution has warranted increasing political responses, which will be discussed in the following sections.

3.5. Global Governance of Marine Pollution

Early legislative attempts to measure and mitigate litter emerging from human activities took hold during the late 20th century, beginning in the 1970s (Kinkela, 2017). In response to mounting scientific documentation of marine pollution caused by anthropogenic sources, various international bodies have proposed strategies and frameworks to limit sources of pollution in the marine environment (Kosior & Crescenzi, 2020). The *Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972*, also known as the London Convention, was adopted by the International Maritime Organization (IMO) and came into force in 1975 seeking to control marine pollution caused by industrial and chemical wastes dumped by vessels, aircraft, or other humanmade structures at sea (IMO, 1972). The London Convention prohibits the disposal of waste but designates some categories of waste disposal that require authorization (IMO, n.d.). In 1996, the London Protocol was proposed by the IMO to modernize and replace the London Convention, by adding additional stringencies that prohibit all waste dumping and the export of wastes for incineration or dumping at sea by using expanded compliance measures, and preferred alternative methods of waste prevention and reduction including product reformulation, cleaner production technologies, input substitutions, and closed-loop recycling (IMO, 2006). The IMO's enactment of the *International Convention for the Prevention of Pollution from Ships* (MARPOL) addressed measures to control the emission of garbage from ships into oceans, in addition to other sources of air and chemical pollution emitted from ships. MARPOL's addition of Annex V, Prevention of Pollution by Garbage from Ships came into effect in 1988 (IMO, n.d.).

In 1994, the *United Nations Convention on the Law of the Sea* (UNCLOS) forged an international agreement for the protection of ocean resources and the marine environment (UN, 1994). Article 194 in UNCLOS requires states take measures to prevent, reduce and control sources of marine pollution (UN, 1994). In 1989, the United Nations implemented the *Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal* to prevent the export of toxic wastes between countries. Amendments to the Basel Convention were made in 2019 to include information specifying non-hazardous plastic materials that can be exported for recycling, ensuring plastics are uncontaminated, or unmixed with other nonrecyclable materials, and will be recycled in an environmentally sound manner (Secretariat of the

Basel Convention, n.d.). Following the earlier adoption of the Basel Convention, the *Bamako Convention on the Ban of the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa* was negotiated by 16 nations in Africa to prevent the import and incineration of any hazardous waste, banning inland and ocean dumping, which came into force in 1998 (UNEP, n.d.). Numerous regional conventions on marine protection include measures to prevent marine pollution in specific geographic areas: the Barcelona Convention 1976 (Mediterranean region); the Abidjan Convention 1984 (West and Central Africa states); the Kuwait Convention 1989 (Persian Gulf states); the Helsinki Convention 1992 (Baltic Sea states); the Bucharest Convention 1994 (Black Sea states); the OSPAR Convention 1998 (European states along the North-East Atlantic Ocean); the Tehran Convention 2006 (Caspian Sea states) (Kosior & Crescenzi, 2020).

In the early 2000s, international coordination around the topic of marine plastic pollution became more stringent in the agenda of the United Nations (Barrowclough & Birkbeck, 2020). In 2004, the UN General Assembly (UNGA) delivered the first resolution regarding marine debris at its annual gathering, which marked a significant step in acknowledging marine pollution through a global focus (Barrowclough & Birkbeck, 2020; UNGA, 2004). The Honolulu Strategy (2011) was a framework proposed by the UNEP and the National Oceanic and Atmospheric Administration (NOAA) with the three goals of reducing pollution from land and sea, as well as reducing the accumulation of debris on shorelines and in aquatic habitats, proposing strategies to improve waste and stormwater management on land, reduce loss of gear, cargo and vessels at sea, as well as litter reduction and management (UNEP & NOAA, 2011). The Manila Declaration was implemented in 2012, where 65 signatories committed to national policies to reduce pollution from marine litter and from agricultural fertilizers, and to undertake improved wastewater management, noting the importance of international coordination towards land-based pollutants in the marine environment (UNEP, 2012).

In 2012, the UN launched the Global Partnership on Marine Litter (GPML) during the UN Conference on Sustainable Development, which functions as a multi-stakeholder and multi-sector partnership for developing knowledge, information, and collaboration between governments, intergovernmental organizations, regional bodies, the private sector, civil society, and academia (GPML, 2021). Marine plastic debris and microplastic pollution was included as a resolution in the first session of the United Nations Environmental Assembly (UNEA) in 2014, acknowledging the range of sources of plastic debris and their impacts on marine health, and recognizing the need for government and international measures (UNEA, 2014). Efforts to address marine pollution are integrated in the 2030 UN Sustainable Development Goals Agenda, in SDG 14.1, aiming to "prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution" by 2025 (UN, n.d.). Ongoing international action is taking place to address the scale and scope of plastic waste. At the fifth session of the UNEA, participating member states articulated the need to negotiate a global, binding agreement to address marine litter and plastic pollution, and this remained top of the agenda in advance of the resumed fifth session of the UNEA in Nairobi, Kenya in 2022 (UNEA, 2021). On March 2, 2022, the UNEA voted to approve a significant resolution to create an international legally binding treaty by 2024, addressing mechanisms to improve production, design and disposal of plastics (UNEA, 2022). This resolution marks a pivotal step towards the alignment of global actions to address plastic pollution, and importantly, the resolution has centred the role of informal waste workers and cooperatives in the plastic crisis (UNEA, 2022).

3.6. Local, Regional, and National Approaches to Plastic Waste

Increasingly, governments are taking simultaneous measures towards addressing plastic overproduction, mismanagement, and pollution by focusing on defined strategies and focus areas. For decades, a waste-centric approach has been employed by governments to address the risks and challenges of plastic pollution, while less focus has been placed on the prevention, production, and consumption stages of the plastics life cycle (Barrowclough & Birkbeck, 2020). Pales & Levi (2018) describe the shortcomings within attempts to mitigate the impacts of plastic production and use, underlining the need "to recognise and address the heavy externalities that product design choices impose on recycling [...] and there is an urgent need to evaluate the costs and benefits of different options to address it – whether the gradual introduction of product regulation, voluntary agreements, standards, industry design protocols, financial incentives, or in other ways" (p. 94).

Currently, there is a wide variety of potential actions that local, regional, and national governments may choose to take towards plastics that span the production, use, maintenance, and disposal stages. There are numerous political focal points in the following thematic categories that Barrowclough & Birkbeck (2020) distinguish:

- Cleaning up environmental pollution;
- Reducing waste leakage;
- Reducing consumption;
- Increasing recycling and reuse;
- Investing in alternative or new markets for plastic waste;
- Reducing plastic production; and
- Reducing pollution across the life cycle.

3.6.1. Plastic Bans, Levies, and Taxes

Bans, levies, and taxes are increasingly implemented policy instruments that focus specifically on the consumption and/or production stages of plastic materials to monitor and reduce the quantity of problematic and nonessential materials that are introduced to the market. The basis of enacting such restrictions are subject to local and regional determinants, and are usually shaped by a combination of economic, social and environmental factors in the local context. To date, many subnational, national, and regional restrictions have been legislated on every continent for a range of plastic products and materials that have resulted in detrimental environmental and socio-economic impacts in the natural and human landscape as litter, including plastic microbeads, plastic bags, and a range of single-use plastic materials (Adam et al., 2020; Bezerra et al., 2021; Clayton et al., 2021; Schnurr et al., 2018; UNEP, 2018; Xanthos & Walker, 2017).

As opposed to interventions that focus on the disposal-oriented nature of plastics, the implementation of bans, levies, and taxes can regulate the upstream plastics value chain. The scope of restrictions chosen by governments varies across the world, that may focus on one or several life cycle stages. The UNEP (2018) delineates four potential areas along the life cycle of plastics in which regulations may be implemented, spanning market entry (regulating manufacture and production of a product); retail distribution (regulating the consumer acquisition and use of a material); post-use or disposal; and trade regulations. Depending on the scope of the restrictive measures, governments may select a total or partial ban that focuses on certain product classes or problematic materials, in addition to using taxes or financial incentives for the manufacture of designated materials to lessen virgin material use or to support recyclable and reusable products (UNEP, 2018). Additionally, national laws may ban or limit the free distribution or use of specific product classes or materials, which may be facilitated using a tax or fiscal incentives to retailers and businesses to encourage reusable alternative to plastic materials (UNEP, 2018). Disposal restrictions are normalized in many national laws but are implemented in different ways. Restrictions may regulate the return, collection, or disposal of materials assigning responsibility to the manufacturer, retailer, or consumer, and may also assign specific fees or taxes for the disposal of a material (UNEP, 2018). Lastly, trade restrictions concern the import or export of materials, regulating the entry of specific products into the market, as well as the global waste trade in scrap plastic (UNEP, 2018).

Most recently, some stakeholders across the plastics value chain have pursued various legal actions in response to such legislation, in attempt to prevent local and national governments from passing regulations that seek to minimize the import, sale, and use of designated plastic materials that have been deemed environmentally harmful and problematic. These legal actions, otherwise termed preemption bans, make it illegal for cities or states to pass legislation that restrict specific plastic materials. Many plastic industry lobbyists representing the American Progressive Bag Alliance and the Plastics Industry Association have successfully implemented pre-emptive measures across the United States to limit the capacity of governments to pass legislation to ban, levy, or tax plastic materials (Gibbens, 2019).

Such instruments are an important option allowing governments to exercise jurisdictional autonomy and propose their own methods of controlling the production, import, distribution, use and/or disposal of plastic materials within the economy, which in turn has resulted in a patchwork of bans, levies and restrictions around the world enacted for a mosaic of plastic products deemed unnecessary or harmful (Kosior & Crescenzi, 2020). Some bans, such as Kenya's stringent plastic bag ban, include severe penalties for noncompliance, whereas in other jurisdictions there is a lack of monitoring protocols in place to track and assess the impacts of the legislation (UNEP, 2021a). There is a large jurisdictional variance in the scope of bans and the methods for their implementation, and it is argued that the piecemeal nature of individual bans, levies, and taxes limits governments from addressing the risks of plastics over their full life cycle (Simon et al., 2021). Additionally, these legislations were making increasing strides towards limiting single-use plastics in food and retail, but progress in new legislation stalled and at times was reversed by political reprioritization during the global COVID-19 pandemic, due to an increasing slant towards use of plastic packaging for hygienic and protective purposes (da Costa, 2021).

3.6.2. International and National Strategies for Plastic Waste

In June 2018, the Ocean Plastics Charter was initiated during Canada's G7 presidency in Québec alongside France, Germany, Italy, the UK, and the EU. Current partners span industry, organizations and governments committed to five goals in the realms of design, production, and after-use markets; collection and management; sustainable lifestyles and education; research, innovation and new technologies; and coastal and shoreline action (Government of Canada, 2018). There are currently 27 countries that are partners in the Ocean Plastics Charter, as well as partners in many sectors in business, industry, non-profit organizations, and academia (Government of Canada, n.d.). The charter works towards 100% reusable, recyclable, or recoverable plastics by 2030, aiming for increased recycled plastic content by 50% by 2030, through support of secondary markets for recycling and elimination of unnecessary plastic items (Government of Canada, 2018).

The EMF has emerged as one of the foremost proponents of a globally aligned circular plastics economy, and proposed a Global Plastics Pact in 2018 that sought the membership of industry, organizations, and governmental signatories, to build transboundary public-private partnerships that permit collaboration and expertise-sharing to harmonize solutions and to fuse efforts that could benefit other jurisdictions. There are currently ten countries partnered in the Plastics Pact Network: Canada, Chile, France, Kenya, Netherlands, Poland, Portugal, South Africa, United Kingdom, and the United States, as well as regional partners including the European Economic Area, Australia, New Zealand, and the Pacific Island Nations (EMF, n.d.). The Plastic Pact Network requires signatories to commit to individual targets in five areas to achieve more sustainable production, consumption, and reuse networks for plastics (EMF, n.d.) by:

1. Eliminating unnecessary and problematic plastic packaging through redesign and innovation;

2. Transitioning from single-use to reusable materials;
3. Ensuring plastic packaging is reusable, recyclable, or compostable;
4. Increasing reuse, collection and recycling or composting of plastic packaging; and
5. Increasing recycled content in plastic packaging.

National plastic strategies have been under development by many nations around the world aimed at committing to an improved recycling economy and limiting the pathways of plastics into the natural environment (Howard et al., 2019). One of the first wide-ranging strategies considering the full life cycle of plastics was developed in the EU. The EU's Plastics Strategy includes the Single-Use Plastics Ban, which seeks to take broad steps towards a circular economy for all plastics by achieving increased recycling targets, prioritizing reusability, and avoiding disposal, as well as by mandating increased recyclability principles in product design, specifically for PET bottles (EC, 2019). The European Commission (EC) contextualizes citizen science data gathered by shoreline cleanups as a key proponent in enacting their Single-Use Plastics Ban, which includes restrictions on such plastic items as cutlery, plates, straws, beverage stirrers, and polystyrene food containers (EC, 2019).

The need for a unified national approach to restricting problematic plastics, improving domestic recycling capacity, and pursuing a circular plastics economy has been identified in many countries, including Canada (Umeozor et al, 2020; Walker & Xanthos, 2018). In Canada alone, plastic production and plastic resin manufacturing is a CAD 35B industry; however, in 2016, sales of domestically recycled plastics in Canada had accounted for only 3.5% of those of primary virgin plastics (Umeozor et al., 2020). The Canadian government has begun to develop approaches towards innovating and investing in improved plastic waste strategies and addressing pollution, in attempts to embrace the environmental and economic benefits of a circularized plastics economy. The Canadian government moved to restrict a preliminary number of single-use plastic items including plastic checkout bags, beverage stir sticks, six-pack rings, cutlery, straws, and some food service ware, also partly informed by national citizen science data identifying the materials most persistent as plastic litter (ECCC, 2019). Additionally, as of May 2021, plastic manufactured items were added to Schedule 1 of the *Canadian Environmental Protection Act, 1999*, designating plastic as a potentially toxic substance in Canada due to its ecological impacts when emitted as litter, and granting government the regulatory power to develop appropriate risk management measures (Government of Canada, 2021; Walker, 2021a,b).

The Canadian Council of Ministers of the Environment (CCME) approved the Canada-wide Strategy on Zero Plastic Waste which proposed targets and plans to limit and eliminate the most problematic plastic materials and increase the reuse and recycling of plastics (Environment and Climate Change Canada, 2019). The CCME's (2019) Canada-wide Action Plan on Zero Plastic Waste has prioritized several action areas including implementing extended producer responsibility for plastic recycling nationwide, focusing on single-use and disposable products, defining national performance requirements and standards, as well as introducing incentives for a circular economy, infrastructure and innovations investment, and public procurement and green operations.

Due to the increasingly large patchwork of national and regional strategies to combat an international problem that defies borderlines, there is a growing consensus that there is an urgent need for a globally binding treaty on plastics to bridge the divide between individual nations' objectives and the need for wider international collaboration and momentum. Simon et al. (2021) illustrated the need to coordinate action to pursue consistent solutions and to forge a globally aligned plan to address each step along the life cycle of plastic production, use, and disposal.

3.7. Extended Producer Responsibility Principle for Packaging Waste

The seminal 1987 Report of the Brundtland World Commission on Environment and Development (1987) referenced the importance of addressing pollution, and the risks of transboundary shipments of waste in the Global South. In particular, the report noted that pollution as a form of waste could be rectified using economic instruments to apply polluter payment principles. It recognized the importance of motivating investments in efficiency to reduce waste generation and pollution by charging fees or penalties for noncompliance. In this vein, mandating producer responsibility is an important opportunity for governments to improve product systems and introduce regulatory methods for waste reduction.

A taxpayer-funded recycling model has been a conventional method of waste management around the world. Beginning in the late-20th century, in many regions of the world, authorities grappling with increasing volumes of solid wastes were faced with the dilemma of effectively increasing recycling and diverting residentially generated waste from landfill and minimizing the life cycle impacts of products at their disposal (OECD, 2021a). Products of greatest concern such as waste electrical and electronic equipment (WEEE), automobiles, household appliances, and hazardous household waste required new forms of coordination and life cycle analysis to develop improved end-of-life management strategies, to mitigate their entry into the natural environment through illegal dumping, abandonment, and landfill disposal (Lindhqvist, 2000).

Conversations about shifting the responsibility for managing materials at their end-of-life phase began in jurisdictions that were encountering these growing waste challenges. Thomas Lindhqvist, a Swedish academic in the field of industrial environmental economics, was among the first advocates for an alternative political approach to managing discarded material goods. In the 1990s, the Extended Producer Responsibility (EPR) principle was first articulated as a waste management approach by

Lindhqvist and his colleagues in a report to the Swedish Ministry of the Environment (Lindhqvist, 2000). EPR is formally defined as "a policy principle to promote total life cycle environmental improvements of product systems by extending the responsibilities of the manufacturer of the product to various parts of the entire life cycle of the product, and especially to the take-back, recycling and final disposal of the product" (Lindhqvist, 2000, p. v). The principle has the ultimate goal of developing "more environmentally adapted products and product systems" (Lindhqvist, 2000, p. i). The EPR principle is an effective method of involving producers in the waste management process to account for environmental, economic, and social externalities within the design of otherwise linear product systems.

In the EPR model, businesses are responsible for paying the costs of end-of-life management of the materials they introduce into the marketplace, incentivizing recovery-based material streams and intending to stimulate improved environmental impacts through better product designs (Kunz et al., 2018; Lindhqvist, 2000). Since its development, the concept of EPR has been applied to many product industries such as automobiles and WEEE, and it has proven to be successful at creating networks of post-consumer material collection and recovery. EPR for the packaging waste stream requires industries to finance, in part or in whole, the end-of-life management of materials that they provide into the market once they are discarded, alleviating tax-funding otherwise required to finance the recycling system.

The earliest responses to improve management practices for packaging waste came into force through the European Union Directive 94/62/EC on Packaging and Packaging Waste, which was introduced to EU member states in 1994 (EC, 2018). This policy marked the beginning of a wide-ranging government response to the issue of packaging waste in the world, targeting packaging waste across Europe. Since that period, numerous political and economic instruments have been developed, pivoted towards solutions that require producers to exert greater leverage in addressing problematic materials in the marketplace.

3.7.1. Models of Producer Responsibility

Both EPR and the term 'product stewardship' are often used interchangeably with each other as equivalent concepts, whereas in some jurisdictions, stakeholders and governments view each as separate approaches (Tasaki, Tojo & Lindhqvist, 2018). For example, in the United States, the Product Stewardship Institute (2012) defines EPR as one distinct form of mandatory product stewardship and describes EPR as distinct from other types of government regulatory programs, as it requires financial and/or operational producer responsibility specifically for the post-consumer waste management of their products.

While mandatory, fee-based EPR for packaging waste is the central waste policy instrument of focus in this study, numerous other policy instruments may be employed in various forms that in turn qualify as a function of EPR, which may overlap with other product stewardship approaches that focus on upstream aspects of a product lifecycle. These different instruments offer ways to minimize or restrict certain waste materials, and to increase waste diversion through a range of product take-back programs, regulatory approaches, voluntary industry practices, and economic and informative instruments (Yu, Hills & Welford, 2007).

As illustrated in the next section, several models are available through voluntary participation, as well as through more formal governmental intervention mandating producer participation. Across the world, there are currently many applications of each of these instruments across various industrial sectors. Within a waste policy framework, the diverse regulatory and economic instruments described by Yu, Hills and Welford (2007) in Table 3.3 are employed by both government and industry for the sustainable management of materials, to address the mismanagement of waste resources, limit the pathways that allow migration of pollutants into the environment, and extend oversight to aspects of end-of-service phases for discarded products (Kaffine & O'Reilly, 2013; Yu, Hills & Welford, 2007).

Table 3.3: *Extended Producer Responsibility Policy Instruments.*

Type of EPR approach	Applications
Product take-back programs	Mandatory take-back
	Voluntary or negotiated take-back programs
Regulatory approaches	Minimum product standards
	Prohibitions on certain hazardous materials or products
	Disposal bans
	Mandated recycling
Voluntary industry practices	Voluntary codes of practice
	Public/private partnerships
	Leasing and servicing
Economic instruments	Deposit/refund schemes
	Advance recycling fees
	Fees on disposal
	Material taxes/subsidies
Informative instruments	Reporting to authorities
	Marking or labelling of products and components
	Information provision to stakeholders (e.g. consumers and recyclers)

Source: Yu, Hills & Welford (2007).

