E-Waste Management under Extended Producer Responsibility in Québec:

Critical perspectives on local strategies, challenges, and opportunities

A thesis submitted to McGill University in partial fulfilment of the requirements of the degree of Doctor of Philosophy

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This thesis is dedicated to my late aunt Ms. Jacqueline Croteau, the first woman in my family who completed graduate studies, at a time when very few women did. She was also the first person to tell me I could do this.

ABSTRACT

The widespread environmental, social, and economic problems associated with increasing flows of used and end-of-life electrical and electronic equipment (e-waste) around the world has been the subject of much research. Extended Producer Responsibility (EPR), an increasingly popular policy approach for managing e-waste has been analysed from various perspectives. However, the exploration of local actors' perspectives, preferences, choices, decisions, and motivations regarding EPR policy development and implementation, and how these factors shape local e-waste flows and ensuing environmental and social outcomes has not been given sufficient attention. Because EPR is identified as a policy tool supporting a circular economy, and its adoption is being promoted for the management of different material flows, detailed investigations of its development and implementation are needed to help understand and improve policy outcomes.

This thesis builds on interdisciplinary work in the fields of industrial ecology, the political economy of environmental regulations, and sustainability transition studies. I used mixed qualitative methods (critical evaluation of policy statements and memoirs, participant observations, action research, interviews, and an online questionnaire) to uncover rich empirical details pertaining to policy implementation issues and challenges. This demonstrates the usefulness of political economy and interdisciplinary qualitative research to help expose the gaps between the normative policy prescriptions in industrial ecology, and actual EPR policy development, implementation, and outcomes, including unintended consequences.

My research explores how and why various actors sought to influence, and then responded to, the development of Québec's e-waste management EPR regulation and its implementation in urban settings, and the resulting policy outcomes. My findings uncover, or confirm, conflicting and converging stakeholder interests as well as redistributive issues that are rarely documented in EPR-related literature and stress the importance of open collaboration and transparency between EPR program management, municipalities, organizations, and other local stakeholders, as conditions of long-term program success. I characterize some of the complexities involved in modifying the material flows generated by large organizations and contributing to urban e-waste flows, and I expose the drivers and barriers shaping municipalities' collaboration with EPR programs. My research also questions the simple opposition between formal and informal e-waste flows as it uncovers a wide diversity of intertwining material trajectories and blurred stakeholder roles, making policy outcomes, including circularity, difficult to measure and improve. Finally, I provide detailed policy recommendations for improving EPR program performance based on my findings, and in alignment with the respect of the polluter-pays principle, greater material circularity and a more just transition.

RÉSUMÉ

De nombreuses recherches ont déjà documenté les problèmes environnementaux, sociaux et économiques découlant de l'augmentation importante de déchets d'appareils électriques et électroniques (D3E) partout dans le monde. Aussi, il existe de nombreuses analyses portant sur la responsabilité élargie des producteurs (REP), une approche de politique publique utilisée pour assurer la gestion des déchets électroniques et qui gagne en popularité. Pourtant, les perspectives, les préférences, les choix, les motivations et les décisions des acteurs locaux qui interviennent de manière à influencer le développement et la mise en œuvre de la REP, et qui, par leurs actions, affectent les flux de D3E en milieu urbain et les impacts environnementaux et sociaux qui en résultent, ont rarement été étudiés. Puisque la REP est promue comme approche soutenant l'émergence de l'économie circulaire, et qu'elle est de plus en plus favorisée pour encadrer la gestion de nouveaux flux de matières, des recherches approfondies pour comprendre son développement et sa mise en œuvre sont nécessaires dans le but d'en améliorer le bilan.

Cette thèse prend appui sur des travaux interdisciplinaires dans les domaines de l'écologie industrielle, de l'économie politique de la réglementation environnementale et des études sur la gestion des transitions en développement durable. J'ai utilisé des méthodes qualitatives (analyse de mémoires et de positions politiques, observations de parties prenantes, entrevues, recherche-action et questionnaire en ligne) dans le but de découvrir et d'analyser de nombreux aspects en lien avec le développement et la mise en œuvre de la REP pour la gestion des D3E. D'ailleurs, ma recherche démontre l'utilité de l'économie politique et de la recherche qualitative interdisciplinaire pour exposer les divergences entre les prescriptions issues de l'écologie

industrielle et la réalité du développement comme de la mise en œuvre de la REP, ses retombées, et ses conséquences inattendues.

J'ai exploré comment et pourquoi de nombreux acteurs ont cherché à influencer le développement du règlement sur la REP pour la gestion des D3E au Québec et comment ces mêmes acteurs ont ensuite réagi, ou se sont ajustés, au règlement et à sa mise en œuvre, surtout en milieu urbain. J'ai mis au jour, ou confirmé, les multiples intérêts convergents et divergents de nombreux acteurs, ainsi que des effets redistributifs qui sont peu documentés dans la littérature sur la REP. Dans le cadre de ce projet, je fais également état de l'importance d'une plus grande collaboration et de la transparence entre ceux qui gèrent le programme, les municipalités, les organisations et autres parties prenantes locales, de manière à assurer la viabilité et le succès du programme. J'ai fait ressortir la complexité de la mise en œuvre de la circularité et de la saine gestion des D3E au sein d'une grande organisation et comment cela affecte le bilan de la REP en milieu urbain, ainsi que les facteurs qui déterminent comment et pourquoi les municipalités collaborent avec le programme de REP, ou non. J'ai aussi découvert que l'idée des flux formels et informels de D3E représente une fausse dichotomie, puisque les trajectoires des matières sont confuses, se mélangent et que les acteurs impliqués ont des rôles ambigus, ce qui rend difficile de mesurer la circularité et les retombées réelles du programme. Enfin, j'apporte de nombreuses recommandations qui, en fonction de mes travaux, pourraient contribuer à un meilleur respect du principe du pollueur-payeur, à la circularité, et à une transition juste.

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ACKNOWLEDGMENTS

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A summer internship with the Commission for Environmental Cooperation (CEC), and work under the guidance of Mr. Francisco Fernandez-Ugalde first launched me on the path of e-waste flows in North America. I found the issue fascinating. My participation in the United Nations University's e-waste Summer School confirmed my interest in the topic and introduced me to an international network of scholars interested in this issue. It is during the Summer School that I decided to start this PhD. Thank you Prof. Ruediger Kuehr, Dr. Deepali Sinha Khetrival, Mr. Reid Lifset, Dr. Jaco Huisman, Dr. Federico Magalini, Mr. Wesley Crock, and others, for encouraging me to start this research.

My deepest gratitude goes to Prof. Madhav Badami, from the McGill School of Urban Planning and Bieler School of Environment for inviting me to work under his guidance. He generously shared his time and expertise as well as his unwavering encouragement and support. His keen analytical perspective and experience helped me to stay focused on the most meaningful and insightful aspects of this project. I hope he had as much pleasure as I did, meeting to discuss my research over tea in his wife's wonderful garden or during walks in the nice neighbourhood that we both share and love.

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CONTRIBUTIONS TO ORIGINAL KNOWLEDGE

When this research was initiated, there was very little work documenting the underlying motivations, preferences and decision-making of various local actors, including municipal civil servants, collectors, and refurbishers and recyclers, related to the development and implementation of Extended Producer Responsibility (EPR) regulations for managing used and end-of-life electrical and electronic equipment (e-waste). Also, the role of large organizations, and especially large public institutions, as major e-waste generators and how their operations affected EPR program success in urban areas, was usually ignored. There were few publications presenting the perspectives of municipalities as they adapted to new EPR programs for e-waste. And while the existence of informal e-waste flows was already well documented in the context of developing countries, there was very little work published on informal e-waste flows in urban areas in the North American context.

The research presented here helps advance the understanding of what shapes urban e-waste flows, in Québec, and in urban settings in North America, more broadly. My work demonstrates the value of critical qualitative work to explore the gap between normative or prescriptive work on e-waste management in the field of industrial ecology and actual policy development and implementation, and policy outcomes. Building on political economy, my empirical investigation uncovers the role of various actors who seek to shape e-waste management policy development and implementation and explores why, how, and with what results, to help explain why every jurisdiction adopts slightly different EPR policies, what scholars call the e-waste policy patchwork. I use a supply and demand framework to explain how local socio-economic dynamics influence EPR policy development, while broader market conditions also affect policy implementations and local outcomes.

The role of organizations in contributing to e-waste management has, thus far, hardly been explored. My research reveals the importance of large organizations as important e-waste generators in urban settings and demonstrates how their role can bolster or undermine the success of e-waste management policies. Considering the role of organizations also sheds light on the limits of EPR policies and the multiple possibilities for improving e-waste management in urban settings, above and beyond EPR policy provisions.

Again, focusing on empirical findings, I identify and explain the drivers leading municipalities to participate and collaborate with EPR programs, or not. I found that program legitimacy, improved logistics, existing social capital, and program funding help support participation and collaboration, while a lack of transparency, the failure to support reuse and local employment, and the lack of resources to meet program requirements challenge municipalities' collaboration. The insufficient financial incentives provided by the program to enlist municipal participation may be an indication that the polluter-pays principle, a key concept underlying EPR policies may, in fact, not be fully respected, and municipalities are therefore still responsible for a significant part of the financial burden of managing e-waste.

Finally, the exploration of "informal" e-waste flows in Montréal documents and explains, how formality and informality changes along material flows, and how part of these flows come about as a result of documentation issues, the lack of financial incentives for certain stakeholders, as well as the interests, discourse and decisions, by EPR programs and government agencies, which limit the participation of certain stakeholders.

Taken together, these insights can inform better policy-making in such a way that outcomes such as greater transparency, social justice, and improved environmental benefits can be targeted and promoted. My use of action research for one of the projects also brings an original scholarly contribution by demonstrating the epistemological value of studying local material flows, by engaging in interventions and experiments to change these flows and contributing to improved material circularity while building knowledge.

AUTHOR CONTRIBUTIONS

This doctoral thesis is structured following a manuscript-based format. It includes four substantive chapters (Chapters 3-6), based on recently published journal articles that present and discuss my research. These chapters are preceded by an introduction to the problem of e-waste and brief literature review (Chapter 1), and a presentation of my research objectives and questions, my analytical framework, and choice of methods (Chapter 2). I provide a synthesis and discussion of my key findings, their implications for policy-making, suggestions for further research, and concluding remarks, in Chapter 7.

All four substantive chapters have been published in peer-reviewed journals, as noted. As part of this thesis, I provide bridging text to introduce each individual paper. Following are the bibliographical references for Chapters 3-6 and a description of author contributions.

Chapter 3:
Leclerc, S.H. and M.G. Badami. 2020. Extended producer responsibility for e-waste management: Policy drivers and challenges. Journal of Cleaner Production 251: 119657.
https://www.sciencedirect.com/science/article/pii/S0959652619345275.

Chapter 4:
Leclerc, S.H. and M.G. Badami. 2022. Material circularity in large organizations: Action-research to shift information technology (IT) material flows. Journal of Cleaner Production 348: 131333.
https://www.sciencedirect.com/science/article/pii/S0959652622009611.

Chapter 5:

Leclerc, S.H. and M.G. Badami. Extended producer responsibility: An empirical investigation into municipalities' contributions to and perspectives on e-waste management. Environmental Policy and Governance. https://onlinelibrary.wiley.com/doi/abs/10.1002/eet.2059.

Chapter 6:

Leclerc, S.H. and M.G. Badami. 2023. Informal E-Waste Flows in Montréal: Implications for Extended Producer Responsibility and Circularity. Environmental Management. https://doi.org/10.1007/s00267-023-01857-2.

As the lead author on all four articles, I was responsible for the conceptualization; methodology; data curation; investigation and analysis. I wrote the original drafts, developed the visualization; took care of project administration and funding acquisition. Prof. Madhav Badami contributed to the conceptualization, the revisions and editing, the visualisation, the project supervision as well as the funding acquisition.

LIST OF TERMS AND ABBREVIATIONS

AC	Air Conditioning Equipment
ARF	Advanced Recycling Fee
ARPE	Association pour le recyclage des produits électroniques
CE	Circular Economy
DVD	Digital Versatile Disc
D3E	Déchet d'équipement électrique ou électronique (e-waste)
EEE	Electrical and Electronic Equipment
EHF	Environmental Handling Fee
EMF	Ellen MacArthur Foundation
EoL	End-of-Life
EPEAT	Electronic Product Environmental Assessment Tool
EPR	Extended Producer Responsibility
EPRA	Electronic Products Recycling Association
GEC	Global Electronics Council
GHG	Greenhouse Gases
HWM	Hazardous Waste Management
IE	Industrial Ecology
LED	Light-Emitting Diode
LCA	Lifecycle Analysis / Lifecycle Assessment
MFA	Material Flow Analysis
OECD	Organisation for Economic Cooperation and Development
OEM	Original Equipment Manufacturer
PRO	Producer Responsibility Organization
REACH	Registration, Evaluation, Authorization and Restriction of Chemicals
RoHS	Restriction of Hazardous Substances
U/EoL	Used or End-of-Life
WEEE	Waste Electrical and Electronic Equipment

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"Remember, always, that everything you know, and everything everyone knows, is only a model. Get your model out there where it can be viewed. Invite others to challenge your assumptions and add their own."

- Donella H. Meadows

Chapter 1. Introduction

This chapter discusses the issue of e-waste management and provides context to situate the rest of this thesis. In addition to explaining why the lifecycle management (from extraction to disposal, or recycling) of electrical and electronic products has become such an important and urgent area for research, it defines some of the key concepts that will be used throughout the thesis. It also offers a brief literature review pertaining to e-waste management, and an overview of the recent development of e-waste management regulation in Québec. The last portion of this introduction presents an outline of the rest of this thesis.

1.1 Issues pertaining to electrical and electronic equipment lifecycles

For more and more people around the world, daily activities have become inextricably tied to the use of electrical or electronic equipment which include a wide range of products such as computers, small household appliances, research instruments, tools and toys. Rising income levels, improvements in manufacturing leading to lower prices, rapid design changes and increased appetites for convenience and/or social status, all lead to the consumption, at an accelerated pace, of equipment transmitting information and/or power by using electrical energy (Forti et al., 2018). The annual increase in consumption of electrical and electronic equipment is estimated to 2.5 million metric tons (Forti et al., 2021). There are multiple environmental, social, and economic impacts arising from this trend.

Vast quantities of natural resources are extracted for the ongoing production of electrical and electronic devices (Williams et al., 2002). Global e-waste research groups estimate that there are currently 69 different elements contained in electrical and electronic equipment (Forti et al., 2021), including precious metals such as gold and platinum, and critical raw materials (e.g., indium, bismuth, antimony). Critical raw materials are in high demand for their use in new technologies; they are difficult to substitute, because of their unique properties, and their supply is limited either because they are geologically scarce, costly to extract and process, or their supply is subject to geopolitical issues affecting market conditions (Ayres and Talens-Peiro, 2013; Graedel et al., 2012).

The extraction of these resources, mainly metals, as well as the manufacturing, packaging, transportation, use, and end-of-life management of electrical and electronic devices comes with a high environmental burden, including water use and contamination as well as significant greenhouse gas emissions (Kuehr et al., 2003). Some of these devices contain toxic elements such as heavy metals (lead, cadmium, and mercury, for example) or brominated flame retardants, which require proper management and disposal, otherwise they pose a threat to workers' health as well as air, water, and soil quality (Nguyen et al., 2019). Besides, the use of these devices contributes massively to increased energy demand (Morley et al., 2018).

Sometimes, electrical and electronic devices are made up of such complex material mixes that this becomes an impediment to proper recycling and material recovery (Hagelücken and Meskers, 2013). By contrast, in ideal conditions, with adequate collection and processing, this would allow, globally, for the recovery of approximately USD 57 billion worth of materials, per year (Forti et al., 2021).

Used and end-of-life electrical and electronic equipment (e-waste) poses additional threats to the environment and to human health when it is sent to the landfill where its contents may leach into water and soil, or when it is shipped to vulnerable foreign contexts where people scavenge and dismantle it using dangerous methods (Thapa et al., 2022). Because of these impacts, today's production and consumption of electrical and electronic equipment are widely viewed as unsustainable (Moreau et al., 2021).

Over the last few decades, the problematic lifecycles of electrical and electronic equipment have become the target of much debate, and have inspired new approaches to public policies, and even international agreements or industry-wide initiatives. The mitigation of negative environmental and social impacts associated with the design, production, distribution, use and end-of-life management of electrical and electronic equipment is now also seen as an opportunity to create employment, promote the development of new technologies, recover precious or critical elements, reduce energy consumption and even, potentially, reduce social inequalities (Ellen MacArthur Foundation, 2018).

However, despite international ambitions and new policies to limit the negative impacts of e-waste, ever more e-waste is continuously generated. The United Nations estimate that 53,6 million metric tonnes of e-waste were generated globally in 2019 (Forti et al., 2021). This represents an annual increase of approximately two million tons per year in the last five years. On a per capita basis, globally, it is estimated that 7.3 kg of e-waste are generated each year. Of this, only 17% was effectively collected and recycled (Forti et. al, 2021). The rest is being sent to landfill, incinerated, or traded and lost to ineffective recycling methods (Ahirwar and Tripathi, 2021; Ellen MacArthur Foundation, 2018) Additionally, new forms of e-waste are continuously created, posing a challenge to even the most up-to-date policies and processing technologies. The proliferation of new and previously unforeseen electrical and electronic products (connected sensors, wearable electronics and e-textiles, electronic cigarettes, flexible photovoltaics) with increasingly complex designs, often embedded in other products, make them difficult to collect, dismantle and recycle (WEEE Forum, 2023). This compounds the problem and confronts municipal waste management programs with an ever more complex waste flow (Köhler, 2013).

As municipalities around the world have been struggling to keep up with the management of this ever-increasing waste stream, crucial governance issues have been raised (UNEP, 2015). Who should collect and recycle e-waste, who should take care of the logistics (collection, sorting, storing, processing), who should pay, and how should these activities be organised in such a way that environmental and health risks are minimised, and potential benefits (employment, access to materials, reuse, and so on) are generated?

Against this backdrop, this thesis critically investigates one specific part of the lifecycle of electrical and electronic products - their end-of-life management - as it happens in a western urban context. For this purpose, I chose to focus on Québec's, and Montréal's experience with e-waste management because detailed in-depth case studies of e-waste management in the Canadian context were missing, and interestingly, Québec sought to innovate with new policy approaches. I investigate how local actors (individuals, or households, and organizations) have been involved in shaping the development and subsequent implementation of an e-waste management regulation. Throughout this thesis, I seek to uncover and critically assess local actors' interests, motivations, choices and decisions; the challenges and barriers they face; and how they help shape, are affected by, and respond to policy development and implementation, thereby shaping policy outcomes. Investigating these local dynamics in depth reveals interesting and important details about policy implementation issues, and gaps between policy prescriptions and how policies play out on the ground. Such an approach can generate useful evidence-based information for making electrical and electronic equipment lifecycles more sustainable. This can also provide improved guidance for devising metrics to assess policy effectiveness beyond simple quantitative measures focusing on the tonnage of materials sent to recycling, and considering, instead, multiple dimensions, perspectives, and more refined objectives related to circularity and a just transition.

1.2 Public policies targeting the lifecycle of electrical and electronic equipment

We have now witnessed roughly two decades of public policy efforts to modify the typical lifecycle of electrical and electronic equipment in such a way that the associated material flows become less "linear" (following an extraction – manufacturing - use - disposal sequence) and more "circular" (based on resource conservation objectives and the narrowing, slowing and closing of material loops) (Bocken et al., 2016). Europeans have led the way, with a series of directives such as the Reduction of Hazardous Substances (RoHS) Directive (European Commission, 2002a) and the Waste Electrical and Electronic Equipment (WEEE) Directive (European Commission, 2002b).

The RoHS Directive was developed with the intention of drastically reducing the quantities of toxic chemicals used in electrical and electronic equipment. The initial RoHS Directive targeted six toxic chemicals (lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls and polybrominated diphenyl ethers); and a subsequent revision of the Directive, in 2019, added another four to the list of restricted chemicals (bis-phtalate, dibutyl phthalate, butyl benzyl phtalate and diisobutyl phthalate). All electrical and electronic equipment being sold on the European market had to be compliant with the RoHS Directive by 2006. The RoHS Directive serves as an example of a public policy mandating changes in the design of electrical and electronic equipment. It makes the Original Equipment Manufacturers (OEMs) responsible for modifying the content of their equipment in such a way that limits harm to the health of people coming in contact with the products, or their components, over their lifecycle. More specifically, because of the RoHS Directive, workers producing the equipment, consumers, as well as those responsible for recycling the equipment, should suffer less exposure to these toxic contaminants.

The WEEE Directive tackled another portion of the lifecycle of electrical and electronic equipment, namely, their end-of-life. This Directive mandated EU member states to adopt Extended Producer Responsibility (EPR) legislation making OEMs responsible for managing their end-of-life products. The WEEE Directive served as an inspiration for many other countries or other jurisdictions that followed suit and adopted similar strategies (OECD, 2014).

Some OEMs have voluntarily improved the design of their products in order to meet energy efficiency criteria, or other environmental requirements, such as increased recycled content. When they meet the necessary criteria, as confirmed by third-party audits, electrical or electronic products can be identified as meeting certain standards, such as Energy Star, TCO Certified, or be registered on the Electronic Product Environmental Assessment Tool (EPEAT)'s registry. EPEAT and TCO Certified are international ecolabelling programs which establish a list of requirements pertaining to the lifecycle of electronic products such as the reduction of toxic components, improved energy efficiency, increased recycled content, or compliance with best practices in corporate social responsibility and respect of human rights during the manufacturing of products. Here, the strategy of voluntarily meeting such environmental criteria is motivated by a greater access to specific markets. Governments and organizations, including public institutions can, and do, require such certifications for the products that they purchase, and this drives industry players to improve their products and their lifecycle impacts (Leclerc and Badami, 2022; GEC, 2022).

Many countries have also come together and drafted the Basel Convention, an international treaty aiming to restrict the transferring of hazardous waste, including used or end-of-life electrical and electronic equipment, from OECD-member countries (presumed to have the capacity to better manage these kinds of waste) to non-OECD countries (Basel Convention Secretariat, 2015).

There are other newer policy approaches aimed at improving the lifecycle of electronic products, which have yet to become more widespread. These include legislative efforts in some countries to curtail planned obsolescence and tax the sales of peripherals (chargers, for example) which cannot be used interchangeably across different brands of equipment, which is considered an impediment to reuse; and initiatives such as “right to repair” acts mandating original equipment manufacturers to provide information on how to repair their equipment, provide spare parts, and so on. These policy approaches can be viewed as complementary to EPR policies. France has been at the forefront of such initiatives (Micheaux and Aggeri, 2021), and Québec has just followed with the recent adoption of the *Act to protect consumers from planned obsolescence and to promote the durability, repairability and maintenance of goods* (Québec, 2023).

However, ensuring the right to repair may have a limited impact on e-waste flows. The promotion of refurbishing and reuse, to extend the lifecycle of products and slow down material extraction, may be challenged by design trade-offs and the difficulty of reconciling product durability and reliability with product modularity and ease of repair (Cordella et al., 2021). Also, consumer behaviours may exacerbate the problem because they prefer replacing some of their electronic products at an accelerated pace, regardless of the condition and potential repairability of their equipment. In some Scandinavian countries, for example, it has been documented that a majority of consumers change their cell phones, and therefore generate more e-waste, just to get the latest model, or access new functionalities (Watson et al., 2017). Perceived obsolescence, the perception that their electronic products are outdated may have a more important impact on consumers’ likelihood of engaging in product repair than does actual product repairability (Makov and Fitzpatrick, 2021). This strengthens the case for using multiple different policies and market mechanisms to help improve electrical and electronic product lifecycles. Sound e-waste management represents a key component of this policy framework.

The point here is not to present every kind of strategy aiming to improve the lifecycle of electrical and electronic equipment in order to make them more sustainable, but rather to demonstrate how different entities (countries, federations, international associations, and industry) are all contributing, by various means, to bring about some change. The examples also serve to demonstrate how various initiatives target different parts of electrical and electronic products' lifecycles, targeting their design (reducing toxic components) and/or targeting their use phase and energy consumption (Energy Star), and/or their end-of-life management (WEEE Directive and Basel Convention). This variety of measures speaks to the complexity of the e-waste problem and hints at the challenges associated with "taming" electrical and electronic lifecycles. Sustainable electrical and electronic equipment lifecycles cannot come about simply through one public policy approach, but rather from multiple simultaneous efforts on the part of different stakeholders. Figure 1.1 (p.9) depicts the generic lifecycle of electrical or electronic equipment and where different policies and measures may be applied (small dark red arrows).

1.3 E-waste defined

In this thesis, I focus on issues pertaining to the management of used and end-of-life electrical and electronic equipment (hereafter U/EoL EEE, or e-waste), as it arises in urban contexts, and more specifically in Québec and the Montréal metropolitan area, in Canada.

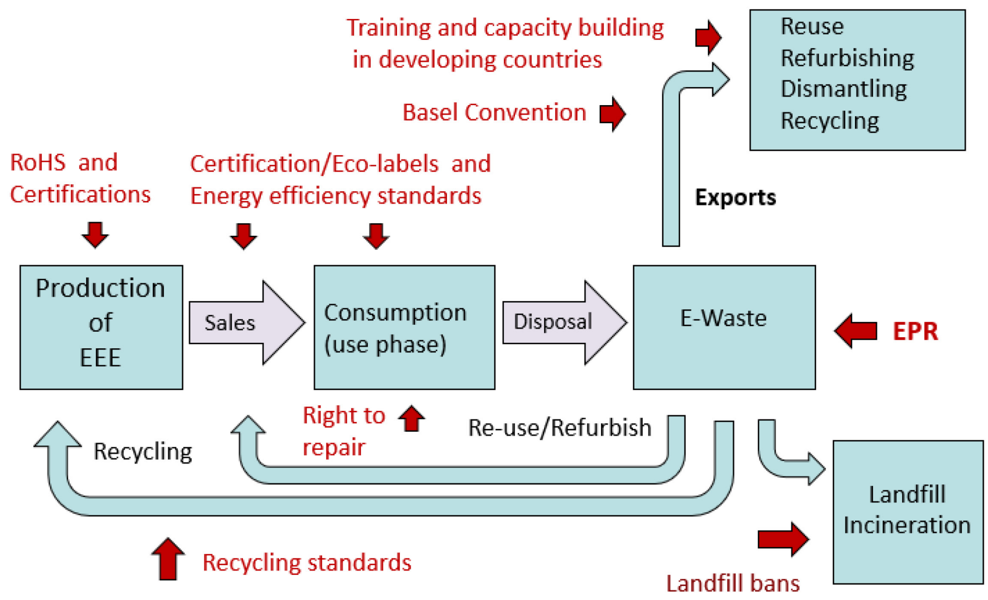

Figure 1.1: Schematic presentation of electrical and electronic equipment lifecycle issues and example solutions.

Definitions of e-waste vary widely across jurisdictions. The United Nations University (UNU) identifies 54 kinds of e-waste and refers to them as e-waste "keys". These keys are used to help standardize e-waste management reporting and statistics around the globe (Baldé et al., 2015). Under the WEEE Directive, in Europe, 10 different types of electrical and electronic equipment and components are designated for collection and reuse or recycling. These cover most of the 54 keys listed by the United Nations' University. The European definition is most comprehensive and includes product categories such as toys, lighting equipment, medical equipment, household appliances, IT and telecommunications equipment, medical devices and automatic dispensers, items that are often left out of such lists in other jurisdictions (European Commission, 2012). For consumers, one may argue, the European Directive's comprehensive scope makes it clear that basically anything which either needs an external source of electricity or a battery for functioning is susceptible to fall under regulatory measures for proper end-of-life management (collection, sorting, refurbishing, reuse, or dismantling and recycling).

While some jurisdictions have chosen to follow in Europe's footsteps and gradually include an ever-increasing list of products as part of their scope for e-waste management, other jurisdictions, by contrast, have been less ambitious (Forti et al., 2018). New York State, for example, only mandates the recovery and recycling of computers, televisions, cathode ray tubes, computer peripherals, small electronic equipment, and small-scale servers, and explicitly excludes many other home appliances, such as smartphones and digital cameras (New York State, 2018). The State of Oregon offers a recycling program covering only computers, monitors, TVs, printers, keyboards and mice (State of Oregon, 2018).

In Canada, the term e-waste is used mainly in reference to used or end-of-life electronics, and excludes things such as tools, toys, and household appliances. The province of British Columbia is exceptional in this regard as its government has gradually sought to apply its recycling regulation to a wide variety of electrical and electronic items, similar to what has been done in Europe (British Columbia, 2022). While the scope of e-waste regulations varies by jurisdiction, and therefore by province, it is useful to note that used and end-of-life products falling outside the scope are not left unmanaged altogether. They are either collected, formally, as part of separate programs, under different names, or, depending on their intrinsic market value, may be collected and recycled by unregulated collection and recycling operations. For example, the Province of Québec has recently decided to mandate the collection and recycling of refrigerant containing appliances by a formal take-back scheme under its umbrella EPR regulation (Recyc-Québec, 2019). And though technically this is a form of e-waste, the province has chosen to allow the set-up of a separate EPR program for this particular type of equipment. Until now, large household appliances and appliances containing refrigerants were largely collected and recycled in an ad hoc fashion, and with little, if any, documentation or standards with regard to their proper treatment. Meanwhile, small household appliances, electrical tools and many other items are still left out of the scope of any program in this province.

In this thesis, and unless otherwise specified in individual chapters, I will use the term "e-waste" in a generic and comprehensive manner, to refer to all possible varieties of used and end-of-life electrical or electronic equipment. I will sometimes distinguish between used equipment and end-of-life equipment. The former has the potential to be reused (directly, or after some repairs or refurbishing) while the latter can only be processed (dismantled and/or shredded) and recycled for material recovery.

1.4 Approaches to the study of e-waste and theoretical context

There exists a rich variety, and important quantity, of literature pertaining to e-waste management. Scholars have analysed this issue from diverse perspectives, including anthropology, human geography, operations management, economics, toxicology and engineering. This reflects the complexity of the topic, and the multiple dimensions (economic, environmental, technological, political, social, behavioural) that it encompasses. The very nature of e-waste, as a complex issue with multiple ramifications, and no unique, simple solution resembles what some call a "wicked problem" (Rittel and Webber, 1973) or a "grand challenge" (Eisenhardt et al., 2016). Hence, many issues, along with multiple dimensions, and at various levels of analysis, have also been explored (for example, international trade flows, environmental and resource use impacts, recycling outputs, greenhouse gas emissions, health and working conditions, and consumer behaviour).

Researchers focusing on e-waste have exposed and quantified a wide range of problems. This includes research focusing on the rapid increase of e-waste found in municipal waste flows and ensuing environmental problems (Kuehr et al., 2003); the increasingly complex material contents of e-waste, which challenges recyclers and hampers the recovery of particularly scarce or critical metals (Graedel, 2011; Graedel et al., 2011); and e-waste trade flows and the serious health and environmental impacts associated with inadequate and dangerous recycling and disposal methods in vulnerable contexts, where proper recycling systems and technologies are unavailable (Nnorom and Osibanjo, 2008; Ongondo et al., 2011).

An abundance of research on e-waste has been contributed from the field of industrial ecology (IE), an interdisciplinary field of research which studies the multiple relationships between human economic activities and the environment, and the material and energy flows resulting from such relationships, with the intent of finding solutions to improve such flows and mitigate their environmental impacts (Boons and Grenville, 2009). Researchers in the field of IE were the first to highlight the problematic material flows associated with the production, consumption, and disposal of electrical and electronic equipment. Williams et al. (2003) sounded the alarm about the unsustainable consumption of electronic equipment by documenting the important quantities of energy and resources needed to produce this equipment. From then on, many other industrial ecologists began to investigate the environmental (and social) impacts associated with the ever-increasing amounts of electrical and electronic products put on the market, and their management (collection, sorting, reuse, dismantling and recycling) once they become e-waste (Kuehr et al., 2003). Through lifecycle analysis (LCA) studies, a quantitative environmental impact assessment method used to inventory and measure the impacts of various systems, including product lifecycles, researchers were able to characterize and quantify the social and environmental advantages of favouring reuse (extending the use phase of the lifecycle), over recycling, as part of the management strategies for e-waste (CIRAIG, 2011). Using this method, researchers also quantified the potential reduction in greenhouse gas emissions associated with the recycling and recovery of metals from e-waste (Magalini and Kuehr, 2010).

In addition to raising awareness about problematic e-waste flows, industrial ecologists articulated a strong normative discourse about the importance of internalising environmental costs into product prices and providing incentives for OEMs to develop products with improved, and more sustainable, or benign, lifecycles (Graedel, 2001). Ultimately, and given the right incentives, manufacturers should develop products that last longer, consume less energy, contain fewer toxics, have a higher recycled content, be easier to recycle, etc. (Fishbein and Ehrenfeld, 2000; Lifset, 1993; Lindhqvist and Lifset, 1998). Inspired by the European policies developed to manage packaging waste, they recommended the use of Extended Producer Responsibility (EPR) for the management of e-waste. EPR policies are based on the “polluter-pays principle” and aim to shift the financial or logistical burden of managing e-waste away from municipalities and back to the OEMs that put the equipment on the market.

This normative contribution has had a major influence on the development of environmental regulations pertaining to e-waste management (OECD, 2001). Environmental protection agencies around the world have been adopting Extended Producer Responsibility (EPR) policies, as prescribed by industrial ecologists (Lifset, 1993). An EPR policy, or regulation, typically leads to the implementation of a material take-back scheme, or program, which is managed and financed by OEMs individually, or collectively through a Producer Responsibility Organization (PRO). A PRO is an organization, most often a non-profit, which develops and manages all the financial aspects, the partnership agreements with municipalities or other local organizations (such as public institutions and businesses other than the PRO or its OEM members), the logistics for the collection and recycling, and communications on behalf of OEMs, in compliance with the government's expectations. These may include target quantities of e-waste to be collected and recycled, number and accessibility of drop-off points, and so on. PROs are usually expected to develop their program and submit it for approval before obtaining recognition by the government's waste diversion agency.

EPR policies are an important part of the legal and regulatory framework governments have developed to help curtail the negative impacts of used and end-of-life electrical or electronic products. More broadly, EPR policies are also viewed as an approach to support the emergence of a more circular economy (i.e., more sustainable production and consumption patterns leading to reduced resource and energy consumption) (Calisto Friant, 2020; Shittu et al., 2021).

Over the years, and as different jurisdictions have experimented with EPR for e-waste management, there have been more case studies or comparative work investigating the actual outcomes, and limits, of EPR policies. Most notably, researchers have been finding that EPR implementation has not been delivering all the expected benefits. Much e-waste remains unaccounted for and is not properly collected or recycled even where EPR programs have been implemented (Magalini and Huisman, 2018). Incentives for eco-design have not materialized as expected in many cases, because the cost of managing EPR programs has simply been shifted to consumers (Lepawsky, 2012; Lifset et al., 2023). Unintended consequences have also come about, such as an increase in recycling, instead of reuse. I provide more details about existing contributions from the e-waste literature in the introductions to Chapters 3 – 6. What I wish to raise here is the idea that there is still much experimentation and learning coming about from jurisdictions implementing such policies and regulations, and that the comprehension of the strengths and limits of EPR has been steadily improving as researchers have been exploring new and more refined questions in relation to EPR and how it has been implemented in various contexts.

It is also worthwhile to mention that the widespread implementation of EPR has coincided with the rise in popularity of the concept of the circular economy (the goal to slow, reduce and close material loops and redesign economic activities respecting planetary boundaries) (Bocken et al., 2016; Desing et al., 2020). New areas of investigation now link the two concepts. Researchers and governments are exploring how EPR is contributing to the circular economy, or not, and in what ways (Compagnoni, 2022). Critical perspectives and questions about the circular economy, with researchers wondering if the concept is equitable, democratic, or effective, are now also directed to EPR, since the latter concept is viewed as a policy option tailored to support the circular economy (Campbell-Johnston, 2021; Thapa et al., 2022).

This thesis contributes to this area of research and critically explores the gap between industrial ecologists' vision and prescriptions for e-waste management through EPR, and how local dynamics are involved in shaping these particular policies, their implementation, and some of their actual outcomes as they play out on the ground. The work I present here also furthers the discussion about the complementarity of industrial ecology and political economy, and how the latter can help explain why and how circularity strategies promoted by industrial ecologists deliver, or fail to deliver, expected outcomes. The content of this thesis is therefore relevant not only to promoting a better understanding of EPR, but also to clarify how EPR contributes, or not, to enabling the emergence of a more circular economy and how this is shaped, in a given context, by the involvement of local stakeholders including municipalities, organizations other than the OEMS and the PRO, waste-pickers, refurbishers, scrap metal recyclers, and so on.

Year after year, global reports document the gap between the quantities of e-waste being generated, and the low levels of formal collection and recycling, even in those countries where exemplary regulatory frameworks have been developed (Forti et al., 2021). My work suggests that macro-level quantitative work can document the magnitude of the problem, but that identifying the actual causes or drivers for low levels of collection and recycling requires a deep dive into local dynamics and an exploration of various actors' motivations, choices and decision-making.

1.5 E-waste as a major urban material flow and urban sustainability problem

E-waste has been recognised as the fastest growing urban waste stream (Basel Convention Secretariat, 2015; European Commission, 2010). Indeed, urban areas are the main locus of electrical and electronic equipment consumption. It is in urban settings that the most e-waste is generated and needs to be managed. Consequently, e-waste is now considered a significant component of the urban metabolism. The stocks and flows of e-waste in urban areas may even be considered as an urban mine as they contain a wide variety of valuable resources to be collected and recovered (Graedel and Harper, 2013).

E-waste management programs and their associated material flows produce many potential economic, social and environmental opportunities and challenges for municipalities and local actors, and specific policy outcomes may be shaped by local economic and political dynamics. Urban material flows may be the result of "multiple interconnected social and ecological processes" where "flows are shaped by the historical context in which they emerge and the urban practices around them" (Broto et al., 2012: 858). It follows that a detailed investigation into the local determinants of material flows, and what happens because of, or in spite of policy-making, should help provide a better understanding of what works, or not, "on the ground", as well as why, and why not.

Urban areas have much to gain from various e-waste management strategies, including reduced environmental risks (from avoiding landfilling of toxic components), employment (from collection, refurbishing, recycling activities), greater access to information technology for less fortunate citizens (through affordable reuse), and access to particular metals (for specialized industries). Simultaneously, a wide range of different social costs associated with the management of e-waste have historically been managed by municipalities and should also be acknowledged, including those related to the collection, transportation, storage, sorting and even dismantling or recycling, in some contexts.

Another motivation for improving e-waste management is the recent call to manage material flows, and therefore product flows along more circular paths (Ellen MacArthur Foundation, 2018). Governments may adopt product take-back policies (OECD, 2001), and encourage recycling for various products, including electrical and electronic equipment, but under a circular economy paradigm, many other actors, such as consumers, organizations including firms and public institutions, non-profits, and local governments must also play a role in improving product lifecycles. However, and because of this abundance of e-waste in urban areas, cities have become fertile ground for the development of "informal" e-waste management activities, well before the implementation of official EPR programs or take-back schemes. The development and implementation of e-waste policies and regulations by environmental protection agencies does not happen in a vacuum since local actors such as waste-pickers, recyclers, repair and refurbishing shops are usually engaged with this material flow, alongside municipalities, before other governments such as state, province, or federal governments seek to tackle the problem (OECD, 2016).

The emergence of sustainable material flows should no longer be viewed only as a macro, or economy-wide endeavour, but also as a possible positive outcome of decisions taken by local actors with regard to their own "internal" material flows. Province-wide, or country-wide regulated, take-back programs, in a sense, represent a minimum baseline for ensuring the recovery of materials. The emergence of more sustainable material flows will, however, require much more than such measures. The decisions taken by local stakeholders and organizations, to reduce or slow down their consumption of certain products or equipment, choosing better designed products, taking care of them so that they last longer, finding local options for reusing them or refurbishing them, etc. will also be necessary for the emergence of a more circular economy. As such, circularity (as a contributor to wider sustainability objectives) is an emergent property of an economic system and must be supported by the constituent parts of the economic system (households, firms, institutions, governments, etc.) in order to become prevalent (Ehrenfeld, 2009).

The adoption and implementation of EPR policies illustrate the usefulness, but also the challenges, associated with environmental multilevel governance systems (Benz, 2019). Their adoption, and implementation depends on the collaboration of multiple jurisdictions (including federal, provincial, and municipal governments, depending on the context), and the involvement of many diverse stakeholders such as municipal workers, consumers, institutions, firms, and so on. In the Canadian context, waste management generally falls under the responsibility of provinces, and it is the provinces that have been adopting EPR regulations, but the federal government is responsible for controlling the transboundary movement of hazardous waste, including e-waste. Québec's provincial government adopted an EPR regulation for the management of e-waste in 2011 but the actual implementation – and the success – of the policy depends very much on the collaboration of municipalities, as well as the ability of the federal government to limit e-waste exports, in alignment with its commitments under the Basel Convention.

1.6 Thesis outline

The subsequent sections of this thesis are structured as follows. Chapter 2 presents the broader context for this work and discusses the rationale for this research. It delineates the specific knowledge gaps that are explored, explains my analytical framework, the research objectives and questions, and discusses the methods that were chosen to carry out the work. It also provides an overview of the challenges and associated limitations of the research. Then, Chapters 3 to 6 consist of four separate published papers attempting to respond to the research questions listed in Chapter 2. I provide bridging text to introduce each of these substantive chapters. Finally, Chapter 7 offers a synthesis of the main findings, a discussion of the ensuing theoretical contributions and policy implications, ideas for future research as well as a few concluding remarks.

There are minor repetitions throughout the introductory sections of the substantive chapters (Chapters 3 to 6, inclusively). This is the result of modifications that were necessitated in response to journal reviewers who specifically requested additional context about e-waste management, extended producer responsibility (EPR) theory, or the recent history of e-waste management in Québec. Similarly, there are minor adjustments that have been made to the numbering of sections in those chapters, to facilitate reading and ensure consistency throughout this thesis. A table which was placed in supplemental materials by one of the journals, because of its length, was reintroduced directly in the text of Chapter 6. I also added a few telling quotes from various interview participants in Appendix 4. These provide additional details from interviews conducted as part of the research presented in Chapter 6. Any remaining discrepancies in style across these chapters reflect the journals' varying requirements.

Chapter 2. Rationale, Conceptual Framework and Methodology

In this chapter, I present the overall justification for the research conducted as part of this doctoral project. I present, in turn, the key problems motivating my work, the research gaps I sought to address, my research objectives and questions, and the methodological approaches I used to address these questions.

Chapter 1 provided a broad introduction to the issues raised by the global increase in the production and consumption of electrical and electronic equipment, and the ensuing challenges posed by e-waste management. In this chapter, I focus on the importance of understanding the complexities of e-waste management policy development and implementation, and specifically Extended Producer Responsibility (EPR), as the most favoured approach for managing e-waste in the OECD context. Because of the multiple dimensions and impacts of e-waste, and e-waste management, and the multiple objectives that are pursued through e-waste management policy-making (reduced pollution, local employment, and resource conservation, for example), I argue that an interdisciplinary approach is necessary to promote a better understanding of this complexity.

Similarly, because so many actors are involved in shaping e-waste management, and e-waste flows, including legislators, consumers, recyclers, OEMs, municipalities, organizations, refurbishers, and waste-pickers; and given that each actor's choices, motivations, and decisions shape policy implementation and outcomes, I argue that these are worth investigating and that qualitative research methods are needed to help reveal and unpack what lies behind policy choices and policy implementation challenges and issues. Given the structure of this thesis, which includes four published journal articles as substantive chapters exploring different aspects of e-waste management in Québec and in Montréal, this chapter discusses the overall conceptual and methodological framework for the whole thesis. Each individual substantive analytical chapter (Chapters 3 to 6, inclusively) provides more detailed descriptions of the methodologies used for the individual projects on which each of those chapters focuses.

2.1 Motivation and knowledge gaps

There are still many unanswered questions pertaining to the actual development, roll-out and outcomes of EPR policies for e-waste management (Compagnoni, 2022). Lepawsky (2012) explains, for example, how the literature tends to avoid engaging with the implementation challenges and technicalities of e-waste related legislation. Also, the use of such policies, or regulations, is sufficiently recent that much trial and error is still occurring, and improvements are still needed (Compagnoni, 2022). Some 78 countries currently have policies aimed at tackling e-waste, but many countries and regions are still struggling with setting adequate performance requirements for such programs (Shittu et al., 2021; Williams et al., 2013). From a review of the literature, three types of knowledge gaps have come to the surface regarding e-waste management in the OECD context and which need to be addressed for continued progress in this area.

Firstly, there have been multiple disconnects between the prescriptions of industrial ecology for EPR, and actual policy development and implementation in various jurisdictions (Atasu, 2019; Castell, Clift, and Frances, 2004). For example, in Canada, as they were adopting EPR policies, many provinces chose not to internalise the environmental handling fees (the cost of properly collecting and processing e-waste) into product prices and accepted, instead, the OEM's preference for imposing separate fees on the purchase of electric and electronic equipment. This short-circuits the implementation of the polluter-pays principle by completely shifting the financial burden to consumers (instead of OEMs) (Lepawsky, 2012). One may argue that the financial burden is always shifted to consumers in the end (regardless of whether the environmental handling fees are visible or not) but in the absence of separate visible fees, manufacturers could decide, on a case-by-case basis (and per product, for example) what portion of the fees is shifted back to the consumer. Also, when flat rate advanced recycling fees are determined per product category (such as televisions, computers, or printers) as opposed to being specific for a given product model and taking account of the lifecycle impacts of individual products, the incentives for consumers to purchase a better model (and for OEMs to make better equipment) is lost (Clift & Frances, 2006; Lifset et al., 2022). The lumping of products into categories with fixed environmental handling fees has been promoted by manufacturers in many contexts, including in Canada. This certainly reduces the administrative burden on the side of the manufacturers, but also reduces incentives for the design of better products (Mayers et al., 2011).

There has been little attention given to the multiple variations in the development and implementation of EPR policies for e-waste management, and the digression away from some of the concept's core elements. To be fair, some research articles do contrast and compare EPR policy variations across jurisdictions (Hickle, 2014a; Williams et al., 2013; Xavier et al., 2021), but few researchers have explored the root causes (the why and how) for such divergences, nor who contributed to policy development, with what interests, and how these factors contributed to shaping policy outcomes in different jurisdictions (De Oliveira et al., 2012; Ongondo et al., 2011). Similarly, industrial ecology developed simple models to predict how specific actors (especially manufacturers) would behave (Fishbein, 2000; Lifset, 1993; Walls, 2006), in response to certain constraints and incentives (paying for collection and recycling, and therefore investing in eco-design), but the attribution of specific roles under EPR could also lead to many other ensuing preferences, decisions, and outcomes. For the moment, industrial ecology's prescriptions for EPR have focused on a normative view of "ideal" e-waste flows (focusing on closing material loops), but have contributed little to understanding the potential, and actual, local social, environmental and economic ramifications, of EPR programs, and especially in an OECD context (Korhonen et al., 2004; Pickren, 2014b). Such an analysis requires the investigation of actors' interests, choices, motivations, and rationale for decision-making through empirical work and case studies using a political economy perspective or other similar approaches which take account of the local political, institutional, economic and historical context (Hobson, 2021). Qualitative research methods are ideally suited for this kind of endeavour.

Secondly, even after more than a decade of experimentation with EPR for e-waste management, and despite continued prescriptions to shift the financial and/or logistical burden of e-waste management away from municipalities and towards manufacturers, there has been little, if any, exploration of municipalities' perspectives regarding, and responses to, e-waste management programs (Cahill et al., 2010). Research investigating what drives municipalities' collaboration and contributions (or resistance) to new e-waste take-back schemes and how this affects policy outcomes is still lacking. According to Atasu and Van Wassenhove (2012) the economic impacts (in terms of benefits or drawbacks) of take-back programs for municipalities remain an open problem to be investigated. EPR policies' impact on municipalities' revenues is an important issue, but financial benefits represent only one aspect of all the possible objectives municipalities may expect to be addressed by sound e-waste management, which may include effective pollution prevention, improved logistics, waste diversion, employment through local refurbishing and reuse, and so on (Williams et al., 2008). Recent literature reviews by other authors also confirm that very little research has dealt with this topic (Andrade et al., 2019). Understanding municipalities' relationships with EPR programs requires reaching out to, and engaging with, those people who are involved in the day-to-day activities related to the planning and management of e-waste flows in municipalities, in collaboration (or not) with the PRO, and eliciting their perspectives, concerns, and motivations, through in-depth interviews.

Lastly, and more generally, EPR policies aim to harness e-waste flows to maximise and improve collection, sorting and end-of-life processing for material recovery through state-of-the-art recycling and refining (Huisman et al., 2015; Lindhqvist and Lifset, 1998). However, the implementation of such programs does not happen in a vacuum, and in many jurisdictions previous e-waste flows exist and many actors (individuals, or households, and organizations) are already involved in collecting, sorting, dismantling, refurbishing, reusing, reselling, and recycling e-waste before the adoption of EPR regulations. The French call these "historical flows" (Federec, 2018), the Québec waste diversion agency calls them "parallel networks" (Québec, 2022c). Unfortunately, there is a lack of research exploring who was involved in managing e-waste before the adoption of EPR regulations in various contexts and what has happened to these actors' e-waste management activities after the regulations were adopted. Are they still active in collecting, processing and reselling e-waste, and if so, how have they adapted or reacted to the changing context after the adoption of EPR, and how does their involvement and decision-making affect material flows and policy outcomes? How does one explain if and why such actors are still involved in managing e-waste flows in areas where EPR has been implemented for a few years, and where the collection and processing of e-waste should now fall under manufacturers' responsibility?

The fact that an important portion of e-waste is still managed, or scavenged outside formal take-back schemes is well documented. Magalini and Huisman (2018) mention, for example, that two thirds of used and end-of-life electrical and electronic products sold in Europe are not returned to official EPR programs. Researchers have quantified the problem, but actual direct feedback "from the ground" to understand who is involved in such pre-existing and persisting e-waste flows; their choices and motivations; and how informal e-waste flows come about in a western urban context is still lacking. One could argue that industrial ecology's normative discourse about EPR has oversimplified the shift of e-waste management responsibilities from municipalities to manufacturers and neglected a broader acknowledgment of all the other actors involved in e-waste management (Lawhon, 2012; Vermeulen et al., 2021). Even legislators often fail to recognize the importance of various actors, by focusing on manufacturers, consumers and municipalities, as part of the allocation of roles and responsibilities in e-waste management policy-making. They may disregard the importance of other organizations (firms and public institutions), including refurbishers and scrap metal recyclers as key stakeholders whose activities can have an important impact on e-waste management policy implementation and outcomes (Campbell-Johnston et al., 2021).

Understanding the successes and challenges met by EPR programs requires a detailed and nuanced perspective of the motivations, preferences and decisions of the actors involved in generating e-waste (organizations, again including firms and institutions, and households), and those involved in collecting, sorting, dismantling, consolidating, refurbishing, reselling, and trading e-waste in a given area, and whether they are working with the EPR program, directly, indirectly, or not, and why so. Additionally, understanding the variety, and extent, of local actors' involvement and interactions in shaping e-waste flows is necessary to identify opportunities for improved social and environmental outcomes. So far, outside of the broad categories such as governments, firms and households, the normative e-waste management literature has often made other actors invisible, thereby neglecting their role in e-waste management; how they would be impacted by EPR programs, and how their contribution could be essential to program success (Davis, 2020). The lack of understanding of who shapes e-waste flows, outside of EPR programs (as well as why and how they do so) can lead to sub-optimal strategies which, at best, miss out on the opportunity to maintain certain types of low-skill employment (in collection and sorting for example), and at worst, lead to increased marginalisation or even criminalisation of vulnerable groups (Davis and Garb, 2015; Kahhat et al., 2022).

As a brief recap, there already exists much research on the topic of e-waste management in different disciplines. However, there are still very few attempts at understanding and explaining implementation challenges, variations in approaches to EPR policy design across jurisdictions, and why policy development and implementation often diverges from industrial ecology prescriptions. EPR, the main strategy for managing e-waste in accordance with the polluter-pays principles is expected to benefit municipalities, but there is little research exploring if, why, and how municipalities interact with such programs or if they benefit from them, how, why, or why not. The roles played by many actors, including large organizations, are often left out of the picture. And while the important quantities of e-waste collected and managed outside of EPR programs ("informal flows") has been estimated and targeted as a problem, there is very little research exploring the drivers which enable such flows to come about and maintain themselves in an OECD context (Davis, 2020; Magalini and Huisman, 2018). As cities represent important hubs for the consumption, use and disposal of resources (Sudmant et al., 2018), and governments and environmental protection agencies are increasingly interested in planning for greater material circularity, it becomes urgent to recognize and understand actual urban experiences and local underpinnings of e-waste take-back schemes as a means to improve social and environmental outcomes.

2.2 Conceptual framework

As discussed above, e-waste management-related activities have the potential to produce many positive environmental and social outcomes, and there exists much guidance aimed at supporting jurisdictions as they go about developing sound e-waste management policies (GIZ, 2019; OECD, 2008; OECD, 2016; UNEP, 2007).

Guidance documents are useful to help understand the importance of e-waste management and providing generic steps to develop EPR programs. However, one could argue that what shapes actual e-waste flows and related impacts as well as environmental, social, and economic outcomes is the result, not only of local regulatory arrangements (inspired by best practices, or not), but also that of a complex web of interactions between many actors' (real and perceived) interests, objectives, and choices, as well as their relation to technology, global markets and public policy. Figure 2.1 (p.28) highlights this complex web of relationships and interactions, which contributes to shaping unique local e-waste management systems and how they in fact play out in specific contexts. This illustration remains a simplified representation, however, as it excludes exogenous factors such as market prices (for plastics and metals, for example), and international agreements (such as the Basel Convention, restricting e-waste trade), which also affect local e-waste management activities. Retailers are also not portrayed as separate actors in Figure 2.1, but their interests and activities in relation to e-waste management, at least in Canada, can be subsumed under the OEMs' and PRO's representation as they are official members of the PRO.

This illustration captures a few key points. First, the environmental and socio-economic impacts resulting from e-waste management are shaped not only by regulators and the policies, laws, or regulatory measures they adopt, but also by local dynamics (the existence of particular actors and interests and how they interact). Global markets (the demand for, and prices for materials) as well as the local availability of technology, for e-waste processing, for example, also form part of the context shaping e-waste management activities in a given region. Against this backdrop, legislators, OEMs (or their PROs), municipalities, e-waste generators (households and organizations), and local collectors, processors, and resellers also shape e-waste management implementation and outcomes, because of their decision-making and behaviours.

Recognising e-waste management as being shaped by many factors, raises the following possibilities: First, given the unique circumstances and combination of actors present in each region, EPR policies may be different because local actors and interests influence policy-making and the development of EPR policies in different ways. Similarly, even where two jurisdictions may have similar EPR policies, the unique configuration of various factors, including access to adequate infrastructure and processing technology, and the presence or absence of different actors (and their preferences, choices and motivations) can affect how similar regulations generate different e-waste management outcomes. Behaviours and decision-making by actors playing out in local areas contribute directly to shaping the environmental, social, and economic impacts of e-waste management in a given context.

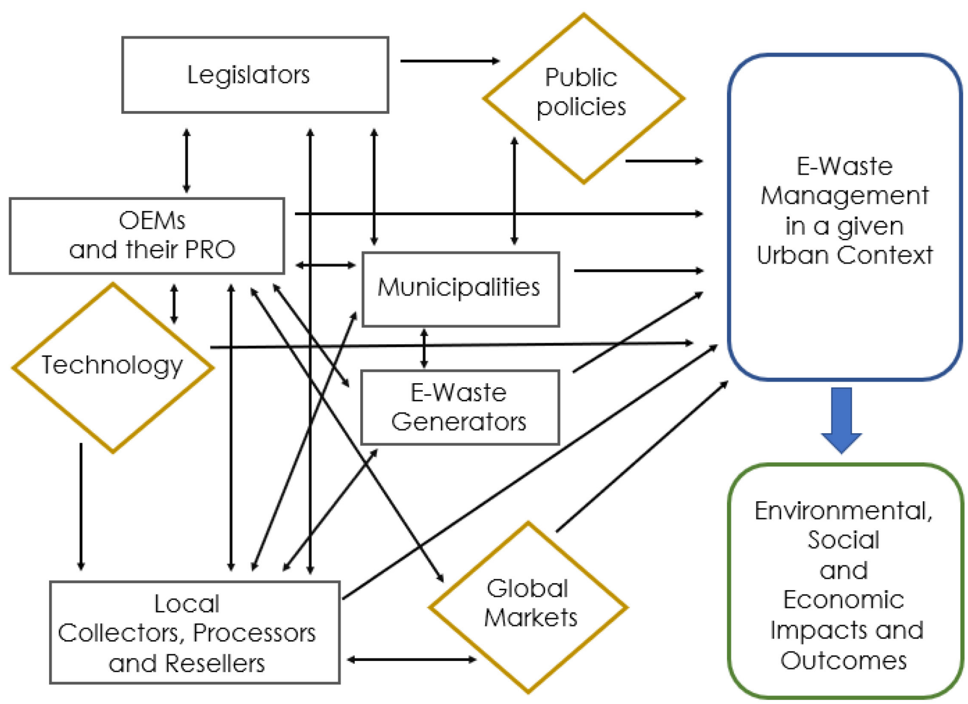

Figure 2.1: Simplified map of actors and factors shaping e-waste management

The areas I chose to focus on for my doctoral research are the interactions, choices, motivations and interests of the various actors identified in the rectangular boxes in Figure 2.1. Households and organizations (firms and institutions) are lumped together in the above figure and are referred to as "E-Waste Generators". I sought to investigate and analyse how these actors interact, how they perceive each other's activities, how their decision-making affects e-waste policy development and policy implementation in Québec and in Montréal, and how they, in turn, respond, react or adjust to e-waste policy implementation. As Broto explains: urban material flows may be the result of "multiple interconnected social and ecological processes" where "flows are shaped by the historical context in which they emerge and the urban practices around them" (Broto et al., 2012: 858).

The choices and decisions of local actors also indirectly shape the reality of e-waste management abroad, such as when e-waste is collected in Québec and exported from Montréal to countries in Africa or Southeast Asia, via the United States, for example. However, the related impacts (abroad) lie outside the scope of this research and are amply dealt with elsewhere (Nnorom and Osibanjo, 2008; Thapa et al., 2022; United Nations University, 2014;).

2.3 The case of Québec

Assuming the social, economic, technological and environmental circumstances between Québec and other Canadian provinces to be similar, in reference to the needs and motivations for adopting sound e-waste management practices, it was surprising that Québec would seek to develop a different approach to EPR, by imposing additional requirements for local processing, the promotion of reuse, mandatory targets and financial penalties, and the modulation for environmental handling fees. Although annual household expenditure in Canada varies slightly per province, the consumption of electrical and electronic equipment, and therefore the quantities of e-waste generated, per capita, could be deemed similar in Québec and in the other Canadian provinces (Statista, 2023). Also, the province shared the same vision of the usefulness of EPR as in other provinces, and like them, has adopted such systems for the management of other end-of-life products (packaging, used paint containers, etc.) (Canada, 2017). E-waste refurbishing and recycling activities already existed here, as they did in other provinces, and the association of manufacturers (EPRA Canada) was also active in Québec, to encourage the adoption of EPR in a way that would be harmonised with the programs previously adopted in other provinces. Nonetheless, differences started to appear when Québec took a longer time to consult with many stakeholders (including municipalities and non-profit refurbishers and recyclers) in preparing its draft regulation. The latter were already active in managing e-waste before provincial authorities decided to regulate e-waste management.

By the time it published its draft regulation in 2009, the Québec government gave a clear indication that it would aim for much more ambitious objectives than was the case in other provinces. This approach meant that the province stood out as an outlier, as a jurisdiction that would attempt to push for novel approaches in its implementation of EPR for e-waste management (Seawright and Gerring, 2008). The details of this approach are discussed in Chapter 3. The point of raising this here is to highlight how these circumstances created a unique opportunity to explore why and how this approach came about, and follow how this would get implemented over time, and with what results.

Québec thus became an attractive case to study which could potentially reveal unique details about EPR policy development and implementation. My expectation then is that from focusing on Québec's recent experience with e-waste management policy development and implementation, I could help document what driving forces (actors' motivations, choices and interests) contributed to this approach, what were the strengths and weaknesses of the government's strategy, as well as some of the related social, and environmental outcomes. Simply put, this could allow me to investigate possible lessons from Québec's experience with EPR as it applies to e-waste management.

2.4 Research objectives and research questions

My research objectives were both empirical and theoretical / conceptual. By contrast to more normative / prescriptive work on EPR, or other research describing regulatory arrangements, I chose to critically investigate Québec's, and Montréal's, experience with the development and implementation of e-waste management following EPR principles. I chose to do so by focusing directly on local actors' choices, motivations, preferences and decisions as well as their interactions, perspectives and experiences. Also, and in light of my findings, I hoped to contribute meaningful insights to ongoing theoretical discussions about EPR's potential, expected, and actual contributions to circularity and sustainable urban material flows.

2.4.1 Empirical research objectives and questions

Considering Québec's ambitious plans for EPR implementation and e-waste management, I developed the following empirical research objectives:

- Characterize the political and economic complexities involved in developing EPR schemes for e-waste management.

- Investigate some of the trade-offs between institutional, economic, technical, environmental and social constraints and issues in relation to the organization of more sustainable urban e-waste flows.

- Explore conflicting and converging stakeholder interests and some of the potential and actual redistributive impacts ensuing from EPR scheme development and implementation.

- ➢ Uncover "who" is involved in local e-waste management activities, discover how these actors interact (collaborate or compete); how they carry out their activities and decision-making regarding e-waste flows, and how this affects the EPR program's performance.
- ➢ Uncover unexpected drivers affecting e-waste flows and how these align, or not, with policy objectives.

The questions I chose to help meet these research objectives were the following:

- Why has Québec adopted regulatory measures different from those in other provinces as part of its EPR policy development, and what factors led to these particular requirements? Also, and using Québec's case, how can we explain the recent emergence of the EPR regulatory patchwork for e-waste, a situation causing manufacturers to face different regulatory mechanisms across different jurisdictions?
- What can we learn from Québec's experience in instituting its e-waste regulation with special provisions for local processing (and respect of the 3R hierarchy), and what have been the successes and challenges in implementing this regulation and its particular requirements?
- How and why do large organizations, and especially public institutions, as major e-waste generators in urban settings, contribute, or not, to e-waste EPR program implementation, and to local circularity more broadly.
- How and why do municipalities engage with an EPR program for e-waste management in a context where they are not mandated to do so? What drives, or hinders their collaboration with the program, and how do their perspectives and responses affect policy outcomes?

- How do "informal" e-waste flows come about in a North American urban context, and specifically in Montréal? Who is involved in these flows, how do they operate and interact, what are their motivations, choices, and interests, and how do these affect policy (and more broadly, environmental and social) outcomes?

2.4.2 Theoretical research objectives and questions

By addressing the above questions in my research, I expected to develop a more critical understanding of the gaps between e-waste policy prescriptions, aspirations, and actual implementation and outcomes. This would also lead to a better comprehension of the usefulness, and possible limitations, of the normative literature on e-waste management.

As mentioned in Chapter 1, the adoption of e-waste management policies, or regulations, which emphasize the shifting of financial and/or logistical responsibilities to original equipment manufacturers (OEMs) represent a relatively recent public policy approach (OECD, 2016). In the literature pertaining to environmental regulations, public policies incorporating economic incentives, or price signals, such as taxes, devised to change firms' decisions about their products or their operations, are often referred to as market-based environmental regulations (Keohane et al., 2005) and implemented in alignment with the polluter-pays principle. The development of such instruments rests on the assumption that rational economic entities (firms) will adapt / adjust their behaviour to these regulations and seek to limit their compliance costs by modifying their operations or their products and reducing their contribution to pollution (Stavins, 2004; Walls, 2003 and 2006). These policy approaches contrast with "command and control" policies such as strict emission standards, design, or technology standards. There is a market-based component embedded in EPR policies whereby it is expected that shifting back recycling costs to manufacturers should provide incentives for them to produce better, more sustainable products, or at the very least products which are easier to recycle (to reduce their end-of-life management costs).

This paradigmatic assumption has been fully incorporated into industrial ecology theories and prescriptions for EPR and has become widely accepted as a fundamental principle (and justification) to manage e-waste through product take-back schemes (Fishbein et al., 2000). However, the main scope of these predictions pertains to OEM's decision-making about upstream equipment design and not local take-back implementation and ensuing material flows. Industrial ecology does not predict or even acknowledge what other potential advantages or drawbacks may arise from involving OEMs in equipment take-back schemes, nor how this could affect other local actors' interests, except for municipalities which are identified as the ultimate beneficiaries of EPR programs (Kalimo et al., 2015; OECD, 2016). There is little discussion in industrial ecology about how EPR programs affect the broader governance of urban material flows, including such aspects as transparency, equity, social justice and other similar aspects, and local implementation aspects are given little attention.

This leads to a few additional questions, which have hardly been addressed in any e-waste related research and which inspired my work and thinking about this issue:

- How could contributions from the political economy of environmental regulation, and previously documented challenges associated with the development and implementation of market-based instruments, complement industrial ecology, improve predictions about policy outcomes, and thereby inform better EPR policies?
- How can qualitative research methods, including case studies and action research help reveal some of the more hidden aspects of e-waste management (including the relationships, and interactions between

various local actors, and who benefits, or not, from EPR policy implementation), and how can these methods help inform policies aiming for more sustainable urban material flows?

- What can we learn from conducting transition experiments and action research to support greater circularity in an organizational setting, and how do these approaches contribute to EPR implementation, and to shaping the urban metabolism?

The following section offers a detailed justification for using qualitative methods, and specifically case studies and action research, to help uncover the complexity of local e-waste flows and EPR program outcomes. It also provides a deeper look at my research methodology and how I structured my work to answer the above questions and address the aforementioned knowledge gaps.

2.5 The usefulness of qualitative methods for studying local e-waste management

As discussed above, local e-waste flows are shaped by a complex web of ongoing interactions among various actors (policy-makers, OEMs, refurbishers, waste-pickers, e-waste generators, etc.) and factors such as local regulations, available technologies, local and global markets, and so on. Uncovering details about these interactions can only come about from finding out who is involved, and then engaging with these actors to understand how they operate (understand their activities), why, or why not (what motivates them), and with what outcomes (how this impacts policy results). In this section, I discuss the usefulness of qualitative approaches, and particularly case studies and action research, to uncover the root causes and determinants of local e-waste flows, as well as the potential of these research approaches for theory building and policy-making purposes.

2.5.1 E-waste management as a "grand challenge" or a "wicked problem"

The complexity ensuing from managing ever-increasing amounts of e-waste can be referred to as a "grand challenge" (Eisenhardt et al., 2016), or a "wicked problem" (Rittel and Webber, 1973). This involves the recognition that e-waste flows represent complex, dynamic, adaptive systems with emergent properties requiring multiple dimensions and perspectives to be understood, and eventually managed. Uncovering the myriad relationships between evolving technical, economic, political and social interactions shaping e-waste flows in a given context therefore requires "a deep immersion over time in the focal phenomena with openness to many types of rich data – from text, observations, and surveys…" (Eisenhardt et al., 2016:1114). This kind of immersion allows one to move away from generic, "one size fits all" prescriptions about who should do what (Kalimo et al., 2015), and instead leads one to explore how materials are managed in reality, by whom, why, and with what consequences for urban sustainability and policy-making.

Indeed, policy-makers should not only consider the aggregate material flows associated with each type of waste generated in their jurisdictions. Rather, they should become interested in the roles played by the different actors engaged in generating and shaping particular material flows. Before devising policies, and instead of deciding who should do what from the onset, and then seeing what happens, policy-makers should look at how things are already being done in their particular context, and identify who needs to be encouraged through what kinds of policies, or economic incentives, to change behaviours (Campbell-Johnston et al., 2021). Because of the important economic and environmental repercussions resulting from changes in material flows, as well as the potential for unintended consequences including redistributive impacts, prudence should guide policy developments and careful analysis should precede any changes in the allocation of authority over material flows. My findings show, especially in

Chapter 3, that the Québec government sought to conduct this kind of assessment, by involving non-profit refurbishing organizations in consultations leading to the adoption of the EPR regulation. However, other important stakeholders, as I discuss in Chapters 4, 5 and 6 seem to have been left out of the consultative process and could have provided useful input and feedback.

2.5.2 Epistemological value of qualitative methods for e-waste management research

Keohane (1997) argues that power, interests, ideas and institutions can help explain "variations in the success or failure of environmental policy". One may argue that this applies to successes and failures with regards to e-waste management as well. Uncovering power, interests, ideas and institutions and how they relate to local e-waste flows, holds the promise of better understanding policy challenges, opportunities and outcomes, as well as their variations across jurisdictions, but this requires in-depth qualitative work. Systematic political science analysis, which may be carried out through case studies, for example, is essential, he writes, "… if we are to understand, at least to some reasonable approximation, why we have the environmental policies we have, and what we might realistically be able to do to improve them" (Keohane,1997:4).

A detailed understanding of how local e-waste flows come about, and a thorough account of "what is happening on the ground", is therefore essential to envision potential policy improvements. Furthermore, a critical perspective suggests "challenging conventional, taken-for-granted conceptions about the world and about how we think about it in order to move beyond "what is" to a state of "what could be" (Thomas, 1993: 4). Only rich empirical details can help inform the key value-rational questions proposed by MacRae (1976: 60):

- Where are we going?
- Is this desirable?
- What should be done?
- Who gains and who loses, and by which mechanisms?

Barles has envisioned the usefulness of qualitative assessments to understand urban material flows:

> "It is possible to question the concepts of proximity, both spatial and social; the governance of flows, including the role of lifestyle and urban practices in material exchanges; and the role of local and territorial stakeholders. To date, this field of interdisciplinary research is fragmentary" (Barles, 2010: 452).

Other researchers also stress the importance of uncovering the complexity of actual urban material flows and their dynamics:

> "Sustainable urban futures will require a fundamental transformation of existing production and consumption patterns in cities, and looking into how these patterns are organized into flows – of materials, energy, people, meanings, and power – is a fruitful avenue to investigate such transformation" (Broto et al., 2012: 858).

Such contributions to understanding how and why phenomena occur, and how these are shaped by contextual circumstances, represent some of the key strengths of qualitative research, and case studies in particular, according to George and Bennett (2005).

2.5.3 Case studies and action research for theory-building about e-waste management

Yin writes that there is "no formula" but that as one's choice of research questions "seek to *explain* some contemporary circumstances (e.g., "how" or "why" some social phenomenon works), the more that case study research will be relevant" (Yin, 2018: 4). He adds that case studies are also most relevant, the more one's investigation requires "in-depth" descriptions. Duncan MacRae explains how case studies allow researchers to "close in" on real-life situations and "test views directly in relation to phenomena as they unfold in practice" (MacRae, 1976: 82). Case study research therefore presents itself as a useful research approach to help uncover and make sense of the multiple determinants of local e-waste flows.

Uncovering which agents shape material flows, why, and how, can provide the initial building blocks for a theory of agents in industrial ecology in general and in EPR theory in particular. Such work can contribute to the development of new areas of research in urban material flow management, in the study of "agent-based modelling" or that of "structural agents" (Axtell et al., 2002; Binder, 2007). As such research is carried out, contributing to conceptual clarity and theory building, this also allows for improved policy-making. As Binder (2007: 1606) proposes: "natural and engineering sciences have to be integrated with social and humanity models in order to provide policy-relevant information". Some political economists focusing on environmental issues also stress the usefulness of such approaches: "a rich understanding of how individuals, firms, and organizations behave is an essential building block of policy" (Dietz et. al., 2011:6). Regarding industrial ecology, then, contributions from case studies and action research can also contribute to moving the field from a focus on "what" towards the "how" and "why", and therefore contribute to its relevance (Andrews, 1999; Breetz, 2017; Deutz and Ioppolo, 2015).

Conducting case study research may be the most adequate response to Davis's critique of the current state of knowledge about informal e-waste flows. He argues: "An estimated 76% of the world's e-waste is believed to move through informal channels, with significant environmental and health consequences. Despite this, strikingly little is known of the flows and actors" (Davis, 2020: 102). He also adds that discussions about informal e-waste flows "only appears in the policy literature as evidence of the e-waste problem" (Idem). The lack of qualitative research, and actual investigations of what shapes informal e-waste flows, especially in a western context, explains why so little is known about the root causes of these flows. Hopefully, with more qualitative contributions, and local case studies, this may generate new knowledge and perhaps even challenge the way we think of e-waste management-related problems. With this type of research, we may be able to pinpoint "the mechanisms that generate the observed patterns" (Tsang, 2014: 374) and perhaps even uncover the existence of "lock-in" situations where transitions to more sustainable outcomes are hampered by habits, institutions, or regulatory arrangements.

Along with case studies, action research can also contribute to uncovering the rich empirical details and causal mechanisms underlying social phenomena, including material flows. This is the case, when researchers engage with "real-life challenges", become "knowledge brokers", contribute to sustainability transitions by testing actual experiments (actively supporting and implementing interventions and bringing about change) while documenting issues in a systematic way, in order to generate useful theoretical insights (Loorbach et al., 2017; Wittmayer and Schäpke, 2014). Bent Flyvbjerg (2006: 236) echoes this idea with the following: "the most advanced form of understanding is achieved when researchers place themselves within the context being studied. Only in this way can researchers understand the viewpoint and the behaviour which characterize social actors". This is one of the approaches I experimented with as part of Chapter 4 where I argue that action research used as a means to explore and modify e-waste flows represents a form of transition experiment (Loorbach, 2007; Luederitz, 2017; Rauschmayer et al., 2015).

In the end, exploring and critically assessing the local determinants of e-waste flows through case studies and action research should provide knowledge which planners can then leverage to improve urban material flows, as well as refine and improve the anticipated environmental and social outcomes of circularity policies. This should allow "extensive theoretical opportunities to reveal new concepts, relationships, and logics of organizing while also advancing social progress" (Eisenhardt et al., 2016: 1113). The exploration of such cases can help build awareness about some particular aspects of "grand challenges" including the acknowledgment of the long time frames during which complex problems unfold. This type of research, which reveals new, sometimes unexpected, insights and rich empirical details provides what Bansal et al. (2018) call a "new way of seeing" and complements quantitative contributions to the study of e-waste flows. The discussion in Chapter 7 will highlight some of the original findings revealed throughout this research, and especially those which could not have been discovered by means other than qualitative research. I will also discuss their relevance for policy-making.

2.6 Research methods

To answer the questions listed above, I chose to carry out my work by focusing on the case of Québec's recent experience with EPR for e-waste management. Also, and because of the multiple dimensions and aspects I sought to explore, including actors' motivations, choices, and decisions, I carefully designed four distinct but related research projects which would uncover different aspects of this experience, each focusing on distinct knowledge gaps: understanding the political economy of e-waste policy development, exploring the role of large organizations, and especially that of large public institutions, in supporting EPR and shaping local material flows, investigating municipalities' relationships with

EPR programs, and uncovering what shapes formal and informal e-waste flows in Montréal. Together, each individual research project represents an embedded case with different units of analysis, each contributing to the broader objective of investigating and learning from the development and first few years of implementation of Québec's EPR regulation for e-waste management. As Yin (2009) explains, embedded case studies help bring focus to case study inquiries by exploring issues in sub-units of analysis, providing multiple sources of evidence and opportunities for triangulation across sub-units. Such triangulation helps support my research project's validity.

Because of the complex nature of e-waste management policy development and implementation, there are inevitable trade-offs involved in the design of one's research methods. E-waste research comparing multiple cases are usually more descriptive than explanatory (Kahhat et al., 2008; Hickle, 2014a). I purposefully designed my work to explore the complexity of policy development and implementation in a given context, along multiple dimensions and from multiple perspectives, and by uncovering rich details, revealing causal mechanisms and unintended consequences. Nevertheless, I also include useful comparative insights throughout my work by comparing policies across Canadian provinces in Chapter 3 and discussing comparisons with findings from other jurisdictions in the United States, Canada and Europe throughout subsequent chapters.

I used a mix of different approaches, which offer the following advantages according to Yin (2014: 65): "Mixed methods research can permit researchers to address more complicated research questions and collect a richer and stronger array of evidence than can be accomplished by any single method alone." Table 2.1 (p.43) lists the four projects I carried out and provides some details pertaining to their respective theoretical underpinnings, the relevant units of analysis I focused on, as well as the expected contributions. Each substantive paper presented in Chapters 3-6 provides additional linkages to the relevant literature, details regarding their theoretical context, as well as a discussion of the methods used, in relation to each individual research project.

Table 2.1: Overview of separate projects and expected contributions

Paper / Chapter	Theoretical Background	Methodological approach	Unit(s) of analysis	Expected Contributions
EPR for e-waste management: policy drivers and challenges	Political Economy Industrial Ecology	Archival / Document analysis Interviews	Policy development and implementation	Explore gaps between policy prescriptions and actual policy-making
Material circularity in large organizations: Action-research to shift IT material flows	Transition Management Action-Research Transition experiments Sustainability and Circularity Studies	Action-Research Transition Management: Diagnosis / Visioning / Intervention / Reporting	University material flows Behaviours Institutional policies and processes	Explore importance of large organizations in EPR program success Organizations' contributions to urban circularity
EPR: An empirical investigation in municipalities' contributions to and perspectives on e-waste management	Industrial Ecology Sustainability and Circularity Studies	Questionnaire and In-depth interviews	Municipalities Municipal stakeholder's preferences, motivations, perspectives and decisions	Insights into drivers and impediments to municipalities contributions to EPR and impacts on policy outcomes
Informal e-waste flows in Montréal: Implications for EPR and Circularity	Industrial Ecology Sustainability and Circularity Studies	Site visits and observations, in-depth interviews, material flow mapping	Urban e-waste flows Stakeholder interactions Choices, perspectives motivations, decisions	Explore how « informal flows » come about, who is involved, why, and with what impacts

2.6.1 Data collection

Patton identifies three kinds of qualitative data collection methods: Interviews, observations and documents (Patton, 2002). I used all three, in addition to action research, another useful approach for generating information and knowledge (Coughland and Coghlan, 2002; Stringer, 2013; Wittmeyer and Schäpke, 2014).

I used archival research mainly to explore who sought to influence the development of the e-waste management regulation in Québec, how, and why, or why not, and with what results. I also reviewed, over the years, the PRO's various policy statements and annual reports, and compared them to the reports of PROs in other provinces. This initial exploration helped me shape my initial participant recruitment, which then grew by snowball sampling (Patton, 2002) thanks to some recommendations as to whom I should talk to next. My list of participants also grew through the use of internet keyword searches, and the use of the provincial business registry (Registre des entreprises, 2018).

In-depth interviews (either in person or over the phone) were constant throughout the whole research period. These were used initially for gathering data through the administration of a semi-structured interview canvas, but also, they were used in an iterative way throughout my research, for validation purposes and triangulation, to better understand and cross-validate the rationales and motivations behind various actors' decision-making, and to assess whether and how these had changed over time. I remained flexible during each interview, making sure I let participants voice their concerns and raise other issues I may not have thought of. Open questions were favoured, to elicit details about the reasoning, interests, and objectives of participants. Over the course of my research, I interviewed municipal civil servants, government officials, PRO representatives, recyclers, refurbishers, e-waste brokers, waste-pickers, scrap-metal recyclers, waste diversion agency officials, and so on. My list of interview participants (by stakeholder category) is provided in Appendix 1, and my initial list of interview questions, also by stakeholder category, is made available, in Appendix 2.

Some of these questions were eventually abandoned (such as questions asking waste-pickers what they thought about the EPR program), because these participants did not know about the program or did not know if or how it related to them, nor how it affected the kinds of materials they had access to and how this changed over time.

The action research project presented in Chapter 4 was a highly valued opportunity to explore and transform the e-waste flows generated by a large organization (and therefore contributing to shaping urban e-waste flows) in the context of the newly adopted EPR regulation. The data generated or collected through this project came from semi-structured interviews, site visits, and the results ensuing from a diagnosis and series of interventions aiming to change institutional procedures and material flows in support of circularity and a wider sustainability transition. The interview questions which were used to help understand the determinants of IT flows across different organizations, and specifically Québec universities, and internal McGill University departments, are provided, in English, in Chapter 4 and in French, as part of Appendix 2.

Additionally, an online questionnaire provided an effective means to gather information from multiple actors spread throughout municipalities in Québec, especially at a time when in-person interviews were not possible because of the Covid-19 pandemic. The questionnaire was anonymous, which, I expected, would lead participants to provide honest, and detailed, answers. The questions were specifically designed to inform two distinct projects (those presented in Chapters 5 and 6 of this thesis). The questionnaire contained 18 questions. Some were open questions (with open text boxes to collect free text) and others had multiple-choice options. An outline of the questionnaire and a description of the multiple-choice answers that were provided can be found (in French), in Appendix 3.

Site visits and participant observations included tours at scrap metal recyclers', e-waste brokers' and refurbishers' facilities, accompanied by their owners and/or site managers. In addition to the visits, I carried out observation sessions outside these facilities, to see, and record, the kinds of materials that were being delivered to these locations, assess the proportion of e-waste that was delivered, relative to other materials, and so on. It is mainly at these locations that I was able to engage with waste-pickers and metal collectors and interview them or recruit them for subsequent phone interviews.

The table 2.2 below lists my main data sources for each project. The type and number of data sources are classified by project. There was some overlap across projects, with some interviews containing questions informing findings in multiple projects, or some documentation or questionnaire questions providing insights on different issues and presented in different chapters or articles.

Because this research involved human participants, it was subject to the University's ethics review process. All stakeholders' anonymity was carefully protected during the course of the project, to limit any risks for participants, and a form was used to obtain participants' informed consent. The Research Ethics Board file number for this project is #106-0717.

Table 2.2: Overview of data collection methods, per project

Paper / Chapter	Archival Research	Online Questionnaire	Interviews	Site Visits and Observation	Action-Research
EPR for e-waste management: policy drivers and challenges	12 memoirs 10 policy documents		7		
Material circularity in large organizations: Action-research to shift IT material flows			20	4	1 Project at McGill
EPR: An empirical investigation in municipalities' contributions to and perspectives on e-waste management	3 policy documents	1 (N-52)	8		
Informal e-waste flows in Montréal: Implications for EPR and Circularity		1 (N-52)	27	8	

Most of the documents referred to in the above table are listed in the References section. However, others are described only in Chapter 3. These were policy statements (memoirs) to which I was granted access, in person only, by Québec's waste diversion agency (Recyc-Québec), but which were not made public, and therefore do not appear among the list of references, unless I could find an online version publicly available.

I have made the point in the previous paragraphs that the specific research gaps, research objectives and research questions I was interested in were, by their nature, best suited to be explored through qualitative research methods, and specifically through the use of case studies and action research. I then provided details about my research design and data collection methods. My findings are presented in Chapters 3-6 and further discussed in Chapter 7. I now turn briefly to the challenges and limitations that I have encountered through this research.

2.7 Challenges and limitations

Addressing the research objectives and questions using the methods presented above required thoughtful planning and significant time to yield the insights and results presented in subsequent chapters. Most challenges, and limitations came from the uneven participation provided by some stakeholder categories (I had to give up interviews with small repair shops because it was particularly hard to reach owners, and I did not have the time for a follow-up), the difficulty of carrying out interviews during the Covid pandemic, or the unwillingness of some participants, to share certain information. As noted in subsequent sections the Producer Responsibility Organization (EPRA Canada, and ARPE Québec) refused to provide any information about the quantities and types of equipment put on the market in Canada or in Québec, nor details about their agreements with municipalities. In the end, these were deemed to be findings in and of themselves.

The manufacturers' representatives were not the only ones who would not share certain information. All other "private / for profit" stakeholders (recyclers, resellers, multi-waste haulers) as well as waste-pickers were reluctant to give any precise numbers about the size of their activities or the profits they generated from their e-waste management activities, though some scrap metal recyclers did provide proportions % of revenues derived from e-waste recycling. For waste pickers and metal collectors, questions regarding revenues from the sale of metals appeared to generate discomfort and were often abandoned in hopes to get answers to other, more interesting questions, such as what they collected, how they dismantled things and where they sold materials. I found, in some cases, that I had to adjust and limit the number of questions I asked.

When the online questionnaire was made available to municipal officials, I was informed that a combination of issues, namely, a crisis in the recycling industry (China no longer accepting many recyclable materials Québec's recyclers usually sent them – especially packaging and printed materials), and the Covid-19 pandemic leading to staffing issues, would make municipal stakeholders less likely to respond to the questionnaire. I was reassured by the variety of participants (which reflected, approximately, the distribution of different municipality sizes) in the online questionnaire. Triangulation, reaching redundancy through interviews, observations, and access to various reports helped bolster, I believe, the validity of my findings (Patton, 2002).

Chapter 3. Extended Producer Responsibility for E-Waste Management: Policy Drivers and Challenges

Chapter overview

As shown in the previous chapters, e-waste flows have increased dramatically in the last few years, posing a threat to the environment, and causing challenges for municipalities and environmental protection agencies throughout the world. An increasingly popular approach to managing e-waste is the implementation of Extended Producer Responsibility (EPR) policies or regulations to redirect the financial and/or logistical burden of e-waste management away from municipalities and the general population and towards manufacturers. Previous e-waste research has documented the emergence of an e-waste regulatory patchwork, with different jurisdictions adopting different EPR regulations, but very little if any attention has been devoted to the causes of such differences.

Why do different jurisdictions structure their EPR regulations differently, with variations in the scope of products, with different targets, with different levels of ambition regarding reuse, or the level of collaboration expected from consumers, retailers, municipalities, and so on? In this chapter, and because Québec's provincial government has chosen to adopt specific measures that are different from other Canadian provinces in relation to EPR for e-waste management, I explore the interests and motivations, and the involvement of various stakeholders in the development of the EPR regulation. While the research presented in this chapter rests upon empirical findings, most specifically the analysis of white papers and position papers (memoirs) by various groups, in addition to a few key interviews, it also builds on important theoretical insights in the field of the political economy of environmental regulation, thereby revealing the usefulness of political economy to help make sense of the forces and factors that shape local and urban material flows in Québec. This is because political economy, as a field of research, recognizes that context, history, culture, technology, individual agency and institutions matter (Keohane, 1997). All of these contribute to shaping policy development, policy outcomes, and material flows. The chapter helps explain how and why Québec chose different policy options for its EPR regulation, in the Canadian context, and thus how the EPR regulatory patchwork comes about, as well as why e-waste management policies differ from industrial ecologists' prescriptions.

3.1. Introduction

In federal contexts, electronic waste (e-waste) management has been characterized by a patchwork of programs, most of which involve some form of Extended Producer Responsibility (EPR) (NERIC, 2006; Kahhat et al., 2008; Huisman et al., 2006; Kunz et al., 2018). In Canada, by contrast, most provincial EPR programs demonstrate similar characteristics. However, Québec's e-waste regulation, passed in 2011 (Gouvernement du Québec, 2011), imposes some unique requirements for its EPR program. We address the following questions: Why did Québec design and implement its EPR program differently? How did the interests and concerns of various actors influence EPR design and implementation in Québec? And, how have these actors been affected by, and responded to, this program? Our aim is not to make normative arguments about ideal e-waste management programs, but to critically discuss the factors contributing to e-waste EPR program design and implementation in Québec, and to explain the differences in this regard between Québec and other Canadian provinces.

We argue that, in federal contexts, differences in the supply and demand functions related to EPR program elements may explain the "varying features of Extended Producer Responsibility" and the "differences in the formulation and implementation of concrete Extended Producer Responsibility/Product Stewardship schemes" (Tasaki et al., 2019: 449). We also suggest that theoretical and empirical perspectives in the environmental regulation literature are useful in understanding the gaps between policy prescriptions and actual policy-making. Further, investigating how the interests, preferences and concerns of stakeholders influence the development and implementation of policies can reveal the challenges associated with the sustainable production and consumption of electrical and electronic equipment.