Early implementation of some of these instruments took place in the United States and Canada for used beverage containers through deposit/refund programs, long before more formalized conceptualizations of EPR were proposed by Lindhqvist and applied to regulation by European waste authorities (Johannes et al., 2021). Based on review by Kaffine and O'Reilly (2013), Canada and the US were among some of the earliest adopters of regulated deposit/refund schemes specifically for beverage containers beginning in the 1970s. The first beverage container recycling scheme dates back to a deposit/refund scheme in Oregon in 1972, followed by Vermont in 1973, Saskatchewan in 1973, Michigan and Maine in 1978, and Iowa in 1979. Many other US states and Canadian provinces quickly began to follow suit, applying other instruments to recycling schemes for vehicle tires, batteries, hazardous products, household devices, and WEEE (Kaffine & O'Reilly, 2013).

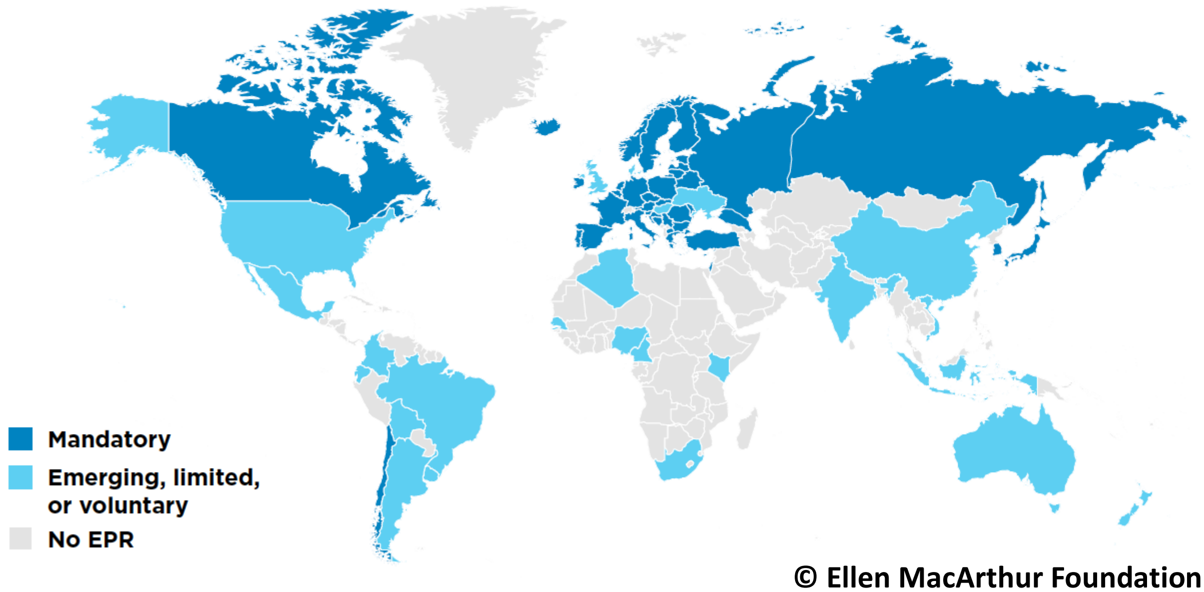
3.8. Defining Responsible Producers of Packaging

Pinpointing producer responsibilities within a network of many actors along a globalized supply chain for consumer goods is necessary to assign correct accountability to achieve the objectives of an EPR program. Clarifying the role of producers in the food industry is essential in the development of EPR programs for packaging, as food brands, grocery stores and retailers, food outlets and restaurants all produce or distribute food products in packaging materials to provide to customers (OECD, 2021a). While obligated producers in EPR programs for packaging are often defined as the fillers of packaging, as opposed to the manufacturers of packaging itself, there remains an ongoing dialogue aimed at engaging actors further up the plastics value chain (OECD, 2018; OECD, 2021a).

3.9. Implementation of the EPR Principle for Packaging Waste

Packaging materials (including beverage containers) account for about 17% of total EPR programs worldwide, while 35% of programs cover WEEE, 17% cover tires, and 20% cover a collective category of used oil, paint, chemicals, large appliances, and lightbulbs (Kaffine & O'Reilly, 2013). In Figure 3.1, the EMF (2020a) has mapped the landscape of EPR programs for packaging existing in 2020, when there were approximately 45 mandatory, fee-based programs in operation.

Figure 3.1: *Overview of Packaging EPR Schemes Implementation Around the Globe in 2020.*



Source: Ellen MacArthur Foundation (2020).

Governments are motivated by different sets of factors in pursuing producer responsibility for packaging waste. By implementing EPR programs for packaging, the financial burden on taxpayers is relieved for the financial source of administering waste management programs. The purpose is to increase recycling rates, reduce landfill usage, and contribute to feedback loops between industry and the recycling market for improved product designs. These goals are even more pertinent in regions where waste infrastructure is lacking or nonexistent for collecting, processing, and recycling packaging materials, identified as one of the most significant sources of plastic litter on land and emissions into rivers and oceans (Jambeck et al., 2015; Kaza et al., 2018). Each region of the world has taken steps towards implementing EPR for packaging waste. These actions complement ongoing policies for plastic bans.

Based on EMF's use of "emerging", "limited", or "voluntary" terminologies to classify nations with different designs of EPR programs implemented for packaging, the range indicates the variance of legislation, policy approaches, types of EPR instruments in place, and specified material coverage (EMF, 2020a). It is difficult to ascertain the full global scale of EPR implementation for packaging waste at a granular level, as legislative information for many national environmental authorities is unavailable, and since many nations are in early stages of program proposals and planning. While this landscape provides a general scope, a regional review of existing EPR programs for packaging materials was conducted, within a quickly moving landscape of national waste policies pursuing involvement from producers in waste management.

3.9.1 Africa

Implementation of EPR for packaging waste in African nations has had varying applications. Fee-based EPR programs for packaging have been minimal to date, but a number of countries operate voluntary programs aimed at specific packaging materials, including deposit/refund programs for plastic bottles. Several new EPR programs for packaging have been proposed across Africa, spanning different regions and islands that are pursuing mandatory financial contributions from producers in the effort to reduce pervasive packaging pollution.

Legislation has been approved for fee-based mandatory EPR for packaging in South Africa as of May 2021, through the national Ministry of Forestry, Fisheries and the Environment's adoption of Section 18 in the *National Waste Management Act*, which covers paper, packaging and some single-use products (de Kock et al., 2020; Langhill, 2021a). South Africa has had a voluntary EPR program in place since 2000, wherein some plastic packaging materials had been covered by a group of national organization organizing collection of various plastic materials on the market (Arp, de Kock & Manyara, 2021).

Kenya's Ministry of Environment and Forestry also passed legislation to approve a fee-based mandatory EPR program for packaging materials in 2020 and developed legislation for the formation of producer responsibility organizations in 2020 (Langhill, 2021a). The *Extended Producer Responsibility Law* under the *Environmental Management and Co-ordination Act* was expected to lead to program development in 2021 (Gerphas, 2020). Additionally, Tunisia and Namibia have developed EPR frameworks but are currently without any program implementation, Ghana, and Cameroon both operate limited EPR programs for packaging covering a slim range of packaging materials, and Nigeria currently operates only a voluntary EPR program for some packaging materials (Langhill, 2021a). Within Africa, there are ongoing attempts to implement EPR for packaging in the future.

3.9.2. Asia

Current implementation of EPR for packaging is varied across Asia (Hu, 2021a). Japan, South Korea, and Taiwan each have mandatory, fee based EPR programs for packaging materials. Japan's EPR program for packaging began with the *Act on the Promotion of Sorted Collection and Recycling of Containers and Packaging* in 1995 (Japan Ministry of Economy, Trade and Industry, 2006). Japan's program had been deemed effective over the first decade of its implementation, as packaging recycling rates rose 27% between 1997 and 2010 (OECD, 2014). Additionally, South Korea's program began in 2003 with the implementation of the *Act on the Promotion of Saving and Recycling Resources* (Prevent Waste Alliance, 2020a). Taiwan enacted an EPR program for packaging materials in 1998, in the *Waste Disposal Act* (Taiwan Environmental Protection Agency, 2012). Additionally, India approved an EPR program specifically for plastic packaging materials in 2020, through the *Rules for Plastic Waste Management* (India Ministry of Environment, Forest and Climate Change, 2020).

Numerous non-mandatory initiatives are managed by recyclers and actors in the private sector across southeast Asia, including the Philippines and Indonesia (Johannes et al., 2021). There are increasing measures but as of 2021 there were no mandatory

EPR programs for packaging in operation. The Association of East Asian Nations (ASEAN) has proposed a regional plastic waste strategy with several targets to reduce marine pollution and improve recycling rates in the region, which included the recommended implementation of a mandatory EPR program for packaging (Hu, 2021b).

Australia has operated a voluntary industry program for packaging since 2010 through the Australian Packaging Covenant, which seeks to make environmental improvements to packaging materials, wherein signatories are required to pursue an action plan and report annually, but are not implicated in a mandatory EPR program (Australian Packaging Covenant Organization, n.d.; Hu, 2021a).

3.9.3. Latin America

Based on available information and legislative documentation, several countries in Latin America including Chile, Venezuela and Colombia have passed mandatory EPR programs for packaging (Langhill, 2021b). Chile approved a mandatory EPR program for packaging through the *EPR Decree for Packaging* in June 2019 (Prevent Waste Alliance, 2020b). Venezuela approved a mandatory EPR program for packaging in 2020 in *Resolution No. 0191* (Gonzalez, 2020). Colombia's Ministry of Environment approved EPR legislation for packaging materials in 2018 through *Resolution 1407* (Mutter & Castellanos, 2021). Other nations are pursuing mandatory programs, including Argentina, while other nations such as Uruguay, Brazil, Bolivia, and Ecuador currently have voluntary programs in place that cover a defined selection of packaging materials (Langhill, 2021b).

3.9.4. Europe

The European Union (EU) took bold regulatory steps to manage and minimize packaging waste in the 1990s and adopted EPR as one of the main policy instruments within an overarching strategy aimed at minimizing landfill use and recycling waste (Filho et al., 2019). There has been a significant regulatory structure to minimize the quantity of waste entering landfills in the EU and implement recycling targets, largely motivated by the limited geography available for landfill infrastructure within a densely populated continent (Lazarevic et al., 2010).

With the passing of EU Directive 94/62/EC on Packaging and Packaging Waste in 1994, the EU took regulatory steps towards the greater recovery and landfill diversion of increasing volumes of household packaging waste that many European nations were discarding on an annual basis. Germany had already begun developing an EPR program for packaging waste in 1991, with the implementation of the German Packaging Waste Ordinance. Packaging materials regulated by EU Directive 94/62/EC comprise paper and cardboard; plastics; wooden materials; metallics; aluminum; steel; glass; and other packaging (EC, 2018). The directive did not originally mandate that member states must implement a mandatory EPR program for packaging as part of their transposition of the Directive, but since 1994 most member states have developed mandatory EPR schemes to manage packaging waste by obligating producers to finance recycling programs for household waste (Filho et al., 2019). Last amended in 2018, Article 7 in EU Directive 94/62/EC requires all member states to implement a mandatory EPR program for packaging waste by December 31, 2024, obligating the few remaining EU states that have not yet developed a program (EC, 2018).

The EU Directive 94/62/EC mandates current overall recycling targets for packaging at 55% until 2025, with a plastic recycling target set at 25% by weight (EC, n.d.). Most European member states that have adopted an EPR program for packaging have documented plastic recycling rates that meet or exceed the EU's current recycling targets (Eurostat, 2021). New targets will increase to require that at least 65% by weight is recycled by December 31, 2025, with 50% targets for plastic recycling differentiated by type. Additionally, targets will increase five years later on December 31, 2030, requiring that at least 70% by weight of all packaging waste is recycled, including a 55% recycling target for plastic.

In Table 3.4, the five EU member states that documented the highest plastic recycling rates in 2019 were Lithuania (69.6%); Czechia (61%); Netherlands (57.2%); Sweden (53.2%); and Slovakia (52.8%) (Eurostat, 2021). Depending on the application, the organization of collection programs and various factors influencing program efficiencies, each country creates different conditions for the operation of their recycling programs.

Table 3.4: *Recycling Rates of Plastic Packaging Waste for Monitoring Compliance with Policy Targets.*

EU Member State	Average Packaging Recycling Rate	Plastic
Belgium	84.2	47.4
Bulgaria		
Czechia	71.2	61
Denmark	71.2	36.2(e)
Germany	63.2(b)	43.3(b)
Estonia	66.2	40.6
Ireland	62.5	27.5
Greece	60.1(e)	37.6(e)
Spain	69.6	51.5
France	65.6	26.9
Croatia	48.9	35.7
Italy	69.6	44.7
Cyprus	66.8	50.5(e)
Latvia	62.4	35.4
Lithuania	61.9	69.6
Luxembourg	71.5	33.4
Hungary	47.3	33
Malta		
Netherlands	80.7	57.2
Austria	65.4	30.8
Poland	55.5	31.5
Portugal	62.8	35.6
Romania		
Slovenia	67.1	50.3
Slovakia	67.5	52.8
Finland	70.6	42
Sweden	63.9	53.2

Mandatory, fee based EPR program for packaging.
Limited or no mandatory, fee-based EPR program for packaging.
Flags: e – estimated; b – break in time series; Source: Eurostat (2021); European Commission (2018).

Lithuania and Czechia had the highest plastic recycling rates in the EU in 2019, but very limited analysis is currently available for the management and performance of both member states' programs. Lithuania's and Czechia's success in waste management has been stated to be due, in part, to their small populations, and the OECD attributes their high recycling rates to the successful implementation of a deposit/refund system for plastic beverage containers (OECD, 2021b). Meanwhile, the Netherlands has the third highest plastics recycling rate among EU member states. The Netherlands has made significant strides in EPR for packaging since its program implementation in 2008. Afvalfonds verpakkingen operates the Dutch EPR program for packaging, and Kennisinstituut Duurzaam Verpakken (KIDV) (Netherlands Institute for Sustainable Packaging) operates to assist obligated companies to undertake improved packaging designs and to select packaging materials that permit easier recyclability and/or reusable designs. The Institute employs their Recycle Check procedure which analyzes the individual components of a company's choice of packaging design to inform producers of the impacts that their packaging material would place on current sorting and recycling capacities in the Netherlands (KIDV, n.d.a). The Recycle Check program has a specific focus on flexible plastic packaging. Additionally, the Institute offers a Sustainable Packaging Compass tool for flexible and rigid plastic packaging materials. The tool is used to analyse three different pillars of improved design: recyclability, circularity, and environmental impact (KIDV, n.d.b).

3.9.5. North America

The US was one of the earliest adopters of EPR for many materials as early as the 1970s, using advanced-disposal fees for beverage containers as well as for hazardous wastes and WEEE. Currently, Oregon and Maine have approved fee-based, mandatory EPR programs for packaging waste. Oregon approved the *Plastic Pollution and Recycling Modernization Act* in 2021, and Maine approved *LD 1541, An Act to Support and Improve Municipal Recycling Programs and Save Taxpayer Money* in 2021 (Maine Department of Environmental Protection, n.d.; Oregon Department of Environmental Quality, n.d.).

Canada currently has five provincial EPR programs for packaging in implementation. The first program was implemented in Ontario in 2004, followed by Québec in 2005, Manitoba in 2010, British Columbia in 2014, and Saskatchewan in 2016

(Diggle & Walker, 2020). British Columbia's recycling program employs a full EPR model and is currently the only program in Canada that receives 100% producer funding while being fully operated by producers, supplementing funding from taxpayers (Recycle BC, 2021). British Columbia's program also achieves the highest recovery rate in the country at 85.5% and is recognized as the leading EPR model in Canada for municipal recycling programs (Recycle BC, 2021).

New Brunswick approved legislation for an EPR program for packaging in 2019, becoming the first province in Eastern Canada to do so, while local governments and stakeholders within other Canadian provinces have proposed legislation and are undertaking public consultations, including Nova Scotia and Alberta (Government of Alberta, 2021; Government of New Brunswick, 2021; Province of Nova Scotia, 2021). Harmonized implementation of EPR for packaging waste in Canada has been recognized as a crucial step towards improved overall plastic waste management and a circular plastics economy (see Appendix A) (CCME, 2019; Diggle & Walker, 2020).

3.10. Conclusion

The risks of plastic mismanagement are increasingly recognized as a threat to wildlife on land and at sea, to global environmental health, and to human livelihoods. Direct and cumulative risks within ecological systems have been increasingly documented, and it has become evident that the persistence of plastic pollution in aquatic and terrestrial environments could have profound implications for the long-term subsistence of wildlife around the world.

There is currently a complex landscape of government approaches and responses to plastic pollution, and current actions address different aspects of the plastic life cycle. Citizen-led actions based on cleanups and citizen science have been significant factors propelling the development and implementation of governmental actions including material bans, levies, and taxes that seek to limit and control the quantity of problematic plastic products within the consumer marketplace. Restrictions have also led to the implementation of large-scale national and international plastic strategies that aim for a united agenda in the effort to mitigate plastic pollution. Currently, policymakers within the international community have recognized the dire need to contend with a pollution issue defying international borders, and to forge a globally aligned strategy for improved plastic production and use for the sake of ecological and human wellbeing, and economic security.

Producer responsibility and private sector engagement are crucial components in achieving transformation along the plastic value chain and in pursuing a reuse-oriented economy for plastics. The EPR principle seeks to obligate industry within the wider life cycle of plastic materials, to bear financial and/or physical responsibility for plastic waste management, specifically for recycling plastic packaging waste. Implicating producers in the functioning of waste management programs would guarantee regular funding for waste collection and disposal services, achieving a crucial first step towards improved plastic management. The environmental and economic benefits of the EPR principle for improved plastic recycling are clear, and the principle is continuing to gain momentum around the world as an effective and vital waste policy to ensure industrial accountability in the plastic pollution crisis. In the next chapter, each provincial EPR program operating in Canada will be examined in detail. Through case study analysis, the following section analyzes the environmental and economic benefits of this waste policy for improved recycling and waste reduction for communities in Canada, and presents potential impacts and benefits of implementing an EPR program for packaging in Nova Scotia.

Chapter 4: Determining Potential Business Impacts from the Implementation of an Extended Producer Responsibility Program for Printed Paper and Packaging Waste in Nova Scotia

4.1. Introduction

The management of residentially generated waste is a costly endeavour for citizens and governments to undertake, and waste mismanagement can place serious environmental and economic burdens on communities. The impetus for recycling recoverable waste materials is to regain valuable resources in production cycles, and to minimize further demand and consumption of raw resources in future manufacturing production (Lindhqvist, 2000; McDonough & Braungart, 2002). Millions of tax dollars are required for collection of recyclable materials, and recycling programs demand significant capital financing and labour. Nova Scotia's (NS) municipalities currently spend upwards of $25M annually on recycling alone (Gorman, 2019).

Printed paper and packaging (PPP) materials comprise a significant proportion of residentially generated waste. The World Bank states that globally, dry recyclable materials consisting of plastics, paper and cardboard, metals and glass accounts for 38% of waste generation (Kaza et al., 2018). Packaging materials like glass, metal, carton and plastic currently provide an essential function for the global distribution of food, beverages, and consumer goods (Varghese et al., 2020). Printed paper products are similarly essential resources for businesses and organizations for distribution of consumer goods, advertising, and public communication. While PPP materials are central within the modern marketplace, and for marketing and public communications, their complex array of physical and chemical properties pose challenges in ensuring efficient and effective collection, and in locating end-markets for their recycling. The cost and logistics required to uphold a municipal recycling program can be staggering for local authorities to undertake, due to increasingly fluctuant and instable global recycling market conditions for plastics, in particular (CCME, 2009). The costs for collection and processing can account for between 77-95% of total costs within recycling programs but could increasingly verge towards higher thresholds considering the greater difficulty in accessing end-markets for the most difficult-to-recycle materials (Giroux Environmental Consulting, 2014). Many materials, including post-consumer plastic categories, have variable resell values, and the costs of collecting and processing those categories in municipally funded waste management programs can often outweigh their potential value in secondary markets, thereby disincentivizing investment in diversified recycling programs (Szaky & Zakes, 2015). Their mismanagement results in greater environmental and social costs.

Large volumes of plastic waste are generated from packaging materials, especially for the storage and distribution of food and consumer products which are often comprised of primary plastics with a short use phase (Geyer et al., 2017; Geyer, 2020). Research has found that food packaging waste alone comprises approximately one-third of all Canadian municipal solid waste (Xanthos & Walker, 2017). Recycling has been upheld as an important step in recovering these resources and mitigating their contribution to plastic pollution (Geyer et al., 2017).