The following section (Section 3.2) introduces EPR as an environmental policy tool and identifies key variations in its implementation for e-waste management. Section 3.3 describes the Canadian experience in e-waste management, presents Québec's regulation, and highlights how it differs from other provincial approaches. Section 3.4 presents the equilibrium political market framework (Keohane et al., 2005) as an analytical tool for explaining the choice of environmental policy instruments. In Section 3.5, we discuss our methods and materials. In Section 3.6, we present our results and discussion. Specifically, we explore the usefulness of this framework to explain Québec's EPR policy, by discussing the perspectives and motivations of various actors that contributed to demand for and supply of support for that policy, based on the written comments (memoirs) of stakeholders who participated in the consultation process preceding the regulation. Also, we assess the implementation of the EPR regulation and its impacts for various stakeholders, based on their feedback, and provide an update on Québec's experience during its first five years. In Section 3.7, we offer concluding remarks and propose questions for future research.

3.2 E-waste management through Extended Producer Responsibility (EPR)

EPR is a policy tool requiring producers to take financial and/or physical responsibility for managing their used or end-of-life (EoL) products. EPR involves establishing a take-back scheme whereby consumers return products to be reused or repaired, refurbished, remanufactured, or recycled, under the producer's responsibility, thus shifting the burden of EoL management from municipalities and taxpayers to producers, consistent with the polluter-pays principle and cost internalisation. EPR has been applied globally to diverse wastes including vehicles, packaging, used oils, paint containers, tires, batteries, and electrical and electronic equipment (WEEE) (OECD, 2016). Although there remains much debate about EPR design, regarding, for example, the policy objectives (Tasaki et al., 2019); whether environmental handling fees should be visible or not (Clift and France, 2006); and the likelihood of EPR programs delivering their expected outcomes (Atasu, 2019), scholars generally agree that such policies should provide incentives for better product design (for example, Dempsey and McIntyre, 2009; Lifset et al., 2013).

3.2.1 EPR policy objectives

EPR often encompasses multiple environmental objectives targeting various product life-cycle stages (design, materials extraction, production, transportation, use, disposal). Walls (2003) identifies the following objectives:

a) Reduction in waste generated
b) Reduction in waste disposed
c) Reduction in hazardous constituents in the waste stream
d) Decrease in virgin material use
e) Lowered pollution in the product use phase
f) Increased Design for the Environment (DfE)

Other scholars have identified up to 16 goals for EPR policies, including stimulating innovation, reuse, and new business models (Tasaki et al., 2019). In designing EPR programs, policy-makers choose among these objectives and combine command-and-control and market-based instruments to achieve them. An abundant literature in industrial ecology, environmental law, and operations management has evaluated these instruments (Atasu and Van Wassenhove, 2010; Huisman, 2013; Clift and France, 2006; Sachs, 2006). However, little has been written about the motivations, interests, or preferences involved in designing EPR programs (Kunz et al., 2018; Tasaki et al., 2019). Tasaki et al. (2019) conclude that we need to better understand how and why stakeholders support and oppose each of their requirements, and the implications for policy design and implementation. This imperative motivates our paper.

3.2.2 EPR policy elements

Various elements of EPR programs have been discussed by Walls (2006). Below, we list the most important elements, drawing on this and other references, to show the variations which may be chosen in establishing EPR programs.

Scope of products

The designated products may differ from one regulation to another. For example, the European definition (WEEE) covers a much broader variety of electronic and electrical equipment (EEE) than do many North American e-waste programs.

Targets

Some regulators mandate specific quantities to be collected, reused or recycled. In some instances, regulators may impose penalties for not reaching targets, or leave it to producers, or their associations, to establish their own targets (Tasaki et al., 2019).

Quality of treatment and degree of enforcement

Regulators may require that e-waste be collected, recycled and disposed of according to specific standards or best available technology. Additionally, regulators may impose export restrictions in accordance with the Basel Convention (UNEP, 1989) to ensure adequate treatment, and limit social and environmental impacts. Lastly, refurbishing and reuse may be required to be maximised before recycling.

Allocation of physical responsibility

Governments specify whether EoL products may be collected and treated by individual producers, or collectively through a Producer Responsibility Organization (PRO), or multiple competing PROs, to avoid monopolies (Fuminori et al., 2011). In some instances, municipalities may be required to collect e-waste while being funded by the PRO (OECD, 2004).

Allocation of financial responsibility

Regulations often determine the financial structure of take-back programs, and cost allocation among stakeholders (Khetriwal et al., 2009). The costs may include the management of historical and orphaned wastes. There may also be specifications regarding budget allocations for administration, research, and public awareness. Producers may choose to pass on the fees they are charged to consumers, or absorb them partly, without affecting their revenues. Instead of billing producers, some regulations allow a fee on consumers, to cover costs of managing EoL products, either at the point of purchase (visibly, or not) or when the end-user returns the product.

The fees are often fixed by equipment category, and can be modulated according to the cost of recycling, or environmental characteristics of products, as in France (OCAD3E, 2015). To ensure that producers (or consumers) pay only their share of costs, fees may be set according to market share, by sampling the waste by brand name (Dempsey and McIntyre, 2009). This arrangement enables increased financial responsibility for producers, even if physical responsibility remains collective. Part of the fees may also be used to fund take-back activities (Atasu and Wassenhove, 2010), or a deposit-refund mechanism, as considered in Thailand (Manomaivibool and Vassanadumrongdee, 2011).

Other obligations

Regulators may impose other obligations to raise compliance and EPR effectiveness. Producers or their PROs may be required to publish annual reports, and invest in awareness campaigns, and R&D. Retailers may be obliged to take back products (as in Switzerland), or inform consumers about sound EoL management (ADEME, 2014; Khetriwal et al., 2009). Imposing municipal landfill bans may also enhance the success of EPR programs.

This list outlines the most obvious variations in EPR programs. As EPR programs are developed and implemented worldwide, the regulatory burden on industry becomes onerous (OECD, 2004; NERIC, 2006). Also, there are conflicting interests facing policy-makers in selecting elements of EPR programs, on which this chapter sheds light in the Québec context. But first, we present the Canadian experience, and Québec's regulation, on e-waste management.

3.3 E-waste management in Canada and Québec

Canada's per capita GDP is similar to that of Austria or Belgium (IMF, 2018), and Eurostats (2015) estimates the electrical and electronic equipment put on the market (POM) in 2015 at 23.8 and 20.98 kg per capita respectively in the latter two countries. We therefore estimate 22.5 kg per capita, for a total of 845,000 tonnes of electrical and electronic equipment POM annually in Canada, which is a mere 0.02% of the global e-waste generated (Baldé et al., 2018).

Environment Canada, the federal environment ministry, has played a key role in raising awareness about the rapidly increasing e-waste being landfilled country-wide. In the early 2000s, Environment Canada sponsored baseline studies on, and identified EPR as an effective policy to address, the problem (EnviroRis, 2000; PHA Consulting Associates, 2006). In 2007, the Canadian Council of Ministers of the Environment (CCME, 2007) developed Canada-Wide Principles for EPR, in collaboration with provincial governments, to spread best practices in provincial EPR strategies.

Then, in 2009, the CCME published a national action plan for EPR (CCME, 2009). This plan was inspired by the OECD's definition of EPR, and specified broad national policy objectives, among which are: "to minimize environmental impacts, maximize environmental benefits, promote the transfer of end-of-life responsibility for the product and/or material to the producer, and encourage design for environment (DfE)" (CCME, 2009: 9). The action plan is non-binding, however, and simply expresses the consensus on "what should be tackled, when and how", without any quantity targets, or monitoring mechanisms. The key performance measure is the number of operational EPR programs and product categories in place by certain target dates. Thus, the federal government promoted harmonised EPR principles but also respected provincial prerogatives, and chose not to monitor the performance of provincial programs. Rather, it follows and documents the number of programs developed (Government of Canada, 2019).

In theory, and despite consensus on broad principles, each province could therefore have gone its own way, as the US states or European countries have done, in implementing EPR. Instead, most Canadian provinces have developed very similar programs.

Alberta was the first province to develop an e-waste management strategy, in 2004, and also the only one with a government-run program not based on EPR. Nine provinces (British Columbia (BC), Saskatchewan, Nova Scotia, Manitoba, Prince Edward Island (PEI), Québec, New Brunswick, Newfoundland and Labrador, and Ontario) have since set up EPR based e-waste take-back schemes in collaboration with the Electronic Products Recycling Association (EPRA). EPRA is an Original Equipment Manufacturer (OEM) association representing 20 large electronic equipment producers in Canada. Created shortly after Environment Canada's call for EPR, EPRA developed an industry consensus about the ideal characteristics of e-waste EPR programs, and played a key role in helping provinces organise their policies. Also, EPRA has closely collaborated with the Retail Council of Canada, the retailers' association. Each of the provincial PROs, which manage the EPR take-back schemes, has representatives of EPRA and the Retail Council of Canada on its board.

3.3.1 Québec's particular approach

"Québec is trying to build the perfect ark while everybody is out sailing…" -- An electronics industry representative (2010)

Québec is the second most populous, and the only majority Francophone province in Canada, (8.4 million population, about the same as Austria). Its GDP per capita was Canadian $41,836 in 2017, as against $45,883 for Canada as a whole (Statistics Canada, 2019a, 2019b)[1]. Québec generated an estimated 52,920 tonnes of e-waste in 2018, based on Baldé et al. (2017); further, around 9,500 tonnes were sent to landfill annually from 2006 to 2009 (Recyc-Québec, 2009). This situation has persisted longer than in other provinces, since Québec was slow in adopting its EPR regulation. This regulation was published as a draft for consultation in November 2009, and adopted, with some modifications, in July 2011, to high expectations from the OEMs, municipalities, and NGOs. These stakeholders had participated in a broad-based consultation committee (of 28 members), which issued recommendations to Québec's Environment Minister in 2007 (Filière des TIC, 2007).

The regulation was broadly conceived, with provisions for a variety of products, including used oils, fluorescent light bulbs, electronics, and used paint

[1] The GDP per capita in the other three largest Canadian provinces in 2017 was $45,948 in Ontario (the largest Canadian province, with over 14 million population); $46,923 in British Columbia; and $50,351 in Alberta, which is a major oil producer (Statistics Canada, 2019a, 2019b).

containers. Its objective was to “reduce the quantities of residual materials to be eliminated by giving enterprises responsibility for the recovery and reclamation of the products (…) marketed by them and by promoting the design of products more respectful of the environment” (MDDEP, 2011).

3.3.2 Québec’s and other provincial EPR programs compared

We now contrast Québec’s EPR program with those in other Canadian provinces, in terms of the EPR program elements discussed in Section 3.2.

Scope of products

The products identified for take-back varied slightly across the other provinces, but most of them focus on consumer electronics. All provinces have phased in more products with time. BC, however, announced early on that it would eventually tackle the 10 waste categories as the WEEE Directive (European Commission, 2012), and has been doing so gradually, including products such as toys, power tools, and scientific instruments.

The equipment designated in Québec’s EPR regulation were to be addressed in two phases -- computers, televisions, printers, phones and some peripherals in the first, and scanners, photocopiers, video games, servers, digital cameras, webcams, GPS systems and the like in the second. The regulation applied regardless of age, type, or brand, thus accounting for historical and orphan products. The extension of categories, which was published for consultation along with the Draft Waste Management Policy, was to occur at a rate of two products every two years (MDDEP, 2010). However, Québec chose not to include household appliances, medical devices, and toys.

Targets

From the onset, BC’s regulation set the aspirational goal of 75% of e-waste to be collected and recycled (British Columbia, 2004). However, the PRO has had difficulty reaching this target, and has since developed lower but progressively increasing, targets. Ontario's PRO, which set its own targets from the beginning, has also failed to meet them, generating criticism from the public and the government, but has continuously improved its performance (E-Scrap News, 2016).

In Québec, producers were mandated to comply with recovery targets in a phased manner. The minimum rate for most products was 40% of POM, to be met in 2015, and increased annually by 5%, up to 65%. Further, whereas none of the other provinces imposed penalties or fines on producers failing to meet their targets, Québec's draft regulation introduced penalties for such producers (or their PROs), and specified per unit calculation values for this purpose, ranging from $2 per unit for a laptop computer, to $15 for computer screens and televisions, with revenues going towards Québec's Green Fund.

Quality of treatment and degree of enforcement

From the beginning, EPRA developed criteria, as part of their Recycler Qualification Program (RQP), for selecting collectors and recyclers for the provincial e-waste program (Alberta adopted the same criteria, although it has a province-run program). The RQP requires third-party audits and certifications, ensuring that products are managed in an environmentally sound manner that also safeguards worker health and safety, from primary processing to final disposition. The fact that the producers themselves collectively developed and imposed this standard upon processors and recyclers – as against the USA's voluntary approach -- would make a good case study in corporate social responsibility. However, because recyclers are not obliged to be part of the provincial take-back schemes (anyone can sell or give away e-waste to anyone operating outside these schemes), a portion of e-waste is likely still gathered, dismantled, and exported to countries without the ability to treat it properly (BAN, 2018).

A novel requirement of Québec's approach was the obligation for recovery programs to respect the 3R hierarchy, unless proven (by producers or their PRO) that existing technology would not permit it, or if a ISO certified life-cycle analysis could justify another approach. The programs are also required to be managed so that products and materials are tracked to their final destination (even if abroad), personal information is destroyed, and local or regional management is favoured.

Allocation of physical responsibility

Some provinces require producers to take collective physical responsibility for their products while others allow producers to opt for collective or individual responsibility. However, in most provinces, EPRA has united with the Canadian Retail Council in setting up PROs to whom producers have delegated their responsibilities. There is thus no large-scale individual producer responsibility (IPR) in e-waste management in Canada. EPR programs are implemented as collective take-back schemes with shared physical and financial responsibilities. Some voluntary IPR initiatives do exist, as OEMs offer take-back schemes through their websites or agreements with specific retailers, but no manufacturer takes back all of its products on its own.

Québec's regulation applies to producers who have designed the equipment, or their first local suppliers. Producers may choose to meet their obligations individually, or collectively through a PRO. Nevertheless, even producers that would choose to establish individual schemes would be obliged to take back equipment of all brands in the same product category as those they sell, regardless of age or condition.

Allocation of financial responsibility

All Canadian provinces with e-waste management programs, including Québec, impose visible Environmental Handling Fees (EHFs), at the point of purchase. The revenues finance PRO operations, including the costs of collecting, consolidating and recycling e-waste (including historic and orphaned wastes), besides research and communications. The EHFs are fixed by equipment category; so, they are the same for all DVD players, or laptop computers, regardless of their individual characteristics. However, there is no cross-financing across categories; thus, one category cannot be charged a higher price to help reduce the EoL management cost of another. EHFs also vary across provinces, reflecting local circumstances (such as geographical distances and transportation costs, available recycling facilities, and economies of scale).

Crucially, therefore, producers do not bear the financial responsibility for e-waste management. They are not billed the real (or estimated) cost of managing their share of the waste. Collective costs are divided across products and fully transferred to consumers. Effectively, then, user charges are imposed on Canadian consumers, while services are managed by the provincial government in Alberta, and by producers in other provinces.

Québec's regulation required that the fees imposed on OEMs for product recovery and reclamation be modulated according to their "toxicity, recyclability, recycled material content, lifespan or impact on the environment and on the reclamation process". This requirement could enable economic incentives usually associated with IPR, at least in theory. Finally, the regulation prohibits cross-financing across equipment categories, as in other provinces.

Other obligations

Only Nova Scotia, as part of its Zero-Waste strategy, and Prince Edward Island, have imposed a landfill ban on e-waste. Further, provincial e-waste management regulations do not oblige their residents to hand over their e-waste to official EPR programs, nor retailers to take-back equipment. Also, no province has restricted the right to collect and recycle e-waste to companies meeting

EPRA criteria, a requirement lobbied for in Europe where e-waste tends to flow to sub-standard facilities (WEEE Forum, 2018).

Québec's regulation includes explicit information requirements for producers. First, program details, number of equipment put on the market, annual reports, third-party audits, five-year plans, and performance measurements, need to be submitted to the Environment Minister regularly. Secondly, the regulation requires public awareness, outreach and education programs, and implicitly, the modulation of fees. No other obligations are imposed on municipalities, consumers, retailers or other parties.

3.3.3 Québec's approach -- Key similarities and differences

Québec did not intend to do everything differently with regard to e-waste; there are also similarities between Québec's and other provincial programs. Neither may other provincial EPR programs be portrayed as a monolithic bloc (see Table 3.1). The scope of products Québec designated for take-back resembled that in Nova Scotia and Saskatchewan. Québec allowed OEMs to delegate their physical responsibilities to PROs or to take care of their EoL products themselves, as have some other provinces.

Crucially, however, Québec's EPR policy incorporated elements which were not adopted in other provincial schemes: enforcement mechanisms and penalties for non-compliance; fee modulation; and enforcement of the 3R hierarchy and local processing. Table 3.1 outlines the key differences between Québec's e-waste management strategy and those in other Canadian provinces. Alberta is listed separately since it is the only province with a government-run program.

Table 3.1: Québec's e-waste strategy compared to that in other Canadian Provinces

	Scope of Products	Targets	Quality of treatment	Physical responsibility	Financial Responsibility	Other obligations
Alberta	Consumer Electronics + Commercial and Institutional Electronics		EPRA Recycler Qualification Program Some promotion of re-use but no enforcement	Alberta Recycling Management Authority (Government)	Consumers pay a visible advance recycling fee Flat rate fees per category of equipment	No other requirements or obligations on other stakeholders
Other Provinces with EPRA-Managed EPR Schemes	Consumer Electronics with additional categories (in phases)	No targets, or some targets (BC: 75%) but no penalties for non-compliance. Continuous improvement	EPRA Recycler Qualification Program Some promotion of re-use but no enforcement	PRO or Individual producers	Consumers pay a visible advance recycling fee Flat rate fees per category of equipment	Nova Scotia and PEI have province-wide landfill bans on e-waste No other requirements on other stakeholders
Québec	Consumer Electronics with additional categories (in phases)	Increasingly stringent targets specified in the regulation. **Enforcement mechanism with penalties**	"According to best practices" (EPRA Recycler Qualification Program) **Respect of 3R hierarchy with LCA justification if different approach** **Local processing should be favoured**	PRO or Individual producers	**Inclusion of environmental handling fees in the sale price** **Fee modulation according to environmental characteristics of products**	No other requirements on other stakeholders

3.4. EPR architecture elements as environmental policy choices

Keohane et al. (2005) developed a political market framework to explain gaps between normative economic theory and the reality of environmental policy-making. Government regulation, and the choice of environmental policy instruments, they argued, are the outcome of interactions between supply and demand functions for the support of policy options.

According to this framework, firms oppose policies that shift a greater cost burden to industry, and favour those which allow the generation of rents and the erection of entry barriers; and prefer command-and-control instruments because of their certainty, and since they may lack the expertise to adjust to and benefit from market-based ones (Keohane et al., 2005; Stavins, 2003, 2004). Meanwhile, environmental organizations favour instruments they can be clearly identified with, and that provide a compelling environmental argument to their donors and members, thereby increasing their funding. Labour organizations typically favour command-and-control policies that protect employment, and existing plants. Lastly, consumers, not being well organized, do not concertedly demand environmental regulation, but prefer policies that limit price increases.

On the supply side, according to Keohane et al. (2005), legislators, being risk averse, tend to favour policies with predictable costs, benefits and distributional effects, and that are perceived by their constituents to be less costly (regardless of the real costs), and that will not lead to firm closures and increased unemployment. They are thus likely to favour strong command-and-control policies that offer political benefits due to their symbolic value, and that are more likely to maintain agency activities and employment, as opposed to market-based instruments that leave the allocation of costs and benefits to the market. Finally, the supply of support on the part of legislators, and the demand of support by various interest groups are aggregated; the ensuing equilibrium levels of support for different policy alternatives are compared, and a policy choice is made. This explanatory framework demonstrates the potential for EPR policy development to generate debate and conflict (Tasaki et al., 2019).

3.5. Materials and methods

We explore how this model can help explain the supply and demand functions that led to the particular elements of Québec's EPR policy. Also, we investigate the perspectives, interests, and concerns of different actors, and their underlying motivations; how these conflicting interests and concerns influenced EPR design and implementation in Québec; and how different actors have been affected by, and responded to, this program. We also discuss how our findings conform with, or not, the sources of supply and demand of support for environmental policy, as identified by Keohane et al. (2005).

After publishing its draft regulation in November 2009, the Ministère du Développement durable, de l'Environnement et des Parcs du Québec (MDDEP) sought and received written comments from various stakeholders; however, these comments were not made public. For this research, government officials willingly provided the list of the 60 stakeholders, or organizations, who sent written submissions (memoirs). The draft regulation dealt with many waste streams, and only 30 of the 60 memoirs focused on e-waste management. Once these organizations were identified, we browsed their websites to find their memoirs. When such memoirs were not available, the first author contacted them via e-mail and/or telephone to ask if they were willing to share them. In the end, the authors managed to access 12 memoirs, in some instances on the promise that no nominal information would be divulged. Our analysis is based on these memoirs, and semi-structured phone interviews with various stakeholders representing industry, government, and refurbishing organizations.

3.6. Results and discussion: demand for and supply of support for Québec's EPR policy

3.6.1 Demand for Québec's EPR policy

The draft regulation sought to implement: enforcement mechanisms and penalties for non-compliance; inclusion of the EHF in the sale price in a non-visible manner; fee modulation; and enforcement of the 3R hierarchy and local processing.

The absence of written comments from consumer associations is striking, given the significant implications of EPR policies for consumers. However, this absence may be because they are not organized, and have only limited access to relevant information; and as Keohane et al. (2005: 584) suggest, environmental policy "may lie outside the core concerns of consumer groups' constituents", and, "… demand from consumer groups for environmental policy instruments is likely to be muted." This does not mean that there were no alternative lobbying efforts; however, on contacting Québec's leading consumer organization to enquire if they had made submissions, we were told that that this issue was not "on their radar screen" at the time.

No labour organization submitted written comments, either, perhaps because EPR was not seen to threaten employment, as would, say, a strict pollution reduction target imposed on a highly polluting industry. Secondly, since most of the electric and electronic equipment sold in Québec is produced externally, any negative effect on labour would not be felt locally.

The other stakeholders that expressed demand for EPR broadly fit into the categories identified by Keohane et al. (2005): OEMs separately, and collectively under EPRA, recyclers and refurbishers, and business lobbies including retailer associations. One key stakeholder group not included in the Keohane model that participated in the consultation process – by way of written submissions and requests for specific regulatory measures -- were municipalities and municipal organizations. Their main requests were expeditious implementation of the regulation, and an as broad as possible scope of designated products.

The role played by municipalities in EPR policy-making needs careful consideration. Where municipalities have the power to adopt EPR, as in the USA, this policy has been adopted without oversight from higher levels of government. In jurisdictions like Québec, in which the provincial government passes this type of regulation, municipalities are essentially stakeholders expressing demand for it. As commodity prices increase, and access to critical materials in e-waste becomes a strategic issue, e-waste management will likely generate renewed interest by federal authorities. But because they may not wish to disrupt the separation of powers and take over responsibility for waste management, federal agencies will likely simply exert demand for EPR policy, or for EPR elements such as a broad scope of products to be recycled, particular quantities to be targeted, and a baseline quality of treatment and recovery (European Commission, 2010; U.S. Department of Energy, 2010). Indeed, this is exactly the role Environment Canada has played, by supporting the Canada Wide Principles for EPR.

Enforcement mechanisms and penalties

Unsurprisingly, the OEMs, retailers, and other business lobbies strongly opposed increased compliance mechanisms and penalties. They argued that consumers should also share the costs of the take-back scheme, and suggested a carrot as opposed to a stick approach, whereby firms or PROs meeting their targets would be rewarded financially, instead of being fined for failing to meet their targets. Other arguments against enforced compliance related to the confidentiality of information such as sales and market share.

Visibility of environmental handling fees

OEMs, business lobbies, and retailers favoured visible fees on the grounds that consumers thereby better appreciate their role in effective e-waste management, and that these fees were the most effective way of funding e-waste management. Further, they questioned the legality of requiring them to pay for orphan and historical products, and they argued that consumers should pay these costs.

The OEMs and retailers also argued that visible fees, used in the other provinces, were straightforward and successful. Their rationale was that developing different pricing and marketing schemes would be costly, if fees were to be incorporated – in a non-visible manner -- in the price of equipment in some but not other provinces.[2] Secondly, visible fees in all provinces avoid consumers being tempted to buy equipment in provinces where prices appear to be lower.[3] Further, they provided survey results demonstrating that consumers prefer transparency regarding EoL management fees. Lastly, they explained how non-visible fees, by being included in the sale price, would lead to increased rents for retailers, because rent is often determined based on gross sales. On the other hand, if EHFs were made visible (and separate from the price of equipment), the rents could remain the same, despite the increased total value of sales.

Fee modulation

Environmental groups were the only stakeholders explicitly favouring modulated EHFs, based on product design and characteristics, as the best means to recognize and reward better product design. OEMs and retailers expressed dissatisfaction with the draft regulation's stated objective to promote "the design of products more respectful of the environment", which, they argued,

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[2] Marketing tools are already different in Québec because they are tailored to Francophone consumers.

[3] EHFs are already different from one province to another. These differences would be exacerbated.

should be pursued through other mechanisms, such as the European RoHS directive (which bans toxic elements in equipment). Interestingly, business lobbies were open to the idea, provided OEMs were given more time, and clear criteria to evaluate products. The OEMs explained that incentivizing eco-design by determining different fees for individual products would be cumbersome and costly, Québec being such a small market, and the policy would have little if any impact on product design, since design changes continuously and rapidly, and is done globally. Instead of fee modulation, they suggested that Québec should require industry to report on its design for environment (DfE) efforts, and engage in green purchasing initiatives, to send a positive signal to industry. Market forces, they argued, were "already sufficient to drive eco-design".

These positions conform with the Keohane et al. (2005) model. Firms may resist modulated fees because of concerns regarding the creation of winners and losers, and disclosure of product specifications; and also because they lack the expertise (or willingness) to adjust to and benefit from this instrument. As well, firms may rightfully apprehend the difficulties of complying with -- let alone capturing the market signals from -- a multitude of already complex schemes across the world, even without the additional burdens of modulated fees based on different environmental criteria in different jurisdictions.

The issue of fee modulation raises many interesting questions. Many industrial ecologists advocate making firms responsible (at least financially) for the management of their waste (Atasu et al., 2010). Operations management experts argue that innovative firms would seek regulations that reward their eco-design initiatives (Fergusson and Souza, 2010); and that there are cost-allocation mechanisms which can achieve this objective fairly, even within collective programs (Gui et al., 2015). But our findings, and the environmental regulation literature, suggest that even innovative firms still prefer shifting the cost to consumers. Further, in small markets such as Québec, the benefits of rewarding firms for their environmental performance are deemed less important than preserving harmonisation across jurisdictions, even if it is unfair to firms with better-designed products.

3R hierarchy and local processing

Environmental groups as well as non-profit refurbishers unsurprisingly supported the 3R hierarchy in e-waste management. Municipalities expressed interest in developing reuse and recycling on their territories, and favoured life cycle analysis to identify the best management alternatives; they likely also share the regulator's interest in maintaining and generating employment.

Non-profit refurbishers have historically been active in Québec; they formed a five-member coalition to submit their joint comments to the MDDEP Minister. They have much to gain from the imposition of the 3R hierarchy – indeed, their refurbishment activities generated, when the regulation was adopted, over 200 full-time, and hundreds more part-time and temporary, positions province-wide. As well, they submitted that they contribute to socio-economic reintegration by training drop-out youths and young adults, and to local digital solidarity, by providing refurbished equipment to schools, charities, and less fortunate individuals. While imposition of the 3R hierarchy would not create barriers to the entry of other organizations, it would allow refurbishers to maintain and expand their activities, because of access to greater quantities of used equipment. Moreover, producers and their PROs would likely require more refurbishing activities to meet their obligations under the 3R requirement. Finally, because refurbishers are spread across the province, they also favoured the importance accorded to local and regional processing in the regulation.

Retailers, on the other hand, opposed the obligation for OEMs to respect the 3R hierarchy or provide a lifecycle analysis to justify approaches to e-waste management, as being too onerous. It is also likely that they oppose increased refurbishing and re-use, in order to deter competition from used products on the market. While the OEMs did not explicitly oppose the 3R hierarchy, they argued that take-back schemes should be flexible and fully managed by OEMs (or their PROs), with the latitude to determine their own objectives and targets; also, they opposed costly lifecycle analyses to justify their operational decisions.

3.6.2 Support for Québec's EPR Policy

The MDDEP Minister and the cabinet took time deciding on support for the draft regulation. Further, there was a Cabinet shuffle between its release in November 2009 and final publication in July 2011 following the consultation period; thus, the new MDDEP minister had to become familiar with the regulation and its implications. In the end, the final regulation largely resembled the draft -- some financial values for calculating the penalties were lowered; reporting requirements were made less cumbersome; EHFs could be indicated separately on receipts (in addition to being included in the price of equipment); and the deadline for fee modulation was extended from three to five years. Some flexibility was also provided in assessing the performance of the take-back scheme so that "very good" results one year could compensate for "average, or poor" results in the preceding or succeeding year. Overall, though, Québec's regulation continued to stand out relative to other provinces -- the government chose to go forward with targets and penalties, enforcement of the 3R hierarchy, and fee modulation.

The following subsections provide an analysis of the possible reasons for the regulator's supply of support for Québec's regulation.

Enforcement mechanisms and penalties

The government could have opposed the enforcement mechanisms and penalties proposed in the draft policy, as did many stakeholders, favouring a "carrot" approach instead, because of the seeming unfairness of imposing penalties on OEMs for not meeting their targets even as Quebecers are allowed to dispose of their electrical and electronic equipment in the trash. In the event, the penalties were maintained but substantially reduced (from $75 to $15 per piece of equipment, in some cases); the government also intended to ban electrical and electronic equipment from landfills, although this ban has not materialised. Québec's regulator may have been comfortable imposing penalties since these would affect businesses whose chief operations are abroad, and not local businesses and employees.

Visibility of environmental handling fees

The government's intention to include the EHF in the sale price in a non-visible manner is congruent with Keohane et al.'s finding that regulators favour instruments perceived to be less costly to their constituents. Visible fees would have been seen by consumers as additional taxes. This intention may also have been motivated by the fact that the sales tax would be applicable to the full product cost, including the EHF; besides, many electronics items are luxury items, and the higher tax revenues may have been seen as a good way to raise revenue. Lastly, the intention may have been driven by the perception that, while both producers and consumers are responsible for e-waste, the primary responsibility falls on producers, and therefore, that it is important to influence their behaviour by making them bear the costs of EoL management.

A compromise was reached whereby the EHFs are: included in the total cost, and the provincial sales taxes are calculated based on this total cost, with the result that provincial sales tax revenues are increased; and allowed to be shown separately on the receipt, thereby serving to raise awareness. Lastly, the EHFs are not only taxed, but also included in the sale price for the purposes of calculating retailers' rents (contrary to the retailers' hopes), according to interviews with a few large commercial space companies.

Fee modulation

The reliance on market mechanisms, by way of fee modulation according to the environmental characteristics of products, was likely supported by the regulator because of the minimal local impacts, as noted earlier. This chapter, and the environmental regulation literature, suggest that jurisdictions in which local firms and employment are least affected by regulation may be the most likely to experiment with novel market-based instruments.

3R hierarchy and local processing

The inclusion of the 3R hierarchy in the regulation, and thereby, the support of local reuse and recycling, is again unsurprising, given its high symbolic potential, and since regulators favour measures benefiting their constituents (Keohane et al., 2005). Note also that Québec has a Sustainable Development Act, which requires that policies follow the polluter-pays and precautionary principles, and cost internalisation (Gouvernement du Québec, 2006). An Environmental Commissioner publishes an annual assessment of all policies according to these principles. In this context, an EPR regulation conveys an impression of coherence in government policy.

The foregoing discussion shows that regulators and other stakeholders have different motivations and interests regarding the EPR policy, and its mechanisms for incentivizing change. The changes to Québec's regulation (from the draft to the final version) indicate where the equilibrium level of support lies for the regulatory elements that are different from those in other provinces. The Québec regulation demonstrates a greater demand for and/or supply of support for an EPR policy that maintains local employment through refurbishing and reuse, and rewards efforts to reduce the environmental impacts of products through modulated fees. At the same time, whereas the regulator's intention was to include the EHF non-visibly in the sale price, so that consumers would perceive that costs remain unchanged, and that the EHF is not a tax, the EHF was in the end allowed to be shown visibly and was taxed as part of the sale price.

This research has sought to explain the unique features Québec's EPR policy, by way of supply and demand functions on the part of the government and other key actors. While it is not possible to discuss the policy development process or these factors in the other Canadian provinces, due to space constraints, the consultation process (before the adoption of its EPR plan) in Ontario, the most populous Canadian province, and Québec's neighbour, allows us to suggest a few hypotheses to explain the differences in Québec's EPR policy relative to Ontario's:

According to our interviews, many of the same stakeholders (OEMs and OEM associations, retailers, recyclers, environmental groups, and municipalities) expressed similar demands, including in relation to visible fees, with regard to Ontario's policy, as in Québec.

While consumers and labour organizations did not participate in Ontario's consultation process, as in Québec, there was a lack of representation from non-profit re-users and refurbishers in Ontario (according to interviews with them), as opposed to Québec, where these actors are well organised, and lobbied strongly for respecting the 3R hierarchy, and ensuring the local processing of e-waste.

The demand for (or opposition to) fee modulation, and the strict targets and penalties, on the part of various stakeholders, including OEMs and retailers, was also the same in both provinces.

Taking these points as a whole, it seems that the difference in the equilibrium level of support for this policy (between Québec and Ontario), and Québec's different approach, is due to differences in both the supply side of support (the regulators' ideology and interest) and demand side of support (vocal stakeholders advocating for local processing and refurbishing for reuse).

3.6.3 EPR for e-waste management in Québec, five years on

So, what has happened in the five years since the adoption of Québec's regulation for e-waste management? How have the province's plans been rolled out and implemented, and to what effect? Below, we assess Québec's progress, or lack thereof, in reaching the objectives it sought to achieve.

The fact that Québec has remained the only Canadian province with mandatory e-waste recovery targets stands out as a unique regulatory example. The financial penalties to be imposed on OEMs or their PRO for failing to meet their targets, based on a percentage of equipment put on the market, were initially targeted to be paid annually, by 2015. Unfortunately, the PRO's public annual reports only quantify the e-waste collected per capita, and the share that is either recycled or reused. Since no information is provided about the quantities put on the market, it is impossible for the public to determine if the PRO is meeting its targets. Moreover, a subsequent agreement between the PRO and the government allowed the former to spread out, and measure, its performance over five years which means that penalties could only be imposed by 2020. Meanwhile, the PRO has lobbied for a five-year delay whereby the targets and penalties would start kicking in only by 2025, if at all.

The PRO was mandated to present to the Québec Government, by 2016, an update on the efforts of its OEM members to design more environmentally friendly products (MDDEP 2011), in terms of, for example, recycled content and energy efficiency, for the purpose of applying modulated EHFs to individual products. Such fee modulation has not been implemented, and the EHFs remain fixed, per product category. Given this, visible fees cannot be expected to raise consumer awareness about better design.

While implementing this measure for electronics appears to be contentious, fee modulation is not uncommon. In Québec, the environmental fees are roughly 20% lower for documents printed on recycled paper than on non-recycled paper (EEQ, 2019). In France, EHFs are 8% lower for packaging containing less material, and up to 100% higher for packaging which cannot be recycled (OECD, 2014); and the EHFs are 20% lower for printers that can be fully dismantled using standard tools, and for which essential components are available for five years (OCAD3E, 2015).

Of the nine Canadian provinces collaborating with EPRA for the collection and management of e-waste, Québec is the only province that reports separate quantities for recycling and reuse; EPRA annual reports in the other provinces only provide the quantities of e-waste collected *and therefore recycled*. The annual reports for Québec over the period 2013-2017 show a sharp increase in the total quantity of e-waste collected for recycling or reuse, doubling from 10,600 tons (1.3 kg/capita) in 2013 to just over 22,000 tons (2.7 kg/capita) in 2017. The percentage of e-waste being reused remains low, however, and has stayed just under 10% of all e-waste collected annually.

Despite Québec having the most EPRA certified refurbishers of any Canadian province, however, materials collected in the take-back scheme usually go straight to recycling. This is mainly due to the age and condition of the equipment collected (often broken and end-of-life, as opposed to used and refurbishable), the way they are handled, which tends to damage them even further (Interview with recycler, 2018), and the lack of consistent demand for used equipment. Most of the refurbishing and reuse is done via large institutional or commercial entities that send their electronic materials to the certified refurbishers. Because the PRO has little control over these factors, it can only play a limited role in the reuse of e-waste. A thriving reuse market is driven by the condition of used equipment; the existence of certified refurbishers; and even the price of metals, which may draw reusable equipment to international markets, and away from local reuse (Huisman, 2015; BAN, 2018).

As for Québec's promotion of local processing: in the first five years of the program, two large e-waste recyclers moved part of their operations to Ontario. The recyclers still consolidate and sort equipment in their Québec locations, and one of them still shreds some small appliances locally, but most electronics are now shipped to newer, more sophisticated recycling sites in Ontario. This does not align well with Québec's regulatory objectives, but reflects the recycling industry's decisions to generate economies of scale and invest in state of the art facilities. Nevertheless, the collection, sorting and even some initial dismantling, and refurbishing still happens in Québec, thanks to its 24 certified recyclers, which are more spread out across the province than are Ontario's eight certified recyclers (RQP, 2018).

3.7. Conclusions and ideas for further research

We have critically discussed the demand for and supply of support for various policy alternatives, and have shown that, while the usual sources of supply and demand identified in the environmental regulation literature, and Keohane et al. 's model, were found in Québec, and the positions of most of the stakeholders essentially accorded with this literature, this constellation of interests may be different in Québec than in other provinces, which may explain the particularities of Québec's EPR policy. We also found that municipalities were a key source of demand for EPR policy alternatives.

These particularities are due to differences in the supply side of support, and the regulators' ideology and interest. The Québec regulation demonstrates a greater demand for and/or supply of support for, among other things, maintaining local employment through refurbishing and reuse, and rewarding firms that make the most effort to reduce their products' environmental impacts.

Québec's regulator may have been comfortable imposing penalties, and modulated fees, since most of the equipment sold there is produced externally, and local businesses and employees would not be affected negatively. Besides, the Québec case shows that jurisdictions in which local firms and employment are least affected by regulation may be the most likely to experiment with novel market-based instruments.

At the same time, the fact that penalties and modulated fees have not yet been implemented, and the 3R and local processing objectives have faced major hurdles because of the age and condition of the equipment collected, and economic considerations and relocation decisions on the part of the recycling industry, demonstrate the hard practical realities of policy-making and implementation, beyond the mere passing of legislation.

Finally, as commodity prices and access to critical materials becomes a strategic issue, the federal role in e-waste management may grow, and the separation of powers and responsibilities between the different levels of government – federal, provincial, and municipal – may become re-aligned.

Lastly, we raise some questions based on our study, which may be of interest to researchers in the areas of industrial ecology, environmental regulation, operations management, and circular economy:

- Are regulatory requirements for reuse and refurbishing (or respect of the 3R hierarchy) for different products more likely to be adopted in those jurisdictions where this industry is already very active?

- What are firms' preferred cost-allocation mechanisms (as opposed to what an optimal or fair cost-allocation mechanisms *should* be)?

- If the modulation of environmental handling fees is in fact imposed, would firms still prefer visible fees?

- Under what conditions would OEMs support modulated fees and greater incentives for better design? What would be the required market size for a firm with more environmentally friendly products to prefer modulated EHFs over the reduced compliance costs due to harmonised regulations, and how does this relate to the elasticity of demand for these products?

- How might better methods be devised for measuring and monitoring the performance of EPR programs, and how can this performance be transparently communicated to the public?

Chapter 4. Material circularity in large organizations: Action-research to shift information technology (IT) material flows

Chapter overview

The existing literature on e-waste management pays little attention to large organizations, as significant e-waste generators in urban contexts, and yet, the ways in which organizations acquire, use and dispose of their electronic equipment can have a significant impact on EPR program success and outcomes, and more broadly, on the circularity of electronic products in urban settings. Québec's initial iteration of its EPR regulation did not mandate publicly funded organizations to engage with the EPR program; nevertheless, McGill University's administration chose to partner with the program.

This chapter presents an action research project that was devised and implemented as a transition experiment, a form of scholarly endeavour which aims to work and engage with stakeholders to diagnose a "sustainability problem" to envision the necessary changes (to incentives, policies, processes, behaviours) and implement the necessary interventions to bring about change. The project, which sought to explore the university's e-waste flows, and to improve the lifecycle management of its electronic equipment, revealed a significant difference between, on the one hand, the social and environmental outcomes resulting from the university's participation with the EPR program and, on the other hand, the benefits of going over and beyond the program requirements by intentionally implementing greater circularity in managing its IT assets and carefully selecting its downstream refurbisher and recycler. This work reveals some of the limits of EPR and the complementarity of organizational initiatives to support greater circularity in urban material flows.

Unsustainable material flows, and barriers to implementing circular economy objectives can be understood as subsets of broader sustainability challenges that can be addressed through transition management experiments. Based on this research project, we argue that action research in transition management can help uncover unsustainable material flows, understand and steer change, and then theorize about the complex systems shaping IT flows in urban contexts.

4.1. Introduction

Decoupling economic growth from resource use is important for bringing the global economy within planetary boundaries (Meadows et al., 1972). The material flows associated with our global economy have been exposed, and proposals have been made to redesign production and consumption along more circular patterns (Graedel et al., 2011; OECD, 2019; Meadows et al., 2004; Webster, 2015; UNEP, 2018; Schandl et. al., 2018), and to generate employment while reducing resource use and environmental impacts at multiple scales (Club of Rome, 2017).

Among the material flows studied, the global production, consumption, and disposal (or recycling) of IT equipment (computers, smartphones, printers, tablets etc.) stand out because of their wide-ranging environmental and health impacts (Kuehr et al., 2003). Williams et al. (2002) sounded the alarm about the energy and resource use related to electronic (including IT) equipment. Researchers from such diverse fields as toxicology, operations management, chemical engineering, political ecology, and sociology have characterized, and proposed strategies to mitigate the environmental and social impacts associated with end-of-life electrical and electronic equipment (e-waste) (Lawhon, 2012; Pickren, 2014; Toyasaki et al., 2011; Leung et al., 2008). E-waste is the world's fastest growing urban waste stream (UNEP, 2018). Researchers have also characterized the potential reduction in greenhouse gas emissions resulting from state-of-the-art recycling and recovery of metals from e-waste (Magalini and Kuehr, 2010), and the environmental advantages of re-using IT equipment relative to recycling, through lifecycle analysis (LCA) (CIRAIG, 2011).

In Québec, the Canadian province where McGill University, the subject of this case study, is located, the provincial government has implemented an Extended Producer Responsibility (EPR) regulation which mandates the widespread collection of e-waste, and its local processing according to the 3R hierarchy (Québec, 2011). Environmental handling fees are applied to designated IT equipment sales, with the revenues covering the collection and processing of e-waste. The program, which involves setting up collection points, hiring and auditing recyclers, and communications and marketing campaigns, is managed by an industry-led non-profit association referred to as a Producer Responsibility Organization -- PRO. EPR policies and regulations have been prescribed to reduce improper e-waste disposal (by landfilling or exports to vulnerable contexts), and encourage the design of more environmentally friendly products (Lifset et al. 2013). EPR also aims to encourage material circularity and implement the "polluter-pays" principle, whereby manufacturers and consumers pay for end-of-life management, instead of municipalities and the general population (OECD, 2001; Atasu, 2019).

While EPR systems are a first step toward material recovery on a wide scale, they do not necessarily slow down consumption nor promote the extended use of IT equipment. A more ambitious vision for managing material flows has come from the concept of the circular economy, which implies "a systemic shift that builds long-term resilience, generates business and economic opportunities, and provides environmental and societal benefits" (Ellen MacArthur Foundation, 2018a), and in which IT equipment would be "loved longer", "kept in use for as long as possible" and eventually refurbished, reused, remanufactured, or recycled for material recovery (Ellen MacArthur Foundation, 2018b), to slow down, close and narrow resource loops (Bocken, 2016; McDonaugh and Braungart, 2001).

4.1.1 Objectives and outline

We present the case of a project conducted from 2013 to 2018 (hereafter, "the project") at McGill University, a major research university in Montréal, Canada, to make its IT material flows more sustainable by aligning them with circular economy principles. This project involved a series of interventions, by the first author, in collaboration with the University's administration and other stakeholders and suppliers. We discuss how these interventions were achieved through action research, and the associated challenges. We seek to show how such initiatives constitute worthwhile transition experiments, contributing useful empirical evidence for similar sustainability initiatives. Ultimately, shifting the global economy, and its associated material flows, towards more circularity, will necessitate multiple small-scale transitions, such as the one we present. The progress achieved in this project demonstrates that there is ample opportunity for action research, and learning-by-doing, as each particular material flow, in each local or organizational context, is investigated and transformed along similar lines.

In the next two sections, we set the context for this work by discussing the circular economy as a normative ideal for achieving sustainability, and the conversion of linear to more circular and regenerative material flows. We also present action research as a useful approach for implementing, and generating empirical knowledge from, material flow and other sustainability transitions (Loorbach et al., 2017), and discuss how action research can bridge the gaps in the literature on IT flows, by enabling a rich and nuanced understanding of what happens "on the ground" when organizations implement strategies towards greater material circularity. In Section 1.4, we briefly describe the project, its objectives, and its internal and external drivers. Section 2 presents the project's Materials and methods. In Section 3, which is structured following best practices in sustainability transition experiments (Luederitz et al., 2017), we discuss in detail the collaborative and iterative interventions that were implemented to make McGill

University's IT flows more circular, including the baseline analysis and external benchmarking, the governance of the project, the challenges associated with the interventions and how they were addressed, the approaches used to measure and evaluate the results of the project, and recommendations for similar interventions elsewhere, based on the lessons learned. The conclusion recaps these lessons and suggests future directions for research.

4.1.2 The case for action research in material flow circularity transitions

The shifting of linear to circular material flows, by using wastes as inputs, is not new (Boulding, 1966). However, efforts toward circularity on a broader scale have only recently become popular. The goal of a circular economy has now been adopted, and better defined, by environmental agencies around the world, to reconcile social progress, economic development, and environmental protection (European Commission, 2020; Geissdoerfer et al., 2017). Governments are adopting policies to support greater energy efficiency and closed material loops (Geller et al., 2006; Delphi Group, 2017, McDowall et al., 2017), with stricter waste diversion targets (e.g., Ontario, 2017), better waste sorting facilities (e.g., Atlantic Canada Opportunities Agency, 2015), sustainable procurement strategies (e.g., Brammer et al., 2011), eco-labelling schemes (e.g., Darnall et al., 2018), and fiscal instruments favouring repair, reuse, and downstream markets for used materials (Brears, 2018).

Moving to more circular material flows entails multiple transitions, in complex social, economic, technological, institutional, and behavioural systems, because material flows result from interactions between these systems (Binder, 2007; Brunner and Rechberger, 2016). Policy frameworks and fiscal incentives for fostering circular material flows may be ineffective because they are poorly conceived, omit certain issues, are difficult to implement, or generate unintended consequences (Meadows, 2008; Stavins, 2003; Zink and Geyer, 2017). This is where empirical research can contribute, by identifying the measures and incentives for stakeholder involvement necessary for successful transitions and providing examples of what works and what does not (Brandt et al., 2013).

There is considerable research in industrial ecology that seeks to guide decision-making for reducing the environmental impacts of human activities (Fischer-Kowalski,1998; Ehrenfeld, 2008; Boons and Grenville, 2009). Industrial ecologists have identified, documented, and quantified numerous unsustainable material flows, by chemical element, product lifecycle, and geographical region. Some material or energy flows are deemed unsustainable because of their environmental impacts, or because resources are rapidly consumed and dissipated (Ciacci et al., 2015), or left unrecovered at the end-of-life (Graedel et al., 2011). Recommendations to make material flows more sustainable focus on better-designed products and processes (e.g., Design for the Environment – DfE), material recovery through recycling, avoidance of dissipative uses, and substitution of polluting with more benign materials (Ehrenfeld, 2009). There is also rapidly increasing normative work pertaining to the circular economy (Geissdoerfer et al., 2017), which prescribes policies for reducing the global economy's material throughput.

Overall, there is a great deal of research, and a good understanding, regarding problematic IT material flows, and how to address them, but few empirically informed theories and blueprints for action, especially on the part of actors other than businesses or manufacturers (as material flow generators) and policy-makers (as agents responsible for waste management) (Loorbach et al., 2010; Loorbach and Wijsman, 2013). Researchers usually identify national governments, environmental protection agencies, firms, and consumers as "key players" whose decisions potentially drive change (Geissdoerfer et al., 2017; Ellen MacArthur Foundation, 2018a). However, municipalities and large organizations such as hospitals, school boards and universities also have a key role in applying circular economy principles to improve their IT equipment flows, even where EPR programs exist. These actors consume large quantities of materials and energy and can test strategies to help narrow, slow down or close material loops, at a sub-scale of the economy (Bocken et al., 2016; McDonaugh and Braungart, 2001).

The industrial symbiosis literature explains how and why circular material flows come about regionally, but from the perspective, mainly, of businesses (Chertow, 2007). There is also some research on sustainable purchasing by institutions (for example Witjes and Lozano, 2016), but this does not imply the complete shifting of material flows. Overall, there is little research to explain how different actors, other than governments and firms, plan and implement their transitions towards optimal material flows and greater circularity, nor about the associated challenges and how they are addressed, and what strategies are useful to encourage stakeholders to collaboratively modify material flows inside organizations. While some experts have called for fundamental changes in individual businesses (Loorbach and Wijsman, 2013), we argue that this is needed within other large organizations as well.

4.1.3 Action research on material flows as sustainability transition experiments

The above section highlights the paucity of empirical studies of what happens "on the ground", when organizations attempt to implement circularity principles in their operations. It is this gap that our paper aims to fill.

Sustainability science, an interdisciplinary field which aims to a) understand the fundamental interactions between nature and society; b) guide these interactions along sustainable trajectories; and c) promote social learning to navigate the transition to sustainability (Kates et al., 2001), may help fill the gap between the detailed material flow diagnoses provided by industrial ecologists, and the normative objectives of a circular economy. Industrial ecology and sustainability science share a normative commitment to sustainability; the two fields are complementary. Sustainability science researchers strive to deliver practical knowledge to facilitate transitions along the lines envisioned by industrial ecologists and circular economy protagonists. As Miller et al. (2014: 240) argue:

> "We contend that sustainability science must link research on problem structures with a solutions-oriented approach that seeks to understand, conceptualize and foster experiments for how socio-technical innovations for sustainability develop, diffuse and scale-up."

The urgency to limit climate change and preserve natural resources and ecosystems (IPCC, 2018) reinforces the argument for action research that shifts material flows as one studies them. There is value in implementing, and then reporting on, attempts at making material flows more sustainable, as such examples are few, especially within organizations. When researchers are directly involved in implementing changes supporting sustainability, such as through action research, their interventions can generate empirical evidence and help uncover the "complex, causal dynamics underpinning sustainability problems" (Caniglia et al., 2017:43). Sustainability scientists involved in transition research can become "knowledge brokers" and "change agents" (Miller et al., 2014), who contribute to social learning, and to empowering individuals in favour of sustainability, by engaging with them and promoting changes in their behaviour and thinking.

Experiments in transition management, as a form of action research where the researcher engages with a community to bring about systemic changes towards sustainable outcomes explore "the processes, policies and procedures, that might help to accelerate and guide emerging transitions out of existing unsustainable "locked-in" systems in a desired direction" (Miller et al., 2014: 243). Such experiments provide examples of strategies, stakeholder engagement, and changed roles and responsibilities. They identify “social, political, institutional and technological leverage points that will help advance socio-technical change toward sustainable outcomes” (Miller et al., 2014: 243). “The participatory approach is thus an instrument for the transition researcher to transfer knowledge as well as to develop new theory” (Loorbach et al., 2011: 81).

Given that material flows represent complex systems resulting from the behaviour of so many different actors “with dissimilar perspectives, norms and values” (Loorbach, 2010: 164), it is through action research, where the researcher is actively involved in modifying material flows, that institutional complexities, feedback mechanisms, and hidden incentives can be witnessed first-hand, understood, and documented (Coughlan and Coghlan, 2002). Here lies the promise of transition management: “that learning and demonstration effects of experiment add to the momentum of emerging sustainable configurations, which are geared to transform unsustainable socio-technical systems” (Sengers et al., 2016: 2).

By choosing the sustainability theories and problems to be tackled, researchers help shape society’s conception of sustainability (Miller, 2013). If shifting unsustainable material flows within organizations are worthwhile transition experiments, our work may provide a useful step in documenting the steering of these flows towards greater circularity, and be viewed as an example of exploratory, experimental and reflexive action research in transition management for sustainability (Wittmayer and Schäpke, 2014; Loorbach et al., 2015; Köhler et al., 2019). It can also bridge the gap between the study of IT material flows, circular economy prescriptions, and real-world organizational strategies and decision-making for optimizing IT material flows.

4.1.4 The project -- aligning McGill University's IT material flows with circular economy principles

In 2013, McGill University, which has 12 faculties, two campuses, 240 buildings, 40,000 students and 10,000 faculty and staff, targeted its e-waste for particular scrutiny. The University's Procurement Services and Central IT Services were interested in understanding the institution's used IT flows because of: a) financial concerns about the budget for IT equipment purchases and their rapid turnover; b) the risk of data loss or exposure due to improper wiping of equipment and software license removal before equipment was donated or sent to recycling; and c) the risk of equipment being wrongfully disposed of, landfilled, or exported to vulnerable countries. Another driver for examining the IT flows was the provincial law making the University's Chief Information Officer (and similar IT executives in publicly funded institutions) responsible for ensuring the "longevity" of institutional IT resources (Québec, 2011).

The project was initiated to understand and then improve the University's e-waste flows. The first author was asked to investigate the University's IT equipment flows and their determinants; document and analyse how used and end-of-life IT equipment was managed in various units, and to make recommendations for standardizing processes, reducing environmental and reputational risk, and achieving cost reductions. As a social scientist who was already conducting research in industrial ecology and on international efforts to reduce the negative social and environmental impacts associated with IT equipment, she approached this task as a unique opportunity to implement circular economy principles in the University's material flows. Eventually, this project was broadened to shift the gate-to-gate lifecycle of all IT equipment, following circular economy principles.

4.2. Materials and methods

The action research project that we report on in this chapter, and in which the first author was an active participant, involved a conscious and carefully planned strategy to transition McGill's IT flows toward greater circularity, even as they were critically investigated. As such, all the activities in this action research project constitute its materials and methods. Also crucially, our methodology was designed explicitly to develop the project from the ground up, based on extensive and intensive consultations within and outside the organization.

The project encompassed a comprehensive range of activities from gate-to-gate, and across several administrative departments and teaching and research units at the university -- sustainable procurement, asset management, internal reuse, internal logistics, change management, and external reuse and recycling. These activities comprised documenting the IT flows at McGill, and investigating their social, economic, logistical and other determinants, and how used and end-of-life IT equipment is managed in various units (baseline analysis); comparing these determinants with those in other institutions (benchmark); setting up a working group to develop and test interventions; developing new systems, processes, and procedures, to enable improved material flows, based on a collective visioning exercise; and implementing these systems, processes, and procedures, and new roles and responsibilities, as well as approaches to measure and evaluate the results of the project, and monitor progress. All these activities, and the lessons learned from them, are discussed in detail in subsequent sections.

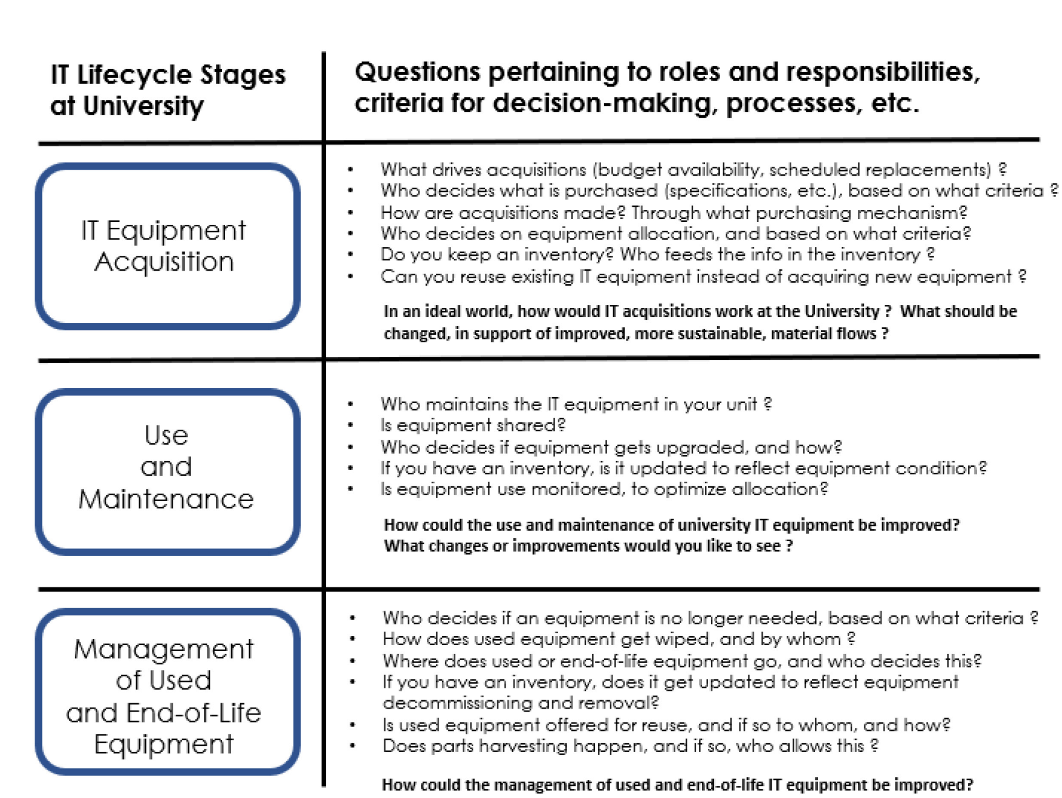

Figure 4.1: Questions used in the baseline and benchmark analysis

In line with the goal of developing the project from the ground up, based on extensive and intensive consultations within and outside the organization, interventions were identified and implemented based on the benchmark and baseline analysis and the visioning exercise. For the benchmark and baseline analysis, and the visioning exercise based on which interventions were identified and implemented, the first author conducted face-to-face in-depth interviews lasting 30-45 minutes with 20 stakeholders involved with managing the University's IT equipment flows (IT technicians, financial administrators in various units, and central IT staff), and with five representatives in other large Québec universities (two in person, three telephonically). The interviews focused on the roles and responsibilities, processes, and criteria for decision-making regarding the three gate-to-gate lifecycle stages (IT equipment acquisition, use and maintenance, and management of used and end-of-life equipment). The questions related to these issues are shown in Figure 4.1. The same questions for each lifecycle stage were asked of all interviewees. The visioning questions, in bold, were posed only to stakeholders at McGill. All interviewees were informed of the negative environmental impacts of IT equipment lifecycles and the importance of reducing them. These interviews yielded rich details about stakeholders' choices, decisions and motivations regarding IT equipment flows.

In the next sections, we describe and explain the project and related activities, and critically analyze and discuss these activities and their outcomes, in terms of the initial circumstances and conditions; the drivers and motivations for action; how the interventions that were put in place were implemented; the implementation barriers and challenges (including inter-jurisdictional issues and trade-offs and conflicts) that were faced and how they were addressed; the approaches used to measure and evaluate the results of the project; and recommendations for similar interventions elsewhere, based on the lessons learned. As noted, this structure specifically follows best practices in sustainability transition experiments, according to key experts in this field (see Luederitz et al., 2017).

Our critical discussion of the action research project and its various activities is based on the active involvement of the first author in the project over several years; very importantly, it also relies on the perspectives regarding IT equipment flows elicited from a wide range of stakeholders and actors from the in-depth interviews for the benchmark and baseline analysis and the visioning exercise based on which interventions were identified and implemented, as well as feedback elicited and obtained throughout the project from various actors and stakeholders regarding implementation challenges and strategies to address them.

In section 4.1.3, we discussed the usefulness of action research in sustainability transitions. However, there may be a perception that such methods, as case studies, are susceptible to "a bias toward verification, understood as a tendency to confirm the researcher's preconceived notions …", according to Flyvbjerg (2006). This perception is only heightened in relation to reports of case studies involving action research in which one of the authors participated actively, such as in this chapter. Flyvbjerg offers a compelling critique of this perception. First of all, as he points out, "the question of subjectivism and bias toward verification applies to all methods, not just to the case study and other qualitative methods." Secondly, while case studies and reports of action research are susceptible to bias and a "tendency to confirm the researcher's preconceived notions", like any other method, they are not inevitably so. To quote Flyvbjerg: "The advantage of the case study is that it can "close in" on real-life situations and test views directly in relation to phenomena as they unfold in practice." Moreover, "… researchers who have conducted intensive, in-depth case studies typically report that their preconceived views, assumptions, concepts, and hypotheses were wrong and that the case material has compelled them to revise their hypotheses on essential points"(Flybjerg, 2006: 235). In any case, the best that researchers can do is to describe the results of the case study involving action research as faithfully, honestly, and dispassionately as possible, while recognizing that it is impossible to completely eliminate subjectivity. And that is precisely what we seek to do here. We are clearly stating the first author's active involvement in the transition that was sought to be achieved. We critically discuss not only the improvements that have come about, but as importantly, the many implementation challenges that were faced and the lessons learned from them, and the pending issues and challenges that remain.

4.3. Results and discussion

4.3.1 Baseline analysis and external benchmarking

Because of the University's decentralised structure, many separate units were involved in managing the equipment, across two campuses. Some large faculties such as Medicine, and departments such as Student Housing and Hospitality Services had their own IT units, which made it challenging to get a clear picture of all the outgoing IT equipment. No one had a clear answer as to the extent to which equipment was reused internally, how the equipment was wiped (for data removal), if at all, and who took care of these steps, why and how.

The bulk of the e-waste generated at McGill was collected by the University's Hazardous Waste Management (HWM) services; this made sense since they frequently traveled around the campus to pick up hazardous products and scrap metals. This collection program was not mandatory, and had developed "organically" over the years. When the project started, HWM were collecting 40-50 metric tonnes (MT) of e-waste annually from both campuses. Visiting their facilities showed that the e-waste designated for recycling included many kinds of electronic devices from research laboratories, with a similar material profile as IT equipment (metal or plastic casings with electronic components, and screens), and not just end-of-life IT equipment. This was partly because, during renovation projects, large quantities of IT equipment were decommissioned simultaneously with laboratory equipment. E-waste was systematically sent to a local recycler, except for small quantities set aside for students' robotics and IT refurbishing clubs.

An interesting finding from interviews with IT technicians in different departments was that e-waste was generated at an accelerated pace because some faculty and staff members, rather than using the University's contracts for their IT purchases, bought “cheap equipment which simply does not last as long as it should” and was difficult to maintain. Such purchases occurred under research grants, or when new staff members were hired and equipment was purchased on a case-by-case basis.

At the same time, it was found that a lot of reuse was happening within departments. Typically, professors handed down their old IT equipment to their laboratory technicians or students. One faculty facilitated the reuse of IT equipment across its departments, but this was an exception. Most reuse happened within departments, and no reuse happened across faculties. One technician commented that he wished he could have received some of the equipment going to HWM for recycling, for reuse in his department, because “it was in better condition than some of the stuff we are currently using”. This signalled a lack of communication across faculties regarding the availability of used equipment, and also that there was no common understanding of what could still be useful, and reused, and what should be sent to recycling. Also importantly, the decision to send IT equipment for recycling was often left to individual faculty and staff members.

Most interviewees were concerned with data security, and sought to ensure that data was properly sanitized before computers, servers, and tablets were picked up by HWM for recycling. There was a wide range of practices to manage data security, though. Some departments sent computers to recycling but stored hard drives until a student was hired to “drill” holes in them, to make them non-reusable. Others had their technicians regularly complete a digital sanitization process on their used or end-of-life computers before HWM picked them up. Yet others required that end-users complete their own data-sanitization before submitting their equipment for end-of-life management. It seemed like a more uniform approach could both reduce risk and facilitate reuse.

Interviews with staff at other universities also revealed wide discrepancies regarding management of IT equipment. Few institutions applied sustainability criteria to their IT-purchases. Only some promoted external refurbishing by local non-profit organizations. Others either gave old equipment to their faculty and staff, or sold it to brokers who wiped and resold it in the business to business reuse sector. Some institutions had detailed inventories, but systematically renewed their equipment (whether functional or not) every 3-4 years. In one institution, used/surplus equipment was made available via an email sent to all technicians likely to be interested in reusing it in their units. Overall, no institution had a fully optimized gate-to-gate IT equipment material flow, compatible with circular economy principles, nor anybody accountable for overseeing this activity. Responsibilities were split between procurement, departments, faculties, IT services, and waste management services, among other units.

In a nutshell, the baseline study hinted at many opportunities and points of intervention along McGill University's IT equipment material flows, to achieve greater circularity, slower material throughput, and improved social and economic benefits. The findings also highlighted the large number of stakeholders who played a role in shaping the University's IT material flows. Some stakeholders were internal to the University, but reported to different administrative or academic units; others were external, including IT equipment suppliers and downstream processors (refurbishers and recyclers).

4.3.2 Project governance

By the time the first author reported back the baseline and benchmark findings to Central IT Services and Procurement Services, it became clear that shifting the University's IT material flows would require much more than ensuring proper collection and recycling. It would take time, and involve much change management, involving engagement with many stakeholders, to build awareness and educate, develop and implement new processes, and modify stakeholders' responsibilities.

At that time, the University adopted its first procurement policy, making Procurement Services responsible for overseeing the management of the University's assets (from purchase to end-of-life management). Following the first author's suggestion, the Director of Procurement Services and the Chief Information Officer set up a special working group, including representatives from Procurement Services, HWM, Facilities Management, and IT administrators and technicians. This group was mandated to work, under the first author's leadership, to develop a comprehensive strategy, incorporating innovative pathways, to shift the lifecycle management of the University's IT equipment, which would now be called "IT assets", towards greater circularity. The group was also to propose, if needed, new policies and procedures, and key performance indicators to monitor progress.

Thanks to the baseline analysis, the working group had a good idea of how things could be changed to improve circularity.

4.3.3 Main interventions

The following sections detail the interventions that were conducted to align the lifecycle management of the University's IT assets with circular economy principles. Taken together, these would lead to greater compliance with the government's new law (ensuring "longevity"), cost savings (through internal reuse), enhanced data security, and reduced environmental and reputational risks, through proper refurbishing and recycling. As these interventions were being implemented, working-group members were re-framing their objective as that of optimizing IT asset management, as opposed to merely improving e-waste management.

Creation of an IT Equipment inventory

Gradually, all incoming IT equipment was entered into an inventory. This began with administrative laptops and desktops, and would later include printers, screens, servers, and other similar IT equipment. The last items to be included would be IT equipment purchased with granting agency funds, because of the complexity of capturing the information from some decentralised purchases by academics. The objective of the inventory was to quantify the incoming IT equipment, allocate responsibilities and accountability to the units purchasing the equipment, and capture data about repairs, upgrades, data-wiping, and transfers.

Initial inventory information was captured at the time of acquisition, as well as through an automated script when users logged into the network. This approach contrasts widely with that at some other universities, where IT equipment was viewed as a "disposable commodity", with very little information retained about individual equipment. The working group saw the inventory as a means to better quantify and monitor the time, energy and fuel spent by HWM for picking up used and end-of-life equipment, and more generally, the total energy use by the University's IT equipment. The inventory was designed to be fully auditable, for reporting purposes. Finally, the inventory was intended to communicate the importance of mitigating the environmental and social impacts associated with IT equipment.

Creation of new responsibilities for IT Asset Stewards and Technical Stewards

During the baseline study, the first author found that there were two kinds of responsibilities shared among the personnel managing IT equipment. Some personnel were responsible for ordering IT equipment from Central IT Services and allocating it to users, and others for equipment set-up, upgrades, maintenance, decommissioning, and data-wiping. These roles were found in many but not all units, depending on whether or not their local IT services were offered by Central IT Services, by an independent service, or neither. It was decided to clarify and formalise these roles and responsibilities regarding lifecycle management of IT equipment. IT "Asset Stewards" would be responsible for their local inventory, ordering and allocating equipment, and declaring any theft or damage on the inventory. They would also be responsible for allowing transfers, among units or faculties, and of used or end-of-life equipment to HWM. Meanwhile, IT "Technical Stewards", usually technicians, would be responsible for equipment set-up, helping the IT Asset Stewards maintain their inventories, ensuring proper equipment maintenance, and communicating availability, or need, of equipment for reuse.

The identification of IT Asset Stewards for each department and unit has been the most time-consuming and challenging aspect of the project, because it necessitated the formal designation of individuals to take on the new responsibilities. Further, the working group had to train all the IT Asset Stewards so they would understand the importance of the inventory, the underlying rationale, its mechanics, and their own roles and responsibilities for achieving greater material circularity.

Because McGill University is so decentralised, and the working group desired flexibility in the allocation of responsibilities at the faculty or departmental levels, workshops were held every few months to educate and train the 70 or so IT Asset Stewards.

Minimum standard requirements

The working group developed Minimum Standard Requirements (MSR) to respond to technicians' concerns regarding ad hoc purchases of low-quality IT equipment by faculty and staff, on which they had to spend much time repairing or upgrading. Also, because this equipment reached its end-of-life or became obsolete much faster, it had to be picked up by HWM far more frequently.

Procurement Services and Central IT Services identified the technical, social and environmental criteria to be applied to IT purchases. These became the official MSR used in the University's calls for tenders, for various IT and electronic equipment, and are intended to become stricter over time. Since some purchases could happen outside the centralized process, all personnel involved in purchasing IT equipment were mandated to respect the MSR, for administrative, and eventually for research applications.

The MSR are brand-neutral (to avoid hindering market competition), and are based solely on operating system performance criteria, including memory, processing speed, and warranty terms. They also include the necessity for equipment to be EPEAT Gold or Silver registered, since most EPEAT registered products are Energy Star certified, contain fewer toxic components, are more likely to have recycled content, and/or are easier to repair or recycle.

Additional social requirements are also applied when purchasing large quantities of equipment through public bidding, such as that the manufacturer be a member of the Responsible Business Alliance (RBA), thus ensuring compliance with a basic code of conduct addressing labour, health and safety, and environmental issues.

The Central IT Services were made responsible for regularly reviewing and updating the MSR. Some researchers had to be reassured that the MSR would not affect their purchases of high-end computers, so exceptions would be allowed for research purposes.

Reuse eligibility criteria

To avoid sending reusable equipment for refurbishing and recycling, and ensure its longevity at the University, it was decided to objectively assess used equipment for its potential reuse before having it being picked-up by HWM. However, since it is not useful to extend the life of equipment beyond a point, it was decided that Central IT Services would establish Reuse Eligibility Criteria (REC) for IT equipment, particularly for computers. Two sets of REC – one for administrative and research use, and a less stringent one for public use campus-wide – were developed and communicated, and targeted for regular update.

While some IT equipment was already reused within departments, IT Asset and Technical Stewards were now mandated to find on-campus reuse opportunities for this equipment, wherever possible. Ultimately, the goal was to allow no IT equipment meeting the REC to leave the University (this was called a virtual gate), to facilitate reuse across units, and avoid surplus equipment being sent to HWM when other units could productively use them. At the same time, reuse on a "one in – one out" basis was encouraged, to avoid retention of too many pieces of used equipment.

While refurbishing and reuse are to be achieved as far as possible, it is important that old equipment containing hazardous substances are not sent out to be reused in the wider society. Multiple sorting steps are taken internally at the University, and externally, at our refurbisher's facility, to ensure that only safe equipment meeting certain quality, safety and capacity criteria get reused.

Communication channels and logistics for reuse

The above section raises the question: How does one department find out if another one needs something and would like to reuse some equipment? The solution was to set up a simple IT-Reuse email listserv. All technicians, system administrators, and other personnel responsible for managing IT equipment in their faculties or departments, were included on this listserv and encouraged to communicate their need for, and/or offer of equipment meeting the REC, besides equipment components and peripherals. All participants gladly joined and quickly started sharing surplus equipment. Computers, servers, audio-visual devices, keyboards, displays, switches, and even printers have been, and continue to be, offered and taken through the listserv.

Initially, some working-group members proposed that the technicians be responsible for transporting used IT equipment across departments. Besides contravening union agreements, this was not viewed as a good use of technicians' time. An alternative arrangement was found thanks to the University's Vice-Principal for Facilities Management and Ancillary Services, who proposed that the Mailroom and Printing Services team, who already serviced many of the 240 buildings on a regular basis, carry, at no charge, small-sized used IT equipment offered on the listserv. Larger equipment (such as large printers or servers) would be transported by contracted moving services, and paid for by the receiving unit.

The internal reuse strategy was initially an important source of scepticism. Some technicians and building directors were concerned about the lack of space for storing equipment destined for internal reuse, and the lack of interest in reusing equipment, because "people prefer getting new equipment". In response, the first author proposed a waiting time of two weeks before reusable equipment meeting the REC could be sent to HWM services, which allayed the concerns regarding being obliged to stockpile material until a unit requested a transfer. Stakeholders were asked to see how this arrangement was working, before requesting additional storage space, which the working-group promised to find, if necessary. In the end, the IT-Reuse listserv proved quite popular and effective; the apprehended lack of storage space is no longer a concern, and all equipment posted on the listserv is usually claimed within minutes, and redeployed within days.

Standardized data-sanitization processes

The University's Central IT Services already had data-wiping guidelines for IT equipment, but it was deemed necessary to refresh them, and make them mandatory. All IT technicians and system administrators were made responsible for data-sanitizing equipment before it could be reused at McGill, or sent to

HWM for external refurbishing and reuse. By ensuring proper data-wiping in-house, sharing some used IT equipment with student clubs, for their refurbishing and repair activities, which contribute to their hands-on learning, was rendered less risky. There would also be less risk of enterprise licenses being used outside the University, and University data exposure.

HWM as the sole unit responsible for collecting used and end-of-life IT Equipment

Allocating exclusive authority to Hazardous Waste Management for collecting the University's used or end-of-life IT equipment was intended to ensure that all IT material flows were going to the appropriate (and contracted) refurbishers and recyclers. With time, and some investments in systems, the hope was that HWM could access the inventory files and confirm the write-off and transfer of IT equipment to external processors, by simply scanning bar code tags placed on the equipment.

Initially, because of resource limitations, HWM was concerned with becoming the only "official" e-waste collector for the University's hundreds of buildings. While it was inefficient for them to collect equipment one at a time, picking them up periodically, when a sufficient number of requests to do so had accumulated might cause delays, and potentially cause system leakage. Besides, the working group was concerned that, because of impatience about delays in pick-ups, units might decide to work with e-waste collectors outside the University's formal programme. Informing faculties and departments about the risks of doing so became an important part of the project's communications strategy.

Also, HWM can now only be contacted for e-waste collection by the formally appointed and listed IT Asset and Technical Stewards (who must in turn be contacted by faculty and staff wishing to dispose of used equipment), which greatly reduces the number of people who can request this service. This also ensures that the proper authorities confirm that the equipment has been wiped and signed-off in the inventory.

New contractual agreements for downstream processing

As noted, the baseline analysis showed that used or end-of-life IT equipment was being sent directly to recycling, when some items could still be reused by communities outside the University, especially given that McGill's REC were strict enough for surplus equipment to interest external refurbishers. HWM and Environmental Health and Safety audited a local non-profit certified IT refurbishing organization which operated a socio-economic integration program for at-risk youth. Because of this education component, the University's Procurement Services and Central IT Services selected this organization to pick-up and refurbish its used IT equipment.

Procurement Services requested competitive bids from local certified recyclers. The idea was that revenues from selling e-waste to the recycler would help fund, in part, HWM's university-wide collection, sorting, and consolidation of e-waste. The highest bidder did not pass the health and safety audit (working conditions were not considered to meet the University's standards), so the recycler with the second highest bid was audited and selected. This recycler had the facilities and equipment required to handle e-waste properly, including more efficient air quality controls in its shredding facilities. As it happened, the same recycler was also receiving the end-of-life equipment and components from the certified refurbisher selected by the University.

But moving from one downstream processor to two, to facilitate external reuse, led to new complexities. This involved, mainly, a commitment from HWM to sort the University's e-waste in two separate piles (one each for the recycler and the refurbisher), and accommodating two different trucks, coming at different times at a busy loading dock with other waste chemicals and substances.

Education and awareness

Raising awareness about the life-cycle impacts of IT equipment was a principal project objective from its inception. When the first author conducted her stakeholder interviews, she explained these impacts as a key rationale for the project, and encouraged her interviewees to envision how to create more sustainable IT equipment flows at the University. All working-group participants were also made aware of these impacts; the need to ensure equipment "longevity"; the economic and environmental advantages of reusing and extending the life of IT equipment; and the importance of reducing the risk of sending equipment to landfill or to inadequate recycling facilities. Finally, training workshops for the IT Asset and Technical Stewards constantly stressed these points, and the University's intention to "walk the talk" and effectively operationalize its 4-R hierarchy (Rethink, Reduce, Reuse, Recycle) as adopted in its Sustainability Policy almost a decade earlier. Articles in the University's media also highlighted these points.

Stakeholders such as Central IT Services managers and IT technicians were invited to site visits and health and safety audits at the local certified refurbishers' and recyclers' facilities, so they could see first-hand the environmental and social benefits of their operations. They could also better appreciate, from seeing the vast size of the recycling plants, the sorting and shredding stations, and the safety and air filtration equipment, what proper recycling of IT equipment required.

Developing a shared vision and understanding was crucial to the project's success. This was initially lacking; for example: even some working-group members referred to the redeployment of computers from one department to another as "recycling", rather than reuse. Some others did not understand the difference between refurbishing and recycling. Also, some considered IT equipment leaving the University to be "disposal"; this catch-all term, usually associated with landfilling, was used instead of specific ones such as "refurbishing", "recycling" and "material recovery". Initially, most stakeholders were unaware of the high embedded energy and water in electronics, and therefore the importance of extending equipment lifecycles. Luckily, the government's regulation helped show that this was not "just" a sustainability and risk management, but also a "compliance", issue. Interestingly, for some stakeholders, "compliance" was the most important justification for the project, while for others, it was an additional push to help make the University's material flows more circular.

4.3.4 Measurement and evaluation of results

The working-group identified the following performance indicators to monitor the Project's implementation.

1. The percentage of MSR-compliant IT-equipment purchased;
2. The number and kind of IT equipment reused across units, via the IT-Reuse listserv.
3. The quantity of equipment sent to recycling.
4. The annual financial incentive paid by the contracted recycler.
5. The number and kind of equipment sent to external refurbishing.
6. The number of hours of work generated by the refurbisher's social reintegration program thanks to the refurbishing of the University's equipment.
7. The number and % of IT Asset and Technical Stewards who have participated in the training workshop.

These indicators were to be reported annually by Procurement Services and shared with the community; they are to be refined, and applied to other material flows, over time.

Table 4.1 on the next page highlights some of the results from the project. Compliance with the MSR is assessed every four years, as part of the University's reporting to the Association for the Advancement of Sustainability in Higher Education (AASHE) Stars ranking system. The increased variety of MSR-compliant equipment reflects the addition of new product categories in the EPEAT registry. The second column (internal reuse) reflects the success of the project in supporting reuse across units. The transfer of IT equipment to the external refurbisher has fluctuated greatly from year to year, and more so since the implementation of internal reuse. In 2015, e-readers could not be refurbished and reused because they had been engraved with the University's name; engraving of IT equipment is now discouraged. The University entered into agreement with a certified recycler in 2016, and much clearer data reporting (tonnage/type of equipment/rebates/etc.) has been provided since then. The last column indicates the percentage of e-waste sent to the recycler under the regulated EPR program. The variation indicates the fluctuating gap between the type of e-waste sent to recycling and the limited scope of the provincial take-back program. Analysis of this gap could help indicate what equipment should be added to this program.

By tracking IT purchases, purchasing more sustainable equipment, more effectively controlling it, favouring internal and external reuse, supporting a non-profit social integration program, auditing and carefully selecting downstream processors, and getting financial incentives for material collection, the working-group was convinced of the social, economic and environmental benefits of the project.

Table 4.1: Summary of Project Outcomes 2014-2020 (adapted from Leclerc and Badami 2022)

	ACQUISITION	INTERNAL REUSE	REFURBISHING			RECYCLING	
YEAR	**% of purchases meeting MSR**	**Internal Reuse (across departments)**	**Electronics to External Refurbisher (units)**	**% Items successfully refurbished**	**# Hours of work for at-risk youth**	**E-Waste to External Recycler (metric tons)**	**% E-Waste under EPR Program**
2014	No MSR (not yet developed)	Program not yet developed	672 Desktops 108 Laptops 3 CRT Displays 89 LCD Displays	50% Desktops 7.3% Laptops 0% CRT Displays 20% LCD Displays	NA	45.6	NA
2015	100% Televisions 92% of Computers and Displays	1 Server 15 Monitors 62 Desktops 1 Keyboard	122 Desktops 68 E-Readers 6 Laptops 46 Displays 440 Hard drives	46.7% Desktops 0% E-Readers 66% Laptops 7% Displays 0% Hard Drives	248	50.2	NA
2016	NA	34 Desktops 3 printers	0	0	0	23.9	69%
2017	NA	3 Server 65 Desktops 38 Displays 2 Printers	0	0	0	49.8	87%
2018	NA	25 Desktops 25 Displays	184 Desktops	41% Desktops	92	70	52%
2019	97% of Cell Phones 4% of Televisions 96% of Imaging Equipment 92% Computers and Displays	70 Desktops 26 Displays 3 Tablets 3 Printers	0	0	0	41.9	80%
2020	NA	186 Servers 43 Desktops 7Displays	117 Desktops 20 Laptops 12 Displays	78% Desktops 100% Laptops 0% Displays	180.5	40.5	35%

However, after a few years, some issues arose and required adjustments. First, it was found that the University was so successful at reusing its equipment internally, and generating only older e-waste, that there was barely anything being sent to the local refurbisher, which posed an interesting dilemma.

Secondly, the project team was asked to be flexible on the "one in – one out" principle applied to equipment reuse. Financial Services wished to provide their staff two screens, and thus requested many used screens. Since they were considering purchasing new screens, it was deemed better to allow internal reuse, and additional equipment per staff, rather than additional purchases.

Third, when a large quantity of high-performance servers were decommissioned, the Network and Energy Management groups raised the issue of space availability and HVAC capacity to take the heat load in areas where the servers were to be relocated for internal reuse. This led to the design of a new authorization process and guidelines for reusing servers, to avoid increased heat loads and additional air-conditioning. Increases in energy consumption due to server reuse would have constituted a circularity rebound (Zink and Geyer, 2017).

Fourth, another situation arose when part of the contracted recycler's operations moved to Ontario, leaving no large-scale end-of-life IT shredding facilities in Québec. This did not threaten the agreement with the recycler, but the University's Environmental Health and Safety team plans to audit the shredding facility in Ontario, to ensure it also meets its health and safety requirements.

Lastly, the Central IT department improved its service management system, by selecting a software which would also incorporate the inventory. However, the new system would not allow multiple licenses for local asset stewards to access their part of the inventory. This will affect the degree of involvement by local actors in maintaining their local/departmental inventory, and implies a yet to be resolved reshuffling of IT asset management roles and responsibilities.

All these experiences show that managing IT material flows requires not only constant monitoring, but also addressing trade-offs and conflicts, and involves unforeseen circumstances and unintended consequences, including potential rebounds.

One final point regarding the results shown in Table 4.1: time constraints and the lack of collaboration by suppliers/distributors have impeded this data collection annually, especially the information about the sustainability attributes of IT acquisitions. As well, inconsistencies in the data, with measures varying by percentages, units, metric tons, is in part due to the fact the data is generated by various stakeholders, with each stakeholder using their own approach for quantifying and reporting material flows. This problem in fact represents an important finding in and of itself regarding the challenges of tracking material flows, as well as highlighting the need to integrate social impacts as part of circularity endeavours.

4.3.5 Potential for the use of similar solutions elsewhere

McGill's effort to make its IT material flows more circular has already inspired the improved management of other asset categories at the University. A similar process has been applied to vehicles, research equipment, and will soon be applied to furniture and appliances. In each case, a similar working-group has been constituted, bringing together the relevant stakeholders, and existing flows have been documented, and potential circularity shifts have been identified. The University is defining MSRs for other assets (based on the quality and sustainability profiles of various products), identifying Asset and Technical Stewards, elaborating reuse eligibility criteria, implementing procedures for reuse, and selecting and contracting downstream processors whose activities respect the University's 4-R hierarchy. Other universities, besides hospitals, municipalities, and international organizations, have been contacting McGill to better understand its management of assets in accordance with circular economy principles.

4.4 Conclusions and Key lessons

Our detailed discussion of a project to optimize IT flows at a large university hopefully shows how action research can be useful for implementing, while also generating empirical knowledge from, such sustainability transitions; and for bridging the gap between the study of IT flows, circular economy prescriptions, and real-world strategies for greater material circularity in organizations. More particularly, our study hopefully provides a rich and nuanced understanding of what happens "on the ground" when organizations implement strategies to achieve this objective, revealing the challenges faced, and the measures and incentives needed to encourage stakeholders to collaboratively modify material flows. Finally, our paper shows that researchers directly involved in such action research can become "knowledge brokers" and "change agents" who contribute to social learning, and to empowering individuals in favour of sustainability.

Our case study offers several lessons that may be useful for similar sustainability transitions in other large organizations. First, project teams need to recognize and understand the complexity of material flows, in terms of their multiple – including logistical, behavioural and financial – dimensions; and the multiple actors and stakeholders, both internal and external, with conflicting interests, objectives and concerns. However, while embracing complexity is important, so is finding quick wins, for sustaining momentum toward successful implementation.

A comprehensive baseline analysis is a critical first step, to understand the key stakeholders, their choices and decisions, and underlying motivations, driving material flows. In our study, this analysis revealed, for example, that e-waste was being generated rapidly because some employees were purchasing low-cost equipment that was difficult to maintain and not long-lasting; that a lack of common understanding and communication regarding what was reusable, concerns about data security, and a lack of uniform institutional systems and processes, were major barriers to reuse and recycling. Following this analysis, it is desirable to carefully identify the multiple project objectives (such as that it is IT asset, rather than merely e-waste, management that is important), and performance indicators, for effective monitoring and enforcement, and mid-course corrections, and which can be refined over time based on experience.

The baseline analysis and project objectives, and indeed long-term project success, in turn critically depend on constant and close engagement with key internal and external stakeholders. This engagement enables becoming aware of barriers and challenges early on; as well, stakeholders often have the most simple, innovative solutions for overcoming barriers, as demonstrated in this case study. These solutions allow low hanging fruit to be picked, and therefore quick wins, thereby freeing up resources to tackle more difficult issues. Finally, giving stakeholders the opportunity to contribute to positive change can generate workplace satisfaction and loyalty.

The provincial legislation mandating longevity of institutional IT resources was an important driving force, but the sustained leadership and commitment of the university administration to go beyond mere compliance to IT asset management was also critical to success. Our case study shows the importance, especially in large, decentralised, organizations, of bringing everybody together, giving project teams freedom to develop a bold, comprehensive strategy, clearly communicating this strategy, allocating roles and responsibilities, and formalizing uniform systems and processes for capturing and tracking data to quantify flows and impacts, and for communication and co-ordination among units.

Project teams should be under no illusion as to the time necessary for these activities, nor about the challenges involved (which again highlights the importance of sustained institutional commitment). Many of these activities were not planned initially, and took more time than anticipated, in the McGill project. Besides, it took several years to develop and implement it, slowly overcoming resistance along the way, and urging people with concerns to wait and see, to bring them on board. Awareness building and education, and constant communication, including regular training workshops, were crucially important in this regard. Finally, unanticipated and unintended consequences and trade-offs – such as those related to space availability and HVAC capacity for reuse of high-performance servers; sorting for recycling and refurbishing; and the low level of external reuse because of high internal reuse thanks to the project – had to be addressed.