Throughout Canada, various provincial EPR programs have already been implemented for products ranging from car batteries, lightbulbs, and WEEE (EPR Canada, 2017; OECD, 2021a). Historically, across Canada EPR has been regarded as an effective strategy to manage problematic waste categories and has been employed for many products due to its effectiveness in waste diversion (Duncan Bury Consulting, 2012). The EPR principle has become recognized as an essential part of improving overall recycling and pollution prevention in Canada (Diggle & Walker, 2020). The Government of Canada includes the EPR principle as an essential component to achieving the Canada-wide Strategy for Zero Plastic Waste. The CCME (2019) ranks EPR as one of the key priorities to achieve a zero-waste plastics economy in Canada in Phase 1 of the Canada-wide Action Plan on Zero Plastic Waste, and has pursued dialogue with provincial and territorial governments to ensure harmonization in implementation of EPR programs across Canada for plastic waste (ECCC, 2019; CCME, 2019).

In NS, EPR programs have been employed for many hazardous waste streams through both provincially regulated and voluntary producer programs. NS currently has several both provincially regulated and non-regulatory EPR and product stewardship programs (Nova Scotia Environment, 2020). The beverage container recycling system is one example of a regulatory program operating in NS. In addition to collection of beverage containers, regulatory programs include collection of hazardous household waste including used oil, consumer paint products, and used tires; non-regulatory collection programs are undertaken independently by business or industry associations for telephone directories and milk packaging (Nova Scotia Environment, 2020).

In Canada, the first EPR program for PPP materials was introduced in 2002 in Ontario (Canadian Stewardship Services Alliance (CSSA), 2020a). Currently, five EPR programs for PPP are underway in British Columbia (BC), Manitoba (MB), Saskatchewan (SK), Ontario (ON) and Québec (QC). These programs are funded fully or partially by industries that supply PPP to the provincial market. Throughout four programs in BC, SK, MB and ON, there were 2,472 active industry stewards participating in EPR programs for PPP in 2020 (CSSA, 2020b). New Brunswick (NB) approved an EPR policy for PPP in 2019, which would be Atlantic Canada's first such program. In October 2021, NB amended its *Designated Materials Regulation* for recycling programs within the *Clean Environment Act* to include packaging materials that would be covered as part of the program, and a draft program plan is planned for completion in 2022 (Corbett, 2021). NS does not yet have an approved EPR program for PPP, despite many proposals from provincial entities and supportive consensus among NS's municipalities to implement it (Province of Nova Scotia, 2021). The *Extended Producer Responsibility and Paper and Packaging Act* - Bill 25 was introduced to the provincial legislature in October 2021 (Nova Scotia Legislature, n.d.).

Stewards across Canada provide hundreds of millions of dollars in annual funds to finance EPR programs in the country. For instance, industry stewards provided $367M CAD (hereafter, all dollar values presented are in CAD currency) in EPR funds to Canadian provinces in 2016, of which NS received no funds (Halifax Regional Council, 2018). By 2020, steward contributions rose to an estimated $485.2M (Éco Entreprises Québec, 2019; Multi-Material Stewardship Manitoba, 2020; Multi-Material Stewardship Western, 2020; Resource Recovery Alliance, 2021; Stewardship Ontario, 2020). Many EPR programs for PPP in Canada are funded through national product pricing models, wherein obligated producers embed their accrued costs of becoming a steward into their products that are sold around the country, thereby offsetting these costs onto consumers who purchase their products (Halifax Regional Council, 2018). This means that Nova Scotians are paying the same price as consumers in other provinces who are receiving waste management support through this mechanism, without receiving any of the benefits and cost alleviation. Furthermore, Nova Scotia citizens are paying recycling prices twice in this regard. Any purchase made in NS that falls within these national product pricing models is in addition to property tax payments that citizens already make on an annual basis, which are the source of funds for municipal recycling programming (Gorman, 2019; Halifax Regional Council, 2018). As such, the province is investing in waste resource management programs in other provinces but faces an unfair disadvantage in that its municipalities have received no industry funds to support its increasingly costly recycling program.

The role of businesses operating in NS is therefore crucial in alleviating the inundating burden of financing the current recycling system in the province and improving recycling performance. The business community in NS is varied in its response to the development of a provincial EPR program for PPP. The Canadian Federation of Independent Businesses (CFIB) and the Retail Council of Canada (RCC), among other stakeholders who advocate on behalf of businessowners across the country, have expressed the position that implementing EPR for PPP in NS may unfairly obligate a small quantity of businesses in the province who would be unfairly required to finance a system that pays for the collection of all PPP materials from businesses who meet the exemption threshold and are thus not required to financially contribute. This position will be expanded further and analyzed in later sections.

The need for a provincial EPR program for PPP waste in NS has been identified by local governments and waste authorities in NS and is the subject of ongoing efforts by members of the Nova Scotia Federation of Municipalities (NSFM) (Halifax Regional Council, 2018). In response, the provincial recycling organization Divert Nova Scotia has identified the current need to understand how businesses operating in the province could be impacted by the potential implementation of an EPR program for PPP. Divert Nova Scotia has directed this research with key objectives to identify the expected impacts on businesses, alongside the environmental gains an EPR program for PPP would bring to the province.

4.2. Methodology

The research objectives of this chapter that have been determined by Divert Nova Scotia are fivefold:

1. Determine the impact of EPR for PPP on small, medium and large businesses in NS;
2. Determine the number of businesses that would likely be impacted at specified *de minimus* levels of $1M and $2M;
3. Determine the types of businesses that would be impacted in NS;
4. In other provinces where EPR for PPP exists, determine the number and types of businesses that are impacted; and
5. Investigate the ways to reduce impacts on NS business based on best practices in other jurisdictions.

These research objectives have required a mixed-methods approach, relying primarily on document review, on data available from the CSSA, data from Canadian provincial stewardship organizations, as well as provincial financial data from Statistics Canada accessed through the Economics and Statistics Division of the Nova Scotia Department of Finance. Following is an overview of the methods that have been employed to fulfill the objectives of this research.

4.2.1. Literature Review

This literature review relied on peer-reviewed, governmental, and regional research that has been undertaken on the topic of implementing an EPR program for PPP materials. Available literature that has been produced for the implementation of an EPR program for PPP in NB has been employed in contextualizing the topic for Atlantic Canada.

An ongoing comprehensive literature review began in November 2018 and continued until March 2020. Peer-reviewed literature was retrieved primarily through the digital Novanet library catalogue available to academic institutions across NS. Additional peer-reviewed literature was located from closely examining the citations included in bibliographies in each article, and relevant literature therein was located. The main search terminology and thematic combinations of terms that were included in search queries are as follows:

- ‘extended producer responsibility’ & ‘extended producer responsibility plastic’ & ‘extended producer responsibility packaging’;
- ‘EPR’ & ‘EPR plastic’ & ‘EPR packaging’;
- ‘packaging’ & ‘brand packaging’ & ‘food packaging’ & ‘printed paper packaging’
- ‘packaging and paper’ & ‘packaging and paper waste’ & ‘plastic waste’;
- ‘product stewardship’; and

- ‘recycle plastic‘ & ‘recycling plastic’ & ’recycle packaging’.

Extensive review of each of the five provincial PPP program regulations in Canada was also completed through an analysis of current program plans and policies that are available through each provincial stewardship organization’s website. EPR program plans were gathered from the organizational websites of Recycle BC; Multi-Material Stewardship Western; Multi-Material Stewardship Manitoba; Stewardship Ontario; and Éco Entreprises Québec. Since each program is renewed in different time periods, any updates or changes to programs that may not have been reflected in the currently available program plans were supplemented through the CSSA’s resources made available on their website.

Resources on the topic of EPR were employed from the Organization for Economic Co-operation and Development (OECD), the EU, and various other governmental organizations that have produced rigorous coverage on EPR issues for all industries currently implicated in EPR around the world.

Lastly, media coverage of PPP recycling has risen steadily over the timeline that this research has been undertaken, especially in regard to the political and social eagerness for the adoption of an EPR program for PPP across the Atlantic region. Canadian and international media coverage in this respect has been another source of relevant literature in conducting this research.

4.2.2. Classification of National Stewards in Canadian Stewardship Services Alliance

The national stewards participating within each program operating in BC, SK, MB and ON are updated and made available at the beginning of each calendar year by the CSSA. The CSSA, established in 2012, operates as the overarching body providing administrative services to four of the five provinces operating PPP programs in Canada

(CSSA, 2020). Québec is currently not a member of the CSSA and operates its PPP program independently. At the time of writing, its own steward data were not available to analyze in this research (CSSA, 2020a).

Available steward data from four Canadian programs were analyzed for several factors: their quantity of total active stewards, the quantity of both resident and voluntary stewards, and industry sector representation within the programs. All 2,472 stewards across four provinces were individually categorized into their respective industry. This was undertaken to gain a general overview of the industries affected in other jurisdictions, and to determine if some industries held a greater participatory predominance in current PPP programs.

Secondly, steward data from the CSSA were analyzed further beyond country-wide classification with focus on SK's program exclusively. Sizeably, SK's EPR for PPP program would be most comparable to NS than the other larger Canadian provinces, in terms of the composition of their small business community. Each steward in SK was classified into one of three categories: businesses headquartered in SK, businesses headquartered within a different Canadian province, and businesses headquartered outside of Canada. This information was analyzed to draw a comparison between two groups: stewards with a SK-based headquarters, and stewards from businesses that have headquarters located elsewhere. This analysis is useful for characterizing the composition of local businesses in SK that are stewards in the provincial program, versus for stewards based outside of SK, and in doing so, it is possible to parallel the information to gauge the proportion of local NS-based businesses that may be implicated in the development of an EPR program for PPP in the province.

The North American Industry Classification Standard (NAICS) is employed as the standard categorical framework in this research to divide industry stewards into their applicable industries to facilitate defined comparison. The NAICS is employed by

Statistics Canada and is composed of 20 industry types that are divided into two main categories of goods-producing and service industries.

Goods-producing industries include:

- Agriculture, forestry, fishing and hunting;
- Mining, quarrying, and oil and gas extraction;
- Utilities;
- Construction; and
- Manufacturing (including that of food; pharmaceuticals; beverages; textiles; paper and wood products; technology and hardware; petroleum and chemicals; consumer goods; as well as packaging materials themselves).

Service-providing industries include:

- Wholesale trade (includes enterprises that may distribute products from a manufacturer, or that may manufacture their own products to sell directly to retailers or other businesses);
- Retail trade (not including restaurant establishments);
- Transportation and warehousing;
- Information and cultural industries (including media; film, sound, and video industries; broadcasting; telecommunications; and libraries);
- Finance and insurance;
- Real estate, and rental and leasing;
- Professional, scientific and technical services (including legal, financial, architectural, engineering, design, and advertising labour);
- Management of companies and enterprises;
- Administration and support, waste management, and remediation services;
- Educational services;
- Health care and social assistance;
- Arts, entertainment, and recreation;

- Accommodation and food services (including restaurants);
- Other services (not public administration, but including repair and maintenance services; personal care services; religious, professional and social organizations; and private households); and
- Public administration.

Stewards were analyzed based on their main industrial sector. The purpose of this analysis has been to identify the most significant sources of PPP materials in Canada. Stewards were classified into only one industrial category based on their main area of activity, though some businesses span multiple operations along their supply chain. This was undertaken to simplify categorization and avoid duplication. For example, a manufacturer that is also involved in retail trade has been primarily categorized in the manufacturing category. If an agricultural food producer is also involved in the wholesale of agricultural produce, the business has been categorized in the goods-producing agricultural sector.

4.2.3. Nova Scotia's Business Impacts

The process of determining the quantity of small, medium-sized and large businesses in NS is based upon a methodology previously used within a 2019 report prepared by Recycle New Brunswick for the Union of Municipalities of New Brunswick, titled "Packaging and Printed Paper Dialogue Phase IV: Report on the Phase IV Packaging and Printed Paper Dialogue" (Léger, 2019). Its methodological approach therein is employed for the purposes of this study. Detailed provincial business revenue data collected by Statistics Canada were accessed through the Economics and Statistics Division of the Nova Scotia Department of Finance. To glean an accurate account of the industry composition in NS, revenue data were accessed from the reporting period of December 2019. In light of the substantial impacts of the global COVID-19 health pandemic on the business community within the country, particularly on small enterprises, data from this reporting period may be able to provide a more accurate account of the industry composition in the province from what could be considered a conventional economic landscape and operational conditions.

4.3. Packaging and Printed Paper Material

Trading activities among human societies throughout history have always required packaging to fulfill essential functions to “contain, protect, identify, and distinguish” goods (Klimchuk & Krasovec, 2012, p. 3). Traditionally, packaging materials were composed of metal, glass, paper, and clay (Hine, 1995). Growing economic globalization coupled with technological innovations in the post-World War II era have required widening trade networks for food and other commodities to travel longer distances, which has necessitated greater volumes of packaging material to store and transport commodities to distant markets (Goldstein, 2012; Hawkins, 2018). Design principles for packaging materials show preference for disposability, lightness of weight (known as material ‘light-weighting’ in product fabrication), and enhanced product hygiene (Miller, 2019). Alongside its physical characteristics, the visual features of packaging design are viewed as integral to brand success in the marketplace, which therefore play a crucial role in the selection of a packaging material in the product design stage that will allow for businesses’ marketing objectives and strategies to be fulfilled (Wagner, 2015). Marketplaces now rely on a flood of packaged goods to stock shelves, acting as “the skin of commerce” (Hawkins, 2018, p. 387).

4.3.1. Categories of Packaging

Due to the complexity of packaging categories and applications used in the marketplace today, it is important to define and clarify the existing terminology of the different functional classes of packaging available in retail outlets. This terminology will be further employed in following sections to describe designated materials collected in PPP programs.

Primary packaging acts as a main container of a product, having direct contact to the contents of the product. Secondary, or grouped packaging, provides less direct contact with the product, but acts as an additional material on top of the main protective layer, and is often used to contain several items for sale together (CSSA, 2020a). Tertiary packaging, also termed as transportation, bulk, or distribution packaging, combines or secures consumer goods in their movement from a manufacturing facility or main holding location to the marketplace (CSSA, 2020a). This category of packaging would secure goods within large shipments on pallets or crates. If removed within a retail location before a transaction, such packaging would not be considered part of the residential waste stream, but if brought home with the consumer to their household, it would be discarded into the residential waste stream and thus would be deemed a designated material in a PPP program (CSSA, 2020a).

Service packaging is provided to consumers to be filled at a point of sale and includes such items as bags that are filled at bulk food counters, and takeout and home delivery food packaging (Recycle BC, 2019). Lastly, ancillary elements upon any of the listed packaging materials, or any features that hang onto or are attached to a package, and which are not intended to act as an integral part of products' long-term storage itself would constitute a PPP material (Recycle BC, 2019).

4.3.2. Packaging and Printed Paper Waste

As a waste class, PPP comprises many diverse types of materials. Printed paper materials act as vital resources for organizational and corporate communication and advertising, and as materials deemed necessary for public use such as telephone books, brochures, and flyers. Packaging is also evidently a crucial material for the protection and transportation of goods in the marketplace and into consumer households.

PPP materials are functionally diverse and are similarly diverse in their physical and material properties, resulting in high levels of variability and complexity, which in turn pose a central challenge in recycling programs when materials are economically or technically infeasible to collect and recycle. The marketability of PPP materials is not homogenous, and the collection and management of these materials requires consistent public participation in sorting and collection, in addition to a large input of financial resources and coordination between many actors. Mismanagement of these materials results in increased litter and pollution rates, landfill disposal, and lost resources.

Throughout modern history, trade in scrap markets has been well developed for metals, glass, and other materials that have had value to humans for centuries (Strasser, 1999). Aluminum and other metal products have historically been considered of higher value for recycling, and more feasible to reuse where the required network and infrastructure has been available. Some glass and metals have relatively stable end-markets for recycling and are considered more sustainable in product reuse systems. Overall, metal and glass materials both perform well in recycling markets due to their material durability, and greater efficiency in recycling compared to the primary manufacture of glass and metal (Food Packaging Forum, n.d.; Gürlich & Kladnik, 2021). According to Novelis, the largest global manufacturer of flat-rolled aluminum, aluminum beverage cans can be recycled and distributed back to a retail outlet as new products within a total of sixty days, starting from their recycling until their redistribution (Hogan, 2019). Glass, a similarly robust packaging material, is optimal to maintain in product reuse systems through beverage deposit systems and other mechanisms; however, the material can also be challenging to recycle because of high rates of breakage and fluctuating market conditions (Giroux Environmental Consulting, 2014).

Through emergent trends in light-weighting and innovation in packaging design, however, plastic has become a popular choice for replacing weightier packaging materials like glass and metal. Plastics for packaging are variable and more complex in their physical and chemical composition than other material classes, and once discarded, they are oftentimes challenging to market for recycling due to their mixed material composition. PPP waste is also subject to higher rates of contamination which affects the quality of materials collected and makes recycling harder to undertake. Packaging materials in many cases are multi-plastic in composition, but during reprocessing and sorting, they are categorized based on their main material, resulting in poorly separated and lower quality materials collected overall (Brouwer et al., 2018). Mixed-material waste does not facilitate cost-effective recycling operations. By placing the financial responsibility for the management of PPP waste on producers, businesses would theoretically be incentivized to optimize their packaging designs and select materials that are less materially complex, and more financially worthwhile to recycle (CSSA, 2020a; Kunz et al, 2018).

Many of the packaging materials that are employed today were designed for their low cost to manufacture and ease of disposal, with little oversight invested into the post-consumer costs that they would place on consumers, households, and communities in the future (Lindhqvist, 2000). In effect, increasing volumes of disposable packaging and paper materials have accumulated at a rapid rate and have left local authorities facing rising costs in the effort to recover resources and limit disposal. Large volumes of disposable material are met with an equally voluminous challenge – a reliance on foreign export recycling markets to accept materials that cannot be processed domestically due to lacking domestic recycling infrastructure.

4.3.3. Challenge of Locating End-Markets

The Chinese government's ban on waste imports entering its country, enacted in 2018, left the global recycling market stranded (Brooks et al., 2018). International efforts to limit mismanagement in the global recyclable material trade continue to attempt to effectively address the problem. Locating international markets for the recovery of recyclable materials is a central challenge for local authorities in NS, who are currently lacking domestic options. In this context, producers are better positioned to navigate these global market challenges and play a pivotal role in optimizing recycling systems (CCME, 2009).

4.4. Extended Producer Responsibility Principle for Packaging and Printed Paper

The CSSA describes EPR as "the concept that businesses assume responsibility for the impact of their product and/or packaging on the environment after it is discarded by consumers regardless of whether it is managed in the waste, organics or recycling stream" (CSSA, 2020a, p. 8). An EPR program balances several goals at once: lowering waste material generated from packaging, increasing the quantity of waste packaging that can be collected and recycled in end-markets, and stimulating redesign for packaging materials that are difficult or costly to recycle, or that pose risks to human health (Azoulay et al., 2019; Geueke, Groh & Muncke, 2018). EPR programs for PPP require a balance between resident participation, operational efficiency along a reverse supply chain, and measurement of progress towards the overall goal of increasing resource efficiency and pollution prevention. In EPR programs for PPP, the economic, and in some cases operational and logistical, responsibility for management of post-consumer PPP is placed on industry. Following is a brief discussion of the key stakeholders and groups of actors in an EPR program.

4.4.1. Producer Responsibility Organization

In Canada, collective EPR programs employ one or several stewardship organizations to represent stewards of a designated class of recyclable materials and act on their behalf (CSSA, 2020a; Kunz et al., 2018). A Producer Responsibility Organization (PRO) is an entity that oversees the registration of obligated stewards and payments to reimburse municipalities for the costs of their recycling program. A stewardship organization is established in response to the approval of a provincial regulation for an EPR program. During the design phase of an EPR program, it would be the responsibility of a PRO to outreach to businesses to introduce them to applicable stewardship concepts, details about the proposed program, and to determine if they would be required to register as an obligated brand owner, first importer, or franchisor doing business in the province that supplies PPP material to residential consumers (Giroux Environmental Consulting, 2014).

A PRO negotiates contracts for collection and recycling services and acts as a "collective service-provider" to industry stewards (OECD, 2016). PROs are responsible for implementing and enforcing the policies and measures to ensure that producers fulfill their obligations by setting the criteria and methodology in which producers will be required to pay costs for the materials that they are putting on the market covering PRO management of collection, sorting, and recycling or other end-of-life treatment (OECD, 2020). This control is a crucial component in how the design of producer payments may facilitate feedback loops between the recycling process and improved material design or Design for Environment.

4.4.2. Full Responsibility Model

In a full responsibility EPR model, producers are responsible for the entire financial cost and operational management of the program. In some full models, like that of Recycle BC's, operational responsibility for collection, program promotion and education are still overseen by either a provincial recycling organization or by individual municipalities, if they choose to continue to operate their programs independently (Recycle BC, 2019). Generally, a full responsibility model requires the producers to finance and operate the process of household collection, processing and locating end-markets for recyclable materials, unless an agreement outlines that a municipality or local stewardship agency will remain responsible for delivering a portion of the program.