While uniform and standardized systems and processes were crucial for success, project implementation occurred in a phased manner, and iteratively, allowing for learning-by-doing, and mid-course corrections. Also, a pragmatic, flexible approach was adopted, wherever appropriate, as exemplified by different reuse eligibility criteria for research and administrative versus public use, and the use of mailing services to transport small IT equipment during their regular runs, to minimize costs, even as HWM served as the single window for picking up and processing e-waste.

Ultimately, shifting the global economy, and its associated material flows, towards more circularity, will necessitate multiple small-scale transitions, such as the one we present. The progress achieved in the McGill project demonstrates the ample opportunity for action research, and learning-by-doing, as each particular material flow, in each local or organizational context, is investigated and transformed.

We close with some ideas for further research. Given the lack of empirical work in this regard, more in-depth case studies on how municipalities and other large institutions shape their IT and other material flows, and how they plan and implement circularity transitions relating to these flows, the challenges they face, and the strategies they develop to surmount them, would be very desirable. As well, it would be useful to study the possibility of networks and partnerships among these organizations in this regard. Another fruitful focus for research would be to study the attitudes and perceptions of personnel in these organizations regarding the useful service life of IT and other equipment, refurbishing and reuse, recycling, and disposal, and concerns such as data security, and to draw lessons for education and communication for encouraging more effective collaboration to modify material flows. Lastly, research to develop indicators to more effectively measure and monitor the outcomes of circularity transitions along multiple dimensions (resource use, environmental, health, socio-economic, and equity) would be very useful.

Chapter 5. Extended Producer Responsibility: An empirical investigation into municipalities' contributions to and perspectives on e-waste management

Chapter overview

The normative and prescriptive literature on e-waste management mentions that municipalities should benefit from EPR policies by being relieved from the financial or logistical burden of managing e-waste. However, there is very little research exploring how and why (or not) municipalities, and their civil servants and elected officials, decide to collaborate with EPR programs. In Chapter 3, I noted that municipalities did take part in consultations surrounding the development of Québec's EPR regulation for e-waste management; they expressed their desire to see the program adopted as soon as possible, and with the widest scope of products as possible. The provincial government chose, however, to give municipalities the full latitude to decide whether to collaborate with the EPR program. This was also the case for other organizations, as explained in Chapter 4. This latitude has allowed both organizations and municipalities to choose to whom they give or sell their e-waste, which can have a significant impact on the EPR program's performance.

In this chapter, in addition to presenting a detailed review of how the relationship between municipalities and EPR programs for e-waste management is usually discussed in the relevant literature, I share the results of an investigation, using an online questionnaire, and in-depth interviews, to understand what drives, or hampers, municipalities' participation with Québec's EPR program for e-waste management. My findings show that perceived program legitimacy, financial incentives, and logistical efficiencies favour municipalities' collaboration with the program. Conversely, I found that the program's limited scope, a lack of program transparency, the inconsistent support of local processing and employment, as well as the focus on recycling instead of reuse has been causing some dissatisfaction among municipal stakeholders. I also found a wide range of perspectives regarding the financial contributions of the program, and diverging opinions regarding the implementation of the polluter-pays principle. I argue that policy-making for e-waste management and circularity needs to consider municipalities' multiple interests and contributions to ensure successful implementation.

5.1. Introduction

Vast quantities of materials, water, and energy are used to produce electrical and electronic equipment, and significant environmental impacts result from their short lifecycle, from the extraction of resources used to make them, to their recycling or disposal (Williams et al., 2002). The Global E-Waste Monitor estimates that 53.6 million metric tons of e-waste (used and end-of-life electrical and electronic equipment) were generated worldwide in 2019 (Forti et al., 2021), primarily in urban areas, where households, businesses and institutions purchase, use and discard this equipment. E-waste is challenging and costly to manage because it contains a complex mix of plastics, various toxic elements, useful and critical metals, and it often arises in small quantities, everywhere. Together, these issues highlight the necessity to shift the lifecycle of these products towards more efficient and cleaner production and use, and greater reuse, refurbishing, and recycling, within a circular economy framework (Ellen Macarthur Foundation, 2018).

Extended Producer Responsibility (EPR) policies and programs are challenging to implement, because of their nature as multilevel environmental governance mechanisms, and the coordination they require to be effective (Cassotta, 2012; Bache et al., 2016). They are often adopted by one level of government (provinces, in the Canadian context), but their implementation and effectiveness depend on the collaboration of other jurisdictions and actors, including, mainly, municipalities, but also federal agencies, industry, institutions and even international organizations (Enderlein et al., 2010; Lepawsky, 2012). EPR programs also need to adapt to changing internal and external conditions, including changes in material flows, changes in decision-making processes, changes in technologies and markets, and even changes in the actual or perceived legitimacy of actors participating in the system (Behnke et al. 2019; Benz, 2019).

Municipalities play an important role in facilitating the collection, sorting and recycling e-waste, but these activities have been changing in contexts where EPR policies have been adopted. These policies, implemented as official take-back schemes, aim to operationalize the polluter-pays principle, by shifting the financial and/or logistical burden of e-waste management away from municipalities to manufacturers or first importers and consumers (OECD, 2016). EPR policies have not put an end to municipalities' e-waste management activities but have led to changes in the logistical, financial and governance aspects of e-waste management. The last few decades of experience with EPR have demonstrated how various jurisdictions have assigned e-waste management responsibilities differently to municipalities, recyclers, refurbishers, manufacturers, households, importers, and other stakeholders. One striking difference across jurisdictions is the level of obligations that remains with municipalities, especially regarding the collection and conveying of e-waste materials to the formal EPR program, and the funding of these activities. These roles and responsibilities vary by country in Europe, by province in Canada, or by state in the USA, and researchers have only recently started investigating which arrangements may be most effective and efficient (Cahill et al., 2010; Hickle, 2014a; Schumacher and Agbemabiese, 2019).

Given the relative recency of EPR policies, adjustments are needed to improve resource recovery, workers' health, employment, and pollution prevention, besides transparency, stakeholder collaboration and accountability. Even in "formal" and well-equipped recycling facilities, the health of workers dismantling e-waste may be at risk (Nguyen et al., 2019), many critical metals are not recovered from metal recycling and refining under EPR programs (Campbell-Johnston et al., 2022), and collaboration among stakeholders involved in EPR is still suboptimal (WEEE Forum, 2020). While such basic issues remain to be resolved, researchers suggest that e-waste management strategies should be more ambitious and assessed against the UN Sustainable Development Goals (Shittu et al., 2021). EPR program updates and improvements along multiple sustainability dimensions therefore seem necessary, and understanding municipalities' actual and potential contributions to EPR becomes even more relevant in this context.

Municipalities' contributions to a more circular economy are crucial. Not only do municipalities consume approximately 70-75% of natural resources (Zucaro et al., 2022), they often have collection and storage infrastructure, and staff to collect and sort different types of waste. Cities are increasingly considered as urban mines, where materials are stocked (while electrical and electronic equipment are in use, or dormant), serving as future reservoirs of resources (Graedel, 2011; Tesfaye et al., 2017). Forti et al. (2021) estimate the total value of raw materials found in global e-waste generated in 2019 to be USD 57 billion. Some recent research even suggests that urban mining, "the systematic reuse of anthropocentric materials from urban areas" (Brunner, 2011: 339) for certain metals is now more cost efficient than mining for similar virgin resources (Zeng et al. 2018). Despite this, research investigating the interests, concerns, and motivations of local actors, as they collaborate, or not, with EPR programs, has been limited. This chapter presents and discusses perspectives elicited directly from municipal stakeholders and explores how and why they interact with a regulated EPR program in a context where they are not mandated to do so. The results provide insights into the conditions for ensuring successful collaborations between municipalities and EPR programs, thereby facilitating positive policy outcomes.

In the following section, we review the relevant literature and highlight the two most common types of work related to municipalities' activities under e-waste EPR programs, namely: normative/theoretical work, and country case studies. Based on this review, we propose a typology for classifying municipalities' approaches to collaboration with EPR programs which we then use to analyze our own empirical findings. We present our research questions and methods in section 5.3, and our findings in section 5.4. Also in section 5.4, we discuss the most important issues raised by our work, and its policy implications. We argue, based on our findings, that as the emergence of a circular economy, resource and energy conservation, and urban mining, are poised to accelerate around the world, sound environmental governance is important, especially if e-waste management is to be assessed against the UN Sustainable Development Goals (Shittu et al., 2021). In our concluding section, we propose several questions for further research, to help explore how EPR can be improved in support of a more circular economy.

5.2. Literature review: The role of municipalities in EPR and e-waste management

The paucity of research directly focused on the interactions between municipalities and e-waste EPR programs is demonstrated by the lack of reference to the words "local", "cities", "municipal" or "municipalities" among the top 50 keywords associated with the term "e-waste" in a recent bibliographic analysis (Andrade et al., 2019). This is surprising, considering that it is in cities that most e-waste is generated, and that resources will increasingly be mined there (Shittu et al., 2021; Tesfaye et al., 2017). Apart from a global survey of various stakeholders which included some questions regarding municipalities' effectiveness in managing e-waste (Tasaki et al., 2018), the involvement of municipalities in e-waste management is addressed mainly in theoretical/normative pieces, and sometimes in comparative policy assessments or jurisdiction specific case studies. We review key articles in these categories and propose a three-part typology of municipalities' collaboration with EPR programs.

5.2.1 Municipalities in EPR theory and guidance for e-waste management

Initial research on EPR began in the late 20th century, coinciding with the German government's first ordinance making industry responsible for managing their end-of-life packaging (Lifset, 1993). The diverse responsibilities assigned to municipalities under such programs was recognized early on. EPR programs allowed for multiple combinations of responsibilities (financial and physical, communications, monitoring and control) to be shared differently among stakeholders. For example, municipalities could remain responsible for the collection and sorting of (packaging) waste, but charge industry to "make up any deficit resulting from the failure of revenues from sales of recovered materials to cover collection and sorting expenses." (Lifset, 1993: 165).

According to Lifset et al. (2013) and OECD (2000), municipalities should benefit from EPR as e-waste management responsibilities get shifted to manufacturers and consumers. The OECD identifies one of EPR's objectives as "reducing the burden on municipalities for the physical and/or financial requirements of waste management" (OECD, 2000: 17). The European Commission's Circular Economy Action Plan, which aims to accelerate and broaden EPR programs mentions that the Circular Economy should work "for people, regions and cities" (European Commission, 2020: 5). However, the OECD (2000) suggests that municipalities may retain certain responsibilities, related to e-waste collection, sorting and processing, and be compensated by producers or manufacturers, or alternatively, sell the materials to the producers for downstream treatment.

According to OECD's updated guidance on EPR, "The role of municipalities in EPR systems is a contentious issue in many jurisdictions" (OECD, 2016: 91). Indeed, as jurisdictions have experimented with EPR, some tensions between the interests and objectives of local governments, manufacturers, and environmental protection agencies have been documented (Hickle 2014a; OECD, 2016). While respecting the need for flexibility and different governance structures, experts stress the importance of clearly defining responsibilities among various stakeholders, to minimize friction, inefficiencies, and policy failures (Monier et al., 2014; OECD, 2016). Kalimo et al., (2015: 50) mention, for example, that some municipalities in Europe have criticized producers for "exploiting municipal collection systems where they do not pay for the services provided." They also argued that the recast European WEEE directive has failed to clarify whether or not producers "should have access, or even a priority right, to WEEE from the predominant municipal collection schemes, and whether the producers' access is free of charge".

Gregory et al. (2009) suggested that municipalities be responsible for maximizing e-waste collection through free, easily accessible collection points, and that they be mandated to hand-in materials to compliance schemes, to reduce the risk of illegal trading and "cherry picking". Kalimo et al. (2015) also suggested that municipalities be mandated, as in Finland, to hand over the collected e-waste to consolidators or recyclers affiliated with the official EPR program, to avoid the reselling of valuable fractions by municipal employees or service providers.

Thus, theoretical writing and guidance regarding EPR schemes portray municipalities as important stakeholders which should benefit from, but also play an active role in some operational aspects of, EPR programs. Prescriptions for municipal involvement range from an openness to flexibility, to mandatory participation in collection, monitoring, and other activities.

5.2.2 Municipalities in comparative assessments and case studies on e-waste management

Outside of specific case studies, most of the substantial research on e-waste EPR programs omits any discussion of why stakeholders, including municipalities, take on the responsibilities they do, or how multilevel governance frameworks are established in this regard. Do municipalities collaborate with programs voluntarily, because of their historical activities in this area, or because they are mandated to do so? Documents such as *The E-Waste Monitor* mention many jurisdictions where municipalities have collection points (in Moldova, Belarus, etc.) but do not specify if the municipalities in these countries are obliged to collect e-waste or to hand it over to formal EPR programs, and under what conditions (Forti et al., 2021). Similarly, the European Court of Auditors (2021) identified municipalities that failed to sort e-waste from their regular waste stream, without indicating if they were mandated, or received any incentives or compensation, to do so.

Some work has documented municipalities' input in designing EPR programs. In Québec, for example, municipalities wanted the EPR program for e-waste to cover the widest possible range of products, to offer compensation for their collection efforts, and to be set-up at the earliest (Leclerc and Badami, 2020). Furthermore, there are many jurisdictions where the roles and responsibilities of municipalities in e-waste management have been agreed upon by multiple stakeholders, through negotiations.

In Europe, Cahill et al. (2010) found that municipal involvement in policy design and implementation was associated with more positive outcomes. While some municipalities are mandated to collect e-waste and others do so voluntarily, the majority of jurisdictions they surveyed provided mechanisms for Producer Responsibility Organizations (PROs) - organizations representing manufactures who are subjected to EPR regulations - to fund municipal collection activities.

In France, municipalities are not obliged to collect e-waste and hand it over to the PROs. However, the municipalities bargain collectively with a coordinating body (OCAD3E) representing various PROs, and agree on a monetary value which PROs pay for the e-waste collected by municipalities. They need to meet certain conditions to get funded by the program, including providing collection services to a minimum population threshold, meeting a target calculated as a quantity of material collected per inhabitant, and supporting program communications. In Belgium, municipalities must collect e-waste and hand it over to the PRO. However, the financial contributions provided to Belgian municipalities are based on a detailed quantification of their related expenses. Both these mechanisms were viewed by researchers as being fair and transparent (Cahill et al., 2010). By contrast, where stakeholder consultation and collaboration is absent, there are "long-term implications for the stability of the system." (Cahill et al., 2010: 478).

In their case study on the Netherlands EPR scheme, Börner et al. (2018) identify municipalities as active partners of an interactive governance mechanism called the "Monitoring Council". Capurso (2014) reported that in Italy (as in France), agreements were negotiated between municipal associations and the coordinating bodies representing multiple EPR schemes, with variations in the resources and approaches applied to e-waste management across municipalities. Further, 98% of French municipalities collaborate with the formal EPR scheme (twice that in Italy), thereby accounting for 68% of e-waste collected nationally (Capurso, 2014).

Some regulatory arrangements and municipalities' responsibilities are also mentioned in case studies for Switzerland (Khetriwal et al., 2009), Maine (Wagner, 2009), United States (Kahhat et al., 2008; Hickle, 2014b), China (Yu et al., 2010), Japan (Sasaki et al., 2004), and Brazil (Xavier et al., 2021), but no direct feedback from municipal stakeholders on EPR programs is ever discussed.

The Maine Department of Environmental Protection (MDEP, 2010) and the Wisconsin Department of Natural Resources (Wisconsin, 2014) did survey municipalities to understand how and why they collaborated with regulated e-waste EPR programs. In both cases, municipalities expressed their general satisfaction with the programs, but raised some issues. In Maine, municipalities wished to see collection site inspections and paperwork streamlined. In Wisconsin, many municipalities failed to collaborate with the official e-waste program or did not understand their obligations regarding outreach campaigns and the enforcement of landfill bans. Because they uncover discrepancies between policy intentions and actual implementation, these surveys demonstrate the importance of going beyond the description of regulatory arrangements and conducting empirical research to understand the perspectives, choices, and motivations of stakeholders involved in program implementation, which is what we do in this article.

5.2.3 Tentative typology of municipalities' roles in E-Waste EPR programs

Existing EPR typologies focus on aspects such as the sharing of physical, financial, and enforcement responsibilities between stakeholders in EPR programs for e-waste (Cahill et al., 2010; Tojo and Manomaivibool, 2011). We propose, based on our literature review, an expanded typology which captures the types of contributions municipalities make to e-waste EPR schemes, the wide range of operational steps taken by various municipalities globally, and funding arrangements related to the collection and transfer of e-waste. These are detailed in Tables 5.1, 5.2 and 5.3 on the next pages, along with examples we found mentioned in the literature.

5.2.4 The importance of stakeholder collaboration

The tables below hint at many possible arrangements for municipalities' involvement in e-waste management. Given this wide variation and the important contribution of municipalities -- in some countries, up to two thirds of all the e-waste collected and returned to the EPR program comes from municipal collection (Huisman et al., 2012) -- researchers have concluded that continued collaboration by municipalities and clearly defined roles for them are essential for successful EPR programs. "Definitions for the role of municipalities and governments" is the first point in the E-Waste Monitor list of what e-waste regulation must include (Forti et al., 2021: 53). Additionally, it is recommended that arrangements be transparent and arrived at through open negotiations among stakeholders (Kalimo et al, 2015; Monier et al., 2014; Forti et al., 2021), which may or may not be facilitated by official mandates for municipalities to participate. What can, and should, be negotiated is still debated, however, since very little research has explored municipalities' perspectives on urban mining and EPR implementation.

Table 5.1: Municipalities' potential and actual contributions to e-waste management

Types of municipal collaboration	Example(s)
Full collaboration E-waste is collected by municipalities and handed over to official EPR program	The Waste Act of Finland makes this mandatory (Kalimo et al., 2015) Maine's Electronic Waste Law specifies that municipalities must hand over designated e-waste to licensed consolidators (Wagner 2009; Hickle, 2014b) Municipalities in France and Italy, on a voluntary basis (Capurso, 2014)
Partial Collaboration E-waste is collected by municipalities but handed over only in part to official EPR program (cherry picking)	Documented practice in the Netherlands (Huisman et al., 2012) Mentioned as an occurrence in Europe, no country specified (Huisman et al., 2008; Kalimo et al., 2015)
Competition E-waste is collected by municipalities but can be sold or transferred outside of EPR program	Mentioned as a likely occurrence, in the European context, without specifying any jurisdiction (Kalimo et al., 2015) Example of Ontario (Kalimo et al., 2015) Example of municipal employees reselling e-waste to third parties, without specifying jurisdiction (Huisman et al., 2008) Possibility in Germany (Cahill et al., 2010)
Avoidance / low capacity / no mandate No collection or marginal collection of e-waste by municipalities	Mentioned as a likely occurrence in China (Yu et al., 2010) Multiple US state regulations without provisions for municipal involvement (MDEP, 2010) Hazardous and Electronic Waste Control Management Act (Ghana, 2016) India (Goodship et al., 2019) Occurrences in Spain, Lithuania and Estonia (ECA , 2021)
Compensation Additional e-waste is collected over and beyond program requirements (in quantity or variety of products)	Some Minnesota municipalities were collecting more than what recyclers were willing to take on behalf of manufacturers (MPCA, 2013) Maine municipalities collected e-waste from businesses, even though these were out of scope (MDEP, 2010)
Enforcement Municipalities ensure compliance with the program or certain aspects thereof	Municipalities in Ireland ensure proper collection (by sub-contractors) and the handing over of materials to the PRO (Cahill et al., 2010) Municipalities in Wisconsin are to enforce the e-waste landfill ban (Wisconsin, 2014)

Table 5.2: Types of collection and treatment activities by municipalities

Possible activities	Example (s)
Curbside collection from households Municipality uses its or contractor trucks to collect e-waste from households	Toronto (City of Toronto, 2020)
Permanent drop-off points (Civic Amenity Sites / Waste Transfer Stations) Municipality has secure infrastructure to collect, sort and prepare e-waste for downstream processors	Cyclade, France (Collectors Project, 2020) Helsinki, Finland (Collectors Project, 2020b) Toronto (City of Toronto, 2020) Netherlands (Huisman et al., 2012) Maine and Connecticut (Schumacher and Agbemabiese, 2019)
Ad-hoc collection events Municipality holds periodic e-waste collection events	Helsinki, Finland (Collectors Project, 2020b) Toronto (City of Toronto, 2020) 800 Local communities in the US (Kahhat et al., 2008)
Treatment Municipality engages in dismantling and other forms of processing	Allowed in Japan (Sasaki, 2004) Allowed in Germany (Cahill et al.,2010)

Table 5.3: Types of financial arrangements for municipalities' e-waste collection activities

Possible types of funding	Example(s)
Non-specific funding Municipalities fund their e-waste collection (in whole or in part) from taxes	Most municipalities in the OECD prior to development of EPR programs Under shared responsibility in Maine (Wagner, 2009)
Pay as you throw funding Municipalities charge households and/or businesses for the collection of e-waste	Japan (Sasaki, 2004)
EPR program funding Municipality can obtain funding (in whole or in part) from PRO	Québec (Leclerc and Badami, 2020) Austria, Belgium, Czech Republic, France, and others (Cahill et al., 2010)
Funding from sales Municipalities gather funds from the sale of e-waste to third parties	Mentioned as a likely occurrence, in the European context, without specifying any jurisdiction (Kalimo et al., 2015) Possibility in Germany (Cahill et al., 2010)

5.3. Research questions and methods

Given the growing interest in urban mining (Prosum, 2017), and global ambitions to develop a more circular economy, additional EPR programs will likely be developed in the future (EC, 2020). Understanding stakeholder preferences, choices, concerns and motivations, and their interactions, can help improve planning, policy development and implementation. It is also useful to understand the benefits and drawbacks that arise from regulatory arrangements allowing municipalities the freedom to collaborate, or not, with formal EPR programs. The social, economic and environmental consequences of municipalities' low or insufficient participation in EPR systems may be significant. The mismanagement of e-waste, namely landfilling, illegal exports, and the loss of valuable resources, warrant further investigation into the determinants of municipal collaboration and support of EPR programs.

In Québec, a Canadian province with a population of 8.6 million inhabitants, municipalities are not mandated to collect, sort and store e-waste. Nevertheless, they contribute roughly half of all e-waste collected (total of 17,476 tonnes, in 2020) and returned to the PRO (ARPE, 2016; ARPE 2020). It is worthwhile investigating what drives municipalities' e-waste management activities and approaches to collaborating with PROs in such circumstances; their (and other stakeholder) perspectives on the EPR program; the implications for program performance and stability; and lessons for other EPR programs. We therefore investigated the following questions in the Québec context:

- Why do municipalities choose to collaborate, or not, with the regulated EPR program?
- In what ways do municipalities engage with the program, and what are the implications for policy outcomes?

- What advantages or benefits do municipalities identify as incentives for collaboration? What drawbacks do they perceive?
- What arguments are presented for not collaborating with the EPR program?
- What improvements do municipalities wish for?
- What are the perspectives of other stakeholders regarding the EPR program and the contributions of municipalities to program success?

Despite their importance for the planning and implementation of circularity initiatives and the sound management of urban mining, these questions have yet to be investigated in the literature. Our study seeks to contribute by addressing them.

We used multiple sources of data and methods to ensure triangulation and validity (Denzin, 1978). First, an anonymous questionnaire with open questions and multiple-choice answers was posted online and made available to municipal representatives responsible for waste management or environmental issues. Municipal associations disseminated the link to the questionnaire, which remained online for three months during the summer of 2020. Québec's waste diversion agency also mentioned the questionnaire in its newsletter. Table 5.4 (p.130) shows the number of participants who answered the questionnaire and shows the diverse population sizes of the municipalities they represented (Québec, 2021). We did not limit the number of participants per municipality, nor did we ask participants to identify their municipality. Although participants came from municipalities of all sizes, and the larger municipalities were well represented, we found that it was challenging to elicit participation, and therefore adequate representation, from smaller municipalities.

Table 5.4: Number of questionnaire respondents by size of population

Number of participants	Size of population in municipality	Municipalities of this size in Québec
2	Less than 1,000	470
10	Between 1,000 and 9,999	539
16	Between 10,000 and 49,999	77
11	Between 50,000 and 99,999	12
8	Between 100,000 and 199,999	5
5	200,000 and above	5

Second, targeted questions were addressed by email to recyclers, municipal civil servants, and administrators of the PRO, to explore, validate, and clarify the actual collaboration between the PRO and municipalities, and their perceptions about this collaboration. Public documents and reports published by the PRO were also consulted. Lastly, phone interviews were conducted with municipal employees responsible for waste management, civil servants from the provincial Environment Ministry, and three recyclers receiving e-waste collected by municipalities. The data gathering was largely conducted during the latter half of 2020. In the end, 52 questionnaires were completed by municipal employees, and ten email exchanges and eight interviews were conducted with various stakeholders, from across Québec. The anonymity of respondents was preserved, as required by our institution's Ethics Review Board.

5.4. Results and discussions

Before we discuss our findings, we briefly describe Québec's e-waste management regulation, which was adopted in 2011 (Québec, 2011). The regulation mandates manufacturers and/or first importers of electronic equipment to collect and process their end-of-life products either on their own (by brand), or collectively through a PRO. Most manufacturers chose to collectivize their collection and recycling under a PRO called ARPE-Québec. To meet its obligations under the regulation, ARPE-Québec must invest in awareness campaigns, set up collection points throughout the province, manage e-waste according to the 3R hierarchy (reduce, reuse, recycle), and meet collection performance targets. The scope of products was to be expanded gradually over time. The PRO collects environmental handling fees from consumers when they purchase equipment, with which it funds the collection of e-waste from municipalities and the other collection points, partnering retailers and charities, and research and awareness building. The fees also cover the sound recycling of materials by certified recyclers.

5.4.1 Main findings from the online questionnaire

Stakeholder familiarity with the program

We explored the level of municipal officers' familiarity with the official EPR program set up by the PRO (Table 5.5). Unsurprisingly, the municipal stakeholders that were unaware of or only somewhat familiar with the program were from cities with smaller populations. Only two of these had a population between 50,000 and 80,000; the rest, including the one municipality that was unaware of it had a population below 10,000. All the municipalities with larger populations knew the program well or very well. This raises interesting questions regarding the challenges of implementing circularity initiatives in smaller municipalities.

Table 5.5: Municipal officers' level of familiarity with the official EPR program

Statement	Number	Percentage
I know the ARPE-Québec program very well	22	42.3%
I know the ARPE-Québec program well	21	40.3%
I am somewhat familiar with the ARPE-Québec program	8	15.3%
I don't know the ARPE-Québec program	1	1.9%

E-Waste collection methods

Municipalities in Québec have no obligations regarding the method or frequency of e-waste collection. Table 5.6 shows that they use diverse methods to collect e-waste. A minority collect e-waste from the curb; also, a minority – including, surprisingly, some large municipalities -- do not have permanent eco-centers where households can bring their hazardous waste, including e-waste.

Table 5.6: Type of e-waste collection infrastructure or activities (multiple options possible)

Type of collection	Number	Percentage
Permanent eco-center	46	88.4%
Collection events	19	36.5%
Municipal services collect e-waste from curbside (on call)	6	11.5%
Municipal services collect e-waste when passing by (ad hoc)	4	7.6%
Our municipality works in collaboration with others to ensure collection (regional waste management authority)	7	13.4%
We have other means for collecting e-waste	7	13.4%

Drivers for collaborating with the PRO

The PRO has formal agreements with "about 200 municipalities" in Québec (confirmed by phone with a PRO representative). The majority of questionnaire respondents (40/52) confirmed that their municipalities had direct agreements with the PRO. Nine respondents claimed their municipalities had indirect agreements with the PRO, via their regional waste management agency. Three respondents mentioned they did not collaborate with the PRO, two of which were very small (populations less than 1000 people). Only one larger municipality whose respondent knew the program "very well" did not have an agreement with the PRO.

We hypothesized that the financial incentives paid by the PRO might be the main driver for collaboration by municipalities. In reality, we found that funding is important but not the primary driver. The perceived legitimacy of the program plays a major role in municipalities' participation (Table 5.7). Participants also commented that it was a "natural process" to work with the program, since they were already collecting e-waste. It appears that Québec's e-waste EPR program benefits from previously existing social capital -- identified as an important factor in successful e-waste EPR programs (Peng et al., 2018) -- including strong connections and shared objectives among municipalities and other actors.

Table 5.7: Criteria stated in support of a "direct" agreement with PRO (multiple choices possible)

Incentive	Number
Financial contributions (payment by the PRO)	27
Program efficiency (efficient collection)	24
Better risk management for the municipality (responsible downstream processing)	27
Because it is the official program recognized by the Québec government	36
Other reasons mentioned (open text)	4

Financial incentives for municipalities and perception of fairness

Of the 40 municipalities with direct agreements with the PRO, most (32) received funding. Three respondents confirmed that their municipalities did not have a financial agreement and five said they were unaware of this possibility, which raises troubling questions. It would be unfair for some municipalities to get funding for their collection and sorting activities, while others do not. The PRO, however, is not obliged to offer a compensation. The content of agreements is confidential and varies across municipalities, but typically covers (according to a municipal official who provided information over the phone) items such as the $/ton rate the PRO pays the municipality, the type of storage that must be provided for the materials, sorting requirements, and the frequency of PRO transportation services to collect e-waste.

The 32 respondents with a financial agreement with the PRO were prompted to describe whether this agreement was fair, adequate or beneficial in an open text box. While all respondents expressed some level of satisfaction with the agreement, their responses ranged from "It's better than nothing, because we used to have to pay for this" and "Yes, it is beneficial and equitable" to "It is a good arrangement, but the funds paid by the PRO could be higher, since they do not cover all of our expenses related to the collection, sorting, and storing of the e-waste". Six participants who had a financial arrangement felt that municipalities should be given more to cover their expenses related to e-waste collection and related paperwork. One of these participants said that the low financial incentives made it tempting to dismantle and sell the equipment for scrap instead of participating in the program. Two other participants made similar comments by mentioning the investments they had to make (investing in sheds, etc.) for storing e-waste securely, and expenses that were never refunded by the program. As one participant wrote: “It is hard to meet 100% of the PRO’s requirements. It takes a lot of space to store those very large televisions and keeping them away from the rain is difficult.” Conversely, two participants mentioned that their municipality would work with the PRO regardless of the funding. They viewed their contribution as a “moral obligation” and service to their community.

Other issues raised about the agreements

Participants identified other concerns related specifically to their agreements with the PRO. These pertained to: the extensiveness of the PRO’s audits, which seemed to overshoot the scope of the program; sudden changes in PRO expectations regarding the mandatory sorting of e-waste streams, going above what had been agreed; concerns about the PRO favouring recycling over reuse; and the lack of transparency about the agreements between the PRO and municipalities.

On this last point, one participant wrote: “We find that this is a lack of transparency and fairness, especially considering that this is an official program; there should be some kind of standard approach in the way the agreements are made with the municipalities.”

Finally, two participants made opposite claims; while one was very satisfied that the PRO worked with a local non-profit recycler, thereby maintaining local employment, another said that the PRO refused to honor their municipality’s long-term relationship with a local non-profit recycler, which had caused friction with the PRO. It would be interesting to find out why and under what circumstances PROs support local employment, or alternatively choose to send materials to be treated by bigger recyclers located near larger cities.

Tracking of e-waste flows collected by municipalities

When asked about the quantities of e-waste they collected, municipalities reported keen interest in this issue, with a majority tracking how much they collect annually (Table 5.8). We omitted to ask whether their quantification methods had changed over time. For example, had their monitoring improved since working with the PRO? Indeed, collaborating with a PRO appears to facilitate the monitoring of e-waste flows since the PRO can provide regular reports (Leclerc and Badami, 2022). Among the six participants in this study who said they lacked access to this data, one had a direct agreement, two had indirect agreements (via their inter-municipal organization), and three had no collaboration whatsoever with the PRO.

Table 5.8: E-waste flow quantification by municipalities

Statement regarding e-waste monitoring	Number	Percentage
We quantify/measure our e-waste flows and follow and compare from year to year.	32	61.5%
We have the data on file but we don't follow or compare data over time	6	11.5%
We don't have the data, but we could ask the PRO or other service providers to obtain it.	4	7.6%
We don't have this information and have no means to find it	6	11.5%
Other (only know from collection events, tracking done by boroughs, etc.)	4	5.7%

Fate of out-of-scope e-waste

Québec's e-waste regulation covered the following items at its launching in 2012: desktop computers, laptops, tablets, screens, e-readers, televisions, printers, scanners, fax machines, phones, pagers and peripherals. In 2013, the following items were added: video game consoles, memory drives, amplifiers, USB keys, speakers, GPS equipment, servers, graphics cards, cameras, and other equipment. Items such as small household appliances, tools, toys, electronic musical instruments, sensors, 3-D printers, and Christmas lights still fall outside the scope of the program. Ten municipalities reported sending these items along with the materials going to the PRO. Twenty-three said they sent them to another recycler. Ten did not know what happened to these items, three indicated that some of these items were being sent to landfill (as in other jurisdictions with limited product scopes (Islam and Huda, 2019)), and six mentioned that these were sent to a local non-profit for downstream processing.

Respondents' additional comments

The last questionnaire item prompted participants to express their desired changes or improvements to the EPR program. Twenty-eight responses were received; one participant revealed their identity and provided additional details telephonically.

Fifteen wished that the scope of products covered by the regulation be expanded to include other electronic products such as small household appliances. Six participants suggested improvements in the PRO's activities, including more frequent/regular pick-ups; changes in PRO employee attitudes during inspections; more generous financial incentives; and more exhaustive reporting regarding collection, reuse, recycling, and overall program performance. Two participants suggested that the program be more accessible. One suggested that collection bins be distributed in banks or grocery stores. Another proposed that the PRO fund small municipalities to help them set-up collection points (we were surprised that this was not the case already). Finally: one participant expressed disappointment in the lost opportunity for local employment in refurbishing: "Many citizens bringing their equipment think it will get repaired. They stick notes on them such as – *Just change the hard drive,* or *Still functional!*; they don't realize everything goes to recycling." This person added: "EPR is the way to fund the program, but we can decide, as a society, what this program is supposed to do with the equipment."

5.4.2 Perspectives from other sources

PRO perspectives

Interviews with PRO staff, as well as PRO reports and publications including memoirs to the government, highlight the important role of municipalities in the success of the EPR program. As mentioned previously, the e-waste collected by municipalities represent roughly half of that managed by the EPR program in Québec, despite some large municipalities not having permanent collection points.

These interviews confirmed that the success of this program largely rested on "a few hundred agreements" with municipalities. New agreements are continuously developed to get "closer to consumers." And while the PRO has asked the government multiple times to mandate municipalities to transfer all the e-waste they collect to the PRO, the organization's employees feel that municipalities are too diverse in terms of size and resources to effectively develop standardized agreements. Regarding the actual collection, sorting and storing of the e-waste by municipalities, the PRO confirmed that there were financial incentives for these activities, but details could not be shared. They also indicated that e-waste from municipalities is considerably more damaged and contaminated by out-of-scope products (and therefore less valuable) than that from collection points in retail stores, for example. Out of scope e-waste was usually accepted from municipalities (as a percentage of contamination) and sent to certified recyclers along with the rest of the e-waste, but there were no refunds for these materials, since no environmental handling fees were collected upfront for their treatment.

Recycler perspectives

The certified recyclers with whom we communicated indicated that, apart from contributing huge amounts of materials, the municipal e-waste flows were often sorted much better than the equipment coming from retail collection points.

Municipalities collected much larger and heavier items such as big screens, sorted and shrink-wrapped on pallets. They also collected older items, resulting from people "spring cleaning/moving/renovating". At the same time, the equipment coming from municipalities, though well sorted, is often dirtier than materials coming from retail collection points, confirming the PRO view.

The recyclers mentioned that many of the computers coming from municipalities had their most valuable components (central processing units and random access memory) removed, and few laptops were ever collected. Cherry picking of valuable components by the roadside, or in municipal facilities, could be possible explanations. For the PRO, curbside disposal of e-waste should be banned by municipalities, as this contributes to "system leakage" or the creation of informal e-waste flows (ARPE, 2016).

Municipal employee from a large city

According to our interviews, some municipalities ask their employees to report back if/when hazardous wastes are left by the curb, so that a dedicated team can collect these materials separately. In one municipality, a truck collects e-waste along with other hazardous wastes from the curb when personnel are available. However, because of the lack of resources, there are often delays in collecting e-waste from the curb, giving scrap collectors time to harvest the most valuable components of the equipment. One municipal manager thought that "in an ideal world, this would be a service delivered on call. There would be a much lower risk of damage done to the equipment if they weren't left by the side of the road until the city truck comes by." The issue of such delays was also identified as a problem in a Paris-Milan case study (Capurso, 2014). Another interesting finding concerned bigger municipalities. One employee provided details about the vast quantities of e-waste regularly collected, stocked, sorted and handed over to the PRO by his borough, for which it received no compensation from the PRO. Funding may have been provided by the PRO but the central administration of this large municipality may not have shared it with the borough. For this borough, the lack of resources to collect all the e-waste, the investment in a storing facility, and the lack of direct funding by the PRO means that little had changed since the EPR program was implemented, "except now we don't have to pay for the recycling, and the PRO does give us a few hundred dollars each year for communication purposes."

5.5 Key issues and policy implications

We now discuss, based on our findings, some key issues regarding municipalities' relationships with EPR programs for e-waste management, and policy implications for similar programs in other jurisdictions. These pertain to the drivers for collaboration; program coverage; local employment; and cost sharing and transparency. We also highlight the trade-offs and conflicts between the perspectives of municipalities, the PRO and other actors and how our findings align, or not, with the literature, which we reviewed in section 2.

5.5.1 Drivers for collaboration

Our research has documented Québec municipalities' willingness to cooperate with the PRO, despite not being mandated to do so. Although a few municipalities work with alternative downstream processors, especially local non-profits, to maintain local employment or supporting refurbishing, we found no municipalities which choose to collect e-waste to resell it or cherry-pick its components. Apart from the municipalities' commitments to environmental stewardship, the fact that the PRO was recognized by the provincial government, the convenience of regular pick-ups, and the financial incentives, were viewed as important drivers for collaboration. Under these circumstances, one may question the usefulness of mandating municipal collaboration, since this could negatively impact the negotiations between municipalities and the PRO. Following the polluter-pays principle, policy-makers need to ensure that the financial burden stays with the PRO if municipalities are mandated to do the bulk of the collection.

5.5.2 Program coverage and circularity

Our research yielded an interesting finding regarding legal and regulatory arrangements to support circularity and urban mining. While municipalities largely collaborate with the PRO, not all municipalities collect as much e-waste as they possibly could. At least one large municipality with more than 250,000 people did not have a permanent collection center for hazardous waste (including e-waste). Citizens in this municipality can only drop-off their e-waste at a PRO's collection point at a retail store, charity, on the curb, or during special collection events. We asked the PRO if they collected more e-waste from their collection points where municipalities do not have hazardous waste collection centers, and they confirmed this was not the case. This means that municipalities without permanent collection centers may be contributing to the leakage of e-waste to informal scrap collectors and/or resellers. From a policy perspective, this implies that circularity strategies should not only focus on municipalities handing over what they collect to PROs (by mandate, or otherwise) but should first and foremost require that municipalities, once they reach a certain population threshold, have the necessary infrastructure to collect hazardous waste, including e-waste. In Québec, such provisions would not be included in an EPR regulation, but rather in the Law on Municipalities and/or the Law on the Quality of the Environment. According to our research, only in cases where municipalities have high e-waste collection rates and where collaboration with PRO(s) is low, should policy-makers consider mandating handing over what they collect to the PROs. In other instances, investment in capacity building, awareness, and infrastructure may be more effective.

The PRO in Québec does respond to the frustration on the part of municipalities regarding the narrow scope of products covered by the regulation by accepting some portion of e-waste outside the scope of their program (as a percentage of "contamination"). However, there is no reporting about the types and quantities of such materials collected and treated by the PRO's mandated recyclers and the related financial arrangements. Material circularity would be best served by reviewing the scope of products covered and reducing the municipalities' burden to sort out the electronic products not covered by the program. At least one municipality mentioned the narrow scope as a justification for not working with the PRO and outsourcing the task of sorting to a local non-profit organization.

Policy-making for circularity should account for the burden associated with the compartmentalization of material flows. Ideally, sorting activities imposed on various stakeholders should reflect the type of downstream processing necessary for best material recovery and not the failure to update the regulation to include new categories. Sorting based on what is covered or not (as opposed to the type of treatment needed) may lead municipalities to consider other downstream options, especially if the refund provided by the PRO is deemed insufficient to cover the collection, storage and sorting effort. Improving/expanding the scope of the regulation, to include more e-waste categories would reduce municipalities' sorting burden and could drive, or consolidate, program uptake.

5.5.3 Local employment

Although municipal stakeholders were unable to quantify the employment opportunities generated by collecting and sorting e-waste, partly because they lacked sufficient staff for this purpose, some did mention their concern for this outcome. As noted earlier, a few municipalities indicated that the PRO's willingness to work with a local non-profit recycler or refurbisher influenced their cooperation with the PRO's program. There is a tension between the PRO's certification and selection of preferred downstream processors and municipalities' existing relationships with local non-profits which may or may not be recognized by the PRO as safe and responsible for this purpose.

This raises important questions for the design of EPR programs, and material circularity. If, as many proponents suggest (WRAP, 2015; ILO 2018, Shittu et al., 2021), the circular economy should contribute to socio-economic development as well as environmental protection and resource conservation, should the environmental handling fees collected by the PRO allow for the funding and maintenance of a diversity of service providers, including smaller, local recyclers which may not be as effective/efficient as larger recyclers? Should part of the funds be used for capacity building? In Québec, one of the PRO's objectives is to limit the program's costs and the environmental handling fees paid upfront by consumers. One may question whether this objective aligns well with circularity principles, health and safety, optimal material recovery, and fair employment opportunities across the province. The question as to "what expenses should EPR cover" is likely to be increasingly debated in multiple jurisdictions.

5.5.4 Cost sharing and Transparency

As noted, municipal stakeholders are divided regarding the PRO's financial contribution to their collection, storing and sorting activities. Some municipal stakeholders compare the PRO's contribution to the expenses incurred prior to the regulation which instituted the EPR program. From this perspective, municipalities are gaining, as they no longer have to pay for the removal of the e-waste they collect. Others view the contribution as "better than nothing", since many do not get any financial contribution from other EPR programs for paint containers, batteries, and lamps. Lastly, other municipal stakeholders take a more realistic view, by comparing the resources they invest in managing e-waste flows relative to the PRO's contribution, which is deemed insufficient in many cases.

Given the number of municipal stakeholders who perceive a net gain, or who would participate even without any funding, it is possible that the PRO benefits from municipal collaboration without adequate compensation for the true costs of collecting, sorting and storing e-waste. Ironically, the social capital in terms of existing networks of collaboration and shared understanding of the importance of effective e-waste management likely facilitates collaboration with the PRO and contributes to the success of the EPR program, while also reducing the need to rely on the polluter-pays principle, and financial incentives, to drive program uptake.

Unfortunately, because the financial agreements between the PRO and Québec's municipalities are confidential, it is impossible to determine how the compensation is calculated, if it varies according to the size of municipalities, the infrastructure they offer, or the sorting they carry out. One cannot assess if the PRO helps fund investments in additional infrastructure or redistributes resources to improve e-waste management in smaller municipalities. It is also not known if the PRO pays for other activities, such as collection points in retail stores and if and how this payment differs from the funding offered to municipalities.

Some municipal stakeholders seemed dissatisfied with this lack of transparency and suggested a more open process to clarify the program's objectives and funding structure, including the sharing of financial incentives in larger municipalities with boroughs.

This section has highlighted, based on our findings, the main issues regarding why and how municipalities in Québec contribute to the EPR program, despite not being mandated to do so. The majority of municipalities participating in this study fully collaborate (as per Section 2) with the EPR program. Most municipalities have permanent drop-off points, hold ad-hoc collection events, and some supplement their collection by picking up e-waste from the curb. But the collaboration goes beyond collection, and includes proper storage, and some sorting. Also, many municipalities go above and beyond the EPR program by collecting and sorting out of scope materials.

Overall, we cannot assess the extent to which the polluter-pays principle indeed applies nor the proportion of the costs that still fall on the municipalities in the absence of details regarding municipalities' expenses related to e-waste management, and the contractual agreements between municipalities and the PRO. While the costs of collecting, storing, sorting and recycling e-waste are passed on to consumers via the advance environmental handling fees (Lepawsky, 2012), the revenues from which are managed by the PRO and redistributed, in part, to municipalities, these funds are deemed by many to be insufficient to cover expenses, which means that municipalities in Québec still finance part of these activities from their own funds, including municipal taxes.

5.6. Conclusions and suggestions for further research

There is a gap in the literature regarding municipalities' actual perspectives and concerns on EPR programs; and what drives their participation in and their general satisfaction or dissatisfaction with them. This chapter aims to fill this gap by critically evaluating the role of municipalities in e-waste management in Québec, where EPR was implemented in 2011, but where collaboration with the official program is voluntary. Our research demonstrates that most municipalities in Québec seek to participate in these programs to limit pollution and promote a more circular economy, which conserves resources and energy, reduces emissions, and contributes to socio-economic objectives such as promoting local employment and access to technologies through reuse. As well, most municipalities view this as an improvement on their previous circumstances where they collected e-waste and had to pay for recycling. Some municipal stakeholders view the financial contribution as insufficient and suggest greater transparency, especially regarding the financial and logistical agreements with the PRO. Such transparency would help optimize the program and allow a better understanding of the extent to which the polluter-pays principle is respected. We show that some municipalities fail to adequately support sound e-waste management because they do not have permanent locations for collecting hazardous wastes, which poses a risk of system leakage, while others are tempted to work with recyclers outside the official EPR program because of its limited product scope and burdensome sorting, or the program's inconsistent approach to working with local non-profit recyclers. We uncover mechanisms affecting the extent to which the polluter-pays principle is actually implemented, and discuss the policy implications of our findings, including whether a mandate to oblige municipalities to collaborate with the PROs is useful or not. These findings are relevant for the planning of urban mining activities, and a better understanding of EPR as multilevel environmental governance systems contributing to the circular economy.

Although our research is comforting with regard to Québec municipalities' collaboration with the province's EPR program for e-waste management, the feedback from different municipalities hint at a number of issues which may also be relevant for many other jurisdictions around the world. Brunner (2011) suggested, early on, that urban mining would require a new knowledge base, and therefore much greater transparency about material flows. More recently, Shittu et al. (2021) proposed that e-waste management should contribute to circularity and to the UN Sustainable Development Goals. The WEEE Forum (2020), Europe's association of e-waste management PROs, are now exploring the idea of greater stakeholder input into the governance of e-waste schemes. As urban mining and circularity ambitions and policies are gaining momentum, our work highlights the necessity to revisit EPR program performance along multiple dimensions, and the significant value of continued empirical and comparative work in this field. To this end, we conclude by proposing some questions for further research.

- How do various EPR programs compare, along multiple dimensions?
- Which EPR programs are the most transparent and collaborative?
- Do the EPR programs that mandate municipal collaboration fare better in terms of social, economic and environmental criteria, and if so how?
- How are negotiations carried out between PROs and municipalities, where mandates exist, and are municipalities satisfied with such arrangements?
- Do mandates contribute to more transparency in e-waste flows?
- Are PROs more generous in delivering financial incentives where municipal collaboration is high, and does one lead to the other?
- How do EPR programs support local employment through refurbishing for reuse, and how is this objective reconciled (in various contexts) with PROs' interests in generating economies of scale?
- Can EPR programs be expected to deliver more ambitious results without additional regulatory measures?

Addressing these questions will hopefully help pave the way towards improved EPR programs and multilevel governance related to e-waste management.

Chapter 6. Informal e-waste flows in Montréal: Implications for Extended Producer Responsibility and Circularity

Chapter overview

The e-waste management literature has amply documented the existence of informal e-waste flows and informal e-waste management activities (collection, dismantling and recycling) in various contexts. E-waste often leaves OECD-member countries and is exported to non-OECD member countries, where it gets processed using ineffective or dangerous methods. The Global E-Waste Statistics Partnership has quantified, for many countries, the discrepancy between the quantity of electrical and electronic products put on the market, the quantities of e-waste arising, per country, on an annual basis, and what gets formally collected and recycled. For many OECD countries, only a small proportion of e-waste gets collected and recycled through formal programs. This provides an indication of the quantities of e-waste managed (collected and processed or resold) outside the formal programs. However, there are few actual characterizations of who is involved in managing these flows, nor why and how they operate, in the OECD context. I also could not find any such work in relation to the Canadian context.

In Chapter 3, I documented how Québec's provincial government did not mandate organizations, nor municipalities to return their e-waste, or the e-waste they collect, back to the official EPR program. The government also chose not to restrict who can collect or recycle e-waste. Through the work presented in Chapters 4 and 5, I found that some organizations and some municipalities do in fact give or sell their e-waste to individuals or businesses collecting and processing or reselling e-waste outside the program, leading to a range of different social and environmental outcomes.

In this chapter, I report on my field work and multiple stakeholder interviews aiming to discover what informal e-waste flows exist in Montréal, how they come about, who is involved, and how they affect the regulated EPR program's performance and outcomes. I have found a much more nuanced and complex situation than what the usual "formal" vs. "informal" dichotomy portrays. Formal and informal flows are often blurred, and change over time, and many actors are involved simultaneously in what would be considered formal and informal activities. Some actors inadvertently contribute to informal activities because of inadequate incentives, limited program scope, reuse activities, parts harvesting and documentation issues. This nuanced understanding helps identify program shortcomings, policy loopholes and possible strategies for more ambitious circularity objectives.

6.1. Introduction

Many governments establish regulated take-back programs for e-waste (used and end of life electrical and electronic equipment), making manufacturers responsible for the financial and/or logistical burdens of collecting and recycling their end-of-life products. Such Extended Producer Responsibility (EPR) policies and ensuing programs usually set collection and processing targets, and define various roles and responsibilities aimed at raising awareness, setting up collection points, and ensuring sound downstream processing, monitoring, and reporting (OECD, 2016). Their implementation can support a more circular economy (Ellen MacArthur Foundation 2018; European Commission, 2020) which is less wasteful, and whereby material loops are slowed, narrowed, and closed (Bocken et al. 2016), and value is retained (Thapa et al., 2022; Vermeulen et al., 2021).

Since the widespread adoption of EPR programs for managing e-waste, environmental agencies, international organizations, and researchers refer to e-waste material flows as being either "formal" or "informal" (Forti et al. 2020; Millington et al. 2022; Parajuly et al. 2019; UNEP 2007). Informal e-waste collection and treatment outside regulated EPR take-back programs are targeted as a threat to the circular economy (Magalini and Huisman, 2018; Québec, 2022b). This is because informal collection and recycling possibly lead to illegal e-waste exports to non-OECD countries (Interpol 2015; Kahhat and Williams, 2012; Thapa et al., 2022), increased landfilling of low value components (e.g., plastics), and sub-optimal recycling, accelerating the loss of precious or critical metals (Campbell-Johnston et al., 2023; Horta Arduin et al., 2019). The most accessible and valuable parts of e-waste such as copper cables, motherboards or hard drives may be cherry-picked with the rest being left for municipalities to manage (Hagelücken and Meskers, 2013; Magalini and Huisman, 2018). Official EPR programs claim that "informal" e-waste collection and recycling challenge their ability to meet their mandatory collection and recycling targets, burden their program with less valuable components, and threaten human health and the environment (ARPE 2016; WEEE Forum 2019).

The activities involved in, as well as the health and environmental impacts of, informal e-waste collection and processing have been well documented in Africa (Osibanjo and Nnorom, 2007; Thapa et al., 2022; Widmer et al., 2005), Asia (Chi et al. 2011; Honda et al., 2016; Streicher-Porte et al. 2005), and Latin America (De Oliveira et al. 2012), and globally (Heacock et al., 2016; ILO, 2014; Perkins et al., 2014). Meanwhile, there is little research investigating the informal collection and recycling of e-waste in OECD countries other than specific case studies in Mexico (Estrada-Ayub and Kahhat, 2014; Kahhat et al., 2022), and Israel (Davis and Garb, 2019).

European researchers (Baldé et al. 2022; Magalini and Huisman 2018) and consultants working on behalf of environmental protection agencies and take-back programs (OCAD3E, 2021) quantify the gap between the electrical and electronic products put on the market, and those collected and treated in compliance with the European WEEE Directive. They also identify the related impacts on material recovery and economic losses. However, very little research so far has exposed the range of actors involved in these activities in an OECD context, nor investigated their operations, motivations, and interactions; how and why their actions support (or not) a more circular economy; and how municipal authorities perceive and respond to these activities. Davis (2020: 102) writes that "strikingly little is known of these flows and actors", despite three-quarters of global e-waste flows moving through informal channels. Xavier et al. (2021) also point to the absence of such work in the Canadian context. We believe that a better understanding of the variety of actors involved in such activities, how they operate, and why, should help inform policy-making.

E-waste management has been regulated for 10 years in Québec and the Producer Responsibility Organization (PRO) managing the EPR program has communicated its inability to meet its collection targets because of "parallel networks" diverting e-waste from the program (ARPE 2016). Montréal is the largest city in Québec, with 4.1 million people in its metropolitan area (CMM, 2022). Our research seeks to investigate informal e-waste management activities in Québec, especially in the Montréal metropolitan area; uncover some of the related social and environmental impacts; understand different actors' choices and motivations; and how these activities affect policy outcomes and circularity objectives. We investigate the possibility that informal e-waste collection and recycling may be an indicator of public policy loopholes, and that instead of being targeted as nefarious, these activities could, under certain conditions, be harnessed and contribute positively to more sustainable urban material flows (Davis and Garb, 2015; Vermeulen et al., 2021; Williams et al., 2013). We discuss how choices made by households and organizations contribute to informal e-waste flows; propose a typology of local actors involved in e-waste management outside the formal program; and document how formal and informal e-waste flows often get blurred, posing a challenge to adequate reporting and environmental impact assessment. The next section presents a brief introduction to critical perspectives on EPR, approaches to defining informal flows, and a description of the Montréal context. The "Methodology" section presents our research questions and methods. The "Results – Montréal's informal e-waste flows unraveled" section presents our findings and contributions to understanding informal e-waste flows in an OECD context. The "Discussion and policy implications" section offers a discussion of the policy implications of our work. This is followed by the "Conclusions and proposals for further research" section.

6.2. Critical perspectives on EPR, informal e-waste flows and the Montréal context

EPR has been used around the world to facilitate the collection and treatment of diverse wastes such as packaging, used oils, tyres, and used or end-of-life electrical and electronic waste (e-waste) (Gupt and Sahay, 2015; Lifset et al., 2013). EPR policies are devised to relieve municipalities from the financial and/or logistical burden of managing certain wastes by shifting this responsibility back to the initial producers, or in some cases first importers of particular products, in compliance with the polluter-pays principle (OECD, 2016). Avoiding pollution, increasing waste diversion, limiting illegal exports, and recovering resources are some of the benefits expected from EPR (OECD, 2016). Another benefit expected of EPR is the creation of incentives for producers to engage in the manufacturing of products with improved lifecycles (Lifset et al. 2013; Walls, 2006).

EPR policies, or regulations, usually define collection and/or recycling targets for manufacturers and first importers, prescribe minimum conditions for program operations (quantity and/or location of drop-off points, type of processing expected, outreach campaigns, etc.), and assign roles and responsibilities to different actors, such as municipalities, retailers, producers or importers, recyclers, and sometimes also consumers (Kalimo et al., 2015; Leclerc and Badami, 2023).

The ensuing programs, often called take-back schemes, function with different funding mechanisms such as advanced recycling fees captured from consumers or purchasers at the time of product acquisition, which are either internalized in the price of the product or passed on directly to consumers, as in many Canadian provinces (Leclerc and Badami, 2020; Lepawsky, 2012;), or payments by producers (manufacturers and/or first importers) as a recycling fee paid after processing, such as in the Netherlands (Vermeulen et al., 2021), or in Maine (Maine, 2006).

While EPR is gradually being used to manage a wider variety of waste categories (European Commission, 2020; Québec, 2022a, b, c), experience and research in different contexts has led to more critical perspectives. These point to technical implementation challenges such as the difficulty of identifying and meeting adequate targets (Huisman et al., 2006), the difficulty of maintaining incentives for eco-design where manufacturers join a collective take-back program under a Producer Responsibility Organization (PRO) (Atasu and Subramanian, 2012), and unintended consequences, such as the favouring of recycling over reuse, accelerating material flows and resource consumption (Dalhammar et al., 2021), and the loss of critical raw materials because of inadequate collection and recycling or insufficient funding (Campbell-Johnston, 2023; Hagelücken and Meskers, 2013).

Other criticisms pertain to the redistributive impacts and spatial or political ramifications of EPR (Lepawsky, 2012; Pickren, 2014). Davis and Garb (2019) offer a detailed review of critical perspectives on EPR, and their research has led to a number of new articles questioning some of the underpinnings of EPR. Thapa et al., 2022 find that EPR lacks social and human dimensions because it excludes certain stakeholders, many of whom play a role in reuse activities and value retention. Vermeulen et al. (2021), based on a comprehensive stakeholder consultation, suggest major improvements to the functioning of EPR schemes in the Netherlands by proposing that the funding (shouldered by manufacturers) be separated from the governance of programs, which should be much more inclusive and democratic. The funding should also provide sufficient resources to support reuse and the activities of actors associated with value retention. Other critics of EPR mention the importance of aligning policy implementation with circularity objectives (Campbell-Johnston, 2021), greater transparency (Leclerc and Badami, 2023), equity, and a just transition (Thapa et al. 2022), as well as contributing to the UN Sustainable Development Goals (Shittu et al., 2021). This gives an indication that take back scheme performance may soon be assessed by researchers, if not by policy-makers, against multiple new dimensions (Campbell-Johnston et al., 2021; Vermeulen et al, 2021). The inclusion or collaboration with a wider range of stakeholders, including those currently associated with informal flows (including waste pickers and metal recyclers functioning outside formal schemes) is identified as a means of increasing EPR program performance while contributing to equity and social justice (Davis, 2020; Davis and Garb, 2015; Kahhat et al., 2022; Thapa et al., 2022; Williams et al., 2013).

Informal e-waste flows

The definition of what constitutes "informality" may vary by context, and by stakeholder (Eurostat 2014:124):

> "The informal sector manifests itself in different ways in different countries, different regions within the same country, and even different parts of the same city. It encompasses different kinds of activities, different types of enterprise, and different reasons for participating."

Indeed, e-waste management research presents informality from different perspectives and can either refer to it as a flow to be quantified and reckoned with (Habib et al., 2023; Parajuly et al., 2017), a series of collection and recycling activities generating negative health and environmental impacts (Forti et al., 2020; Huisman and Magalini, 2018), or as an economic sector made up of specific actors (waste pickers, scavengers) (Gomez-Maldonato et al., 2023) engaged in such activities. According to Magalini and Huisman (2018), only a third of electrical and electronic equipment sold in the EU was properly collected and processed as per the WEEE Directive, despite its ambitious targets, and its adoption over a decade earlier. They highlight the environmental risks (ineffective depollution, landfilling, exports), and the economic effects (lost revenues, but also savings, for take-back programs) associated with the scavenging of electronic products and components. Forti et al. (2018) quantify e-waste generated in a jurisdiction as the sum of what is collected in the formal take-back program (formal), what is treated through other recycling facilities unaffiliated with the formal program (other), what is sent to landfill (bin), and those quantities for which treatment is unknown (gap). Informal collection and treatment flows can therefore be classified either under “other” or “gap”. A detailed study in France including a survey of 6000 households and involvement of 120 stakeholders quantifies and differentiates between what is collected in the formal program, and other flows, broken down into: landfill, scrap metal recycling, exports of reusable items and unknown flows including illegal exports (Ecologic, 2021). Extensive household surveys are necessary to characterize the differences between these flows (Ecologic, 2021). Similar quantification exercises refer to “complementary flows” in the context of Denmark (Parajuly et al., 2017), as “leaks” or “alternative channels” in France (OCD3E, 2021), or “circular economy (CE) leakage” such as when used electronics are shipped from Europe to countries outside the OECD (Thapa et al., 2022). Horta Arduin et al.’s study about the recovery of critical raw materials in WEEE refer to “non-documented routes” and “complementary flows” and mention that such flows include “equipment reused, e-waste disposed in the municipal waste stream, as well as undocumented exports either as (illegal) waste or as reusable items” (Horta Arduin et. al., 2019; 4). A definitive consensus on what constitutes informal flows, informal activities, and informal actors is still lacking. This may reflect the diversity of actors involved in e-waste management in different contexts and cities. Also, the proper classification and quantification of flows outside the formal program may include a significant margin of error, because, for example, what is sent to landfill or exported may be overestimated and misrepresent items that are still kept in storage at home (hibernating stock) (OCAD3E, 2021).

Informal e-waste management activities (collecting, dismantling, cherry-picking, reselling outside the formal program) are recognized as dynamic flows changing rapidly and adapting to various legal or market circumstances (Forti et al. 2020). Scheinberg et al. (2016) mention the "clashes and conflicts" between informal recyclers and re-use operators, and official waste management systems. According to them, informal recyclers (1) challenge municipal services, by breaking items apart and leaving unwanted portions to be managed by official waste management organizations, thus complexifying municipal workers' tasks; (2) threaten social norms and labor protection by perpetuating poor working conditions; and (3) compete with official EPR programs by diverting materials.

There are few empirical accounts of informal e-waste management activities in the OECD context (Davis and Garb, 2019; Kahhat et al., 2022). As Davis explains, (2020:102) "This might be because of its invisibility to policy-makers or due to an unfounded sense that the informal sector will evaporate and be replaced by a newly established formal sector." Studies in France (OCAD3E, 2021), Denmark (Parajuly et al., 2017) and the Netherlands (Vermeulen et al., 2021) point to the importance of better understanding such activities and their potential, as a means to improve circularity strategies. Informal e-waste management activities can contribute to material circularity by salvaging resources which would otherwise be landfilled. Informal waste pickers support themselves and their families, manage large quantities of waste, keep them out of landfills, and even contribute to municipalities' waste diversion targets (Leclerc and Badami, 2023;

Scheinberg et al. 2016;). Many suggest that EPR program success could be supported by strategies to partner with informal actors in a way that preserves the livelihood of marginalized populations and reduces environmental harm (Davis, 2020; Thapa et al., 2022; Williams et al., 2013). The Global E-Waste Monitor recommends: "If an informal collection system exists, use it to collect e-waste, and ensure e-waste is sent to licensed recyclers through incentives" (Forti et al., 2020 :53). Davis and Garb (2015) propose a useful continuum to classify the various options, or approaches, governments or environmental protection agencies use to engage with informal e-waste recyclers. These approaches range from hostility towards informal recyclers, to synergy where formal and informal recyclers are meshed and collaborate. More empirical studies are needed to document which approaches could function with which actors, in an OECD context, especially since informal e-waste management activities may involve much more than informal recycling. An association of PROs has lobbied for adopting and enforcing collection, sorting and processing standards for all e-waste flows, to ensure a level playing field (WEEE Forum 2019), but this may not be realistic considering the variety of activities carried out by different actors involved in informal flows (Davis, 2020).

E-waste management in the Montréal context

Waste management in Canada falls under provincial jurisdictions. Québec, the province where the Montréal metropolitan area is located, adopted its EPR regulation in 2011 mandating manufacturers or first importers to manage their used or end-of-life e-waste products by setting up individual or collective schemes (Leclerc and Badami, 2020; Québec, 2011). Under this regulation, batteries, and mercury lamps were designated as separate e-waste categories requiring separate EPR programs. Large household appliances as well as air conditioning equipment were only added to the list of designated products as part of a regulatory revision in 2022 (Québec, 2022a, b, c). Because these three categories have their own separate programs, we considered them as "e-waste" in the context of this study, but refer to them as being "outside the scope" of the main EPR program we focused on, which is the one covering other electrical and electronic equipment. The program we focused on covers seven broad categories of equipment: computers, tablets and laptops; televisions and displays; printers, scanners, and photocopiers; telephones and answering machines; other portable IT equipment such as smartphones, digital cameras, emitting and receiving devices, and e-books; non portables such as projectors and video consoles; and peripherals and accessories such as keyboards, cables, routers, servers, external drives, etc. (Québec, 2011). Two telecommunications firms (Bell and Videotron) launched their own individual programs to recover the cell phones, routers, cables and chargers and other similar equipment they put on the market. All other manufacturers and first importers joined a single non-profit PRO called ARPE (Recyc-Québec, 2023).

Québec's EPR regulation sets specific requirements for manufacturers (or their PRO), including obligations pertaining to communications and outreach, the setting up of accessible collection points spread out across the province, investments in research and development, local processing following best practices, the respect of the 3R hierarchy (reduce, reuse, recycle), and increasingly stringent recovery targets based on quantities put on the market and product longevity. For example, and as part of the 2022 revision, the collection targets for computers and printers is 40% of the quantity of products put on the market (POM) 5 years before, and this percentage is "increased by 5% every 2 years until a 50% rate is attained, followed by a 5% increase every 3 years until a 65% rate is attained." (Québec, 2022a,b,c). Penalties for not meeting targets were replaced, in 2022, by an obligation to reinvest in the program and devise an improved recovery strategy. By 2020, ARPE had 1787 members, including manufacturers and retailers, and 979 collection points spread out across the province (ARPE, 2020), An annual estimate by the Global E-Waste Statistics Partnership (2019) suggests a wide gap between the e-waste generated (757 kt) and formally collected in Canada (101 kt), which means that only 13% of Canadian e-waste was managed within formal programs. The population of the Montréal metropolitan area is 4,1 million, representing 10,43% of the Canadian population (39,29 million). On a per capita basis, then, for 2019 we can estimate that approximately 80kt of e-waste was generated in Montréal. This however is based on UNU-KEYs, a list of 54 different e-waste products which represents a much broader scope of products than those currently targeted under Québec's EPR program (Baldé et al., 2015). Taking Québec's four e-waste programs together (electronic products, mercury lamps, cells and batteries, household appliances and air conditioners), these only cover 28 of the 54 product categories listed under the UNU- KEYs (Forti et al., 2020). Nonetheless, based on the ARPE's annual report for 2020, a total of 17,4 kt of e-waste (electronic products only) were collected for all of Québec, of which 755 tons were reused and 16,7kt were recycled. Montréal's population represents almost half of the province's population, so approximately 8,7 kt of e-waste was collected by the formal program in Montréal, in 2020.

The PRO does not disclose any information regarding what is put on the market so it is impossible to assess whether or not it meets its targets. The difficulty to obtain such data is a recurring theme, in e-waste management studies (Habib et al., 2023; Ongondo et al., 2011;). However, the Canadian PROs, including Québec's PRO for e-waste do report that they have difficulty meeting their targets because they are facing competition from informal flows (ARPE 2016; Basel Action Network 2018; Heacock et al. 2016). In Québec, the PRO, the Environment Ministry, and the Waste Diversion Agency overseeing the work of the PRO refer to informal flows as "informal networks" or "parallel networks" which implies the existence of organized networks of actors competing with the official program (MELCC, 2021; Québec 2022b). Since the regulation's publication in 2011, Québec has placed no obligations on households, organizations, or municipalities to hand over e-waste to the program, as is done in Switzerland, for example (Confédération Suisse, 2021; Leclerc and Badami, 2020). No one needs a permit to collect e-waste, sort or dismantle e-waste, though the environment ministry does require that recyclers storing and/or processing hazardous waste be registered and meet certain conditions and disclose certain information (material flows and destinations) upon request. The use of the term "recycler" as part of one's business activities is not restricted, so anyone engaged in collecting and reselling scrap metals (including e-waste) can advertise themselves as "recyclers" even if they are not involved in any processing, which causes some confusion. Governments interested in limiting human exposure to toxic materials should regulate who is allowed to register their business as "recyclers" and "refurbishers", to ensure they have adequate collection and storage facilities, and proper safeguards for employees dismantling and refurbishing equipment. This is important since workers dismantling e-waste ingest toxic particles even in formal settings (Nguyen et al., 2019).

Also, the PRO has been free to decide on what basis it would collaborate with other actors engaged in e-waste management and with which other entities it would share part of the environmental handling fees (eco-fees) as monetary incentives. The PRO in Québec has been sharing incentives with municipalities and selected recyclers, but no further details are available (Leclerc and Badami, 2023). No incentives are provided directly to e-waste generators (households and organizations). Private multi-waste haulers, recyclers and refurbishers wishing to provide services to the PRO and receive materials for processing, need to invest in adequate infrastructure to store, sort and/or recycle e-waste, and must go through a pre-qualification process (RQO, 2023), but pre-qualification does not ensure that the PRO will involve and hire these businesses. This creates uncertainty and a disincentive to join the program (according to our interviews with multi-waste haulers and recyclers). This aligns with findings that PROs in other contexts are not very favourable to the inclusion of other actors in take-back programs (Campbell-Johnston, 2021). The PRO leadership mentioned in an interview that about a hundred recyclers in Québec compete with the program (Guillemette, 2018), but this does not distinguish between those recyclers that take all possible scrap metal, as opposed to those that specialize in e-waste collection and processing.

As this chapter was being finalized, the Québec government adopted an amendment to its EPR regulation to ban any recovery of e-waste by organizations working outside the formal program (Québec, 2022a). The text reads: "No one may recover or reclaim a product covered by this Regulation or entrust to another the recovery and reclamation of such a product, otherwise than as part of a recovery and reclamation program developed pursuant to section 5." (Québec 2022). Assessing this amendment's usefulness, as a means to put an end to informal e-waste management in Québec was not part of our research because the amendment was adopted after this chapter was drafted, but our findings highlight some of the limitations of this approach. Previous research has criticized such bans because they are difficult to implement and enforce, they are generally detrimental to reuse and other value retention activities and have a negative impact on poor communities (Williams et al., 2013). Québec's new amendment was not informed by consulting with actors involved in e-waste management activities outside of the program (MELCC, 2021). The government has yet to provide any guidance or definitions for what would be considered as "recovery or reclamation", and whether this includes collection, dismantling, refurbishing, or even trading and reselling of e-waste. Depending on how it will be implemented, this recent amendment may contribute to further marginalizing and criminalizing the practices of various actors (Davis 2020; Millington et al., 2022; Thapa et al., 2022). Figure 6.1 illustrates the e-waste flows that one would expect to come about from implementing Québec's EPR regulation. The dotted lines represent reuse flows.

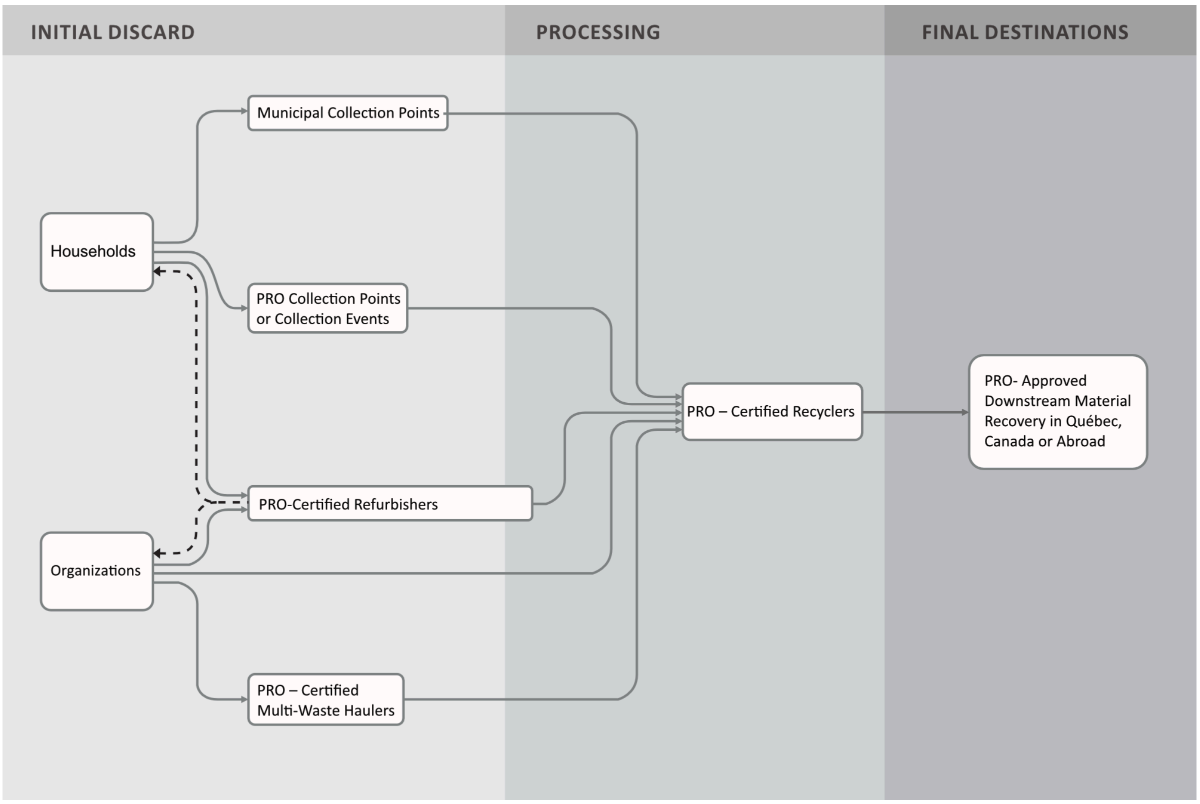

Figure 6.1: Vision of formal e-waste management under Québec's EPR program

6.3. Methodology

We used an exploratory case study approach to investigate informality in e-waste management in Montréal. "Exploratory case studies are used to help gain insight into the structure of a phenomenon in order to develop hypotheses, models, or theories" (Scholz and Tietje, 2002:4). Our work was also informed by Structural Agent Analysis, an approach for identifying, mapping, and understanding the behaviour of agents, as they shape material flows (Binder 2007). This approach complements economic and engineering perspectives on material flow analysis for designing better policy interventions.

Our research aimed to identify and investigate the activities of all possible types of actors operating outside the formal EPR program, and involved in collecting, sorting, storing, dismantling, and/or reselling e-waste, in metropolitan Montréal. This would enable investigating the claim that these informal operations function as a network competing with the formal EPR program, and help uncover the underlying causes of these activities, who benefits from them, and the repercussions for society and the environment. We investigated who is involved, how they operate, with what resources, what they do with materials, and why. Besides addressing these questions, we explored the perceptions and understanding on the part of informal actors of their own activities, and how they relate to, collaborate, or compete; as well as how municipalities and other actors involved in the formal program perceive and respond to those functioning outside of it.

The research was carried out over 2018-2022, and comprised the following components:

1. An in-depth search of websites and governmental registries to identify recyclers/refurbishers and other businesses involved in e-waste management.

2. Site visits and in person observations of scrap metal recyclers' facilities and operations, including the type/quantity of contents brought to them by households and informal collectors.

3. In person and phone interviews with actors involved in the collection and management of e-waste both inside and outside the regulated program.

4. An anonymous online questionnaire to elicit municipal employees' perspectives about informal e-waste management activities in their jurisdictions.

Table 6.1. (p. 163) shows the various sources and approaches used for information gathering.

Table 6.1: Information sources

Method	Number and description of sources
Online research	Search on Google and governmental business registry using the following keywords (in French): metal recycling, recycling, scrap metals, electronics recycling, metal collection, e-waste, electronics refurbishing, electronics resale, computer recycling.
On Site Visits	2 refurbishers participating in the program 1 multi-waste hauler participating in the program 5 scrap metal recycling operators not participating in the program, two of whom offered a detailed tour of their operations
Interviews	4 municipal employees 3 representatives from recyclers participating in the EPR program 2 PRO representatives 8 curb-side waste pickers and scrap metal collectors 1 multi-waste hauler (owner) participating in the program 1 multi-waste hauler (employee) not participating in the program 2 used IT brokers/resellers not participating in the program 3 scrap metal recyclers not participating in the program 3 owners of used IT collection/recycling/resale companies not participating in the program
Online Questionnaire Survey	52 municipal employees

Interviews were conducted with the stakeholders listed in Table 6.1, using a script specific to each actor's activities and relationship with the PRO. Interviews lasted from 15 minutes to 1 hour, depending on participants' willingness to collaborate. We asked questions on a wide range of issues related to their choices, decisions, motivations, and perspectives regarding their e-waste collection and processing. The questions relating to informal e-waste activities in the online questionnaire of municipal authorities aimed to elicit their awareness of and concerns regarding these activities. The anonymity of respondents was preserved, as per the requirement of our institution's Ethics Review Board.

6.4. Results – Montréal's informal e-waste flows unraveled

Figure 6.2 illustrates the actors and e-waste flows we observed and documented as part of this research. Again, the dotted lines represent local reuse activities. We excluded any detailed interactions with IT repair shops for lack of time and given that exploring their activities would require another research project.

This section describes our main findings as they pertain to:

- Actors directly contributing to informality
- Municipal representatives' perspectives on waste pickers and metal collection and processing outside the program
- Material trajectories crossing formality and informality

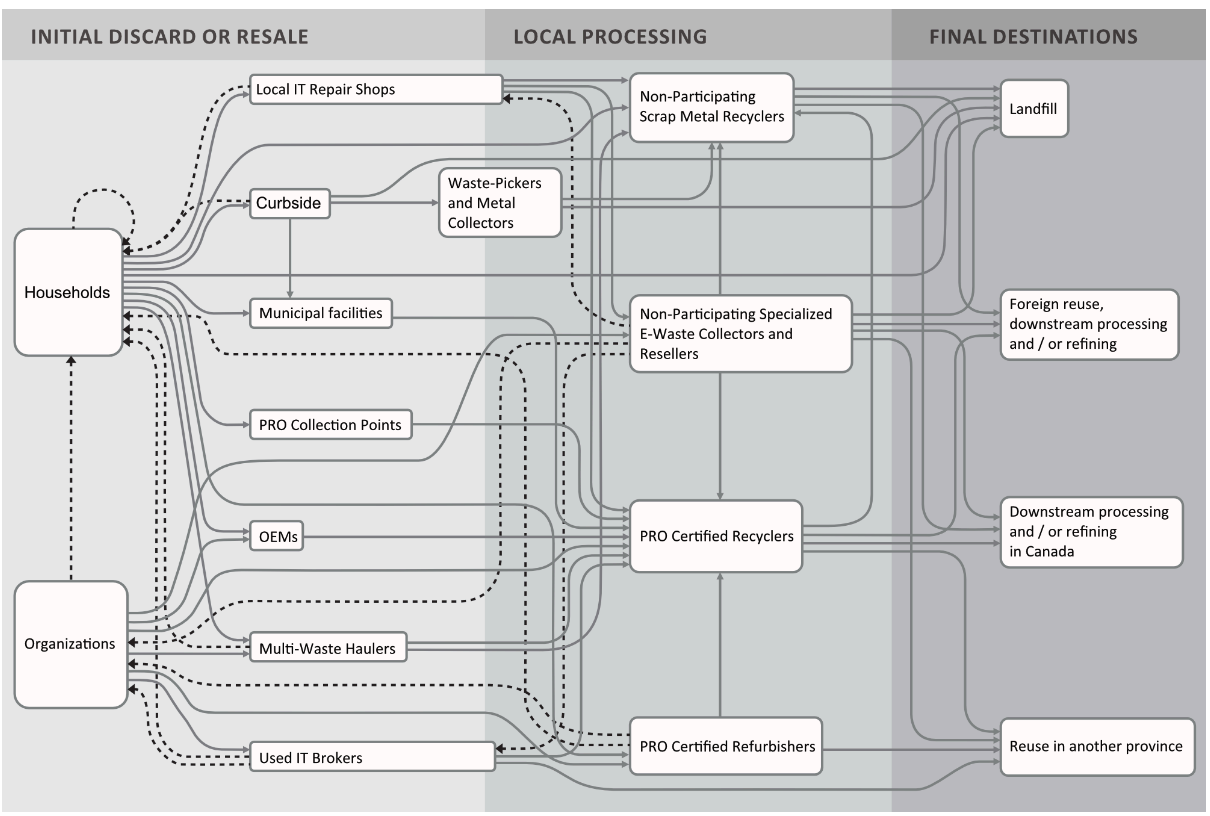

Figure 6.2: Actors and e-waste flows identified in this research

6.4.1 Types of actors directly contributing to "informality"

Many actors generate and manage informal e-waste flows in Montréal; the activities of each type of actor produce different social and environmental risks and benefits. We distinguish e-waste generators (households and businesses) from other actors who may collect, store, sort, dismantle, repair, trade or resell e-waste outside of the EPR program. The full list of actors we initially found could be associated with informal flows, outside of e-waste generators, is provided in table 6.2. (p.166). The table demonstrates the complexity that is lost when policy-makers and researchers focus on a simple "formal" versus "informal" dichotomy. We continue discussing the most important actors below, including e-waste generators.

E-waste generators (Households and Organizations)

The fate of e-waste flows, and the resulting economic, social, and environmental impacts, are determined by the materials' condition and initial source. We have found, as have Kahhat and Williams (2012), that it is choices made by households and organizations that determine, from the outset, whether e-waste will be gathered and processed through the regulated program, or not, though some material trajectories later shift and cross between informality and formality, depending on circumstances. Unfortunately, no data is available to confirm what proportion of e-waste comes respectively from these two sources, which would be useful to help understand related material flows, and especially reuse flows.

Table 6.2: Actors directly shaping informal e-waste flows in Montréal

Actors	Activities	Operations	Business model	Materials management	Social and environmental risks	Relationship to the PRO
Curbside Waste-Pickers	Curbside collection and materials harvesting Some manual dismantling and sorting (focus on quality / value) Rapid material turnover	Ad hoc activities, no regular clients Few resources involved (truck and basic tools) One or two people together No solicitation or communications with people getting rid of items	Sell components to local scrap metal recyclers Local operations May visit 2 or 3 different recyclers to avoid being targeted for income tax remittances	Harvest copper coils and wires, aluminum casings, electronic components and household appliances Basic dismantling, stripping copper cables	Release refrigerant gases Throw out unwanted materials in regular waste stream (landfill) Can harm themselves while dismantling Some burning of cables No capacity to store, accumulate or ship materials	No relationship to the PRO's program Profit from program shortcomings (out of scope items and large items people cannot bring back to collection points) Household appliances make up the bulk of electronics they collect and dismantle
Metal collectors	Collect all possible metals Pick up from curbside but mainly on call Do some sorting but little dismantling (focus on quantity) Quick material turnover	Minimally organized, with name and phone number on truck, business card but may or may not be registered business May have a few partners or employees Some recurring customers among construction and renovation companies	Sell components to scrap metal recyclers May get paid for demolition, collection, and transportation service Local or regional activities Show knowledge of varying prices and plan / choose recyclers accordingly	Some develop relationships with plumbers, window installation companies, garage mechanics Some may be recommended by scrap metal recyclers for collection services	May release refrigerant gases from appliances Landfilling of low value components No capacity or interest in storing, accumulating, and shipping materials Car parts and large household appliances are included in their collection activities	No relationship to the PRO's program Electronics represent a marginal portion of their metal collection

Table 6.2: (continued)

Actors	Activities	Operations	Business model	Materials management	Social and environmental risks	Relationship to the PRO
Multi-waste haulers	Collect all sorts of wastes from homes and businesses	Registered businesses, with advertisements, multiple trucks and employees. Some manage "in house" sorting stations for corporate clients	Paid for collection services and generate additional revenues from selling materials, where possible	Metals sorted from other wastes and sold to scrap metal recyclers Other high-value waste streams are sold also	Collecting and selling e-waste represent only a small fraction of their activities	Some PRO-affiliated companies return equipment intact to the program Non-participants dismantle or sell electronics locally outside of program
Used IT Brokers and Resellers	Buy and resell institutional or business IT equipment on the local market, mainly Focus on high value/ reusable office electronics No interest in end-of-life materials	Registered businesses. Cater to small and medium enterprises needing recent equipment at a discount price Many have public store-front activities	Purchase recently used equipment "fleets" and resell them in bulk or by unit Have a physical warehouse-type store Buy from auctions across Canada Don't solicit businesses and institutions for their equipment	Do minimal refurbishing, when needed Avoid older equipment needing work Generate little end-of-life components	Resell to local end users No dismantling	Some return equipment to the PRO, if they can't resell it on the local market Can get funding by the program if they can ensure traceability Because of trans-provincial brokering, they blur the data for reuse and recycling across provinces
Free agents	Employees or sub-contractors who divert more valuable compo-nents and resell them outside of usual business activities	Completely ad hoc Individual actors finding "higher value options" for used components and diverting them to other streams for their individual profit	Rogue activities but contributing, in many cases, to slowing material flows	Contribute to local reuse instead of recycling	Product lifecycles are extended on the local market as a result Low volume	Free agents may operate everywhere including among official subcontractors of the PRO's program Marginal activity but can divert value out of the program

Table 6.2: (continued)

Actors	Activities	Operations	Business model	Materials management	Social and environment al risks	Relationship to the PRO
Specialized e-waste collectors and resellers	Collect used and end-of-life electronics (mainly computers, servers, printers, and screens) Actively offer collection services (via phone-email or fax) to businesses and institutions	Registered businesses Own larger trucks Sometimes have transporta-tion sub-contractors in different cities, in Québec or across Canada Some have names and websites which resemble the formal regulated scheme, to look official Some have warehouses and dismantling workshops but no public access	Pick-up medium to large quantities of e-waste from businesses and institutions, usually for free Some impose minimum quantities for collection Some offer to redistribute a portion of reusable equipment to charities	Few (5 or 6) large players in Québec, some of which have obscure or misleading operations (multiple company names and websites with the same phone number) One has been found to export e-waste illegally to countries outside of OECD (BAN, 2018)	Some resell components to repair shops, but no store open to the public Some materials are resold to local scrap metal recyclers Logistic capabilities for exports. Confirmation of past exports to Asian markets and ongoing sales to USA Sorting and dismantling operations under the radar and plastics are landfilled Do not meet the same health and safety, data security, pollution control, and accountability standards as recyclers officially certified by the regulated take-back program	Compete directly with the PRO's program by targeting larger e-waste generators (businesses and institutions), and going after high volume transactions Sometimes return some equipment or materials to recyclers participating in the program

Table. 6.2: (continued)

Actors	Activities	Operations	Business model	Materials management	Social and environmental risks	Relationship to the PRO
Scrap Metal Recyclers	Buy all possible scrap metal (including e-waste)	Large, registered businesses with warehouses and varying levels of equipment and machinery to sort, remove gases and oils, shred, compact, and ship materials	Buy materials and resell to downstream processors (mainly refiners)	Manage industrial and construction scrap metals, industrial tailings, end of life appliances, vehicles, infrastructure components, and some electronics	Do not meet the same health and safety, data security, depollution, and accountability standards as recyclers officially certified by the regulated take-back program	Not recognized as official recyclers by the PRO, but can be recognized as official downstream processors (aggregators) for some e-waste material flows

Households

Households contribute directly to informal flows if they leave e-waste by the curb where it gets scavenged by waste pickers, or if they sell their e-waste directly to scrap metal recyclers. It is also difficult to distinguish between those two flows and what goes to landfill since waste pickers, metal collectors and scrap metal recyclers gathering e-waste from households send less valuable components to landfill (confirmed through interviews with representatives of each group). Municipal waste management programs in and around Montréal usually proscribe the landfilling of e-waste (CMM, 2016), but many items such as large displays, printers, and household appliances (vacuum cleaners, tools, fans, slow cookers) falling outside the program – recall the important number of product categories corresponding to UNU KEYs left out of scope of Québec's EPR regulation -- are often placed by the curb with the expectation that they will get picked up by municipal waste management services. These often get collected or cannibalized by waste pickers before the city crews find the items (confirmed by interview with municipal workers). The small size of some items (batteries and/or cell phones, USB keys, etc.) makes them likely to be disposed of in household garbage, as has been documented in other contexts (OCAD3E, 2021).

Some 76% of Québecers know the program (ARPE, 2020), but consumer behaviour studies would be needed to explain why households choose other downstream options. We carefully observed waste pickers collect and dismantle e-waste by the curb and deliver materials to scrap metal recyclers. Some households also accumulate materials until they have enough to sell to scrap metal recyclers. One scrap metal recycler mentioned that households accumulate scrap metals and come to sell them:

> "More and more households are sensitized to the importance of recycling. I now have roughly 15% of materials coming from households. These people don't collect scrap for a living. They come here with fancy cars. They don't purposefully bring electronics, but they may have a used desktop they bring along with an old aluminum window frame, an old garden chair, or other random items. Me taking their computer is just a service to these people, so they don't have to go drop things off elsewhere."