The preference for a full responsibility model takes the onus off a local government to deliver recycling programming and allows a producer to have full control over program planning and administration. Producers are best positioned to carry out the most efficient and effective recycling systems, due to their ability to access and locate recycling end-markets on a global scale, as well as to respond to inefficiencies by making alterations to their product designs and selection of packaging materials.

A full responsibility model may allow a contract to be defined between producers and municipalities, that incorporates existing municipal infrastructure and other resources into the new program. In the transition from a municipally run recycling program to a full EPR model, any publicly owned recycling infrastructure may become a stranded asset unless producers agree to contract with a local government to employ pre-existing facilities or human resources in the new program (Halifax Regional Council, 2019). Therefore, stewards may contract with local governments to use sorting facilities, vehicles, or other investments that have been made in the past. Additionally, a local government may remain the first point of contact with citizens in delivering educational materials for the program, or other services.

4.4.3. Shared Responsibility Model

In a shared responsibility model, stewards and local authorities are both financially and operationally responsible for a portion of the recycling program. A percentage of total annual program costs incurred by a municipality are reimbursed by obligated stewards. In Canada, the common percentage for municipal reimbursement currently ranges between 50% to 100%. A funding formula is employed in each program to determine all eligible costs that industry stewards are required to reimburse a municipality.

A shared EPR model allows for municipal or regional waste authorities to continue to have decision-making power over program design and operation, which is an avenue that is ideal for municipalities that have made significant investments within publicly owned infrastructure for their recycling programs (Giroux Environmental Consulting, 2014).

There are criticisms and disadvantages to the shared model. Some disadvantages from an industry standpoint include their lack of control over program operations, since program administration, contract setting, and logistical decision-making power remain within the hands of municipalities. Industry finances the recycling program but does not have equal authority to control program delivery, or to implement program efficiencies to reduce overall costs. Additionally, there is found to be less impetus for industry to undertake packaging design changes in a shared model, resulting in reduced impact on design-for-environment objectives (OECD, 2018). A full EPR model allows for more direct feedback loops between the standpoints of waste collection and industry, wherein assuming the complete task of locating end-markets for recyclable materials would theoretically incentivize a producer to identify and undertake changes to their product designs and create more efficient material choices for optimal recyclability.

4.4.4. EPR System Actors

Lindhqvist (2000) defines four primary actors involved in an EPR program: producers, users, waste managers, and authorities.

4.4.4.1. Producers

Identifying the party along a supply chain responsible as a financially obligated producer may not be immediately straightforward (Lindhqvist, 2000). Early in the development of European EPR programs, this issue was debated regarding which actor(s) should assume responsibility for managing such end-of-life materials. A supply chain can comprise many actors involved in the initial extraction of raw resources, in the design and development of materials, in product distribution, and in retail (Lindhqvist, 2000). Therefore, a producer may be defined as any actor along the supply chain spanning raw material extraction, manufacturing and assembly, and distribution (which includes post-production actors like wholesalers, importers, dealers, and retailers) (Lindhqvist, 2000). In response to this complex matter of identifying a responsible party, EPR programs for PPP materials set three categories of obligated stewards to clarify and define responsibility. These include 'brand-owner', 'first importer', and 'franchisor'.

From a Canadian standpoint, the CSSA states that stewards may be deemed obligated if they provide any type of packaging or paper materials to residential consumers through sale, or through distribution of informational or promotional materials (CSSA, 2020a). Many stewards do not operate exclusively as businesses that produce or distribute PPP materials but may be a non-commercial entity that distributes PPP material as part of an educational or community purpose. Churches, municipalities, and universities may qualify as obligated stewards in an EPR program for PPP, as they currently do in some EPR for PPP programs across Canada (CSSA, 2020a).

Once a producer has been identified, there are two categories that define their participation in an EPR program, based on their operational conditions and their status as brand-owners, importers, or franchisors in the jurisdiction that they are operating in.

Obligated Stewards

Obligated stewards, also termed as resident stewards, are required to report and pay fees if they are a brand-owner, first importer, or owner of a franchising business operating within a jurisdiction supplying any designated PPP materials to residential consumers that will be generated in the residential waste stream.

An entity is deemed an obligated steward if they qualify to report and pay fees for the PPP materials they introduce into the marketplace, based on a set revenue-based or weight-based threshold. In Canada, there are various exemption factors in place to determine obligated and non-obligated producers in each provincial program. These exemptions are also termed as *de minimus* conditions. If a producer meets any of the *de minimus* criteria, they would be required to commit to an annual agreement that indicates that they fall within the applicable exemption threshold (Giroux Environmental Consulting, 2014). These exemption factors may be based on the following considerations and will be expanded upon in following sections describing how they are implemented in other provinces:

- Revenue-based threshold;
- Weight-based threshold;
- Single point of retail sale;
- Low volume steward fees;

- Flat fee categories; and
- Franchisor and franchisee obligations.

Simply put, any PPP-using organization that is not exempted from any of the provincially set thresholds for obligated stewards is required to report and pay their proportionate material fees annually.

Voluntary Stewards

Any non-resident stewards may be deemed responsible for designated PPP if they register to become voluntary stewards. Voluntary, non-resident stewards become obligated to report designated PPP materials and pay fees on behalf of another entity that supplies PPP material in a jurisdiction. Once a voluntary steward registers in one jurisdiction, they are responsible for reporting and paying fees for all of their brands that supply designated PPP materials to residential consumers within that specified jurisdiction (CSSA, 2020a).

4.4.4.2. Users

A user is defined as any private or professional consumer or patron (Lindhqvist, 2000). By making purchasing decisions, the user fulfills a fundamental role in product systems as a consumer, and crucially, they are the first point of contact with waste managers when products become waste. Users fulfill an essential role as effective sorters of household waste and participants in recycling programs. While the user is an essential stakeholder in product systems as a consumer and citizen, they have comparatively little authority and power to innovate product designs and alter the supply chain for PPP materials that producers themselves have (Lindhqvist, 2000). Users do have a role to play in bolstering product improvement and innovation through engagement and participation in consumer campaigns, and as informed and effective recyclers in the home and in public.

Additionally, the user plays an essential role as a taxpaying citizen which upholds the infrastructure and networks that are necessary for municipally run recycling programs to exist. Furthermore, from an EPR standpoint, the user continues to play an essential role as a consumer who indirectly pays some of the costs of an EPR program through national product pricing schemes or deposit/refund systems, which are embedded into a products' total costs (Kaffine & O'Reilly, 2013). While there is no one-size-fits-all model for the financing of an EPR program, the consumer plays an essential role in EPR for PPP programs in Canada.

4.4.4.3. Waste Resource Managers

These actors consist of the labour roles required along the entire recycling supply chain, beginning with waste collection, sorting, processing, treating and recycling (Lindhqvist, 2000). Depending on the particular model, waste managers may be public employees of municipal programs, or private employees of a third-party waste company that has been contracted by a municipality, or an industry or business association.

4.4.4.4. Authorities

These actors are composed of all applicable levels of government comprising municipal and provincial levels who have legislative power in proposing, enforcing, and regulating an EPR program (Lindhqvist, 2000). Whether an EPR model is built on a full or shared responsibility funding model, the relationship between all actors, especially that between authorities and producers, is critical in ensuring the financial and operational components of a program are well-defined and that all parties are fairly compensated and engaged. Monitoring and enforcement protocols to ensure industry stewards are fulfilling their duties are crucial, as are program targets to ensure that the program is achieving measurable progress in creating an efficient recycling system, and in reducing detrimental environmental impacts.

4.4.5. Design for the Environment

The central goal of the EPR principle is to achieve feedback loops between all implicated actors in the waste resource management chain. Improving the material characteristics of product systems for easier recyclability, safer disposal, or avoided disposal altogether by maximizing recyclability are concepts that together form EPR's Design for Environment (DfE) goal (Lindhqvist, 2000). There are a multitude of methods and actions that a producer could choose that encompass design improvements. This includes individual steps or a combination of the following concepts and activities depending on the relevance and applicability to the material make-up of the product (Kunz et al, 2018; Lindhqvist, 2000):

- reusability;
- repairability;
- refurbishment;
- leasing;
- cascading;
- capacity-sharing; and
- dematerialization.

Program elements in producer responsibility can instigate supply chain changes that can be prompted or enforced by a number of factors in the program design. A range of instruments, ranging from economic, informational, or regulatory may be used to incentivize a producer to minimize or phase out their use of problematic or hazardous substances that pose a risk to human or environmental health.

4.5. Extended Producer Responsibility for Packaging and Printed Paper Programs in Canada

There are more than 80 provincial product stewardship programs across Canada for various materials (CSSA, 2020a). Currently, there are five EPR programs underway for the collection of PPP materials. In Canada, EPR for PPP programs cover residentially generated materials collected in residential waste streams. The programs do not involve waste materials generated through the institutional, commercial and industrial (ICI) sector. In Table 4.1, characteristics of each of the five programs include their regulatory frameworks, the overarching provincial stewardship organization administering each program, years of operation, as well as the residential scope of their collection program.

Table 4.1: *Overview of Provincial PPP Stewardship Programs in Canada in 2020.*

Provincial PPP Programs	Provincial Stewardship Organization	Regulation	Year Active	Full or Shared	Producer Funding	Residential Stream Collection
British Columbia	RECYCLEBC	***Environmental Management Act, 2003*** *Regulation 449/2004, Schedule 5* May 2011	2014	Full	100%	Multi- and single- family dwellings, depots, streetscapes, municipal parks and plazas
Saskatchewan	Multi-Material Stewardship Western	***Environmental Management and Protection Act, 2002*** *Household Packaging and Paper Stewardship Program Regulations* February 2013	2016	Shared	75%	Multi- and single-family dwellings, depots
Manitoba	MMSM Multi-Material Stewardship Manitoba	***Waste Reduction and Prevention Act, 1990*** *Packaging and Printed Paper Stewardship Regulation* December 2008	2010	Shared	80% (100% by 2024)	Multi- and single-family dwellings, depots
Ontario	Stewardship Ontario	***Waste Diversion Transition Act, 2016*** (formerly ***Waste Diversion Act, 2002***) *Blue Box Waste Regulation*	2004	Shared	50% (100% by 2023)	Multi- and single-family dwellings, depots
Québec	Éco Entreprises Québec	***Loi sur la qualité de l'environnement (Environment Quality Act)*** *Regulation respecting compensation for municipal services provided to recover and reclaim residual materials*	2005	Shared	100%	Multi- and single-family dwellings, depots, streetscapes, municipal public spaces

Sources: CSSA (2020a); Éco Entreprise Québec (2019); Multi-Material Stewardship Manitoba (2017); Multi-Material Stewardship Manitoba, 2021b; Multi-Material Stewardship Western (2015); Recycle BC (2019); Stewardship Ontario (2020).

4.5.1. British Columbia

Recycle BC describes its provincial program as a reverse supply chain operation (Recycle BC, 2019). BC has had a full producer funding model since 2014, whereby 100% of their PPP program is funded by obligated stewards and operated in a shared model with Recycle BC. The program maintains a 85.8% recovery rate (Recycle BC, 2021). As of 2020, BC had a total of 1,273 stewards: 1,050 resident and 223 voluntary stewards (CSSA, 2020b). Recycle BC's program was the first of any jurisdiction in North America to report on detailed material-specific PPP collection, and to set targets on sub-categories of both rigid and flexible plastics (Recycle BC, 2019). In Table 4.2, BC, alongside SK, is one of two provinces that implements a 'single point of retail' exemption as part of its exemption categories (CSSA, 2020a).

Table 4.2: *Recycle BC Program.*

RECYCLEBC	**Types of Paper Product**	**Material Exclusions**	**Revenue-based Exemption**	**Tonnage-based Exemption**	**Single Point of Retail Sale Exemption**
Types of Packaging <u>Materials collected:</u> paper, metal, glass & plastic Primary, secondary, tertiary, service & ancillary elements	- Flyers - Brochures - Booklets - Catalogues - Telephone books - Newspapers - Magazines - Paper fibre - Paper used for copying and writing	- Unsafe or unsanitary paper items - Bound textbooks, reference or literary books	- ≤$1M in annual revenue in BC - Charitable organizations do not need to register - No online sales - Not part of chain or franchise	Businesses that supply ≤1,000 kg of PPP 'Low Volume Stewards' pay a flat fee with tonnage between: - 1,000 kg – 2,499 kg & 2,500 kg – 4,999 kg Increasing to: - 5,000 kg – 9,999 kg & 10,000 kg – 15,000 kg	Businesses operating a single storefront

Sources: CSSA (2020a); Recycle BC (2019).

4.5.2. Saskatchewan

Multi-Material Stewardship Western (MMSW) is the provincial stewardship organization overseeing all producer obligations and facilitating the reporting and payment of annual fees from all obligated stewards. As of 2020, SK had 553 stewards: 298 resident stewards, and 255 voluntary stewards (CSSA, 2020b). The program maintains a 76.5% recovery rate (MMSW, 2021). Under the provincial program agreement, stewards can choose either to submit their own plan for collecting and recycling PPP materials or become member to MMSW that develops a plan for stewards to meet the requirements of the regulation (MMSW, 2015).

In 2014, the province added a permanent exemption for businesses generating less than $2M in annual revenue, for those supplying less than one tonne of residential packaging and paper, and for those operating a single retail store location. A two-year transition period was instated for implementing an exemption from reporting and paying fees for low-generating stewards. Visible in Table 4.3, SK is the second province that maintains a ‘single point of retail’ exemption.

Table 4.3: *Multi-Material Stewardship Western Program.*

Multi-Material Stewardship Western	**Types of Paper Product**	**Material Exclusions**	**Revenue-based Exemption**	**Tonnage-based Exemption**	**Single Point of Retail Sale Exemption**
Types of Packaging <u>Materials collected:</u> Glass, metal, paper, boxboard, cardboard, paper fiber, and plastics Primary, secondary, tertiary, service & ancillary elements	- Flyers - Brochures - Booklets - Catalogues - Telephone books - Newspapers - Magazines - Paper material used for copying and writing	- Unsafe or unsanitary items - Bound books - Plastic pallet wrap - Distribution, industrial or bulk packaging not meant for residents to bring to the household - Cutlery - Packaging sold as empty (e.g. waste bags) - Items an integral part of a product's containment (e.g. toner cartridges and disposable cameras) - Durable packaging with a useful life of >5 years and remains with a product throughout its useful life	≤$2M in annual revenues in SK	Businesses that supply ≤1,000 kg of PPP 'Low Volume Stewards' pay a flat fee with tonnage between 1,000 kg – 5,000 kg	Businesses operating a single storefront

		- Materials made of wood, ceramic, crystal and rubber			

Sources: CSSA (2020a); Multi-Material Stewardship Western (2015).

4.5.2.1. Comparing Saskatchewan and Nova Scotia's Industry Composition

Due to comparable provincial populations and composition of small business communities in both provinces, sizeably, SK's EPR for PPP program may be most applicable for comparison with NS than another larger Canadian province. NS's proposed EPR program employs the same revenue-based exemption of $2M for small businesses, the same weight-based condition of <1 tonne of PPP annually, as well as a single point of retail exemption. In Table 4.4, small businesses constitute the largest proportion of businesses in NS and SK, though these data are representative only of businesses operating with employees in each province. Further information on total businesses operating in NS both with and without employees is available in following sections.

Table 4.4: *Number of Small, Medium, and Large Employer Businesses in Nova Scotia and Saskatchewan in December 2019.*

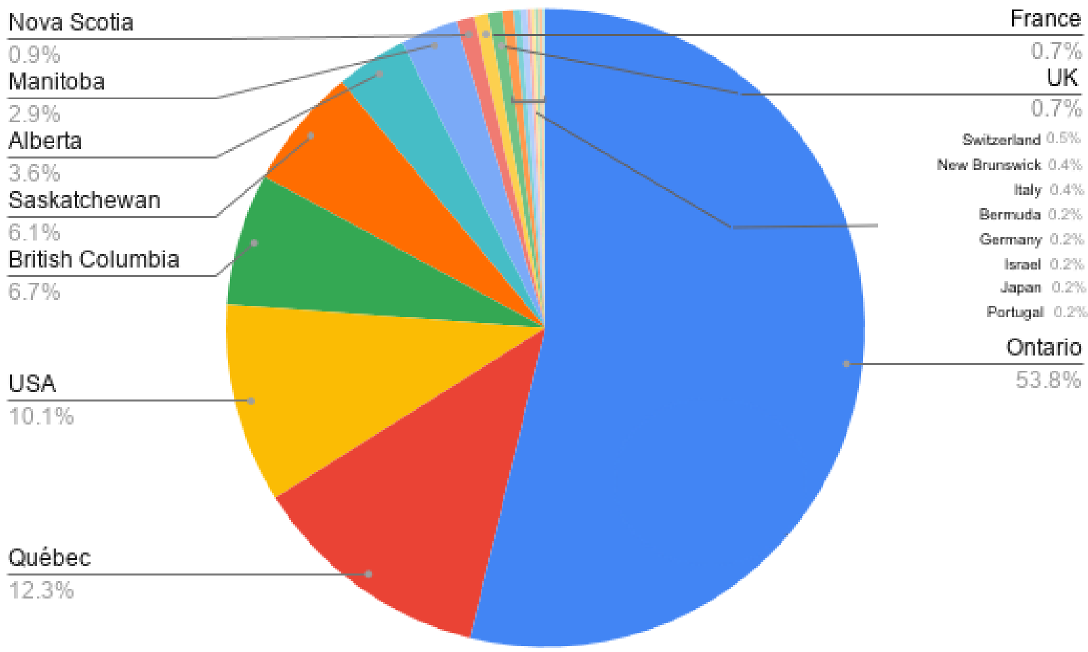
Province	Small businesses (1-99 employees)		Medium businesses (100-499 employees)		Large businesses (500+ employees)		Total businesses with employees
Nova Scotia	29,876	98.0%	542	1.8%	68	0.2%	30,486
Saskatchewan	41,008	98.3%	647	1.6%	77	0.2%	41,732

Source: Innovation, Science and Economic Development Canada (2020).

In Table 4.4, NS was dominated by smaller business enterprises in the province in 2019. It is clear that the largest proportion of employer businesses is concentrated in the enterprises that are composed of under 100 employees. Findings in SK demonstrate an almost identical actuality in industry composition, indicating a larger presence of small employer businesses within the province.

Using national steward data available from the CSSA, a headquarter analysis of SK’s industry stewards has been undertaken to locate trends that might illuminate important insight for obligated stewards in an EPR program for PPP in NS. National steward data demonstrate that SK sees low amounts of locally headquartered businesses represented in its total group of stewards, and a larger quantity of Canadian subsidiary brands and multinational corporations. SK’s resident stewards that are headquartered within SK total merely 33 local businesses, or approximately 6% of total industry stewards. A larger proportion of its stewards are located outside of the province. This demonstrates that only a small proportion of SK’s local business community is obligated in the province’s program, and larger corporations with multiple locations or subsidiary brands continue to play a predominant role in financing the program. These trends are visible in Figure 4.1.

Figure 4.1: *Composition of Industry Stewards in Multi-Material Stewardship Western Program in 2020.*



Source: CSSA (2020b).

4.5.3. Manitoba

Multi-Material Stewardship Manitoba (MMSM) is the province's stewardship organization. As of 2020, the province had a total of 791 stewards: 545 resident, and 246 voluntary stewards (CSSA, 2020b). The program maintains an 80.3% recovery rate for PPP materials (MMSM, 2021a). MB is the only province that does not maintain a *de minimus* condition for exempted stewards to avoid registering with the provincial stewardship organization. Table 4.5 shows further details of the province's program plan.

Table 4.5: *Multi-Material Stewardship Manitoba Program.*

MMSM Multi-Material Stewardship Manitoba	Types of Paper Product	Material Exclusions	Revenue-based Exemption	Tonnage-based Exemption
Types of Packaging <u>Materials collected:</u> Glass, metal, paper, boxboard, cardboard, paper fibre & plastics - Primary, secondary, tertiary, service & ancillary elements	- Newspapers - Glossy magazines - Directories - Lottery tickets and information - Product warranties and instructions - Envelopes, statements and inserts from banks, credit companies, utilities and service providers - Informational forms and promos from governments - Free posters and calendars - Unsolicited promotional coupons, handbills, and flyers -Transportation and transit schedules	- Bound reference books, literary books, or textbooks - Purchased calendars - Envelopes - Greeting cards - Paper fibre - Paper used for copying and writing	- All stewards are required to register regardless of revenue - Exempt from reporting materials if gross annual revenue in MB is ≤$750,000	N/A

Sources: CSSA (2020a); Multi-Material Stewardship Manitoba (2017).