Households contribute to reuse (delaying e-waste arising), when they reuse items found by the curbside, resell items for reuse, or get items repaired or refurbished. They contribute to formal e-waste management by bringing items to official PRO collection points, to PRO refurbishers (some will take items from households), or to municipal facilities which return them to the PRO.

Organizations

Organizations play an important role in shaping Montréal e-waste flows because of the quantity of electronic equipment they purchase and use, and because many decommission equipment that is recent and valuable (as confirmed through interviews with resellers). Sometimes, when their equipment is still relatively recent, organizations sell their e-waste on the market, with brokers reselling it on local, national or foreign markets. Equipment sales destined outside Québec fail to be tracked and likely add to informal flows. Organizations' other contributions to informal flows come from donating or selling e-waste to multi-waste haulers, scrap metal recyclers, or specialized e-waste collectors and resellers who do not participate in the EPR program.

Organizations contribute to formal e-waste flows when they send their e-waste directly to PRO-certified refurbishers and recyclers. Also, some organizations sell or donate their used electronics to their employees, which contributes to reuse, delaying the time when the materials enter formal and informal e-waste streams (Leclerc and Badami, 2022).

Actors contributing to informal e-waste flows as "generalists"

Informal e-waste flows is usually associated with waste pickers and metal collectors, scrap metal recyclers, and private multi-waste haulers. We refer to them as generalists because, in the Montréal context, they do not focus exclusively on e-waste. They handle e-waste, but none of them seek to do this exclusively. E-waste represents only a small fraction of what they collect (as we observed from waste pickers' loads, visits at scrap metal recyclers' facilities, and interviews).

- **Waste pickers and metal collectors**

Waste pickers wander about the streets to collect all sorts of metals and will collect e-waste or scavenge their most valuable parts (copper cables, coils, motherboards, metal casings). As one interviewee reported: "I am having the best time ever! I have no boss to report to, I have my own schedule, and every day is like a treasure hunt. I am making hundreds of dollars each week, and I can be in my pajamas in front of the television at 3:00 p.m. relaxing and stripping cables (i.e. removing plastic from copper wires)." Another waste picker mentioned how he had engaged in burning piles of cables at an underpass and let the firefighters put out the fire before returning to recover the copper: "I don't know if other people do this. If I didn't know any better and if I lived way out in the country it could be tempting, because it is faster and gives you top-grade copper for reselling." Waste pickers' collection routes depend on proximity to their homes and recyclers (to sell their loads to), and perceptions about "better, more lucrative areas". Our study aligns with other research showing that disadvantaged individuals are overrepresented among waste pickers (ILO 2014). One older waste picker told us: "this is what my father taught me to do, and I don't know what else I could do," while dismantling an AC unit outside a recycler's facilities. A waste picker turned metal collector mentioned that "all these guys are on welfare and do this on the side. They don't want to get caught making money. It's risky because the scrap metal recyclers to whom they sell the load may keep track of them. Some large recyclers are strict and take a copy of your driver's permit when you sell metals to them."

Metal collectors also sell metals to scrap metal recyclers, but they have regular clients. As one man explained: "Waste-picking is entry-level. If you are smart and you really want to make money, then you get a nicer truck, you get business cards and get regular clients such as construction businesses that generate lots of metal scrap, and then they just call you up, so you don't have to wander around." Another metal collector described his "progress" in the business: "Now I make lots more money picking up scrap from small construction and renovation projects. If I run into cables and other random electronics, I just give those to my cousin. He still has time to strip cables. I used to gather scrap metal in my basement and strip cables, but I don't do that anymore."

Waste pickers and metal collectors have the same downstream outlet (scrap metal recyclers) but we distinguish their activities because the risks of waste-picking, which involves dismantling, are more important than those associated with collecting, transporting, and reselling metals, including e-waste which has been left intact. This is also an indication that, given the right incentives, these actors could possibly bring back intact e-waste items to the metal recyclers or to the PRO and forego the difference in revenues generated by dismantling items at home, especially since these items already represent only a fraction of the items they collect, which includes bed frames, vehicle parts, barbecue carcasses, window frames, AC units, used bicycles, and so on. From our observations, we estimated that e-waste items falling within the scope of the regulation represented less than 5% of their loads (as seen in the back of their vehicles), while another 10-15% represent items falling in the other e-waste categories identified by UNU-KEYs (household appliances, tools, luminaires, toys, ventilators).

Per individual, waste pickers and metal collectors have a very small impact on the amount of e-waste which fails to be recovered by the formal take-back program, but the number of people engaged in such activities can lead to a significant e-waste flow (~ 5% of all the materials processed by scrap metal recyclers, according to our interviews). The main environmental risks associated with their activities are due to not capturing gases, leaving toxic components (such as broken leaded glass) by the roadside, and the landfilling of contaminated plastics and other low value components. Given their limited resources, waste pickers and metal collectors do not accumulate materials and ship them abroad. However, by salvaging components from the curb, they are also recovering valuable metals from items outside the scope of the formal program, so their overall environmental impact is unclear. So long as households deposit items by the curbside, waste pickers will be attracted to them. Creating incentives for waste pickers to return whole equipment to the formal program should be considered as a policy option and/or factored in the PRO's cost structure, as suggested in other contexts (Davis and Garb, 2015; Forti et al., 2020; Vermeulen et al., 2021).

- **Multi-waste haulers**

Multi-waste haulers are paid for the removal of all kinds of waste. They collect furniture and random commercial wastes such as used tools, protective equipment, wooden pallets, used fire extinguishers, or items to be removed before demolition and construction. They sometimes manage e-waste which may or may not fall in scope of the program. Some multi-waste haulers participate in the formal EPR program, but most do not, because of the costs and barriers to entry into the program (the need for storage space, obtaining certifications, etc.). Multi-waste haulers who are not participating in the PRO's program resell reusable items or bring e-waste to scrap metal recyclers.

- **Scrap metal recyclers**

There are approximately 12 large scrap metal recyclers in the Montréal area, roughly two-thirds of which are affiliated with the same firm. These recyclers have large infrastructures for storing, sorting, shredding, compacting, and shipping metals. Three of them agreed to be interviewed; two offered a tour of their facilities, and one shared governmental audit questions. We observed these operations sort, pile, compact, and ship whole container loads of scrap aluminum, steel, iron, and other metals, from diverse sources including households, industries, and roadwork crews. E-waste represented a small fraction of their material throughput. "E-waste makes up about 5% of the materials that come here, excluding large household appliances" said one recycler, and this was confirmed by another. Two recyclers admitted to asking their staff to dismantle computers and remove the motherboards, typically when things slow down in the winter. In a follow-up call a few years later, one of the scrap metal recyclers said they had stopped dismantling because it was not worthwhile. "We just sell the stuff directly to another downstream recycler for dismantling, shredding, consolidating and shipping to a refiner."

These scrap metal recyclers are not collection points for, nor do they generally work with, the PRO. They only had a few pallets of e-waste while we visited, but these contribute to material flows outside the official program. We wondered why these scrap metal recyclers were not part of the program. Two of them said they had never been approached by the PRO. One had contacted the PRO to enquire if they could work together; however: "They were going to ask me to invest in a sheltered and secure space they could inspect at any time. The cost would be roughly CAD 10-12,000 to build the shed, but they weren't offering any compensation in exchange. Also, there would be lots of paperwork. It's just not worth it." The PRO may not be interested in the e-waste collected by the scrap metal recyclers, because its origin is unknown; it is old; and/or it is likely to have valuable parts removed, and therefore be less financially attractive for its certified recyclers. Including scrap metal recyclers in the formal program would involve additional costs and require incentives for waste pickers to return intact equipment. The PRO may not be interested in covering expenses for access to greater material flows. This echoes findings in Europe: "The pressure from the EEE (Electrical and Electronic Equipment) industry to reduce or keep costs down easily aid some of the undesired market forces, that are creating economic and social losses" (Magalini and Huisman 2018:11).

Scrap metal recyclers still have to report how they stock and manage e-waste if the Provincial Ministry of Environment requests this information. Québec's law on the environment allows the Ministry to audit anyone who manages Hazardous Domestic Waste (RLRQ, q-2, Art. 70.5), and one of the scrap metal recyclers shared the audit questions with us. They had to provide all details of the transactions (bills and destinations) for all the e-waste collected and resold in a given year. The Ministry could technically compile this information to compute the proportion of e-waste managed through this informal flow, but we could not confirm that this is done.

Actors contributing to informal e-waste flows as "specialists"

This category of actors includes five or six specialized e-waste collectors and an equal number of used IT resellers / brokers. These actors have warehouses and large trucks, or subcontracted transport companies working for them, and they operate mainly in the business-to-business sector.

- **Used IT brokers and resellers**

Brokers or resellers purchase and resell used IT equipment fleets, mainly large quantities of desktops, laptops, screens and servers. They buy them from auction sites and resell to organizations. They do not solicit businesses and institutions for their used electronics. They engage in very little repairs or refurbishing (they may occasionally add memory to some equipment, for example), but they focus on securing recent equipment destined to reuse markets. Some have storefront activities at their warehouses where they sell to individuals, but mainly to small and medium size firms (confirmed from site visits and interviews). Their activities pose few health and environmental risks because they do not engage in dismantling or disposal, but their activities span across provinces, which blurs e-waste traceability for EPR programs. According to our interviews, these businesses are not interested in dismantling equipment or exporting any material outside Canada.

The relationship between brokers and resellers and the PRO is ambiguous. Technically, the PRO is not interested in collecting the e-waste they generate, because it is of mixed origin (across provinces) and cannot be treated using eco-fees gathered in Québec – confirmed by phone interview with the PRO -- but we observed that at least one such reseller had bins identified with the PRO's logo on their premises, and the manager on site confirmed that they did send some materials to them. A journalist also documented a similar flow of e-waste from brokers to the PRO (Guillemette, 2018). The funneling of these businesses' end-of-life equipment and components back to the program would be an improvement. Ultimately, brokers and resellers exist because organizations change their equipment frequently. The development of leasing or buyback programs by OEMs would keep this flow "visible" and reduce inter-provincial flows.

- **Specialized e-waste collectors and resellers**

This small group of businesses manage important quantities of e-waste outside the formal program. They market themselves as "recyclers" and sometimes use deceptive or underhand methods to solicit donations of large quantities of used or end-of-life equipment from organizations. Some have names resembling that of the PRO, while others refer to the official take-back program on their website, as if they participate in it, and to redirect pick-up requests from households, but without collaborating with the program. These actors are difficult to reach and less likely to agree to interviews. One of these e-waste collectors was found to be exporting e-waste to non-OECD countries (BAN, 2018).

These are direct competitors to the formal take-back program, with some having operations across Canada. Some have the logistical capacity to capture important material flows, and the resources and expertise to dismantle and sell components locally and abroad. "We don't sell much outside of Canada and the US.", said one of these actors. "But for a little while we did export LCD screens to China because they wanted to recover indium. We don't do that anymore, there is plenty of opportunity to sell e-waste in Canada and the US. Just check online, you can sell capacitors, motherboards, cables, everything." The three people we spoke to among this category of actors said they could not find a market for plastics, so they sent them to landfill.

One of these operators presented itself as a "charitable" organization. Although its name and website made it sound like a recycling business, it only collected e-waste from other businesses and institutions, resold what it could (in Canada, according to the interviewee), gave some used equipment to charities, and sent the rest to other recyclers. There is confusion regarding the downstream activities of these companies, and it is unclear whether they return equipment to recyclers affiliated with the formal take-back program. PRO-certified recyclers talk of these businesses as having unlawful activities, including possibly exporting e-waste to non-OECD countries. Conversely, at least one specialized e-waste collector and reseller claimed to be returning a part of their e-waste to the formal e-waste stream by selling it to recyclers affiliated with the official program. One representative even claimed that they were "in the midst of getting the certification join the official take-back program", but this did not happen, even after three years.

This small group of actors seemed heterogeneous in their values, operations, and strategies. One owner was readily available to answer our questions and explain their work. Their business had been established before the PRO's program was launched and had long standing partnerships with major organizations (school boards, multinational companies, hospitals, municipalities, etc.). They said, "My business's reputation is very important, and all our operations are clean. We deal with serious companies and would never risk exporting materials to developing countries. It is just not worth it." They confirmed that they were regularly solicited by businesses in China, Pakistan and Africa to ship e-waste, but would not do so. They had a small team doing manual sorting and dismantling. "We sell in Canada, and only sometimes in the US, to those who will offer the most. I wish I could sell directly to refiners, but sometimes I just can't get a big enough load. They want a full container, and I usually have a few pallets worth of some type of material, so I have to work with another recycler as a middleman who will consolidate a bigger load."

Another interviewee added: "Sometimes we sell perfectly reusable equipment, and sometimes we break things apart." They said they were shocked that publicly funded institutions gave them very recent, top of the line computers, simply because they change every two or three years. As a taxpayer, it made them upset, but they were happy to make a profit from picking up computers, wiping their hard drives, providing data destruction certificates, and reselling them. When asked about the PRO's program, they said they knew it well but would not work with it because: "It would be too constraining and way too much paperwork. Besides, there is room for a diversity of actors, and we play an important role by supporting reuse. We sell the spare parts to small IT repair shops. I don't think we could do that if we worked with the PRO."

When asked about the specialized e-waste collectors, one PRO-certified recycler expressed their frustration: "Did you know that this school board decided to give all their equipment to the company that was caught exporting material illegally to Africa? It was in the news! How could they even consider working with them?" Our finding that large organizations and public institutions may hand over their e-waste to businesses working outside the formal take-back program contradicts the assumption (Hagelücken and Meskers, 2013) that institutional IT equipment in "industrial countries" are more likely to be properly tracked, documented, managed in closed loops, and returned to manufacturers.

According to one specialized e-waste collector working outside the program "There are only about five of us who do this seriously outside the PRO's official program." We also confirmed this from our research. Nonetheless, the existence of major brokers and resellers, and specialized e-waste collectors and resellers demonstrates the glut of used and reusable equipment in Québec. Informal reuse and recycling flows seem to result from the OEMs' success in selling and replacing functional equipment at an accelerated pace.

6.4.2 Municipal representatives' perspectives on informal e-waste management

We reached out to municipal civil servants and elected officials responsible for waste management in Québec to elicit their views regarding the activities of waste pickers and metal collectors on their territories. Of 52 respondents to our online questionnaire, 21 said that waste pickers and scrap metal collectors offer a public service by helping recycle metals. Nine even said waste pickers contribute to environmental protection. One municipal stakeholder wrote: "Scavengers take care of things that are left outside of the official program." Some are concerned that it is unclear what they do with some of the materials they collect, "but at least they divert things from the landfill". A majority (35 out of 52 respondents) said that they would appreciate waste pickers' activities being better organized, monitored and regulated, for health, safety and environmental purposes. Only seven respondents viewed waste pickers and metal collectors as competitors of the PRO and municipal waste management. The perception that waste pickers' and metal collectors' activities are largely complementary to the formal take-back program does not align with the "conflicts and clashes" identified by Scheinberg et al. (2016) in Europe. This different perspective may reflect the limited scope of products designated under Québec's regulation, and the significant contribution of waste pickers and metal collectors in salvaging valuable metal flows coming from other e-waste categories.

6.4.3 Material trajectories crossing "formality" and "informality"

We came across unexpected cases which challenge the usual dichotomy between formal and informal flows. First, some households can bring their e-waste to the original equipment manufacturer (OEM) if it has a physical store which takes back its equipment, or they can return it to the manufacturer by mail. While contributing to circularity in the spirit of Individual Producer Responsibility (IPR) (Atasu et al., 2010), this flow is often informal because it cannot be reported in Québec's EPR program. To generate economies of scale, manufacturers usually consolidate all their e-waste in a few larger cities and then transfer everything to one PRO-certified recycler. The recycler may be in Montréal, but because one cannot trace back the ownership of the material to households or organizations from Québec only, the material is recycled according to best practice but is undocumented as part of the program. In-scope products of mixed origin can make up at least 3% of all e-waste at a PRO-certified recycler's facility, according to one interviewee. This scenario does not apply to OEMs only. Any organization which is susceptible of consolidating its e-waste from multiple provinces, and processing it in Montréal, may inadvertently generate informal flows since the recycler cannot register the waste and receive program funding when e-waste is of mixed origin. In such cases, the treatment is "formal", the recycling follows best practices, but the flow is considered "informal". According to one recycler, the PRO may even verify that the e-waste quantities generated by organizations and declared as part of the program is aligned with the size of their operations in Québec.

Other scenarios also occur. A scrap metal recycler which was not an EPR program participant, served as an approved downstream processor (or consolidator) who gathered materials from PRO-certified recyclers, to reach sufficient quantities for shipping to a refiner. This means that scrap metal recyclers suspected of contributing to informal flows (and exports) partner with the PRO in the official program for consolidating and shipping some materials. Therefore, if a waste picker separates aluminum casings from electronics left by the curbside, and brings them to a scrap metal recycler, the aluminum may well end up mixed with aluminum from the formal take-back program. Part of this flow will be formal, and accounted for, and the other part will be informal.

Also, some repair shops do accumulate e-waste and send it for recycling under the PRO's program, as explained by recyclers participating in the program. However, they need to demonstrate that the equipment (whole items) come from Québec and are therefore eligible for free recycling under the program. According to one recycler: "Some mom and pop shops do this, especially if they have the space to accumulate sufficient quantities, but most do not. They usually sell their stuff to scrap metal recyclers or other specialized e-waste collectors outside the program".

Thus, there is no water-tight separation between formal and informal flows, and this distinction is blurred in multiple ways along material value chains. Taken together, these scenarios indicate that formality or informality may not fit, as an adjective to be applied to actors. Formality and informality may be an emergent property of material flows (as dynamic systems), or even a rhetorical tool used by the PRO to keep other actors from partnering in the program.

The informality "domain"

Quantifying and comparing the relative importance of "formal" and "informal" flows was impossible because of the lack of reliable data. However, our research allows us to clarify what should be captured and measured in future quantitative assessments of informality in the context of Montréal. We show what lies behind the "formal" versus "informal" dichotomy in Figure 6.3, with the boxes in the dashed perimeter providing a comprehensive picture of informal flows. Informality is not merely the difference between the quantity of in scope e-waste which arises, and the quantity of that e-waste that is collected and processed by the formal program. We suggest sorting out other e-waste flows for a more realistic portrait of what is informal, as has been suggested by Forti et al. (2020) and attempted in France through household interviews (Ecologic, 2021). For instance, one should distinguish between e-waste that is in scope but still hibernating; sent to landfill (by households, for example); being reused elsewhere in Canada; in scope and properly managed by participating recyclers but excluded because it lacks a paper trail (estimated at 3-5% by a large PRO-certified recycler) or has missing parts. Items which do not make their way into the formal program are not necessarily mismanaged or exported, though that is also possible. Mapping this out against all the potential e-waste arising in Montréal, i.e. taking account of all 54 categories identified by UN-KEYs allows us to better understand the role of waste pickers and scrap metal recyclers in diverting many categories of e-waste from landfill, and not merely collecting and recycling in-scope e-waste.

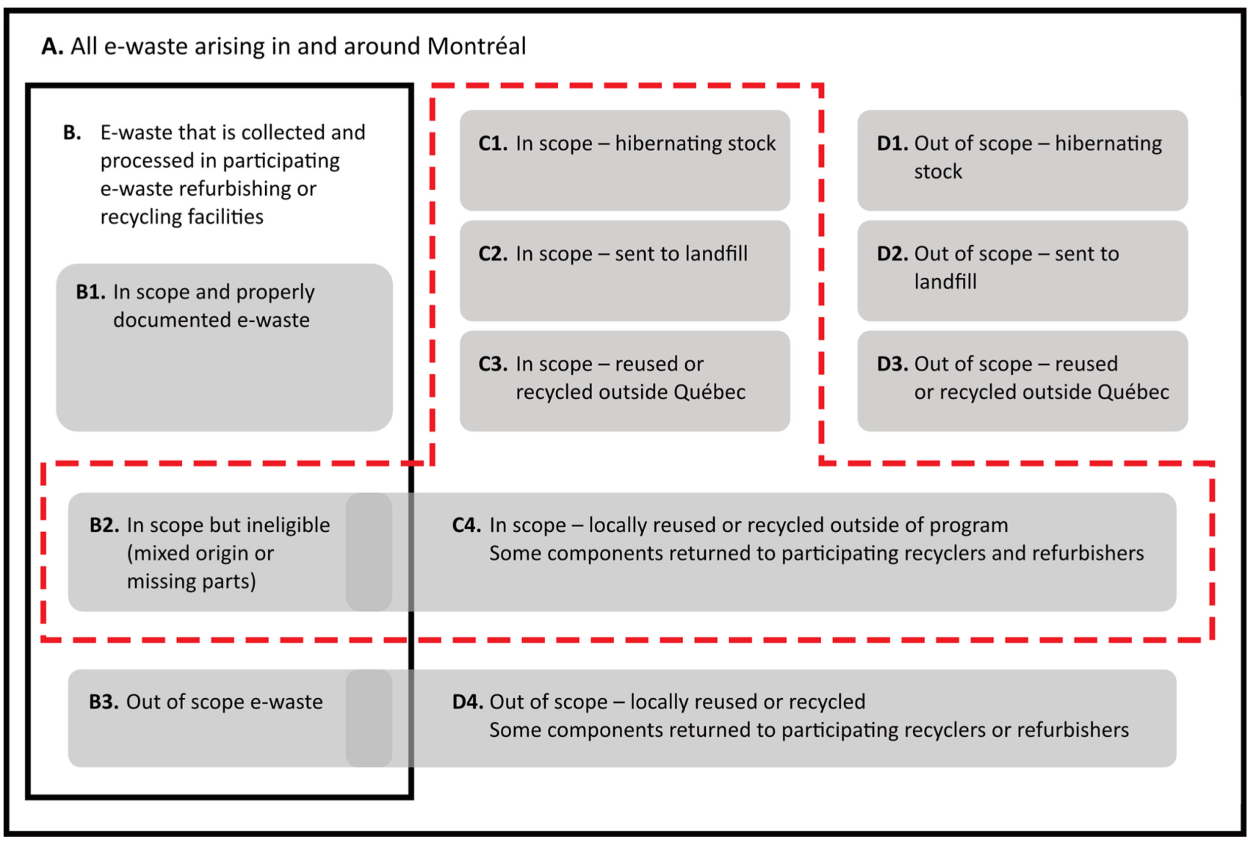

Figure 6.3: Map of informal "domain" within all e-waste flows in and around Montréal

Our research shows that indiscriminately targeting the operations of actors involved in informal flows, as envisaged by Québec's recently announced ban on the recovery of e-waste outside the formal program, may not be practical, nor generate positive outcomes, without careful planning and operationalization. To be effective, this policy would have to distinguish between flows resulting from reuse and flows of materials destined for dismantling and recycling. It would also have to account for the contributions of generators (households and organizations) to informal flows, including flows from public institutions.

6.5. Discussion and policy implications

Whereas informal flows are characterized by the PRO and their overseeing agencies in a way that implies an organized network of actors competing with the official take-back program, we have identified diffuse material flow trajectories constituted by transactions involving many types of actors, none of whom collaborate in structured or permanent "networks". Also, our research reveals a nuanced situation, with no water-tight separation between "formal" and "informal" flows. As in other contexts, formal and informal flows are often blurred in several ways (Kahhat et al. 2022), material flow trajectories change over time, and many actors are involved in both formal and informal activities. Such an in-depth and nuanced understanding of local e-waste flows is essential for effectively documenting and transforming such flows through sensible policy-making.

We highlight how "informal" flows result from many different activities, not just rogue dismantling and exports. Some materials go through formal collection and proper downstream treatment but cannot be documented to meet the PRO's requirements; large quantities of reusable equipment enter the market and are managed through resale in and outside Québec but cannot be tracked; and in-scope and out of scope items or components are intermingled. For this reason, and also because of the lack of publicly available data regarding what is put on the market, by product category, it is difficult to estimate the materials treated outside the official take-back program.

Informal flows are an indicator of, among other things, rapid equipment turnover by various organizations. If turnover rates were slower, the e-waste would not be as valuable and lucrative to resell, and perhaps more likely to be redirected to the PRO and its affiliated recyclers and refurbishers.

Our work hints at the PRO's lack of interest in providing different actors proper incentives for them to return complete, or intact, items. What constitutes informality, is also driven by the PRO's perspective of which organizations or actors it agrees to collaborate with, and what flows it wishes to control, and recognize, or not. E-waste from the curb is accepted in the program if it has been collected by city crews, but not by waste pickers. E-waste coming from bins placed at retailers, without any proof that the equipment comes from Québec, is accepted, but similar equipment coming from IT repair shops would need to meet additional conditions to be accepted in the program. And finally, the PRO does not recognize scrap metal recyclers as partners for the collection of e-waste but identifies them as partners for downstream processing and the accumulation of sufficient quantities for shipping to refiners. This aligns with Lepawsky's conclusion that EPR programs have significant redistributive impacts because they decide who should be compensated for e-waste management activities (Lepaswsky, 2012), as well as Davis and Garb's (2019) argument to the effect that EPR programs reshape material flows and legal-economic structures.

Our analysis shows that informality also stems from decisions made by households and organizations, and various actors involved in managing e-waste outside the formal program, and that understanding the motivations underlying their decisions in this regard could help tailor more effective policies. Mandating publicly funded organizations to hand over their e-waste to refurbishers and recyclers partnering in the program could dramatically reduce the e-waste managed outside the formal program. Also, enlarging the scope of products covered under the regulation could reduce confusion among households, reduce the risk of landfilling, and facilitate program uptake (Kumar and Holuszko, 2016).

We found that many waste-pickers and metal collectors in Montréal manage small amounts of e-waste outside the formal take-back program, with the material they collect being consolidated by few players for whom this material flow remains marginal. Conversely, only a handful of large businesses, with the capacity to collect, dismantle, resell, and ship materials, manage more substantial e-waste flows outside the program. While some actors may export materials unlawfully, we also found that some support greater circularity, by making useful components available for local refurbishment and repair. Some of these actors contribute to retaining value, by slowing, narrowing, and closing resource loops (Bocken et al., 2016; Thapa et al., 2022).

Unfortunately, our interviewees, including scrap metal recyclers and specialized e-waste collectors and resellers confirmed that they were never contacted by the PRO nor the waste diversion agency to understand their operations and potential contributions toward program improvement. According to Davis and Garb's typology of approaches to managing informality, the Québec government's approach has been either "hostile" to or "disconnected" from other actors collecting, transporting and processing e-waste outside of the program (Davis and Garb, 2015). In other jurisdictions, there is increased interest in favouring a more inclusive and democratic approach to EPR and circularity, with the expectation that more transparency and greater collaboration with multiple stakeholders would increase material recovery and drive more sustainable outcomes, in alignment with a just transition (Vermeulen et al., 2021). New approaches such as the "All Actors Approach" in Europe (WEEE Forum,

2020) could enable the emergence of more transparent and sustainable e-waste flows, by giving a voice to actors involved in managing "informal flows" and enlisting their cooperation in improving the tracking and downstream processing of e-waste. This approach aims to bring the most important stakeholders (municipalities, scrap metal recyclers, the PRO, consumers, and major institutions) together to better define roles and responsibilities, agree on incentives, reporting and so on. Vermeulen et al. (2021) go further and speak of a Circularity 3.0 and suggest the decoupling of EPR program funding from governance mechanisms. They propose that EPR programs should protect, improve, and incentivize the activities of actors contributing to value retention (refurbishing, reuse, and so on), and suggest the creation of "circular value chain management organizations" which would oversee the implementation of circularity for various product categories. The very first step to establishing more sustainable e-waste flows would indeed require that governments and waste diversion agencies be interested, even if minimally, in the activities, and related social and environmental outcomes, of those existing actors currently shaping e-waste flows in their jurisdictions.

6.6. Conclusions and proposals for further research

Our work hopefully contributes to a more nuanced understanding of the roles and motivations of various agents as they shape e-waste material flows in an OECD urban context, and of the dynamics underlying informal e-waste flows and policy options for engaging with various actors to improve take-back program performance, material circularity, and solidarity with marginalized populations. At the same time, we warn against a widespread ban on "informal activities", especially if this policy fails to distinguish between reuse and recycling activities, does not target more dangerous activities such as manual dismantling, and omits to account for all the material collection and waste diversion activities by some actors because of the program's narrow scope.

Our work also raises many questions for further research. Given the many different types of activities involved, and the associated social and environmental risks, it would be wise to tailor policy-making to go beyond merely "capturing" flows for meeting program targets. Could other actors be engaged to become active participants in improving program performance while reducing environmental risks and protecting livelihoods, especially for marginalized populations? How is informal e-waste collection and recycling tackled in other North American cities? How have other jurisdictions in the OECD encouraged individuals who are collecting e-waste to bring back intact items to the program? Are some PROs more liberal in the way they fund their programs, collection infrastructure, and incentives? Are PROs willing to increase funding for collectors and recyclers where the activities of these actors are unlikely to be banned or restricted, or in jurisdictions where PROs face strict penalties for not meeting their collection targets?

Such comparative studies investigating other jurisdictions' strategies for managing informal e-waste flows in the North American and other OECD contexts would be useful for developing more socially and environmentally sound circularity strategies.

Chapter 7. Key Findings and Discussion

7.1 Introduction

The research presented in this thesis was developed with the intention to fill a specific research gap, namely, to discover new findings by investigating the development and first few years of implementation of an e-waste EPR regulation from a local perspective. The research accounted for the experience of local actors, including municipalities, large organizations, and local e-waste collectors, refurbishers and recyclers as they sought to shape this regulation, and how they were affected by, reacted to, adapted, supported, or challenged its implementation. This research aimed to offer new insights to the e-waste management literature by using an interdisciplinary lens and building upon previous theoretical work in the fields of industrial ecology, the political economy of environmental policy, and sustainability and transition studies.

The findings uncovered throughout this research are numerous and varied. These reflect the multiple dimensions and perspectives that were considered, the different units of analysis that were explored, the variety of information sources used for generating insights, as well as my long-term engagement and ongoing conversations with multiple stakeholders. Thus, the work presented throughout the previous chapters, and synthesized in the next few paragraphs align with, and fulfill the research objectives and questions I had established and presented in Chapter 2. My empirical findings fall into the following main categories: the uncovering of actors' interests, motivations and choices; the characterization of complex material flows or trajectories (blurring the line between what is formal and informal); the identification of contentious issues around program funding and incentives; and the assessment of various policy successes and shortcomings. Taken together, these findings speak to the usefulness of exploring what happens "on the ground" and "over time" as environmental policies are developed, adopted, and rolled out, as opposed to describing and comparing policy prescriptions.

I have also managed to present useful theoretical contributions by demonstrating the value of interdisciplinarity and including political economy perspectives and approaches in understanding the challenges pertaining to EPR policy development and implementation. My work also conveys the usefulness of qualitative work, including case studies and action research to make sense of urban material flows, uncovering unintended consequences and redistributive issues, and identifying potential policy improvements in support of circularity and a more just transition.

The following paragraphs summarize the main findings from each of the four previous chapters. A subsequent section highlights new insights which are revealed from bringing these chapters together, namely: the importance of understanding the metabolism of organizations as key contributors to the larger urban metabolism (municipalities) of which they are a part of; the uncovering of a complex relationship between e-waste tracking / documentation and the sound management of e-waste in the local economy; and the usefulness of longitudinal studies in understanding and improving urban material flows. This is followed by a discussion of the theoretical contributions and policy implications of this research, and topics for future research.

7.2 Key empirical findings

7.2.1 Findings presented in Chapter 3

The research project presented in Chapter 3 aimed to explore why Québec adopted regulatory measures different from those in other provinces as part of its EPR policy development, and what factors led to these particular requirements. Using Québec's case, I wanted to see if I could help explain the recent emergence of the EPR regulatory patchwork for e-waste, a situation causing manufacturers to face multiple different regulatory mechanisms across different jurisdictions. I was also expecting the research to help understand the gap between industrial ecology's theoretical prescriptions for EPR, including the creation of incentives for original equipment manufacturers to design products with improved lifecycles (eco-design), and actual policy-making and implementation leading to the lack of such incentives. Here are some of the key findings from this project:

1. Municipalities and non-profits historically involved in e-waste refurbishing and recycling were very active in promoting the EPR regulation but with the expectation that local processing be favoured and adherence to the 3R hierarchy (reduce, reuse, recycle) be maintained. Their hope to see local employment preserved, and their active involvement in policy development explains, in part, why Québec introduced specific measures in favour of local processing and the 3R hierarchy. To this day, Québec remains the province, in Canada, where e-waste sorting and initial dismantling still involves the most non-profit businesses.

2. Consumer associations did not participate in the consultations leading to the development of the regulation, although consumers would be impacted by paying the environmental handling fees. This aligns with previous empirical work in political economy.

3. Manufacturers, or their representatives, have little interest in the use of modulated environmental handling fees to encourage better product design. According to their perspective, the potential benefits of this market mechanism would be difficult to predict, and conflict with economies of scale generated by a more streamlined and harmonised program.

4. Regulators' policy aspirations and objectives are driven in part by ideology, broadly defined as their level of faith in governmental interventions, as explained by Keohane et al. (2005). However, factors such as global market forces (in terms of consolidation in the recycling industry, for example), and pressures exerted by manufacturers to delay the implementation of certain regulatory mechanisms (including penalties for not reaching targets), affect policy implementation and environmental outcomes.

5. It is possible, as is mentioned in the political economy literature, that jurisdictions may be more likely to experiment with progressive and innovative regulatory mechanisms, when the impacts of such initiatives affect mainly businesses, and workers, located abroad (because the ensuing repercussions will not be felt locally).

This chapter provides a useful contribution to understanding the political economy of e-waste regulatory development and highlights the importance of considering local interests and dynamics as legislators develop the governance framework(s) for managing material flows and supporting circularity. It reveals, also, how industrial ecology's prescriptions sometimes fail to acknowledge local contexts and how particular interests and global market forces can get in the way of key implementation targets, such as the creation of incentives for eco-design.

7.2.2 Findings presented in Chapter 4

The research presented in Chapter 4 was aimed at understanding how, and why, large organizations (and especially public institutions) as major e-waste generators in urban settings contribute, or not, to e-waste EPR program implementation, and to local circularity more broadly. In this context, I also investigated what we can learn from conducting transition experiments and action research to support greater circularity in an organizational setting, and how this can contribute to transforming the urban metabolism. I highlight some of the main insights from this work, here:

1. Large organizations generate significant e-waste flows, and their collaboration with the EPR program is essential to program success and to supporting a more circular urban metabolism. EPR policies are likely to be ineffective if they fail to mandate or adequately incentivize the participation of organizations.

2. The collaboration of large organizations with EPR programs is essential to program success but has a limited impact on local circularity, more broadly defined as the goal to reduce, slow and close material loops. Organizations' greater contribution to more sustainable material flows involves (in addition to collaborating with EPR programs); more sustainable procurement of electronics, and the creation and maintenance over time, of internal and external reuse loops, as well as safe and environmentally sound recycling.

3. The transformation of material flows in large, decentralized, organizations requires resources, including continuous involvement by interdisciplinary teams, and can be facilitated through action research experiments.

4. Incentives for organizations to implement circularity practices include reducing reputational risk (avoiding illegal exports or landfilling), reducing costs (by promoting reuse), ensuring data security and improved software licence management, contributing to sustainability (including resource conservation and protection of human health), and compliance with Treasury Board and granting agency expectations to ensure the longevity of IT assets paid for by public funds.

5. Organizations can use the value of their e-waste material flows (as a source of revenue for recyclers) and reputational clout, to drive health and safety improvements at recyclers' facilities, in some cases forcing the latter to improve their operations above and beyond what is expected by the official take-back program.

6. Reuse strategies need to be scrutinized to avoid rebound effects, even within institutional settings.

Overall, this chapter also provided an original contribution by demonstrating the potential for institutional contributions to circularity and resource conservation (the slowing and narrowing of resource loops), above and beyond the services provided by the EPR program, which focuses mainly on the closing of material loops through recycling. The research also documents how circularity is an emergent property of a system and how circularity initiatives within entities at the sub-economy level (such as in organizations) can contribute to the circularity of the larger metabolism (the city, or urban metabolism).

7.2.3 Findings presented in Chapter 5

This part of my research investigated how and why municipalities engage with an EPR program for e-waste management in a context where they are not mandated to do so. I sought to explore and understand their perspectives on the program; what drives, or hinders their collaboration, and how their collaboration and response affect policy outcomes. I also sought to find out how municipalities' experience with, and feedback on, EPR programs could inform policy improvements. The most significant findings are listed here:

1. There are many incentives for municipalities to participate in and collaborate with e-waste EPR programs. These include: efficient logistics (collection services), perceived contribution to circularity, perceived legitimacy of the program, and financial contributions to municipalities

from the EPR program (PRO). Contrary to expectation, municipal representatives' perception of funding as a driver for collaboration varied greatly.

2. Some municipalities, even large ones, are simply not equipped to collect hazardous waste at permanent locations, which challenges program performance. Fixing this issue requires modifications in other legal or regulatory mechanisms lying outside the scope of the EPR program.

3. Disincentives to participate in the program include the PRO's occasional lack of collaboration with pre-existing local refurbishers and recyclers, as well as the PRO's expectation that materials be sorted by municipalities. Not all municipalities have the necessary resources to meet this expectation.

4. Improvements suggested by municipalities include: greater program transparency about material and financial flows, improved financial incentives in accordance with the polluter-pays principle, a wider program scope (covering more product categories), and increased support of reuse.

5. Many municipalities collecting e-waste products falling outside the scope of the program send these items to landfill, which threatens resource conservation as well as the protection of water and soil from potential emissions.

This chapter sheds light on municipalities' experience with EPR programs and provides much needed empirical data in an area of research where most work is still very much normative / prescriptive, or descriptive (i.e., comparing regulatory frameworks, but without gathering direct feedback from municipal stakeholders). My research revealed a wide range of attitudes towards the EPR program. While most municipalities favoured collaboration, some also refused to collaborate, for various reasons.

This chapter raised new questions by highlighting how existing social capital such as the collective consensus about the importance of collecting and reusing or recycling e-waste not only supports and facilitates EPR program uptake, but potentially reduces how the polluter-pays principle gets leveraged. Environmental handling fees paid upfront by consumers to help fund the program may be artificially low because municipalities are willing to participate in the program regardless of the amount of funding they receive from the PRO. This situation cannot be investigated until greater transparency in the program is instituted, as is the case in Belgium and in France, for example.

7.2.4 Findings presented in Chapter 6

For this part of my research, I explored how informal e-waste flows come about in a North American urban context, specifically in Montréal. I sought to investigate who is involved in these flows, what their activities, choices, and motivations are, and how these drive policy outcomes. I interviewed a wide variety of actors involved in shaping these flows, to understand how they operate, and examine in detail what their activities reveal about the EPR program's potential shortcomings, and how its implementation aligns, or conflicts with various actors' interests, and so on. Key lessons drawn from the analysis are provided here:

1. I distinguish between e-waste generators (households and organizations) whose initial decisions about e-waste disposal shape subsequent material trajectories, and actors managing e-waste outside the program as generalists (processing e-waste as a by-catch) and as specialists (directly targeting large e-waste flows and competing with the PRO).

2. I found that the “formal” and “informal” dichotomy, as is usually presented in the literature, is an oversimplification of numerous flows straddling formality and informality, with no water-tight separation between the two.

3. Informality appears as an emergent property of the whole system and cannot be attributed specifically to activities and categories of individuals, because actors categorised by the PRO as being “informal actors” contribute to “formal flows” within its own program, and “formal actors” process “informal flows” outside the program because of documentation issues or materials missing parts. I illustrate the possible combinations as the “informality domain”.

4. The notion of informality, I found, is also shaped by the PRO and Waste Diversion agency’s discourse, and the PRO’s choice of actors it decides to collaborate with and provide incentives to, confirming previous work in human geography to the effect that EPR systems shape political economies and have important redistributive effects.

5. I also found that many municipalities perceive scrap metal collectors as providing complementary services to their constituents (and do not compete with the PRO), because they collect items left outside the program and bring them to get recycled.

6. Actors categorised as “informal” by the PRO and the waste diversion agency, I found, have been left out of the consultation processes leading to regulatory developments affecting their activities and therefore also future policy implementation and outcomes.

7. Major flows outside the program can be traced to reuse across provinces. Interprovincial reuse challenges e-waste traceability but should not be confused with dangerous recycling methods and illegal exports. Thus, not

all e-waste management outside the formal program poses a threat to human health and the environment.

This last chapter provides rich details uncovering the complexity of e-waste flows, and the variety of actors involved in these flows, in the North American urban context. It sheds light on the fact that the PRO's imperative to ensure its compliance with the EPR regulation, while limiting program costs, causes tension with its interest to access materials collected outside the program, its obligation to support refurbishing and reuse, and the safeguarding of decent working conditions throughout the e-waste value chain. Unfortunately, the PRO does not provide information about the quantities of products that are put on the market by its members, and it does not share information about the allocation of incentives to various stakeholders, including municipalities, which makes any measurements of policy outcomes particularly challenging. Some local actors, including scrap metal recyclers, would be open to, and interested in, collaborating with the PRO, but so far, the conditions imposed by the PRO have been an impediment to such collaboration. Recent regulatory developments indicate that the government has agreed to mandate this collaboration by making it illegal to collect and process e-waste outside the PRO's program. It will be interesting, in the future, to see how this will contribute to greater quantities being returned to the program, or not.

7.3 Additional insights and policy-making suggestions

In this section, I discuss some findings that only appeared in light of the combined information or cross-validation from different research projects reported in this thesis. Three of these findings are reported here, namely, the discovery of how local organizations' e-waste flows affect EPR program performance; the existence of a complex relationship between e-waste flow documentation and responsible processing; and the causal mechanisms determining the extent to which the polluter-pays principle is effectively applied through EPR in a given context.

7.3.1 Organizations as major contributors to urban waste flows

Thanks to the information uncovered by the action research project pertaining to the lifecycle management of McGill University's IT flows, and the feedback received from recyclers who collaborate or compete with the official program, as presented in Chapter 6, I have discovered the critical importance of institutional metabolisms as drivers of local material flows. More critically, it appears that what happens to used and end-of-life electronics generated by universities, school boards, hospitals, colleges, and other large organizations (including businesses, or firms, other than OEMs and their PRO) has an important impact on local e-waste flows and EPR program outcomes. These significant e-waste flows (for example the thousands of computers, smartphones and screens changed each year, in the case of McGill, alone) can contribute to local access to technology and local employment through refurbishing, reuse, and sound material recovery. Because of this, setting parameters for such local refurbishing and reuse within EPR regulatory frameworks should be a priority. The recent amendments brought to Québec's EPR regulation in Fall 2022 addresses this by making it illegal for anyone to collect or recover e-waste outside the formal program. A clearer approach would have been to mandate public institutions, for example, to sell or give their e-waste to refurbishers or recyclers that are partners in the program. The nuance between these two approaches is important. The latter option would have put the responsibility on organizations to work with the program, whereas the new amendment tends to criminalize those who do not partner with the program and aims to make them disappear.

7.3.2 A complex relationship between e-waste documentation and e-waste processing

Throughout my various research projects, I have discovered a wide variety of e-waste flows, and multiple combinations of outcomes, despite what is intended by the provincial regulation. While the provincial regulation aims to support responsible processing with adequate documentation by the take-back program, I found, instead, that all possible combinations of outcomes still occur.