4.5.4. Ontario

Stewardship Ontario (SO) is the provincial stewardship body administering Canada's oldest PPP program, which was begun in 2005. As of 2020, Ontario had a total of 1,823 stewards: 1,794 resident, and 29 voluntary stewards (CSSA, 2020b). The province currently maintains a 57.3% recovery rate (SO, 2021). Table 4.6 shows further information on the conditions set in the provincial program plan.

Table 4.6: *Stewardship Ontario Program.*

<table>
<tr><th>Stewardship Ontario</th><th>Types of Paper Product</th><th>Material Exclusions</th><th>Revenue-based Exemption</th><th>Tonnage-based Exemption</th></tr>
<tr><td rowspan="2">Types of Packaging

<u>Materials collected:</u> Glass, metal, paper, plastics & textiles

Primary, secondary, tertiary & ancillary elements</td><td rowspan="2">- Newspapers

- Glossy magazines

- Comic and puzzle books

- Product catalogues

- Directories

- Lottery tickets and information

- Product warranties and instructions

- Envelopes, statements and information from banks, credit companies, utilities and service providers

- Information, forms, and promos from governments

- Business, investment and securities information

- Promotional calendars and posters

- Unsolicited coupons, handbills, and flyers

- Transportation and transit information</td><td rowspan="2">- Bound reference books, literary books, or textbooks

- Purchased calendars

- Envelopes

- Greeting cards

- Paper fibre

- Paper used for copying and writing</td><td>≤$2M in annual revenue in Ontario</td><td>N/A</td></tr>
<tr><td colspan="2">Businesses with gross sales >$2M but supplying less than <15,000 kg of materials must report but are not required to pay fees</td></tr>
</table>

Sources: CSSA (2020a); Stewardship Ontario (2002).

4.5.5. Québec

A total of 55% of the ÉEQ's total program cost is funded by retailers, distributors, and first importers; the remaining proportion of costs is covered by manufacturers of consumer goods by 33%; providers of general services by 8%; and manufacturers of durable goods by a remaining 3% (ÉEQ, n.d.). In Table 4.7, the material exclusions listed are comprehensive of more diversely characterized products than CSSA-administered programs.

Table 4.7: *Éco Entreprises Québec Program.*

Éco Entreprises Québec	Types of Paper Product	Material Exclusions	Revenue-based Exemption	Tonnage-based Exemption
Types of Packaging <u>Materials collected:</u> Paper, carton, plastics, glass & metal - Materials that contain, protect, wrap or notably present products at any stage in the movement of the product from the producer to the consumer and is intended for a single or short-term use and designed to contain, protect or wrap products	- Newsprint inserts and circulars - Catalogues and publications - Magazines - Telephone books - Paper for general use - Other printed matter	- Agricultural containers - Containers and packaging sold as products meant to contain or package materials (e.g. waste bags) - Long life containers or packaging designed to accompany, protect or store a product for >5 years - Books - Newspapers (covered separately by Recycle Médias)	- ≤$1M in annual revenue in Québec	- ≤1,000kg of PPP annually

		- Personal and official identification documents like birth certificates, passports and medical records		

Source: Éco Entreprises Québec (2019).

4.6. Classification of CSSA National Stewards

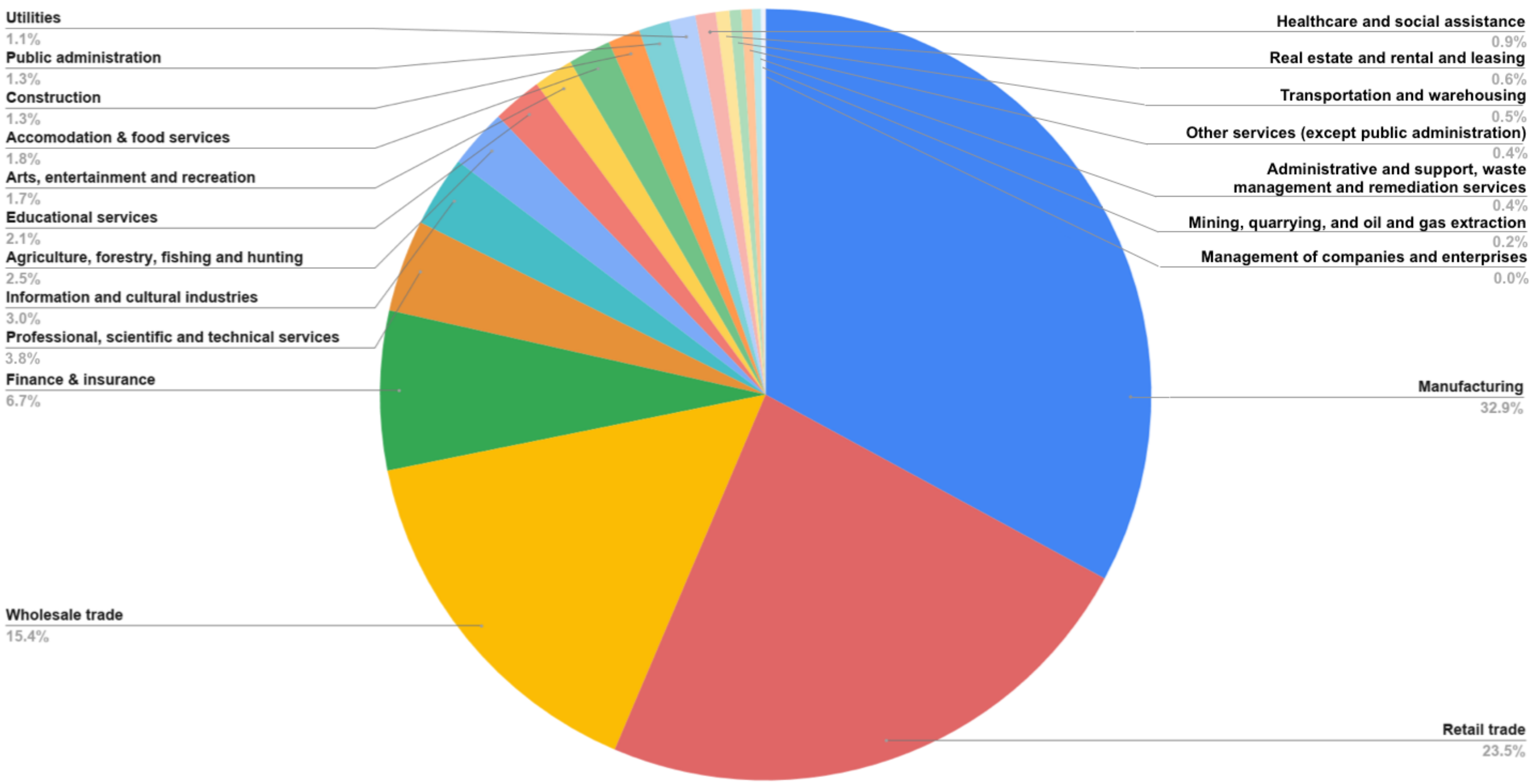
In 2020, there were a total of 2,472 stewards participating in BC, SK, MB and ON's programs. The total membership of Québec's provincial stewards was not available at the time of writing, and it was therefore not possible to reach an entirely inclusive total of stewards active across all five programs in Canada. Stewards responsible for financing each EPR program emerge from various industries and range from multinational brand owners and franchises, to non-commercial institutions and organizations. Such non-commercial entities are large enough generators of packaging or printed paper that they become obligated to fulfill their responsibilities.

A total of 558 (about 23%) of stewards are implicated in all four programs. Based on the available data from BC, SK, MB and ON, the total 2,472 stewards listed on the CSSA's national steward registry were individually classified into 20 industries. This was completed to identify any existing patterns and trends that are currently observable in Canadian EPR programs for PPP among the organizations and businesses that are implicated in PPP programs today. While this particular classification cannot be observed as an all-encompassing resource for Canadian EPR for PPP as a whole, since it is lacking steward classification data from the ÉEQ, it may still be useful as a representative guide in illuminating which industries currently contribute most to the PPP waste stream, as well as which industries participate most in EPR for PPP.

One significant trend that can be easily ascertained in Figure 4.2, is that stewards are currently dominated by the manufacturing industry, by approximately one-third. Following that, the retail trade and wholesale trade industries together comprise an approximate 40% of stewards. The wholesale industry comprises a range of supply chain actors that are involved in the provision of products to market; while they may have manufacturing operations, their main business activity consists of wholesaling merchandise through distribution and supplying directly to the retail sector and other businesses (Statistics Canada, 2017).

Close to 75% of the CSSA's national stewards are represented by just three industries: the manufacturing sector, the retail trade sector, and the wholesale trade sector. The remaining share, about 28% of stewards, is composed of 17 other industry categories each occupying a much smaller share in EPR for PPP programming. Non-commercial entities such as educational services and public administration contribute a significant amount to the PPP waste stream as well, considering their relatively small share as stewards compared to the predominating manufacturing industry. Further research would be required to clarify the composition and nature of PPP materials and usage among these industries – specifically, by identifying the quantities of PPP materials introduced to the marketplace for commercial purposes, and the quantities of PPP materials for distributional, educational, or other non-commercial means.

Figure 4.2: *Industrial Classification of Stewards in BC, SK, MB and ON EPR Programs for PPP in 2020.*



Data Source: CSSA, 2020b.

4.7. Extended Producer Responsibility for Printed Paper and Packaging in Nova Scotia

In November 2018, a unanimous resolution was passed by the NSFM to support the province's development of legislation and a regulation for a full EPR model for PPP (Halifax Regional Council, 2019). The Municipal-Provincial Priorities Group of the Nova Scotia Solid Waste-Resource Management Regional Committee has been leading the charge in pursuing an EPR program for PPP in the province. The Priorities Group has proposed a full EPR model to be funded 100% by producers, and it includes conditions that are intended to create a fair landscape for all stewards. Various exemption conditions for small businesses are based on the following thresholds (Halifax Regional Council, 2019):

- Revenue less than $2M;
- <1 tonne of PPP to NS residents annually;
- Operating as a single storefront;
- Not supplied or operated as a franchise; and
- Newspapers and registered charities.

The proposal also includes the following stipulations for the dynamic between industry stewards and municipalities in NS:

- Maintain residential curbside access for all citizens in the recycling program;
- Maintain bi-weekly collection schedule at a minimum;
- Maintain a comprehensive sort list inclusive of currently designated recyclable materials;
- Provide ICI sector access to the program;
- Allow municipalities a right of first refusal to provide collection and program education services to residents; and
- Use existing municipal infrastructure and resources in the program.

4.7.1. Identifying Small, Medium and Large Businesses in Nova Scotia

The total quantity of registered businesses in the province of NS in December 2019 are listed in Table 4.8. The Unclassified industry category has been omitted from this analysis. In December 2019, Unclassified businesses totaled 7,445 in the province. Unclassified businesses have not been specifically included in previous regional analysis of EPR for PPP. Further investigation may be required to identify the particular activity of this class of businesses and to clarify potential impacts that this group could face in the province.

Table 4.8: *Total Enterprises with and without Employees in Nova Scotia, December 2019.*

Industry (NAICS categories)	Quantity
Agriculture, forestry, fishing and hunting	7,720
Mining, quarrying, and oil and gas extraction	190
Utilities	95
Construction	7,425
Manufacturing	1,740
Wholesale trade	2,105
Retail trade	6,175
Transportation and warehousing	2,810
Information and cultural industries	1,050
Finance and insurance	5,660
Real estate and rental and leasing	10,450
Professional, scientific and technical services	6,935
Management of companies and enterprises	845
Administration and support, waste management, and remediation services	2,320
Educational services	770
Health care and social assistance	6,565
Arts, entertainment, and recreation	1,390
Accommodation and food services	2,945
Other services (not public administration)	5,985
Public administration	300
Total	73,475

Source: Statistics Canada (2020).

The industrial community in NS is characterized by many small and locally owned enterprises that operate in both the production and service sectors. A small business in Canada is classified as operating with less than 100 employees (Statistics Canada, 2020). This is the manner in which some entities in the province define small, medium and large businesses by size-based comparisons of workforces.

The Priorities Group has proposed a small contributor policy of setting a *de minimus* condition at $2M (Gorman, 2019). Businesses that exceed the $2M threshold for the small business exemption policy would be affected as obligated stewards if they qualify as either brand owners or first importers of PPP that generates waste in the residential stream. Tonnage-based information on PPP usage and other conditions would evidently need to be considered in tandem with these findings.

For a summary of the concentration of small, medium, and large businesses that operate in the province, provincial revenue data from Statistics Canada provide quantities distinguished by industrial sector (Table 4.9). In Table 2019, a total of 20 categories quantifies NS-based businesses into ranges of $1M and $2M in annual revenue, as well as businesses that gross higher than $2M in annual revenue. All industry categories included in Table 4.9 could expectantly employ PPP materials and contribute to PPP waste in the residential waste stream. While Table 9 is comprehensive of the industrial sectors with active stewards in EPR for PPP programs across Canada, any absent industries that will not be captured in this analysis may require additional research.

Two different numerical counting methods are used within provincial revenue data that has been presented, due to data having been made available by the Economics and Statistics Division of the Nova Scotia Department of Finance in two different formats. Sector totals below $1M and $2M revenue employ an exact numerical counting method. In contrast, business total above $2M revenue employ a numerical counting method wherein figures appear rounded to the nearest fifth value. This disparity in counting methods is due to Statistics Canada's own variable reporting formats. While sector information will evidently vary in its specificity due to this disparity in counting methods, conclusions that are reached are sensitive to this.

Table 4.9: *Enterprises with and without Employees in Nova Scotia by Revenue Ranges of $1 and $2M in December 2019.*

Industries in Nova Scotia	< $1M in Annual Revenue	< $2M in Annual Revenue	> $2M in Annual Revenue
11 – Agriculture, forestry, fishing and hunting	7,291	7,525	195
21 – Mining, quarrying, and oil and gas extraction	155	165	30
22 – Utilities	49	57	35
23 – Construction	6,388	6,570	555
31-33 – Manufacturing	1,237	1,356	380
41 – Wholesale trade	1,204	1,398	710
44-45 – Retail trade	3,746	4,571	1630
48-49 – Transportation and warehousing	2,477	2,587	220
51 – Information and cultural industries	814	894	145
52 – Finance and insurance	5,008	5,231	435
53 – Real estate and rental and leasing	9,975	10,168	280
54 – Professional, scientific and technical services	6,438	6,662	280
55 – Management of companies and enterprises	743	780	70
56 – Administrative and support, waste management and remediation services	2,000	2,119	205
61 – Educational services	68	709	60
62 – Health care and social assistance	5,901	6,219	340
71 – Arts, entertainment and recreation	1,275	1,343	40
72 – Accommodation and food services	2,226	2,680	280

Industries in Nova Scotia	< $1M in Annual Revenue	< $2M in Annual Revenue	> $2M in Annual Revenue
81 – Other services (except public administration)	5,605	5,818	165
91 – Public administration	238	258	45

Source: Statistics Canada (2020).

Based on Table 4.9, a total of **62,838** businesses operated below the annual revenue threshold of $1M in 2019. A total of **67,110** businesses operated under the annual revenue threshold of $2M in 2019 (an increase of approximately 4,272 businesses from $1M). There was a total of **6,100** businesses listed that generate above $2M in annual revenue, and that would fall above a revenue-based exemption threshold as proposed by the Priorities Group – a considerably smaller amount than the number of businesses who would likely be exempted.

4.8. Expected Impacts on Businesses in Nova Scotia: Observations and Analysis

Developments in the current marketplace have resulted in a significant reliance on packaging materials to transport and contain commodities, as well as a growth in the use of printed materials for media, advertising, promotional information, and within educational industries. The flood of discarded PPP materials into the residential waste stream has placed an overwhelming burden on modern waste management systems, with repercussions that are increasingly costly and operationally complex for local governments to address in efforts to keep up with waste generation rates and reduce landfill waste and environmental pollution in the process. The complexity of modern packaging materials, in addition to the instability of global recycling markets, creates a complex landscape for local governments to navigate, who have very little influence on product supply chains and very little capacity to improve product designs from their vantage point. The technological limitations of modern recycling infrastructure decrease what can be recycled and diverted from landfill. Requiring industry to finance recycling programs, instead of taxpayer funding, would foreseeably ensure proper PPP management, reduce waste of valuable materials, and avoid environmental impacts of pollution and further resource consumption. EPR programs for PPP also create opportunity for feedback loops between waste management systems and producers, who are better poised to increase efficiencies and undertake product changes to optimize recyclability of PPP materials moving forward. For this reason, EPR for PPP is being proposed in the province.

An EPR program for PPP would require the most significant generators of PPP materials in the marketplace to be responsible for their fair market share. The proposed framework of a full EPR program for PPP in the province would require industry to finance 100% of the costs of recycling collection, processing, and exporting materials to end-markets. Determining the impacts on producers who would be responsible for upholding an EPR for PPP program in the province requires further investigation.

Various exemption thresholds and conditions exist within the EPR principle, which are used in tandem in determining obligated industry stewards. The Priorities Group has set a number of exemption conditions for stewards and to accommodate small businesses that include a $2M *de minimus,* as well as a weight-based exemption condition set at one tonne of PPP annually. Additionally, the Priorities Group has set conditions based on single storefronts and franchisee restrictions. Combining provincial revenue findings alongside additional weight-based data relating to PPP usage of businesses in the province would be the next step in determining obligated stewards in the province.

Analysis of SK's industry stewards shows that only a small proportion (approximately 6%) of their total stewards is comprised of local businesses headquartered in that province. If SK's low proportion of local stewards provides any indication of the quantity of local stewards who may become obligated in NS, only a small percentage of the province’s local businesses would be impacted. While SK’s program plan resembles the same revenue and weight-based conditions in NS’s current proposal, the program is not identical and therefore any comparisons should be nuanced in this regard.

The business community in NS is composed of a large proportion of small businesses operating below $2M revenue. A total of 6,100 businesses have been identified as grossing higher than $2M, sitting above the revenue-based exemption condition. This portion represents just 8.3% of all businesses in the province. Most impacts to high-grossing businesses in the retail trade sector and the wholesale trade sector have been indicated.

The proportion of affected businesses above the $2M threshold as a proportion of all businesses operating in that sector in NS is presented:

- Agriculture, forestry, fishing and hunting: 2.5%
- Mining, quarrying, and oil and gas extraction: 15.8%
- Utilities: 36.8%
- Construction: 7.5%
- Manufacturing: 21.8%
- Wholesale trade: 33.7%
- Retail trade: 26.4%
- Transportation and warehousing: 7.8%
- Information and cultural industries: 13.8%
- Finance and insurance: 7.7%
- Real estate, and rental and leasing: 2.7%
- Professional, scientific and technical services: 4.0%
- Management of companies and enterprises: 8.3%
- Administration and support, waste management, and remediation services: 8.8%

- Educational services: 7.8%
- Health care and social assistance: 5.2%
- Arts, entertainment, and recreation: 2.9%
- Accommodation and food services: 9.5%
- Other services: 2.8%
- Public administration: 15%

Considering these proportions are strictly based on the consideration of revenue and are thus not inclusive of all exemption conditions available in the development of an EPR program for PPP, the individual proportions that have been calculated above are representative of the maximum quantity of stewards in each sector that could be impacted by a revenue-based threshold. Many businesses in all sectors would likely be exempted on the basis of low rates of PPP material output, or due to a relatively low reliance on PPP materials in relation to other classes of businesses.

These findings demonstrate somewhat of a correlation with findings from national steward data. While the CSSA's national steward data do not include details that explain why particular sectors dominate across the country, the greater presence of businesses from manufacturing, retail, and wholesale industries suggests a heavier volume of PPP material usage among them. Since retail, wholesale, and manufacturing businesses in other programs qualify as stewards at a greater rate across the country, the expectation for NS is that participating stewards would not deviate from that actuality. According to the CSSA, many of the largest producers in NS are multinational corporations who themselves have made commitments to improve their packaging designs and increase recycled content in their product materials (Halifax Regional Council, 2019). It could therefore be considered within the best interests of industry to participate in a full model of EPR for PPP to become better positioned to achieve these commitments.

As it has been made visible through analysis of SK's industry stewards, some NS businesses are stewards in other EPR for PPP programs. Further research would be useful to quantify how many NS-based businesses are already industry stewards across Canada and, if applicable, internationally.

4.9. Reducing Impacts on Nova Scotia Businesses

Authorities in NS have worked on strategies that have engaged industry stakeholders and municipalities in the province to identify their concerns and interests. A number of mitigative solutions are discussed that have been proposed by provincial actors and the CSSA that would ensure fair impacts to businesses operating in the province, and also ensure that industry is paying their fair market share into an EPR program for PPP.

4.9.1. Determining Exemption Conditions

Firstly, exemption categories are implemented within provincial programs to ensure the contributions of stewards are proportionate to the PPP materials they introduce to the residential consumer, and thus to ensure that small organizations and businesses are not unjustly or disproportionately impacted by a PPP program. As discussed, there are a number of factors that can be implemented in program planning to accommodate all ranges of industry and ensure a level playing field in the process.

Past development of PPP programs in other provinces left the process of determining exemption conditions to the PROs, which led to significant confusion expressed by stewards relating to large financial impacts anticipated by small businesses (Giroux Environmental Consulting, 2014). This lack of engagement and integrated dialogue with producers in provinces has created a "strained public relations" between the PRO and members of the business community, as well as with regulators and businesses who had expressed sentiments of abandonment within an overall important dialogue (Giroux Environmental Consulting, 2014, p. 25). To avoid previous shortfalls made in this regard, it is recommended to undertake long term and consistent consultation with the business community to identify and understand the collective needs and operational conditions of stewards across all affected industries.

The proportion of stewards who sit above the $2M revenue threshold Is smaller in comparison to the quantity of stewards that operate below that threshold. This arises a matter of free ridership that concerns some industry stakeholders including the RCC and the CFIB. Entities like the RCC and CFIB posit that a $2M *de minimus* condition provides a disproportionate advantage to small businesses, who comprise the larger proportion of industry in the province, which would unfairly require a much smaller group of medium and large stewards in the province to finance the collection and recovery of all PPP materials in the residential waste stream, suggesting a scenario that would result in a minimal number of businesses accounting for the entire PPP waste volume generated by all businesses in the province.

What is not usually noted in this argument is that once obligated, a steward is exposed to a number of options to offset the incurred costs of EPR for PPP. There are a number of different avenues available to a steward to finance their costs in an EPR program. Internalizing the costs of participating in an EPR program within products sold to consumers is commonplace, thus offsetting the costs of becoming an obligated steward. Once obligated to pay, an industry steward has mechanisms available to them to respond to the costs incurred and respond accordingly – these include advanced disposal fees and deposit fees that could be embedded into the cost of a product and applied at the point of sale (OECD, 2006). As discussed, many stewards in Canada already rely on national product pricing to embed the costs of becoming an obligated steward into the commodities that are sold to consumers around the country.

4.9.1.1. Single Point of Retail Exemption

For further discussion on the effectiveness and fairness of various exemption categories, the CSSA upholds that single storefront exemptions, also definable as single point of retail exemptions, are not needed to promote greater fairness, since revenue-based and weight-based conditions will achieve enough in leveling the playing field for small businesses (Halifax Regional Council, 2019). Such a condition may be an ineffective indicator for measuring the size and relative impact of an enterprise. Exemptions measuring tonnage and revenue alone have been found to achieve necessary benefits proportionate to the needs of small businesses.

4.9.2. Harmonization

Current recycling conditions in Canada consist of many fragmented and disjointed elements, wherein many disparate programs can operate within the same province and might mandate their own set of recyclable material lists. This disjointed landscape of recycling in Canada underlines harmonization as one of the foremost key issues that EPR for PPP attempts to address.

Establishing a streamlined provincial or Atlantic Canadian approach for the central elements of an EPR for PPP program would benefit producers. Harmonized definitions in program plans must define the legally obligated parties, designated PPP materials, and performance targets and metrics (Halifax Regional Council, 2019). Standardized factors concern the percentage of steward contribution for program funding (full or shared); designated PPP material lists; levels of service for urban and rural households, and depots; and standardized material fees (Giroux Environmental Consulting, 2014). Consistency among all program elements in this regard would better allow and simplify negotiations with the business community in program design, who would likely be obligated across multiple jurisdictions in the implementation of a regional program (Giroux Environmental Consulting, 2014). Further strategies could include harmonized criteria for minimum physical requirements on product innovations redesigns to achieve meaningful design-for-environment principles (Filho et al., 2019).

As the CSSA states, it is difficult to achieve true harmonization across all economic and operational factors in one jurisdiction without a mandated national standard for harmonization countrywide (Halifax Regional Council, 2019). As it stands currently, EPR for PPP programs continue to operate with their own particular intricacies and respond to the unique needs of local stakeholders in each province.

Harmonization is also important for consistency in what a sector pays for cost per kilogram of the same material across provinces. For example, as of 2014, the newspaper sector paid 0.5¢/kg in Ontario but 20¢/kg in BC (Giroux Environmental Consulting, 2014). This underlines the need to determine harmonized material fees as well as stable market prices not subject to regional inconsistencies; if the material properties of a product category are not altered by geographic region, their price should not be subject to change.

4.9.3. Fee Differentiation Among Recyclable Materials

Some assessments of EPR for packaging waste have pointed out the lack of differentiation of producer fees between those who achieve better circular design, and those producers who have been motivated to alter the problematic features of their packaging designs and pursue reusability (Filho et al., 2019). Around the world, PROs often employ weight-based fee payment systems that get averaged across producers, thus not identifying who among producers is making strides in improved packaging redesigns and circularization (Filho et al., 2019). Motivation for producers to undertake innovation could be integrated into EPR programs through fee differentiation or a hierarchy of EPR fees through the emerging concept of eco-modulation, that seeks to incentivize producers towards choices like redesign or mandating banned substances, and reward successes through reduction of fees (Kunz et al., 2018; Filho et al., 2019).

Materials that have been consistently difficult or impossible to market based on recycling market conditions were identified with research undertaken with local authorities and waste managers in Atlantic Canada in 2014 and are shown in Table 4.10. According to Giroux Environmental Consulting (2014), material processors noted the PPP materials collected in each Atlantic province that were most challenging to recycle.

Table 4.10: *Collected Materials Difficult to Recycle in Atlantic Canada in 2014.*

<table>
<tr><th>New Brunswick</th><th>Nova Scotia</th><th>Prince Edward Island</th><th>Newfoundland and Labrador</th></tr>
<tr><td>Wax-coated packaging</td><td>Plastic film</td><td rowspan="9">Boxboard limitation to 20% in bales</td><td>Plastic bags</td></tr>
<tr><td>Plastic bags</td><td>Coloured glass</td><td>Clamshells</td></tr>
<tr><td>EPS</td><td>EPS</td><td>Glass</td></tr>
<tr><td>Plastic film</td><td>Coffee cups</td><td>Styrofoam</td></tr>
<tr><td>Glass</td><td>Aerosols</td><td>Plastics #6 and #7</td></tr>
<tr><td>Newsprint</td><td>Milk cartons</td><td rowspan="4">Plastics without a number</td></tr>
<tr><td>Plastics #3 & #6</td><td>Gable tops</td></tr>
<tr><td rowspan="2">Clamshells</td><td>Select boxboard and paper that is compostable</td></tr>
<tr><td>Frozen juice containers</td></tr>
</table>

Source: Giroux Environmental Consulting (2014).

There are many materials that are deemed too difficult to market for recycling and are thus excluded from recycling programs altogether. The EPR Environment and Sustainability Standing Committee of the Halifax Regional Council has measured that industry currently employs upwards of 84 packaging materials, some of which are currently landfilled in the province since domestic recycling technology is unequipped to process them, and end-markets for their recycling are not available (Halifax Regional Council, 2019). The proposed EPR program for PPP would require industry to maintain the existing designated materials list currently employed in recycling programs in the province, and ideally increase the quantity of collected materials by locating new end-markets for their recovery. For any remaining material categories that are not able to be efficiently recycled, industry stewards would have the capacity to take steps to altogether phase out the use of problematic materials in packaging design within their own supply chains.

4.9.4. Investment in Regional Recycling End-Markets

An EPR program for PPP is still subject to the same fluctuating end-markets conditions for recycling regardless of program financing. Stewards financing PPP collection, processing, and marketing could develop mechanisms to incentivize local investment in recycling infrastructure as opposed to foreign recycling end-markets. Analysis by Duncan Bury Consulting (2012) found that any employment losses in the landfill waste collection and disposal sector would likely be offset by additional jobs made available through the collection of a greater number of recyclable materials. The employment and economic impacts of EPR made possible in the switch from a non-producer funded model has been shown to increase employment through additional diversion activities as well as potential market development (Duncan Bury Consulting, 2012).

Stranded assets represent a central concern in the transition from a municipally run program to EPR for PPP in NS. Publicly owned recycling infrastructure and human resources within the current program are considered essential elements to integrate into a producer run operation. A key stipulation in the currently proposed program asks that municipalities are allowed the right of first refusal to contract with industry to deliver collection and educational services in a producer-funded model.

4.9.5. Individual Producer Responsibility

The emergent term of 'individual producer responsibility' (IPR), coined by Lifset and Lindhqvist (2008), attempts to reposition the original vision of EPR in individualizing the capacity of each producer in their own supply chains to alter their product systems and assume greater responsibility in developing different end-of-life services for the products they put onto the marketplace. Membership in a PRO allows for a collective system of responsibility in EPR programs. In the Canadian context and around the world, there has been a preference for such collective EPR systems that focus on meeting collection and recycling targets on behalf of groups of producers or entire industry associations (OECD, 2021a). While these collectives may make it administratively, logistically, and financially less burdensome on obligated stewards to report materials and pay fees, the framework set out by the PRO may disincentivize businesses from assuming greater accountability in broader product innovation in integrating modularity, reuse, or other environmental considerations into product design (Kunz et al, 2018; Lifset & Lindhqvist, 2008).

Since the majority of EPR systems have been formed using the model of collective responsibility, design-for-environment achievements and industry-wide progresses in packaging choices have not been as wide-ranging by comparison with the original conceptualizations of the EPR principle for packaging system transformation (OECD, 2016). By tending toward light-weighting and shifting packaging choices between different classes of disposable materials, which merely minimizes the volume-based costs incurred as a steward, conventional business responses to their obligations in PPP programs have avoided some deep-set product improvement in the overall packaging supply chain. The feedback loops between all actors in the EPR framework that are necessary for a wider transformation towards design-for-environment require concerted supply chain coordination and a communicated understanding of the real economic, technological and environmental challenges and hurdles each actor faces in handling PPP materials and managing them in modern waste infrastructure. These feedback loops can mobilize actors in their otherwise discrete realms of manufacturing, retail, and waste processing to make long-lasting improvements to product design, manufacturing, and development of waste sorting technologies (Lindhqvist, 2000). EPR is as much a principle of communication and knowledge-sharing, as much as it is a legislative and economic instrument.

4.9.6. Design for Environment

Stories of EPR for PPP succeeding in supply chain innovation have taken place within Canada. In Ontario, rigid plastic clamshells commonly distributed to grocery stores to contain fruits, vegetables, and baked goods were posing an ongoing challenge to recyclers (SO, n.d.). Clamshells are fabricated from different types of similar looking thermoformed packaging – polyethylene terephthalate (PET) is of higher value and is easier to recycle in end markets, compared to clamshells made from polystyrene (SO, n.d.). Due to municipal facilities lacking the sorting technology to sort out the higher value plastic from lower grades, contamination between those different materials was becoming a major challenge resulting in unmarketable PPP materials (SO, n.d.). In 2011, the provincial stewardship organization achieved a commitment from the retailers Loblaw, Sobeys, Metro, Walmart, and Safeway to coordinate with their suppliers to source strictly PET clamshell packaging for their shelves. This success story in establishing a municipal, retail, and manufacturing feedback loop is an encouraging record of the potential inherent in EPR for PPP programs to accomplish wide-ranging design-for-environment changes in Canadian product systems.

4.10. Conclusion

The main objective of this study has been to investigate the foreseeable impacts that small, medium-sized, and large businesses operating in NS could expect amidst the implementation of an EPR program for the residential packaging and printed paper waste stream. Currently, there are five such EPR programs underway in Canada, but no such programs yet exist in the Atlantic provinces. NB was the first of the Atlantic provinces to announce an EPR program for packaging and printed paper, and it is slotted for program implementation in 2023. Meanwhile, there has been long-lasting municipal support for such a program to be implemented in NS. Divert NS has identified the existing knowledge gap in determining the potential business impacts that such a program may have in the province. This study has presented some key considerations and best practices from other jurisdictions to help reduce negative or disproportionate impacts on enterprises in the province.

A registry of national stewards from the CSSA was employed to produce a comparative visualization of the industrial sectors impacted most by EPR for packaging and printed paper in Canada, and to identify the industries that are implicated most in four of the five EPR programs in Canada. All industry categories are found to contribute to the PPP waste stream across Canada. The industries who appear to contribute most to the PPP waste stream nationally are concentrated in manufacturing, in retail trade, and in wholesale trade.

Finally, characteristics of the small, medium and large business community in NS were investigated. Analysis of the current program in SK shows that a very small proportion of the stewards financing that system is composed of local businesses based in the province, and the program is rather dominated by larger businesses based outside of that jurisdiction. Due to a comparable economic landscape between SK and NS, these findings could be considered relevant for the context of NS.

Based on exemption thresholds that have been proposed by authorities in the province, *de minimus* conditions have been set at $2M to determine obligated stewards. It was identified that, similar to national data, enterprises in retail trade and wholesale trade may be more directly impacted by the implementation of an EPR program for PPP in the province. Small businesses in the province far outweigh the quantity of medium and large enterprises. A small portion (8.3%) of highest grossing businesses in the province were indicated as potential stewards in the province. Further such research into how additional exemption thresholds may affect or relieve PPP-generating organizations in NS is essential and recommended.

EPR programs have the capacity to lessen the burdens on communities facing high volumes of PPP materials in their waste management programs. With further harmonization of such programs across Canada, it could result in significant achievements in establishing long-lasting and tangible feedback loops between all central actors in the waste management hierarchy. By normalizing EPR obligations among industries using PPP materials in their supply chains and operations, such momentum could create the impetus for design-for-environment improvements, minimizing PPP waste altogether, and altering supply chain flows to create more sustainable product systems in communities around the world.

Chapter 5: Pathways to a Reuse-Oriented Economy

Producer involvement in municipal recycling programs addresses the urgent need to provide adequate funding towards waste collection and recycling. EPR transfers the financial and/or administrative burden in waste management away from towns and cities to better manage packaging waste and to reduce the pathways towards environmental pollution. The EMF (2020a) posits that mandatory EPR is a crucial step on the ladder towards a circular economy since it is the best method of securing ongoing and stable funding towards recycling programs, and it requires wider actions by the private sector to undertake methods of waste reduction and material improvements. EPR comprises numerous methods for producers to both financially and physically exercise responsibility for their products, leaving room to examine the wider set of potential approaches that can be undertaken by actors in the marketplace to make material improvements to the sustainability of their products and supply chains. While the EPR principle was intended as a multi-pronged approach to improve the basis and outcomes of recycling (Lindhqvist, 2000), it remains crucial to assess the ways in which DfE can be achieved through EPR programs. Some steps employed by governments and industry will be elaborated in the next sections.

Beyond the payment of EPR fees for municipal recycling programs, many other instruments are available for governments and producers to implement changes across various stages along the value chain for packaging. These options range from regulatory and voluntary methods that can be employed in combination, mandated by government across industries or within an individual company (Yu et al., 2008). Policymakers and researchers stipulate that implementation of a range of these measures in combination are essential in reducing continued mismanagement and pollution caused by plastic packaging (EMF, 2017; EMF, 2020a; PACE, 2021). Through a regulatory approach, implemented top-down from various levels of government, available methods include bans, levies and taxes on virgin plastic production, which have been proposed by various actors as a method to encourage progress towards a circular material economy, by mandating that industries across the plastic value chain internalize the complete environmental and social costs of virgin plastic production (Adam et al., 2020; Bezerra et al., 2021; Clayton et al., 2021; EMF, 2020a; Enkvist & Klevnäs, 2018; Nwafor & Walker, 2020; Schnurr et al., 2018; Xanthos & Walker, 2017). Imposed regulatory bans on production and sale of specified materials allow for the most problematic materials to be removed from the market, outside of a market-driven approach of incrementally changing industry practice. Additionally, producers can adopt various voluntary EPR instruments, including commitments to national or global strategies like the EMF's Plastics Pact. Other examples of voluntary EPR are economic instruments like deposit/refund programs, and product take-back programs, which require greater logistic coordination.

5.1. Assessments of DfE Progress

Assessments of progress in DfE achieved through EPR programs for packaging vary depending on the particular jurisdiction in question. While many producers' approaches have been geared towards dematerialization, by reducing packaging size and weight, these approaches continue to employ disposal-oriented design principles as a paradigm. The concept that DfE could be accomplished via economic feedback loops as incentives and disincentives within companies has been limited due to the collective nature of the EPR model, where EPR costs are shared by groups of industry stewards and coordinated by PROs (Lifset & Lindhqvist, 2008). In a collective responsibility model, the financial aspects of producer responsibility allow producers to absorb the financial costs while minimizing wider physical changes to their products and their supply chain model.

The OECD (2021a) analyzes the use of fee-modulation to incentivise producers to use preferred materials subject to a range of fees that are proportionate to their recyclability and environmental impacts upon disposal. The nature of a collective EPR system allows producers to share the costs of being an obligated steward, thereby reducing the granularity of incentives or disincentives on stewards regarding the recyclability and performance of their material choices in the post-consumer market. Fee-setting is undertaken by PROs and is usually set at a basic level based on material weight and/or product type (OECD, 2021a). Eco-modulation, alternatively, is a mechanism by which fee-based EPR intends to incentivise the reduction of problematic and hard-to-recycle materials, by creating a monetary feedback loop once waste materials are collected and recycled (OECD, 2020). Eco-modulation in collective EPR programs works to close a gap whereby individual material prices are adjusted to reflect their full costs to collect, manage and process them in the recycling market, beyond weight-based thresholds.

Additionally, analyses of DfE for packaging in EU member states found that harmonization plays a significant role in industry adoption of greater DfE principles in their product design. When program requirements and material fees vary across many jurisdictions, it is considered more feasible by multinational companies to undertake minimal changes to product design in one market to meet jurisdictional requirements, as opposed to making largescale investments in redesign across their overall supply chain (OECD, 2021a). It is logistically more feasible for multinational companies to invest in minimal alterations to existing packaging material in a linear economy, compared to logistically transforming their supply chain, like implementing a reverse model (Coelho et al., 2020; Muranko et al., 2021).

5.2. Exploring Methods for Improved Circularity and Achieving DfE Principles

Focusing on the aim of the EPR principle to incentivise upstream DfE to improve product design, different methods have been proposed to pursue design improvements and integrate circular principles to improve the overall sustainability of a material choice. In the EMF's (2020b) guidelines for upstream design innovation in the consumer goods industry, three objectives for achieving circularity in packaging materials are elimination, reuse and material circulation. Methods for elimination of problematic materials have been proposed by different stakeholders, including industrial associations and private-public partnerships, to prevent the continued circulation of difficult to recycle materials, and orient packaging material designs towards design for optimal recyclability (Gürlich & Kladnik, 2021).

5.2.1. Elimination of Problematic Materials

The deregulation of petrochemical inputs to plastic production has resulted in decades of concerning but mystifying products in the marketplace used for packaging, causing unknown health impacts to consumers (Azoulay, 2019). Additionally, such development in the petrochemical industry has allowed for the configuration of many types of packaging properties, using such elements as additives, inks, colourants, and moulding techniques that cause difficulties for sorting and recycling materials. Various strategies propose the identification and elimination of the most problematic plastics that are both nonrecyclable and hinder the sorting and recycling of other valuable materials via contamination in the waste stream (EMF, 2020b; PACE, 2021).

The EMF proposes two possible approaches for elimination of problematic materials: direct and innovative (EMF, 2020b). Direct elimination would be necessary for nonessential packaging materials and would require steps to remove them from supply, whereas innovative elimination requires actions to locate a suitable and unproblematic substitute for the original material. Identifying substitutions for such materials would be necessary to proceed with a viable transition to more sustainable and circular packaging alternatives, especially to ensure that substitutes would not result in additional hindrances in the recycling system and ensure that viable recycling markets exist to manage them.

As previously discussed, governments have legislative capacity to implement bans or restrictions on the manufacture of certain problematic materials. Such bans may target one or several stages of the life cycle of plastic materials, regulating market entry, retail distribution, post-use and disposal, and trade (UNEP, 2018). For example, advocates have called for the complete production ban of multi-material sachets and polypropylene products that are commonly used in materials like chip bags and sealed dry goods (Liamson et al., 2020). An estimated 164 million multi-material sachets are used in the Philippines each day which compose approximately 52% of the plastic waste stream in the country and are a major source of land-based plastic pollution (Liamson et al., 2020). Their post-consumer life has made it a pollutant of great concern due to lacking recycling infrastructure and the risks they pose to the region ecologically, socially, and economically. Various methods to address this particular item of concern include legislating an EPR program for litter collection and prevention. Policy measures to ban the sale and production of problematic packaging materials have been proposed bottom-up by community members and global organizations that would have the potential to make substantial changes to plastic pollution.

National governments have the capability to legislate more comprehensive restrictions that prohibit the manufacture, import, sale and use of designated substances that are deemed environmentally harmful. For example, as described previously, the Canadian government developed legislation to prohibit microbeads on a national level through the addition of plastic microbeads to the List of Toxic Substances in Schedule 1 to the *Canadian Environmental Protection Act, 1999* in 2017 (Government of Canada, 2017). Such wide-ranging actions allow governments to phase out the most problematic materials and enact harsher restrictions that target the most harmful plastic materials.

5.2.2. Increasing Recycling and Recycled Content

Currently, plastic recycling is plagued by multiple issues of contamination, sorting technology, and inconsistent quality of collected waste and recycled output, amidst ongoing economic competition with lower market prices of virgin plastic (Pales & Levi, 2018; PACE, 2021).

Stakeholders in the World Packaging Organization have proposed a packaging design framework for optimized packaging design principles that would facilitate a streamlined recycling approach upon disposal (Gürlich & Kladnik, 2021). The guideline proposes design standards for all packaging materials based on three main criteria, in material (including additives, barriers and colour); decoration and other components (including labels, sleeves, inks, designs, and adhesives); and closure systems (including seals, foils and opening aids). The framework analyzes an extensive range of PET, PE, and PP packaging items to identify all features that impact the quality of collected materials, stipulating best practices that could simplify plastic recycling including use of transparent material, and reduced use of additives, composites, and inks (Gürlich & Kladnik, 2021).

Among other stakeholders along the value chain in agriculture and retail, the Canadian Produce Marketing Association (CPMA) proposed a Preferred Plastics Guide in 2020 to guide the Canadian fresh produce sector, informed by current recycling capacities available in Canada. The guide subdivides plastic packaging choices into three categories of focus: unfavourable, minimize, and preferred. Unfavourable items include materials that CPMA members should strive to eliminate in the short-term, including PVC, polystyrene, and oxo-degradable plastics (CPMA, 2020). Members are encouraged to seek alternatives for the materials designated within the category to minimize use, including laminates and multi-layer film plastics (CPMA, 2020). Lastly, preferred materials are deemed highly recyclable plastics including PET, HDPE, LDPE, PE, and recycled PET (CPMA, 2020).

The Golden Design Rules proposed as part of the Global Plastics Pact network in partnership with The Consumer Goods Forum are a set of standards to optimize the design and recyclability of plastic packaging materials and components (Canada Plastics Pact, 2021). Nine individual features currently comprise the set of standards and are meant to act as a set of guiding principles for both packaging manufacturers and for the consumer goods industry that employs packaging in their operations (The Consumer Goods Forum, 2021). The guideline consists of the following nine standards:

1. Increase recycling value in PET bottles by eliminating pigments and using recyclable sleeves;
2. Remove problematic elements that hinder the sorting process;
3. Eliminate excess headspace in flexible packaging to a maximum of 30%;
4. Reduce the use of plastic overwraps that store other packaged goods;
5. Increase recycling value in PET trays by employing clear and mono-material designs;
6. Increase mono-material use in flexible packaging;
7. Increase recycling value in rigid plastics like HDPE and PP;
8. Reduce the use of virgin plastics in tertiary packaging by using recycled and reusable materials; and
9. Use on-pack recycling instructions for consumer awareness and instruction.

The development of various industry-tailored guidelines for packaging materials and packaging design signals an increasingly concerted effort to target actors along the entire value chain. Upstream changes must implicate packaging manufacturers for these design standards to achieve improved DfE and make long-lasting transitions away from problematic plastic applications in the food packaging industry (EMF, 2020).

Individual brands have also made voluntary commitments to increase their integration of recycled content in their containers and bottles, including leading consumer goods brands like Coca-Cola and Unilever (EMF, 2019). Further research on packaging materials is focusing on the chemical safety of using recycled plastic materials for food containment, and long-term viability of recycled plastics is a subject of increased attention (Geueke, Groh & Muncke, 2018). Producers and brand-owners centre improved recyclability and higher recycled content as the mechanism to improve the sustainability of their packaging (EMF, 2017), but there is evidence of a consensus among policymakers and researchers that recycling is not sufficient to address the ongoing surge of plastic packaging materials in a disposal-oriented economy (Simon et al., 2021). Many elements within emergent packaging design guidelines permit a continued disposal-oriented approach that do not address novel reusable approaches to food packaging, thereby centring plastic recycling as the solution to minimize mismanagement of packaging waste. Identifying various methods to improve plastic production and management is important in widespread solutions, as is steps to minimize the production and distribution of disposable materials overall.

5.2.3. Reducing Disposability

Numerous analyses on the impact comparisons between different disposable materials, as well as between disposable materials and reusable materials, are undertaken to assess the varying environmental costs in their usage. Among various methodologies that are available to gauge the environmental impacts of a product, life cycle analysis is often employed to assess the relative impacts of each material across each stage of production, consumption, use and disposal. Such assessments employ several environmental impact categories including natural resource depletion, global warming potential, toxicity, acidification and eutrophication potential, ozone depletion, air emissions, water consumption, waste, and energy (Abejón et al., 2020). Comparative analyses between different packaging materials include assumptions in their assessments about the quantity of total uses, sources of energy use across their supply chain, production processes, transportation distance, and the methods of waste management when a material becomes waste, thereby making it difficult to clearly declare the preferability of one material substitute compared to another (Abejón et al., 2020; Gordon, 2020). Ongoing analyses for reusable alternatives to disposables have found that reusable food packaging materials prove more sustainable compared to disposable options based on numerous sustainability criteria spanning water use, energy, transportation, threat factors to biodiversity, and other variables (Coelho et al., 2020; Verburgt, 2021; Villenueva et al., 2021).

Reusable packaging typically includes design for safe and bulk transport, frequent sterilization, and multi-purpose or standardized design to accommodate a practical, scaled model that facilitates sharing between different firms (Rethink Plastic & BFFP, 2021). Usage rates of reusable materials, otherwise known as break-even points, are used as a measurement that indicates the number of times that a reusable product would have to be used to have a lesser life cycle impact than its disposable product equivalent. The substitution would entail an overall reduction in energy, water and raw material inputs used in the manufacturing of a disposable material equivalent, as well as its disposal costs; however, substitution for a reusable package would increase the need for upkeep and cleaning requirements along its lifetime, requiring ongoing energy and water inputs (Zero Waste Europe & Reloop, 2021).

Findings uphold that multiple use of items is crucial to reduce overall environmental impact (Korbelyiova, 2020), since reuse can reduce environmental impacts caused by mining and extraction, deforestation, manufacturing, distribution, consumption, and disposal of single-use products (Muranko et al., 2021) which are extensive depending on the packaging material choice. It is important to identify the kinds of barriers that stand in the way of brands taking voluntary actions towards a reuse-oriented approach for packaging. The following section will examine several current examples of endeavours to design reusable packaging systems using reverse logistics and product-as-service systems in the consumer goods industry.

5.3. Product Reuse Systems

Efforts to avoid disposability have shifted a focus towards alternative activities like reuse, refill and return for food and beverage packaging, based on reverse supply chain models (Beitzen-Heineke et al., 2017; EMF, 2019; Hawkins, 2021). These concepts revitalize past models for reusable, refillable and returnable packaging for food distribution that were once entrenched networks between industry and households, including reuse systems for glass milk bottles (Strasser, 1999; Vaughn et al., 2007).

From a reuse-oriented approach to avoid disposal altogether, there are many designs and logistical arrangements that have been proposed for use, consisting of novel efficiencies and relational changes between the business and consumer. Reuse-oriented systems available today range from a combination of bulk-dispenser stores, zero-waste stores, voluntary take-back programs operated by businesses, and deposit/refund systems for packaging materials. Due to a lack of incentives, a clear legal framework, and low harmonized standards for reusable packaging within the industry, emergence of modern reusable packaging systems has been limited, and voluntary uptake of these alternatives has been met with barriers (Gordon, 2019).

By replacing 20% of the current volume of disposable packaging materials that are presently used for the distribution of consumer goods with reusable alternatives, the EMF (2019) estimates savings upwards of USD 10B across industrial supply chains. A combination of political prioritization, consumer and citizen eagerness, and corporate responsiveness has led to various global strategies pursuing systemic change, positing reusable packaging as one of the most important features of a circular economy. Pilot reuse models have been showing increasing voluntary uptake among numerous established multinational consumer brands, which marks a shift in the normalization of reusable networks for food delivery and essential items (Coelho et al., 2020; EMF, 2019; Muranko et al., 2021). Currently, many multinational food and personal care brands are beginning to participate in pilot studies around the world to better understand the opportunities of a reuse economy, and how to transform or add new business models towards a feasible reverse logistics operation (Muranko et al., 2021).

5.3.1 Reverse Logistics and Product-as-Service Models for Reusable Packaging

The economic, aesthetic, and logistical influences within package design are substantial, and are limited by the design of linear distribution channels that bring packages to market. Wikström et al. (2019) state that "the tensions between marketing and sustainability, both on a strategic and an operational level, enhance the tensions that packaging designers must resolve" (p. 536). Additionally, packaged consumer goods are often produced distant from their site of sale and consumption, therefore withstanding long distribution channels that must accommodate limitations of shipping and handling. A linear supply chain therefore creates a set of barriers that impacts the ability of brands to pivot to alternative modes of product delivery. Since producers are inhibited by the constraints of a linear business model, several logistics businesses have begun to partner with large multinational brands to intervene and accommodate a shift to a reusable system (EMF, 2019; Grace, 2019).

In a reverse logistics operation for reusable packaging, there are two categories that are distinguished as a business-to-consumer (B2C) context, and a business-to-business (B2B) context (Coelho et al., 2020; EMF, 2019). These two categories can be differentiated by their flow of goods and services, where B2C requires transaction between a business and a consumer, while B2B comprises transit packaging, crates and pallets, and other non-consumer materials used along the supply chain network between producers, suppliers, and retailers (EMF, 2019). There is evidence that B2B materials, also known as tertiary packaging, can facilitate simpler reuse for materials like crates and pallets, which usually do not venture outside of distribution channels between businesses, and circulation of goods is more easily facilitated (Coelho et al., 2020). Analysis has also shown that B2B systems play a significant role in enabling the functioning of reusable or reduced packaging use in a B2C context, as the selection of packaging materials is largely driven and dictated by supply chain actors in production, distribution and retail stages (Zero Waste Europe & Reloop, 2021).

5.4. Reuse Models for B2C Systems

B2C systems could employ alternative product delivery formats and could forge new opportunities spanning subscription services for home grocery delivery, and deposit/refund systems for reusable containers for return and refill (Coelho et al., 2020). Product-as-service models are being proposed and implemented more in large urban centres around the world to function as closed-loop supply chains. The EMF's (2019) categorization of B2C reuse systems includes four different present-day models of reusable packaging systems spanning from consumers participating by filling packages at home; returning packages from home; refilling packages on the go; and returning packages on the go. The activity of 'filling at home' signifies the delivery of filled containers to the home of the consumer via a subscription service, while 'returning from home' requires operations to pick-up the emptied packaging at a consumer's home, undertaken by a designated pickup service. 'Refilling on the go' offers users various product refilling options through designated in-store dispensers, whereas 'returning on the go' requires users to return emptied packages to a participating retail location, or another designated drop-off point within a community. These four models of reuse activity are elaborated in greater detail in Table 5.1.

Table 5.1: *Business-to-Consumer Reuse Models.*

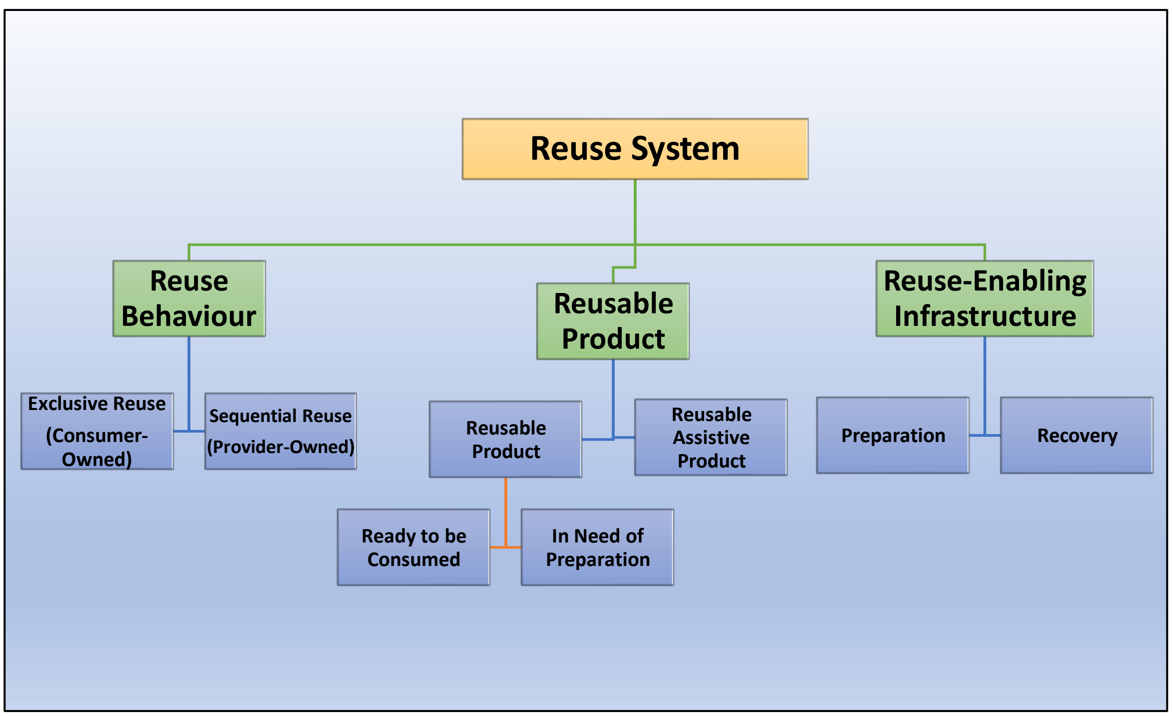
Relational Model	Logistics	Considerations
Refill at home	Functions in traditional stores or via e-commerce through doorstep service	- Suitable for home grocery and food deliveries - Reduction of transportation and packaging costs by supplying refills in concentrated form
Refill on the go	- User requires and carries own container - Functions in traditional stores and dispensing points within urban environments	- Reduction of transportation and packaging costs by supplying refills in concentrated form for dispensing machines - Requires a distribution network of dispensaries in retailers - Opportunities to provide better food access through mobile dispensing systems and availability in public spaces
Return from home	Coordinated via e-commerce through doorstep service	- Requires pickup of empty containers and delivery of new product - Options for deposit and reward schemes to incentivise return of packaging - Optimal for urban environments
Return on the go	Functions through shared drop-off locations	- Shared logistics for cleaning and refilling infrastructure and facilities among brands

Source: Ellen MacArthur Foundation (2019).

From Table 5.1, the use of these models could accommodate various sectors across the food industry in restaurants and cafes, fast-food and take-out, and in traditional retail, as each option includes various components of voluntary and economic instruments that are included within EPR models (EMF, 2019; Gordon, 2019).

In a comparative sense, Muranko et al. (2021) provide critique towards the EMF's description of B2C models, stating that each model "primarily frames reuse around specific actions such as refill and return, leaving unaddressed issues such as ownership of reusable products and the interactions that users have with infrastructure" (p. 5). While consumer motivation to participate in a reuse-oriented economy are key in ensuring the long-term feasibility and sustainability of a reuse system, the operational elements of the systems are considerably complex. Muranko et al. (2021) propose another conceptual reuse model that maps product reuse systems through various potential B2C pathways, using a review of 92 current reuse programs. Their modelling illustrates the possible variability in the functioning of product reuse systems. Three primary components of reuse systems are included in the model, which span core reuse behaviours, consumption of reusable products, and reuse enabling infrastructure, which are shown in Figure 5.1.

Figure 5.1: *Reuse System Elements.*



Source: Muranko et al. (2021).

Reuse behaviour can range from exclusive or sequential reuse of a package which requires a user's own reusable materials (mugs, containers, bottles and jars) with unlimited access, or using packages that are kept in circulation and that are owned by the provider, and shared through successive access (Muranko et al., 2021). Exclusive reuse requires that a user is responsible for cleaning and preparing their reusable materials for the refilling processes, relying on the availability of water and cleaning supplies for upkeep, as well as some form of reuse enabling infrastructure like a food provider or a bulk dispensary. Sequential reuse, in comparison, functions in a product-service system relying on a number of different provider-operated mechanisms, including home deliveries or deposit/refund systems.

Reusable products can range from a specific vessel that holds a consumable, an assistive product like a pouch, a cartridge or canister, or reusable shopping bags. In sequential reuse, return is an essential part of circular logistics through a shop drop-off, doorstep pickup, or return bins to transfer possession back to the provider. Depending on the user's behaviour, the reusable product, and the nature of the infrastructure that facilitates reuse, several models are available. Current examples of different models are underway in the food industry. Muranko et al. (2021) posit that of all options, sequential reuse has a greater capacity for closed-loop systems because the return infrastructure for empty containers is controlled by the provider who is best positioned to maintain and keep reusable materials in circulation and in preparedness to be reused on an ongoing basis.

5.4.1. Loop

Currently, one example of a reverse logistics model employing sequential reuse is Terracycle's Loop delivery service, underway since 2019. The Loop service partners with global brands and retailers with economies of scale and brand recognition amongst consumers. Loop offers home delivery service for popular grocery brands including a wide range of snacks and staple pantry foods, personal care, and household cleaning products delivered in reusable and refillable containers in a prepared state (Grace, 2019;

Loop, n.d.). Loop has partnered with a range of consumer goods brands owned by multinational companies like Unilever and Procter & Gamble, and with fast-food brands like Burger King, and are piloting in large urban centres in Europe, Asia and North America (EMF, 2019). Loop has recently initiated a reusable mug and food packaging program with Tim Hortons locations across Canada (The Canadian Press, 2020).

Companies participating in the delivery service program maintain ownership of the physical containers used in the delivery program (Grace, 2019). Users pay a deposit fee to participate in the program and are reimbursed when emptied containers are returned in their designated reusable carrying bag after each rotation (Loop, n.d.a). Depending on the region, shipment of containers is operated by a reverse logistics provider partnered with the company (Loblaw Companies Ltd., 2021). In Canada, Loop partners with shipping and transport company FedEx for deliveries and pickups, whereas in the United States, Loop is partnered with United Parcel Service (UPS) (Loblaw Companies Limited, 2021; Loop, n.d.b). Logistics service providers are physically responsible for the pickup and delivery of containers from customers, and Loop is physically responsible for cleaning and sanitation of containers within their designated facilities to prepare food containers to be refilled and redistributed (Coelho et al, 2020; Grace, 2019).

5.4.2. Shortening the Loops in Reuse Systems

If novel approaches toward reuse and product-service systems are restricted to the largest multinational brands, some argue that will not address other sustainability concerns like long distribution channels between customers and consumer products (Muranko et al., 2021; Wagner, 2020). Beitzen-Heineke et al. (2017) upholds that smaller networks of circulation and local reuse networks are most beneficial in reuse models, that include small producers and local enterprises, which Coelho et al. (2020) describe as prioritization beyond closed-loop designs, towards shortened loops altogether in food distribution. Wagner (2013) discusses the ways in which small and locally owned producers and retailers are better positioned to employ more direct methods of packaging reuse and return with their customer base, noting that packaging take-back models and deposit/refund systems can facilitate shorter loops, compared to global food brands and suppliers that rely on complex reverse logistics operations to provide a reuse system to consumers. The difficulty for smaller producers to establish reuse networks with their customer base is the lacking economy of scale, especially in rural and decentralized settings (Personal communication with Nova Scotia agricultural business, October 25, 2020). While shortening the loops between the production and distribution of food and essential items is optimal in a reuse-centred economy, it is difficult for these systems to operate in rural economies where there is a lacking population density. This consideration of scale within product-as-service and delivery systems underlines the importance of prioritizing the local economy and shorter networks of trade.

The central aim of EPR programs is to implicate producers in assuming responsibility for their products during the end-of-life phase and fulfill improved product designs that promote reuse and reduce waste disposal. By examining various instruments that are available within the scope of the EPR principle, there are many opportunities to build a reuse-oriented model of product distribution that could pivot from a disposal-oriented framework, to expand and normalize the availability of reuse systems in the marketplace. While many current industrial and governmental strategies pursue increased waste collection and streamlined recycling capacities as the method to achieve a circular plastics economy, there are many opportunities to invest in alternative modes of consumption that would limit the circulation of disposable plastic materials and create long lasting networks between citizens and their food providers.

Chapter 6. Conclusion

Plastic packaging materials are embedded within the functioning of many human industries, notably in the distribution of food and beverages, and have led to the emergence of a disposal-oriented society that has had profound effects on waste generation rates, pollution, and food availability. Various industrial, economic, and socio-cultural transitions impacted human consumption practices, and impacted practices within household waste generation. The increased production, distribution, and consumption of disposable packaging materials throughout industrializing societies paved the way for the success of plastic materials in the consumer marketplace and the emergence of a plastic packaging economy. The availability of low-cost feedstock from petroleum sources transformed the functioning of many aspects of the consumer economy and contributed to significant changes in the design of the global food and beverage landscape.

Plastic production relies on primary resources from the global petrochemical industries, that economically incentivizes the use of raw feedstock and inhibits the growth of a robust recycling industry for plastic waste. This reality of plastic production has entrenched a linear functioning plastics economy as opposed to one based on resource conservation. Plastic production and waste are implicated in other pressing sustainability crises of biodiversity loss and climate change. Waste management systems around the world have been ill-equipped or ill-designed to respond to the high volumes and rates of disposable plastic materials. Plastic waste has infiltrated the biosphere and has created profoundly harmful effects on wildlife on land and at sea. Such harm has illustrated the persistent threat that mismanaged plastic poses to environmental health, and a threat to human wellbeing. The high environmental, social, and economic costs of plastic waste are currently demanding global governmental interventions that have resulted in a mosaic of approaches that focus on different aspects of plastics' life cycle. This has resulted in a global patchwork of methods, which complexifies the global goal of addressing the root of plastic overproduction and mismanagement. Governmental intervention has responded to the crisis through a cascade of approaches, but the role of industry is acknowledged as essential in achieving wide-ranging solutions.

Waste mismanagement of plastic packaging materials is caused by a complex range of economic and technical barriers that make it difficult to manage high rates of plastic waste currently generated by citizens around the world. These barriers are underpinned by the high costs of formal waste collection, which remains inaccessible and infeasible for many governments across the world. Mismanagement of recyclable materials contributes to an inefficient economy which demands the use of more raw resources and wastes valuable resources in the process. Historically, the onus for grappling with these materials has fallen onto taxpayers and governments, which requires significant capital financing and labour for solid waste resource management. A large amount of packaging materials flooding the marketplace and distributed to citizens has left municipalities struggling with large volumes of discarded materials to collect and process, and with the task of finding recycling end-markets in fluctuant global market conditions. The Extended Producer Responsibility principle is recognized as a waste policy approach that implicates the producers of materials in accounting for their end-of-life costs once materials are discarded into the waste stream, that takes the wider life cycle implications of plastic packaging materials into account. The EPR principle provides tremendous opportunity to pivot waste management responsibility away from local governments and citizens, and onto industry to require the physical and/or financial contributions of producers to provide a steady and permanent stream of resources to manage waste and build more sustainable resource flows. Governments around the world have pursued EPR program implementation for many waste streams, and it has been proven to have beneficial impacts on increased collection and recycling rates for packaging materials. Currently, while there are many governments around the world pursuing EPR programs for the packaging waste stream, EPR for packaging waste has operated predominantly throughout the European Union, and it has been implemented in slower pace throughout Asia and North America.

There are currently five Canadian provinces that have implemented EPR programs for packaging, which has lessened the financial and administrative burden on local governments in delivering recycling programs to their citizens. Stakeholders in Nova Scotia are currently eagerly pursuing the implementation of an EPR program for packaging to attain the financial and environmental benefits of producer responsibility in managing waste. As municipal recycling programs within Nova Scotia operate in a piecemeal function, a harmonized and cohesive program for the printed paper and packaging waste stream has not been achievable to date. Nova Scotia is currently shouldering a recycling program that is increasingly costly to administer amidst growing amounts of recyclable materials generated into its residential waste system. Since Nova Scotia is dominated by many small enterprises within the provincial business community, efforts to reduce negative or detrimental economic impacts on that group of stakeholders is an area of focus. In examining the current landscape of industrial stewards participating in EPR programs for packaging in other Canadian provinces, analysis suggests that many national stewards financing recycling programs are large producers who introduce printed paper and packaging materials to the consumer marketplace, predominantly in the manufacturing, retail, and wholesale sectors. Based on provincial revenue data, the total expected quantity of businesses operating in Nova Scotia who would be implicated in a potential EPR program for packaging in the province is low in proportion to all producers operating in the province. This finding shows the implementation of an EPR program to improve recycling capacity in Nova Scotia would not foreseeably create an adverse effect upon the local business community in the province.

Gaining the contribution of producers in waste management is an important and crucial step in improving the plastic value chain overall. Efforts to limit the disposal of plastics altogether also warrant new efforts, which is an essential point towards overall packaging waste prevention and minimization. The various instruments available within the EPR principle consist of a range of methods to reduce waste and improve product industries along their value chain. Incentivizing the use of reuse-systems represents a key opportunity to create more sustainable networks of food distribution that reenergizes previous models based on returnable and refillable packages, that have otherwise been eroded over time towards a disposal-oriented consumer economy. Various reuse system models are available that engage producers and customers in new relations that contrast from a disposal-oriented economy. Lastly, further opportunities exist to improve the functioning and availability of reuse systems in different regions that would result in more sustainable food systems and networks. The necessary progress towards a reuse-oriented economy requires concerted efforts and participation from every facet of the global community.

Appendix A

"Implementation of harmonized Extended Producer Responsibility strategies to incentivize recovery of single-use packaging waste in Canada" (2020)

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Implementation of harmonized Extended Producer Responsibility strategies to incentivize recovery of single-use plastic packaging waste in Canada

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A B S T R A C T

Millions of tonnes of virgin (primary) plastic are produced annually, while recoverable (secondary) plastic rapidly accumulates as waste in landfills and the environment. Single-use plastics (SUPs) have short lifespans, and most of this waste is generated by packaging from global food industries. Food packaging waste comprises approximately one-third (8 million tonnes) of all Canadian municipal solid waste, and only 20% is recovered for reuse or recycling. Extended producer responsibility (EPR) strategies leverage corporate resources to reduce SUP waste generated by consumers. Implementation of EPR strategies allows local jurisdictions to gain greater control over their waste streams. Although Canada has had a national EPR strategy since 2009, it is currently only implemented for packaging in five provinces (e.g., British Columbia, Saskatchewan, Manitoba, Ontario and Québec), and is currently under development in New Brunswick. In this short communication, a case example of EPR implementation in Nova Scotia is provided which highlights the potential economic benefits for municipalities ($14–17 M CAD in estimated savings), for improved solid waste management and for increasing recycling rates. Further, a regional EPR strategy is recommended for all Atlantic Canadian provinces (e.g., Newfoundland and Labrador, New Brunswick, Prince Edward Island and Nova Scotia) now that the Canadian federal government has announced a move towards zero plastic waste under the Ocean Plastics Charter.

1. Introduction

Millions of tonnes (Mt) of virgin (primary) plastic are produced annually, while recoverable (secondary) plastic rapidly accumulates in landfills and the environment (Jambeck et al., 2015). In 2015, an estimated 407 Mt of primary plastics (including single-use plastic [SUPs] food packaging) entered consumer markets globally, of which 302 Mt became waste within a year (Geyer et al., 2017). SUPs typically have an extremely short lifespan, and most of this waste is generated by packaging from food industries (Pettipas et al., 2016; Schnurr et al., 2018). Food packaging waste comprises approximately one-third of all Canadian municipal solid waste (equivalent to roughly 8 million tonnes from residential and non-residential sources), and only 20% is recovered for reuse or recycling (Xanthos and Walker, 2017; Statistics Canada, 2020). The remainder accumulates rapidly in landfills (86%) or leaks into the environment (1%) (ECCC, 2019). SUP food packaging has proliferated in recent decades because of food safety concerns, consumer convenience and low cost. Costs for collecting and recovering post-consumer plastics vary widely. For example, global recovery rates of polyethylene terephthalate and high-density polyethylene are often 10% of primary plastics produced, while recovery of polystyrene and polypropylene is often very low, or non-existent. Production of recycled plastics is currently not economically competitive compared to primary plastic production which is highly government subsidized (OECD, 2018).

Extended producer responsibility (EPR) strategies leverage corporate resources to reduce SUP waste generated by consumers. The EPR concept was first developed in Sweden by Thomas Lindhqvist in the 1990s, to make producers internalize external (socio-economic) costs associated with end-of-life management and to incentivize recovery-based, integrative waste streams (Giroux Environmental Consulting, 2014; Kunz et al., 2018). In Canada, producers are defined as brand owners, manufacturers, or first importers. EPR strategies hold producers accountable for high levels of unrecovered primary plastics generated in municipal solid waste.

Ultimately, the responsibility for most municipal solid waste (MSW) management programs in Canada falls onto consumers and municipalities, yet municipalities have limited capacity

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Appendix B

"Environmental and economic impacts of mismanaged plastics and measures for mitigation" (2022)

environments

MDPI

Review

Environmental and Economic Impacts of Mismanaged Plastics and Measures for Mitigation

Avalon Diggle * and **Tony R. Walker**

School for Resource and Environmental Studies, Dalhousie University, Halifax, NS B3H 4R2, Canada; trwalker@dal.ca
* Correspondence: avalon.diggle@dal.ca

Abstract: The mismanagement of plastic materials has grown to become a mounting global pollution concern that is closely implicated in unsustainable production and consumption paradigms. The ecological, social, and economic impacts of plastic waste mismanagement are currently transboundary in nature and have necessitated numerous methods of government intervention in order to address and mitigate the globalized and multifaceted dilemmas posed by high rates and volumes of plastic waste generation. This review examines the current landscape of a plastics economy which has operated with a linear momentum, employing large quantities of primary resources and disincentivizing the functioning of a robust recycling market for collecting plastic waste and reintegrating it into the consumer market. This contextualizes an increasing plastic pollution crisis that has required global efforts to address and mitigate the ecological risks and socio-economic challenges of mismanaged plastic waste. A timeline of government interventions regarding plastic pollution is described, including numerous international, regional, and local actions to combat plastic waste, and this is followed by an examination of the relevance of the extended producer responsibility principle to improve plastic waste management and obligate industry to assume responsibility in waste collection and recycling.

Keywords: plastic pollution; marine litter; food packaging; single-use plastics (SUPs); recycling and reuse; extended producer responsibility (EPR)

check for updates

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1. Introduction

Plastics have become ubiquitous in the global economy and are integrated into the functioning of many industrial sectors [1]. Many plastic applications are added to long-term stocks, while in contrast, plastic packaging materials have a very short life cycle and are currently discarded as waste in large volumes [1,2]. Large volumes of primary plastics are produced and discarded within the same year, resulting in millions of tonnes of primary industrial resources that are not recovered and reintegrated back into the economic market [1,3]. Growth in the production and consumption of disposable packaging materials currently contributes to most domestic waste streams internationally, as packaging waste accounts for an estimated 15–35% of household solid waste around the world [4].

Improper management of waste packaging materials is an increasingly burdensome task for communities and citizens to address. The material complexity of the packaging waste stream restricts the efficient functioning of secondary recycling markets, and the pace and scale of primary plastics production has hampered the capacity of recycling industries to produce substantial feedstock at a quality and scale necessary to compete with virgin plastics, inhibiting a thriving secondary market for plastic packaging [1,5,6]. Furthermore, inadequate plastic recycling has caused the leakage of land-based plastic waste into terrestrial and aquatic environments, through insufficient or nonexistent waste management infrastructure [7]. Since the introduction of plastic material to the consumer market, a burgeoning plastic pollution crisis has been occurring on land and at sea [8]. This review seeks to examine the ongoing impacts and risks of plastic pollution in the natural

Appendix C

Dalhousie University Social Sciences & Humanities Research Ethics Board Project Approval

DALHOUSIE UNIVERSITY
Research Services

Social Sciences & Humanities Research Ethics Board
Letter of Approval

June 28, 2019

Avalon Diggle
Management\School for Resource and Environmental Studies

Dear Avalon,

REB #: 2019-4813
Project Title: Exploring the Capacity of Extended Producer Responsibility Strategies to Mitigate Single-Use Packaging Pollution from Food Industries in Nova Scotia

Effective Date: June 28, 2019
Expiry Date: June 28, 2020

The Social Sciences & Humanities Research Ethics Board has reviewed your application for research involving humans and found the proposed research to be in accordance with the Tri-Council Policy Statement on *Ethical Conduct for Research Involving Humans*. This approval will be in effect for 12 months as indicated above. This approval is subject to the conditions listed below which constitute your on-going responsibilities with respect to the ethical conduct of this research.

Sincerely,

Dr. Karen Beazley, Chair
Divert Nova Scotia SR-R4-19-01

Appendix D

Interview Recruitment Script for Businesses

Contact name

Name of business

Business address

Subject: Extended Producer Responsibility Strategies for Food Packaging in Nova Scotia

Greetings,

My name is Avalon Diggle, and I am a graduate student at the School for Resource and Environmental Studies at Dalhousie University. I am currently undertaking a study examining the development of an extended producer responsibility (EPR) collection program for printed paper and packaging (PPP) waste from food products in Nova Scotia. EPR is an industry stewardship policy in which producers are responsible for paying the costs of end-of-life management of their products. Participants are being sought for an approximately 1-hour long online interview session on the topic of packaging choices in your company. This study seeks to localize the perceived opportunities and barriers in applying EPR towards food packaging in Nova Scotia. Viewpoints of the local business community of the province will be explored.

The perspective of brand owners, producers, and distributors within the food industry in Nova Scotia are key in understanding the impact of EPR on the local business community. Participation from the industrial community of Nova Scotia in this study would provide an important component to addressing the financial, environmental and social factors at play in developing an EPR program. Those in decision-making positions in your company related to packaging choices, marketing objectives, as well as those that are able to provide background on the progression of the company's choices in supply chain management for food containment would be ideal candidates for participation. I would kindly ask that this message could be disseminated to appropriate members of your company aligning with the listed criteria. Please find attached to this message the consent agreement for participants to consider, which will provide further information on the proposed interview procedure.

If representatives from (business name) are interested in taking part in this research, prospective participants will be asked to directly contact myself, Avalon Diggle, the lead researcher in this study, by email using the contact information provided below. A recruitment period can be determined which is most feasible for your organization, allowing a suitable timeline for prospective participants to contact me after study information and consent documents have been disseminated to them. Interview sessions are proposed to take place within regular working-hours via video conferencing software, or, if more suitable, via telephone, in order to accommodate the public health parameters of the current COVID-19 pandemic.

Please do not hesitate to reach out to me if you have any questions or concerns regarding this study, at Avalon.Diggle@dal.ca

Sincerely,

Avalon Diggle

Master of Environmental Studies Candidate

School for Resource and Environmental Studies

Dalhousie University

Appendix E

Interview Consent Form for Businesses

Project title: Exploring the Capacity of Extended Producer Responsibility (EPR) Strategies to Incentivize Recovery of Packaging and Printed Paper (PPP) Waste Generated from Food Packaging in Nova Scotia

Lead researcher: Avalon Diggle, School for Resource and Environmental Studies, Dalhousie University, Avalon.Diggle@dal.ca, (506) 609-2211

Supervisor: Dr. Tony Walker, School for Resource and Environmental Studies, Dalhousie University, (902) 494-4478

Funding provided by: Divert Nova Scotia

Introduction:

Representatives from (business name) are invited to take part in a study for a graduate thesis by me, Avalon Diggle, a student at the School for Resource and Environmental Studies, which will explore the development of an extended producer responsibility (EPR) strategy for printed paper and packaging (PPP) waste for food products in Nova Scotia. Participation in this study is voluntary. Your decision of whether or not you choose to participate will not be made known to your employer. There will be no impact on those who do not participate in the study. Further details on the nature of the in-person interview sessions are found below.

Purpose and Outline of the Research Study:

This study will collectively examine the perspectives and expertise of the local industrial community in Nova Scotia. Using video-conferenced interview sessions, perceived opportunities and barriers towards a diversified EPR program will be explored.

Representatives of (business name) are invited to participate in an approximately 1-hour interview session on the theme of the company's decisions regarding packaging choices, packaging design in relation to marketing choices, and perceived opportunities and barriers for company participation in a potential EPR collection scheme for PPP in Nova Scotia. The theme of the discussion will cover such questions as:

- *Is your company already involved in other EPR for PPP programs elsewhere in Canada or abroad?*
- *What packaging and/or paper materials do you use most heavily in your operation?*
- *What do you perceive are the barriers to participation in EPR for businesses in the food industry who operate in the same sector as you?*

This study will be taking place throughout 2020 and results will be formulated in a Master's thesis to be completed by October 31, 2020. If participants are interested in accessing the final results, please contact the lead researcher wherein a summary of results will gladly be shared.

Who Can Take Part in the Research Study:
You may participate in this study if you are involved in making decisions in this business's food packaging supply chain, in both a food safety and financial analysis capacity. Eligible participants will also be decision-makers in a marketing and branding capacity in the company, relating to packaging decisions.

What You Will Be Asked to Do:
Each interview session is proposed to take place via video-conferencing software. Each interview session will last for approximately 1-hour. Follow-up interviews may be requested with members of the company, if required by the researcher and agreed to by the participant. The interviewing period will take place beginning in August 2020, and may remain ongoing until the completion of the final thesis in October 2020. Interview sessions are proposed to take place within working-hours via video interview. An otherwise determined time for sessions to take place can be proposed by participants, which would be most suitable and logistically-convenient. The responses collected during the interview sessions will be linked to your general role in the company, but all questions will remain within the professional capacity of your job. Please note that the interview session will be audio recorded.

You may decline to answer any and all questions posed during the interview session. You will be given the option to be quoted directly. Participants may choose to withdraw from the study at any time throughout its duration. If you decide to stop participating at any point in the study, you can also decide whether you want any of the information that you have contributed up to that point to be removed, or if you will allow the researcher to use that information. Should you decide to stop participating, your decision will not be made known to your employer. You may decide until October 1, 2020 before the submission of the final thesis is due.

Possible Benefits, Risks and Discomforts:
Your involvement as a participant and company representative in this research would be used to later inform and guide future research surrounding EPR for packaging in Nova Scotia. This research will also have the potential to inform and build stakeholder engagement in EPR for PPP overall.

The risks associated with your involvement in this study are minimal. Choosing to discuss the logistical details of company food packaging choices in this study may involve disclosure of otherwise discrete information. Such disclosure will be used for the purposes of the study only. Your involvement may also result in your identifiability through your general professional role, specifically among co-workers who may also be participants in the study. As stated, all questions will be asked within the professional capacity of your role, and will not be used to identify your name or personal details.

How your information will be protected:

All data from the interview sessions will be securely stored on the lead researcher's computer, and all files will be encrypted, and password protected. Exclusively myself, the lead researcher, and my supervisor Dr. Tony Walker will have access to the audio files. Data analysis after each session comes to a close will be undertaken solely by me.

Please feel free to contact me at Avalon.Diggle@dal.ca if you would like to seek clarification on any of the information listed above. If you have any ethical concerns about your participation in this study, you may also contact the Research Ethics office at Dalhousie University at (902) 494-1462, or by email at ethics@dal.ca

Signature Page

I have had the opportunity to read the details of this study and what will take place in the proposed interview sessions. I have been given the opportunity to discuss it and my questions have been answered to my satisfaction. I understand that I have been asked to take part in at least one interview that will occur via a virtual method acceptable to me, and that I will be recorded during the interview sessions. I understand direct quotes of things I say may be used that will identify my role that I occupy in the company. I agree to take part in this study. My participation is voluntary and I understand that I am free to withdraw from the study at any time preceding October 1, 2020.

______________________________ ____________________________ _______________

Name Signature Date

I agree that my interview may be audio-recorded ☐Yes ☐No

I agree that direct quotes from my interview may be used identifying only my general company role, and not my name ☐Yes ☐No

Appendix F

Interview Questions for Businesses

1. What is the quantity of packaging and printed paper materials (PPP) that your company uses to place products on the market in Nova Scotia and if applicable, other jurisdictions?

2. What packaging and/or paper materials do you use most heavily in your operations?

3. How would you link your marketing objectives and the choices you make in packaging?

4. Is your company already involved in other EPR for PPP programs elsewhere in Canada or abroad? If so, how long have you been participating in those programs?

5. Have you already been approached by Nova Scotian organizations or governmental entities regarding legislation for an EPR program PPP in the province?

6. Has your company made investments in alternative (non-disposable, non-plastic, refillable/returnable) packaging choices in the past? If not, what have been the main barriers?

7. Do you think there are viable and economical alternatives to the packaging your company is employing right now that is available in 2020?

8. What are the drawbacks that are present for the introduction of reusable or refillable containment for the products you sell inside and outside Nova Scotia? Outside Canada?

9. What do you perceive are the barriers to participation in EPR for businesses in the food industry who operate in the same sector as you?

10. What incentives do you think would empower businesses to seek out alternatives to disposable PPP?

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