For instance, because McGill University's Environmental Health and Safety team audited a certified recycler (a recycler that is part of the program and funded by the PRO), and found that the working conditions there were unsatisfactory, this means that e-waste managed by that recycler may be well tracked by the program – and counted as properly managed – but not processed in a responsible way. A similar suboptimal scenario occurs when certified recyclers participating in the program shred perfectly reusable equipment. This scenario aligns with the necessary requirements for tracking and documentation, but the processing does not follow the ideal scenario, where reusable equipment is redirected towards reuse, as mandated by the program. This outcome was documented as part of the feedback received by municipalities. Following the possible outcomes as illustrated in Figure 7.1, the two scenarios previously discussed represent situations found in quadrant c. When e-waste is generated locally and responsibly recycled by a recycler certified by the program but mixed with e-waste from other provinces, this e-waste cannot be accounted for as part of the program. This is an example that could be classified in quadrant b (responsible processing but insufficient documentation). Similarly, the collection of reusable equipment, its refurbishing and resale on the local market should also be considered a positive outcome in terms of responsible processing, but this information may not be captured as part of the program if it is done by actors working outside the program. The case of waste-pickers breaking electrical and electronic equipment apart and burning cables represents a situation fitting in quadrant d, the worst possible outcome. The best possible outcome whereby e-waste management respects the 3R hierarchy, processing is done respecting human health and using environmentally sound techniques, while also being tracked and documented could be illustrated as an outcome fitting in quadrant a.

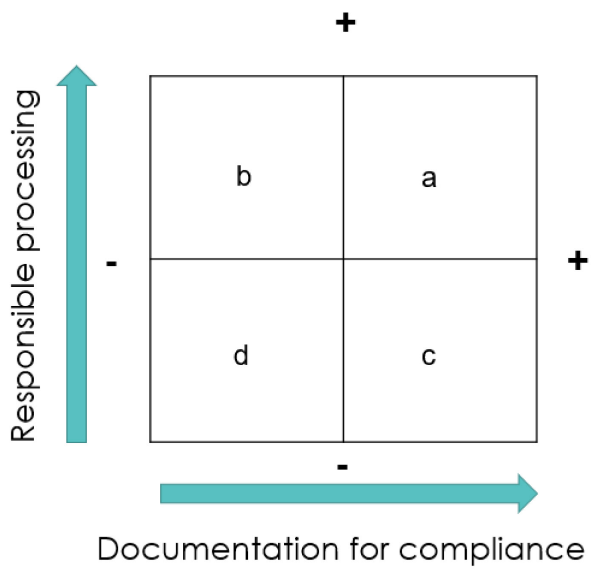

Figure 7.1: Possible combination of outcomes for processing and documentation

7.3.3 Causal mechanisms behind the implementation of the polluter-pays principle

Various components of this research have contributed to uncovering how the polluter-pays principle is effectively applied, or not, in the context of e-waste management in Québec. Of these, municipalities' (continued) willingness to pay for e-waste management represents one of the key factors determining how much funding will be spent by the PRO to drive program uptake, especially where municipalities are not mandated to participate in the program. Because some municipal representatives say they would support the program even without any funding (and because they feel a moral obligation to do so), this threatens the concept of shifting the burden towards OEMs. Other local factors, or determinants, such as the provincial government's willingness to mandate collaboration by other actors, also shapes the likelihood of the PRO taking on a greater portion of the costs to access e-waste flows and make the take-back program function effectively. In the context of Québec, as we have seen, the threat of penalties to be applied to the PRO for not meeting its targets, and the constant delays in their enforcement means that the PRO had few incentives to spend more funds to enlist the participation of waste-pickers and scrap metal recyclers to return equipment to the program. The financial consequences for failing to meet targets never actually materialized, and the latest revision to the regulation specifies that any eventual penalties will come, instead, as an obligation to increase investments in the program (Québec, 2022c). Figure 7.2 below illustrates some of the causal mechanisms shaping the effectiveness with which the polluter-pays principle is applied. The shaded boxes represent the findings I uncovered throughout my research.

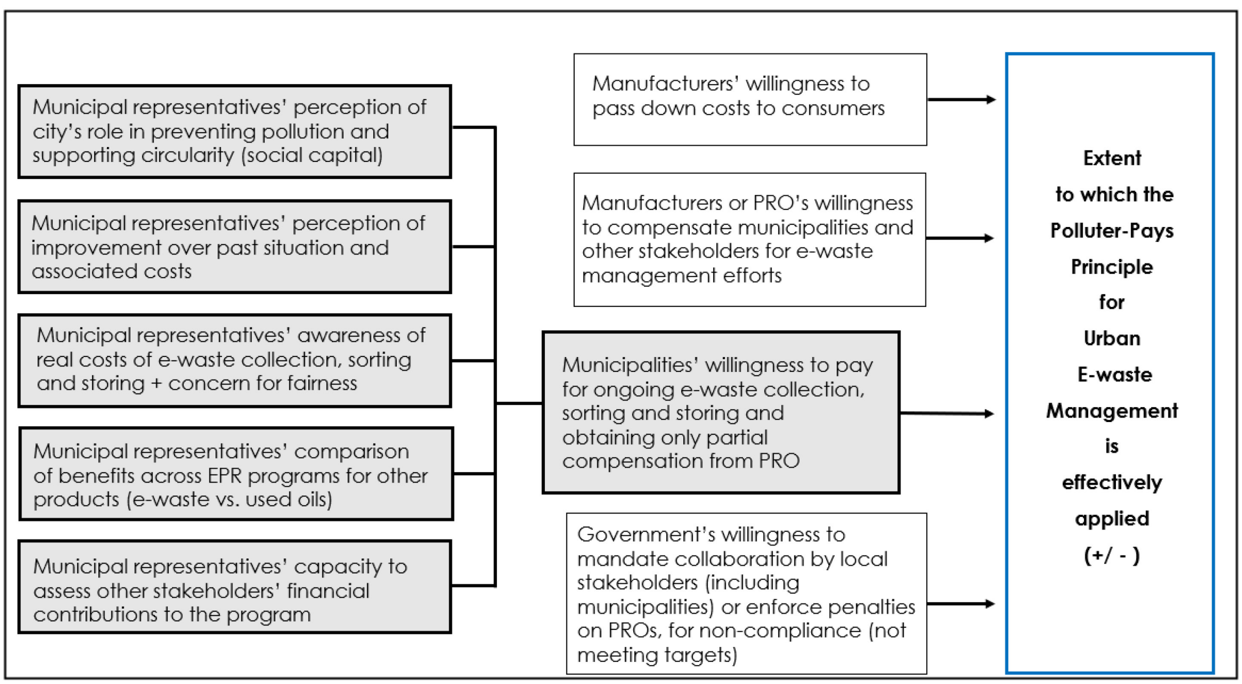

Figure 7.2: Contextual determinants of polluter-pays principle implementation

7.4 Theoretical contributions

This section provides an overview of the main theoretical contributions resulting from the research reported in this thesis. These contributions are, in turn, a demonstration of the usefulness of interdisciplinary perspectives to help make sense of EPR policy development and implementation challenges; the usefulness of qualitative research approaches to uncover and characterize complex material flows; the discovery of local actors' interests in EPR program objectives, governance and metrics, and finally, the usefulness of longitudinal perspectives in the study of urban material flows.

7.4.1 Interdisciplinary perspectives on e-waste management

Chapter 3 demonstrated the usefulness of political economy to help unpack the complexities involved in the development of EPR policy, and especially how various actors attempt to shape or influence the adoption of specific regulatory measures, as well as how policies play out on the ground. Not only does this perspective help explain key variations in EPR policies across jurisdictions (the e-waste regulatory patchwork), it also sheds light on EPR policies as instruments leading to important redistributive impacts. For example, the way EPR regulations are drafted affects who gets to collect and process e-waste, under what conditions, with what sources of funding, and so on. Again, the unpacking of various actors' interests (municipalities, in Chapter 5), and those of other local actors (scrap metal recyclers, and refurbishers, as in Chapter 6), as part of an assessment of the intricacies of the regulation's implementation, also reveals some of the multiple dimensions which need to be considered in the context of planning for circularity and the local governance of material flows.

While this thesis focuses on e-waste flows, one may argue that a similar political economy perspective should be used more systematically in all studies pertaining to the development and implementation of circularity strategies, and indeed, to the study of environmental policies, more generally, as Keohane (1997) points out. All attempts at changing material flows imply the reconfiguration of authority (or power) over resources and changing the way social and economic impacts are distributed. These issues have yet to be given sufficient attention, as is recognised by some researchers investigating e-waste management (Lepawsky, 2012; Davis 2020; Vermeulen et al., 2021). Incorporating this perspective as part of EPR policy development should help with a more careful analysis of existing "structural agents", promote adequate representation, consolidate participation, and predict and enable better policy outcomes (Binder, 2007). Similarly, over time, taking account of actors and interests can help correct policy implementation problems and avoid unintended consequences.

While their focus is not specifically on e-waste management, some researchers are developing a new normative discourse about the circular economy and the need for increased interdisciplinarity in industrial ecology. They now acknowledge the importance of assessing the (potential and actual) redistributive impacts of circularity strategies. This dissertation serves as an example of a form of political-industrial ecology, as an "Integrative research that incorporates social, political, policy, institutional, and/or spatial considerations into industrial ecology analyses ("politics in industrial ecology")" (Breetz, 2017: 392). It also serves as a contribution to critical perspectives on the circular economy, an interdisciplinary field of research which investigates the political, social, and environmental ramifications of circularity strategies, including EPR policies, by contrast to the usually descriptive and/or celebratory work on the circular economy (Hobson 2021). Hobson refers to this area of study as a critical environmental politics' perspective on the circular economy.

7.4.2 Qualitative methods for understanding e-waste flows

As mentioned in previous sections, and especially in Chapters 2 and 3, the understanding of e-waste flows in western contexts has benefited from ample normative work, quantitative assessments, and comparative analyses of regulatory instruments. My research, which adds to the few studies that address the local determinants of e-waste flows, offers an in-depth understanding of how local actors' interests, perspectives, choices and motivations affect e-waste related policy development and policy outcomes. My findings demonstrate the usefulness of mixed research methods, incorporating the use of action research, archival research, online questionnaires, in-depth interviews and participant observations, and deep immersion and engaging with a range of different actors to understand what is going on, as well as how and why policies play out the way they do on the ground. Only this combination of qualitative methods could reveal the following findings:

- Who sought to influence the development of Québec's EPR regulation, why, and how;

- How various actors respond to policies, how, why, and with what consequences for policy outcomes;

- Why some municipalities fail to adequately collect hazardous waste on their territories or share e-waste funding from their central offices to boroughs;

- Who collects and processes e-waste in Montréal, and what happens to various materials, and why;

- How organizations generate and manage e-waste, and why, how this impacts the EPR program, and how this can be changed (and what challenges come about along the way);

- What municipalities appreciate from the current program, or not, and what improvements they would like to see, and why;
- Who and what defines and shapes informal e-waste flows, how, why, with what social and environmental impacts, and how this could be changed.

As governments seek to promote greater circularity, exploring how current material flows come about through such careful qualitative investigations would be highly desirable. As such, my work hopefully contributes to the idea that political economy and qualitative investigations can favourably complement industrial ecologists' contributions to understanding and shaping material flows. Such work can help reveal the social embeddedness of industrial ecology, as a field of investigation, by demonstrating the usefulness of understanding local specificities and the role played by local actors in shaping material flows (Andrews, 1999; Broto et al., 2012; Newell and Cousins 2015; Breetz, 2017).

7.4.3 Uncovering actors' interest in new performance requirements

Many actors, and specifically municipal stakeholders and non-profit refurbishers, expressed an interest in seeing Québec's e-waste program evolve and meet new requirements. Of these, more transparency about financial and logistical aspects, and increased efforts in support of reuse, were regularly mentioned. One of the interviewees I cited in the municipalities paper in Chapter 5 stated that EPR is the way the program is funded, but that it is society, or the community, which should decide how the program works and what should be its objectives. These expectations coincide an evolving normative discourse about e-waste management. Indeed, researchers and non-governmental organizations now target EPR not only as a waste diversion strategy, but also as a means of supporting circularity, a way to manage the urban mine, and even a strategy to help support the United Nations Sustainable Development Goals (Prosum, 2016; Shittu et al., 2021; Campbell-Johnston et al., 2021).

Together, the shift in normative discourse in the literature, and similar feedback from local actors interacting with the program in Québec, point to the need for a new conversation about EPR program objectives and performance metrics. These could include multiple dimensions such as transparency, inclusiveness and collaboration, health and social benefits, and local employment and access to technology, besides waste diversion, and other environmental and resource conservation considerations. This could allow for new comparative work, and assessments along multiple objectives over and beyond the quantities of materials collected and refurbished or recycled, the number of drop-off points and the cost of running the program. Over time, EPR programs could evolve from compliance driven programs to more comprehensive circularity strategies demonstrating leadership and contributing to the transition to economic systems more respectful of safe and just Earth system boundaries (Rockström et al., 2023). Figure 7.3 below illustrates possible combinations of performance measures which range from compliance to leadership.

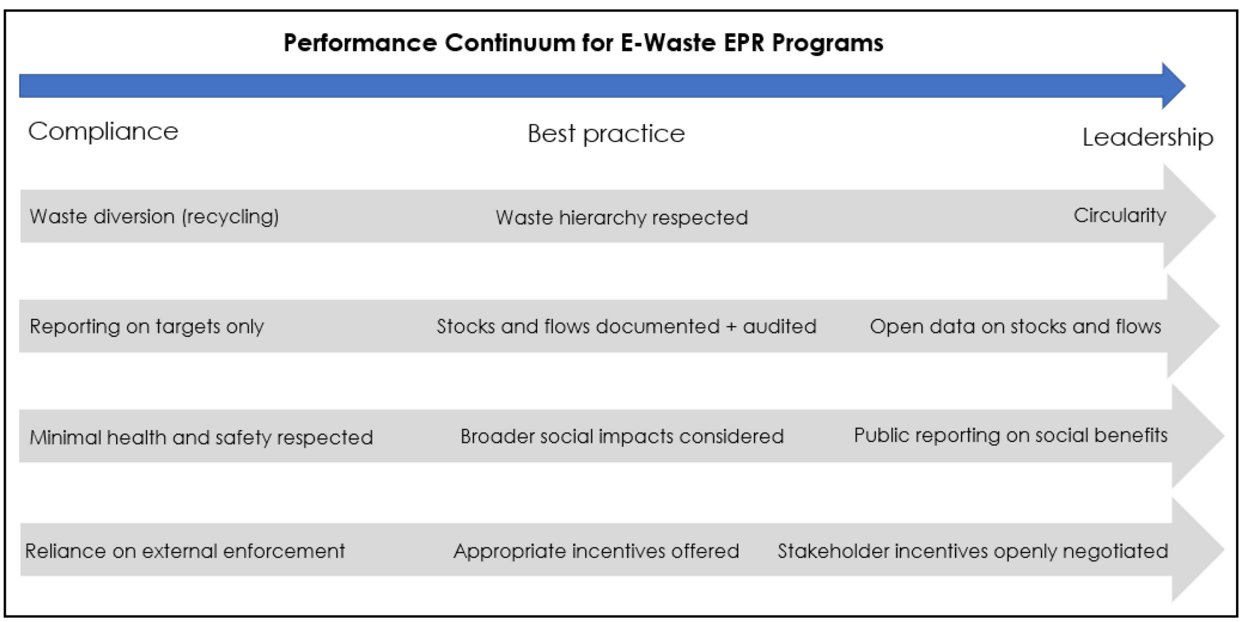

Figure 7.3: Proposed performance spectrum for e-waste EPR programs

7.4.4 A longitudinal perspective

Material flows change over time, as do actors' perceptions about material flows, and their intentions and actual efforts to change material flows. The research presented here demonstrates the usefulness of assessing changes in e-waste related issues, in a given context, over time. My research shows how regulatory mechanisms fail to get implemented because of various reasons (local lobbying, market forces, etc.), how strategies in favour of reuse can lead to rebound effects down the road, and how various actors may develop a more critical perspective about EPR programs, over time, after having collaborated with the program over a few years. Research in this field can produce useful insights by devising projects with questions that are investigated through time. Investigations into why and how changes come about (or not) could provide an indication of the mechanisms to be used to accelerate change, where needed.

In my particular case, it was a longitudinal perspective which allowed me to witness that Québec's EPR program maintained a certain level of decentralization, by keeping a network of local non-profit dismantlers active across the province. This perspective also allowed me to document how organizational e-waste flows fluctuate over time and need maintenance and reporting mechanisms to facilitate continued performance. It allowed me to see that the implementation of penalties and modulated ecofees, even though they had been announced early on, never materialized even ten years later. It also allowed me to observe how slow it has been for the legislators to add more products to the scope of e-waste to be recovered through the program, and how this negatively impacts municipalities' eagerness to participate.

7.5 Policy implications

There are multiple lessons for policy-making emanating from this research, some points being most relevant for provincial policy-makers, and others for municipalities. I distil the five most critical points in the following paragraphs.

Firstly, the scope of EPR programs should be devised very mindfully, and with careful consideration for how things will play out after regulatory measures are adopted. In Québec, the failure to include a more comprehensive scope of e-waste from the beginning (especially leaving out tools, e-cigarettes, Christmas lights, earbuds, toys and small household appliances) leads to the continued landfilling of e-waste, creates confusion among actors, causing some to prefer working outside the program. This is especially the case where the PRO expects municipalities to take care of part of the sorting, instead of incorporating this in the activities it pays recyclers to carry out. The annual quantity of e-waste generated globally and falling in these categories (now called "Invisible e-waste") contains almost USD 10 billion in raw materials (WEEE Forum, 2023).

Secondly, adopting provisions for greater transparency in the EPR program relating to local material flows and financial flows should be a key policy objective. This would support greater program legitimacy and stakeholder participation by helping ensure that municipal collaborators receive adequate compensation for their collection, sorting, and storing activities, and enable the monitoring of efforts directed to support local processing. In some countries, such as in Belgium and France, for example, negotiations with Producer Responsibility Organizations are done collectively and municipalities are paid (for collecting, sorting and storing) based on actual costs. Choosing to keep agreements between municipalities and the PRO confidential makes it impossible to determine the extent to which the polluter-pays principle is implemented and may hinder municipal participation.

Thirdly, legislators need to understand that EPR program success depends on a range of different policies, and not only on the EPR regulation itself. I have identified four of these. In Québec, for example, the program's performance could be improved by the adoption of modifications to the provincial Cities and Towns Act (C-19), to ensure that all municipalities have adequate infrastructure to collect, sort and store hazardous waste (including e-waste) from their citizens instead of holding ad hoc events only. Treasury Board regulations could be revised to ensure that public funds are used to buy only the most sustainable (and longer lasting) equipment. The Treasury Board could also require that public bodies including academic institutions, school boards and hospitals, return used and end-of-life equipment (for free), or sell equipment with a high residual value, to refurbishers and/or recyclers that are part of the program. Lastly, regarding actual recycling activities happening on its territory, the provincial government should regulate "who" can register a business as an e-waste recycler (as a business that actually collects, sorts and processes used and end-of-life electrical and electronic devices through dismantling and/or shredding and resale), and mandate strict health and safety inspections in these facilities.

Fourthly, legislators should recognize that various local actors (including municipalities) are increasingly interested in the actual operationalisation of EPR programs, and sound management of material flows on their territories. They also expect to see changes and improvements, and to have a voice in how these programs function. Municipalities are concerned about the social, economic and environmental repercussions of EPR programs, and who benefits from them. The health and safety of their constituents, access to technology, and local employment in refurbishing or recycling activities, are important to them. A democratic and open approach to improving EPR programs should involve periodic reviews with actors collaborating with these programs and the opportunity for them to provide input and feedback. The feedback I documented in the context of Québec, specifically in Chapter 5, resembles that recently provided by similar stakeholder groups during consultations in the Netherlands (Campbell-Johnston et al., 2021).

Finally, legislators should recognise the important redistributive impacts of EPR programs and acknowledge the important (intended and unintended) logistical and financial repercussions of changing material flows and/or who has authority over material flows. In Québec, important actors (scrap metal recyclers, for example) have been fully left out of the EPR program, when in fact they could have been encouraged to participate in it in return for some form of fair compensation, but the PRO had no obligation to work with them. Instead of expecting the PRO to enlist the collaboration of more actors, the government has recently chosen to ban all e-waste collection and processing activities outside of the program. Not only will this regulatory change be difficult to enforce, but given the current scope of products falling outside the program, an effective ban on "informal" collection and recycling could threaten the recovery of many resources falling outside the program, the bulk of which are managed by actors whose activities could be banned. It follows that any attempts at changing material flows should avoid a simplistic "one size fits all" approach. Instead, interventions should be pragmatic, results-oriented, and be based on a careful analysis of what goes "where", "why" and "how".

7.6 New developments and pathways for future research

The findings presented in this thesis illustrate the complex and changing dynamics that characterise the governance of e-waste flows. The ever-increasing stream of products, the changing material profile of products, the ongoing evolution of regulatory arrangements, and the concomitant changes in the behaviours of actors involved in generating and managing these flows, all contribute to this complexity. Considering this, there are multiple new areas of research which should be explored to further our understanding of the challenges of e-waste management and help devise better strategies to improve its social, economic and environmental outcomes. Below are a few ideas I would consider worth exploring.

7.6.1 Approaches for reducing and managing informal flows

As many take-back programs in large urban areas in OECD countries struggle with informal flows (Global E-Waste Statistics Partnership, 2019), it would be useful to conduct comparative work to explore the different approaches that have been used to understand and tackle this issue in different jurisdictions, and raise awareness about the related successes and failures. Particular attention should be given to assess if, and how, strategies aiming at reducing informal flows are effective in reducing negative environmental impacts (hazardous methods of dismantling, landfilling and illegal exports) while ensuring that their implementation still supports the lifecycle extension of reusable equipment and components.

My research hints at many drivers contributing to the proliferation of informal flows and has highlighted how some of these flows may contribute to positive environmental and social outcomes, such as local refurbishing and reuse. There are many possible points where local authorities and policy-makers can intervene to improve the management of materials. Some jurisdictions, such as New York State, and the State of California, mandate registration for e-waste collection and treatment activities (New York State, 2023). The State of California distinguishes between the roles and associated risks of e-waste generators, collectors and recyclers, establishing various reporting obligations, and or inspections for different activities (California, 2023). In Switzerland, e-waste generators (households and organizations) are mandated by law to give their equipment back to the formal take-back program (Confédération Suisse, 2021). How are these strategies effective in reducing negative environmental impacts (landfilling and illegal exports), and do they still allow for the reuse of IT equipment and/or the scavenging of useful parts to facilitate the repair and life extension of different equipment? Are some PROs more liberal in providing incentives to a variety of actors willing to return e-waste to their programs and can such collaboration be driven by strict penalties to PROs for not meeting their targets? Ultimately, continued research to understand and manage the determinants or factors that shape formality and informality in urban e-waste flows should contribute to the development of sound circularity policies, allowing for a variety of actors to participate and contribute to environmental protection and the preservation of human health.

7.6.2 Understanding local actors involved in managing other U/EoL material flows

Secondly, there is (still) surprisingly little research investigating the motivations, choices and activities of local actors involved in e-waste management; this lack may be a consequence of EPR regulations which presuppose a transfer of all, or most, e-waste management toward OEMs or their representatives under the PRO, with little acknowledgment of existing actors and existing material flows. My work offers only a glimpse into the variety and complexity of activities driving the management of e-waste flows in the city of Montréal and the province of Québec. But other EPR programs exist, for other end-of-life products, and many other valuable waste flows are also being targeted for improved circularity. Understanding the activities of different actors, the resources they focus on, their motivations, and interests, before the adoption of EPR programs would provide useful context for designing better product recovery strategies, given local dynamics. The forthcoming surge of used and end-of-life electric vehicles, photovoltaics, and other similar items should prompt more research into the preferences, the roles and responsibilities of various actors, and how their efforts might be co-ordinated for more effective e-waste management. More research regarding the fair distribution of responsibilities, and resources, including those to be assigned or allocated to municipalities should be investigated further and addressed through extensive comparative work.

It would be interesting to compare whether jurisdictions where municipalities are mandated to collaborate with EPR programs boast better e-waste collection, reuse and recycling results, and/or if the municipalities in such contexts find their arrangements with the PROs to be fair. Moreover, does a mandatory approach lead to different social and economic outcomes in terms of local employment, and the inclusion of other actors?

7.6.3 Circularity, transparency, and a critique of EPR

The work presented in this thesis raises important questions regarding transparency in EPR programs, and in circularity policies in general. The normative discourse about circularity has yet to articulate a clear vision of the roles and responsibilities of various stakeholders with regard to gathering and communicating information, not only in relation to material flows, but also financial flows, logistics, and contractual agreements. Circularity strategies have yet to be recognised as instruments with major redistributive impacts, in addition to having environmental impacts which, in and of themselves, may or may not result in beneficial outcomes because of various rebound effects (Lehmann et al., 2022; Lepawsky, 2012; Zink and Geyer, 2017).

Transparency in EPR programs and in circularity-related policies in general is a wide-open area of research which should be explored through comparative work. Should the shifting of e-waste management responsibilities to manufacturers inevitably come at the cost of less transparent practices, or could this be changed in the Québec context? Are take-back programs managed by governments (as opposed to EPR) any more transparent? And what does this mean for future materials management based on new data technologies and the internet of things (IoT)? Some organizations have high hopes for improved e-waste management using data generated by connected items (ITU, 2021), but we have yet to find out who will have access to this information, under what conditions, and so on and so forth. Will EPR still be the most preferable policy option for e-waste management if/when improved data is made available, or will the data generated by the IoT lead to new circumstances, such as manufacturers' exclusive access to information, changing the way EPR programs are managed, how OEMs interact within the PRO, or how the PRO collaborates with other stakeholders? For the moment, manufacturers have not been interested in the modulation of environmental handling fees (ecofees), but will this change in the future, with increased access to data through the IoT?

7.6.4 Impact assessment of product scope

There is a need for quantitative research exploring the loss of resources (and associated economic losses) due to the narrow scope of designated products under Québec's regulation and other provincial regulations in Canada, which have a similarly narrow scope. No one has yet detailed the complete list of electrical and electronic items that fall through the cracks, and which municipalities are left struggling to manage. As we have seen, sometimes these items are sent to recycling, and sometimes landfilled. This may represent significant economic losses for municipalities because of increased sorting costs, but also lost employment from the absence of proper dismantling and recycling, for those portions that are currently landfilled. There are two avenues of research here. Quantifying these out-of-scope flows would be a worthwhile exercise, as would be an exercise in projecting what benefits (as well as complexities and costs) would ensue from adopting the all-encompassing definition used in the European Union, which covers almost anything that operates with an electric cable or a battery.

7.6.5 Impact of right to repair on local material flows

The "right to repair" movement is gathering momentum (Wired, 2022). Different jurisdictions are looking into the possibility of mandating manufacturers to make replacement parts available for their electrical and electronic equipment, increasing the number of repair shops that are authorised to repair equipment, and even allowing consumers to repair their own equipment (European Parliament, 2020; House of Commons Library, 2021; Apple, 2021). Considering the findings in this thesis, the adoption of right to repair regulations can be expected to bring changes to current material flows in several ways. While the expectation, from a policy perspective, may be that the lifecycle of products will be extended, it also means that more spare parts will be produced and shipped or disseminated across the urban landscape. As repairs are done by households, will old parts be returned to OEMs, thrown in household waste, or will PROs be asked to take-back used or broken parts, something they have been reluctant to do, thus far? Will the right to repair lead to the opening of new repair shops funnelling material flows away from take-back schemes unless the latter start to work with repair shops to access more e-waste flows? Will households tend to stockpile used electronics for future use when they find the time to repair them? The prospects for increased local employment may appear favourable, but the overall social and environmental repercussions of such regulatory initiatives, including how EPR programs will dovetail with right to repair policies will have to be explored in more detail.

This section has provided a few examples of potential new research areas focusing on e-waste management and studies about EPR. This is by no means an exhaustive list of all the potential work to be conducted. The list does, however, uncover new areas where emerging complexity needs to be unpacked and understood.

7.7 Concluding remarks

While e-waste continues to be produced at an ever-increasing speed, and jurisdictions are still struggling to develop the most effective policies to manage this waste flow, there is a need to explore how policy options are developed, and what successes and failures come about as they are implemented. This research has explored the case of e-waste management in Québec, with the double objective of generating useful empirical insights and meaningful theoretical contributions using mixed qualitative methods. This research demonstrates the usefulness of interdisciplinary approaches and political economy to help explain some of the implementation gaps between industrial ecology prescriptions about e-waste management, and actual policy development and implementation. It uncovers the usefulness of action research as a means for researchers to identify some of the root causes of e-waste flows and take on the role of change agents in transitions aiming to change material flows. An in-depth immersion among e-waste collectors, recyclers, refurbishers, brokers, waste-pickers, and municipalities, the key actors shaping local "formal" and "informal" e-waste flows, sheds light on some of the complexity behind actors' motivations and behaviours as well as policy shortcomings, misconceptions, and potential improvements. The various projects revealed an interest and genuine appetite by many actors to see circularity strategies in general, and EPR policies in particular, become more ambitious and transparent. It would be desirable to promote additional qualitative investigations such as this one, to better understand the local specificities and determinants of e-waste flows, and their associated social and environmental impacts. Such work can help refine policies and contribute to improved normative EPR theory for e-waste management and other emerging waste flows, bringing them in line with improved circularity strategies and a more just transition.

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Appendix 1: List of interview participants

Table A.1. Summary table of interview participants

Stakeholder Categories		Number of Participants	Relevant Thesis Chapter(s)
I.	Waste-pickers and metal collectors	8	6
II.	Multi-waste haulers	2	6
III.	Electronics Brokers and Resellers	2	6
IV.	Refurbishers	3	3,4,6
V.	Recyclers	6	3,4,5,6
VI.	University technicians and managers	20	4
VII.	Municipal employees	4	5,6
VIII.	Others (PRO, Provincial government employees, trade associations, etc.)	7	3,4,5,6

Appendix 2: List of initial interview questions per stakeholder category (in French)

Questions d'entrevues initiales classées par catégories de participants:

I. Petits transporteurs/recycleurs improvisés (petits ferrailleurs)

1. Quels DEEE ramassez-vous, comment et pourquoi ? Quels DEEE ne ramassez-vous pas, pourquoi ? Comment faites-vous ça ?
2. Ramassez-vous des équipements complets ou seulement des pièces ? Lesquels, et pourquoi ?
3. Quelles pièces, ou appareils, laissez-vous derrière, et pourquoi ?
4. Ramassez-vous d'autres matières que des DEEE ? Quoi, comment et pourquoi ?
5. Si vous ramassez d'autres matières, pouvez-vous nous dire quelle proportion (par masse, ou volume) les DEEE représentent sur le total ?
6. Où amenez-vous les DEEE ou les pièces de DEEE, et pourquoi ?
7. À qui vendez-vous le matériel ? Où est situé cet endroit (ces endroits). Quels types d'activités/débouchés sont offerts pour le matériel ?
8. Si vous faites affaire avec plusieurs acheteurs/agents pour votre matériel, SVP nous expliquer qu'est-ce qui va où, et pourquoi.
9. Apportez-vous votre chargement directement à vos acheteurs ou autres partenaires, ou devez-vous apporter des choses chez vous afin de les démanteler davantage avant d'en vendre les pièces ? Que démontez-vous, comment, et pourquoi ? Quels avantages/bénéfices et inconvénients en résultent ?
10. Que font vos acheteurs avec le matériel, et où, à votre connaissance, envoient-ils le matériel ?
11. Ramassez-vous les DEEE seulement en bord de route, ou allez-vous en ramasser aussi dans des commerces, organizations, institutions ? Si oui, lesquelles, pourquoi, à quelles fréquences, et pour quelles quantités ?

12. Dans quelle municipalité/quartier avez-vous des activités ? Où faites-vous la collecte, et pourquoi ? Ramassez-vous aussi de la matière dans d'autres quartiers ou municipalités ?
13. Si vous ne ramassez les DEEE que dans ce secteur, pourquoi est-ce le cas ?
14. Depuis combien de temps faites-vous cette activité ?
15. Faites-vous cela seul, ou avez-vous des partenaires ou collègues ? Parlez-nous de votre horaire (heures, partage du temps de travail) et de vos ressources (camion, etc.
16. Quelle proportion de votre salaire annuel provient de vos activités de collecte de matières ? Et de cette portion, laquelle revient à la collecte des DEEE ?
17. Vous faites cela à temps plein ou à temps partiel ?
18. Pouvez-vous nous dire combien de $ vous pouvez obtenir (en moyenne) pour un chargement, ou un voyage, de matière, incluant vos DEEE ?
19. Combien de fois par semaine/jour/mois vous rendez-vous avec votre chargement chez vos acheteurs/partenaires ? Devez-vous avoir des quantités minimums ? Comment, pourquoi ?
20. Pensez-vous que les types de matières que vous ramassez en bordure du chemin ont changé au fil du temps ? Pensez-vous qu'il y a plus (ou moins) de certains types de matières, et plus (ou moins) d'autres types de matières. Comment cela a-t-il changé, ou pas, au fil du temps, et avez-vous une idée pourquoi ?
21. Savez-vous qu'il existe maintenant un programme réglementé de gestion des DEEE ? Croyez-vous que ce programme ait affecté vos activités ou s'il a eu un impact sur les flux et la disponibilité des DEEE dans la région ? Quels avantages/inconvénients y voyez-vous ?

II. Entreprises de collecte, de transport et de tri multi-matières

1. Quels types de matières collectez-vous ?
2. Ramassez-vous des matières principalement du secteur résidentiel, ou des institutions ou d'autres organisations ? En quelles proportions (masse ou $) ?
3. Faites-vous le tri de ces matières ou vendez-vous simplement les lots de matières à d'autres entreprises ? Lesquelles ? Comment ? Pourquoi ?
4. Pouvez-vous nous indiquer quelle proportion (masse ou $) de la matière que vous gérez provient de DEEE ?
5. Quelles sortes de DEEE collectez-vous ? Variétés, proportions ?
6. Est-ce qu'il y a des sortes de DEEE que vous ramassez, tout particulièrement, ou que vous évitez de ramasser, comment et pourquoi ?
7. De quel secteur (résidentiel, institutionnel, industries, ou autre) provient la majorité des DEEE que vous gérez ?
8. Faites-vous un tri des DEEE en vue d'en retirer les composantes réutilisables, revendables telles quelles, ou revendez-vous la matière telle quelle à titre de matière recyclable ? Si vous faites les deux, expliquez-nous dans quelle proportion et pour quel type de DEEE cela s'applique (% recyclage % réemploi).
9. Faites-vous vous-même quelque forme de démantèlement/déchiquetage, ou est-ce que ça va directement (sans manipulation) chez un recycleur/reconditionneur ? Pourquoi ?
10. Pouvez-vous SVP nous indiquer qui sont vos partenaires (recycleurs/reconditionneurs/raffineurs) et où sont situées leurs opérations ? Sont-ils à Montréal, au Québec, au Canada, à l'étranger ? En % ou $? Pourquoi faites-vous affaire avec eux ? Quelles sont vos motivations ? Cela change-t-il au fil du temps ?
11. Pouvez-vous spécifier comment vous écoulez vos DEEE par fraction/composante/ou type de matière ?

12. Savez-vous si vos partenaires sont des membres certifiés de l'ARPE. Cela est-il un enjeu ou un critère pour vous ? Pourquoi ?
13. Que pensez-vous de la réglementation actuelle sur la gestion des DEEE au Québec ? Comment cette réglementation affecte-t-elle vos activités (ou non), ou les flux de matières que vous gérez ?
14. Si vous êtes membres de l'ARPE, pouvez-vous nous dire depuis combien de temps, et si cela est bénéfique pour vous ou votre organisation ? Pouvez-vous nous parler de ce partenariat et comment cela influence votre traitement de la matière ?
15. Si vous n'êtes pas membres de l'ARPE, pouvez-vous nous dire pourquoi vous ne l'êtes pas ? À quelles conditions, ou pour quelles raisons, seriez-vous intéressés à vous joindre au programme, ou non ?
16. Avez-vous d'autres commentaires concernant la gestion des DEEE au Québec, ses avantages, ses lacunes, et ce qui pourrait être amélioré ?

III. Revendeurs de D3E usagés (boutiques spécialisées / sans reconditionnement)

1. Depuis quand faites-vous ce métier ? Êtes-vous propriétaire ? Qu'est-ce qui vous intéresse ou vous motive à faire cette activité ?
2. Quels genres/types d'appareils électroniques usagés achetez-vous et revendez-vous. Pourquoi ces appareils en particulier ?
3. Combien d'équipements (par catégorie) revendez-vous par année ?
4. De qui achetez-vous et à qui revendez-vous ? Consommateurs, entreprises, institutions, etc. ? Pourquoi faites-vous affaire avec ces acteurs en particulier ?
5. Quel pourcentage de ce que vous achetez arrivez-vous à revendre, et avec quel % de bénéfices ? Quelle est la marge de profit sur chaque type/catégorie d'appareil ?

6. Cette activité vous permet-elle de bien gagner votre vie ? Est-ce votre revenu principal ? Combien d'employés travaillent pour vous ?
7. Effectuez-vous des modifications/réparations aux appareils ? Comment, pourquoi, et pour quels types d'équipements ? Cela améliore-t-il la valeur de revente des appareils ? Meilleure marge de profit ?
8. Achetez-vous des équipements reconditionnés ailleurs ? Lesquels, d'où viennent-ils ? Pourquoi ?
9. Que faites-vous avec les appareils ou composantes que vous n'arrivez pas à revendre ? Où vont-ils ? Qui s'en occupe ? Spécifiez si vous devez aller les porter en qq part ou si quelqu'un vient les chercher et sous quelles conditions. Est-ce différent pour différentes sortes d'appareils ou de composantes ? Pourquoi ?
10. Faites-vous un tri entre ce que vous jetez et ce que vous gardez ? Quels sont vos critères ? Que gardez-vous et que jetez-vous et pourquoi ? Comment disposez-vous des appareils ou composantes dont vous ne voulez plus ? Où vont-ils ?
11. Pouvez-vous nous donner le nom de l'entreprise qui reprend vos DEEE ? Pourquoi faites-vous affaire avec eux ? Pour tous les types de DEEE ou seulement quelques catégories ? Qu'est-ce qui vous arrange dans cette entente avec eux ?
12. Savez-vous si la ou les compagnies qui reprennent vos DEEE (ce que vous n'arrivez pas à revendre) est une entreprise certifiée par ARPE-Québec ? Est-ce une entreprise de Montréal ? Du Québec, du Canada, ou étrangère ?
13. Est-ce important pour vous que vos partenaires (recycleurs) soient certifiés par l'ARPE, on non ? Pourquoi ?
14. Savez-vous s'ils traitent eux-mêmes la matière ou s'ils l'acheminent encore à d'autres entreprises pour plus de tri, de démantèlement, etc. ?
15. La vente de vos DEEE représente-t-elle une source de revenus ?

16. Finalement, faites-vous plus d'argent en revendant des appareils tels quels, en revendant des appareils que vous modifiez, en revendant des composantes, ou en vendant vos DEEE pour le recyclage ? Quelle proportion de vos revenus, par flux ?
17. Avez-vous été témoin de changements (ou non), au fil du temps, dans le types d'appareils et de composantes auxquels vous avez accès pour la revente ?
18. Savez-vous que la gestion des DEEE est réglementée au Québec (programme de REP) depuis quelques années ? Qu'en pensez-vous ?
19. Si cela fait assez longtemps que vous êtes dans le secteur, pouvez-vous nous dire si vous pensez que la réglementation et le programme de l'ARPE a affecté vos activités, ou les flux de matières que vous gérez ? Cette réglementation a-t-elle affecté la quantité ou la valeur du matériel avec lequel vous travaillez et/ou la sorte d'appareils, de matériel, de composantes que vous achetez et revendez ? Cela aurait-il affecté votre situation financière, vos revenus (en bien ou en mal) ?
20. Avez-vous d'autres commentaires au sujet de vos activités/opérations ou concernant la gestion des DEEE au Québec et à Montréal ?

IV. Reconditionneurs

<u>Questions pour tous les reconditionneurs :</u>

1. Depuis quand cette entreprise est-elle en affaires ?
2. Combien d'employés ? Temps-plein, temps partiel…
3. Entreprise à but non lucratif, ou non ?
4. En opération depuis combien de temps ?
5. Recevez-vous du financement public et, si oui, pour quels aspects de vos activités ?
6. Quels types/sortes d'appareils ou de composantes électriques ou électroniques traitez-vous ?

7. D’où vous proviennent ces appareils et/ou composantes (consommateurs, entreprises, institutions ou autres) et en quel pourcentage ?
8. Devez-vous payer pour acheter ces appareils/composantes, ou débourser des fonds pour y avoir accès ? Combien, pourquoi, comment ?
9. Combien d’équipements (par catégorie) reconditionnez-vous par année ? Pourquoi ? À quel coût ? Quels sont les défis en lien avec chaque catégorie ?
10. Où vont les appareils que vous avez reconditionnés ? Donnés, vendus, à qui, et où ? Pourquoi ?
11. Où vont les appareils/composantes que vous ne réussissez pas à revendre ? Nom des entreprises ? Montréal ? Québec, Canada ? À l’étranger ? Certifiés ARPE ?
12. Tirez-vous des revenus de votre revente de DEEE à des recycleurs, et combien cela représente-t-il en % de votre chiffre d’affaires ?
13. Est-ce important pour vous (ou non) que vos partenaires recycleurs soient certifiés ARPE ?
14. Parmi les appareils que vous n’arrivez pas à revendre, faites-vous un tri ou envoyez-vous tout au recyclage ?
15. Comment vos activités ont-elles changé (ou non) depuis l’adoption de la réglementation de REP pour la gestion des DEEE ?
16. Le matériel (appareils et composantes) auquel vous avez accès a-t-il changé au fil du temps et, si oui, comment ? La nature et la quantité de ce que vous recevez, ce que vous reconditionnez et ce que vous revendez aurait-il changé depuis l’application du nouveau règlement sur la REP ?
17. Pensez-vous que la réglementation sur la gestion des DEEE ait été avantageuse (ou non) pour vos activités, comment, et pourquoi ? Enjeux sociaux, économiques, environnementaux ? Positifs ? Négatifs ?

18. Si vous n’êtes pas certifiés par l’ARPE, pourriez-vous me dire pour quelles raisons en particulier ?
19. Si vous n’êtes pas certifiés par l’ARPE, à quelles conditions seriez-vous prêtes à vous faire certifier par l’ARPE ?
20. Avez-vous des commentaires concernant le programme de REP et ses effets désirables ou indésirables ?
21. Avez-vous d’autres commentaires concernant vos activités et/ou la gestion des DEEE à Montréal et au Québec ?

<u>Questions additionnelles pour les reconditionneurs partenaires de l’ARPE :</u>

1. Depuis quand êtes-vous certifié par l’ARPE ?
2. Quelles étaient les principales motivations derrière votre adhésion à l’ARPE ?
3. Comment cette certification a-t-elle été bénéfique pour vos activités (ou non) ? Avantages/inconvénients financiers, logistiques, etc. ?
4. Comment cette certification a-t-elle modifié/influencé vos activités et/ou votre situation financière, vos processus, ou vos partenaires ?
5. Avez-vous des commentaires concernant la situation et les activités des reconditionneurs sous le régime de l’ARPE ?

<u>Questions additionnelles pour les reconditionneurs qui ne sont pas partenaires de l’ARPE :</u>

1. Que pensez-vous du programme de l’ARPE, et comment décririez-vous les relations de votre entreprise avec ce programme ? Collaboration/Évitement/Partage d’info, etc. ?
2. Collaborez-vous avec des entreprises ou des organisations qui sont des membres certifiés de l’ARPE ? Comment, depuis quand, à quelle fréquence et pour quoi faire ?

3. Y'a-t-il des raisons particulières pourquoi votre organisation n'est pas certifiée par l'ARPE ? Pouvez-vous expliquer ?
4. À quelles conditions seriez-vous intéressés à devenir une entreprise certifiée par l'ARPE ? Qu'est-ce qui pourrait vous convaincre de vous y joindre ?

V. Recycleurs

Questions pour tous les recycleurs

1. Depuis quand votre entreprise est-elle en affaires, et depuis combien de temps traite-t-elle des DEEE dans la grande région de Montréal ?
2. Combien d'employés avez-vous dans la région de Montréal ?
3. Pouvez-vous nous indiquer en % de quelles sources vous obtenez votre matière à recycler ? Consommateurs individuels, petits ramasseurs, entreprises, institutions, points de collecte de l'ARPE, entreprises de collecte multi-matières, éco-centres, municipalités, reconditionneurs (certifiés ou non certifiés), etc. ?
4. Y'a-t-il des différences entre les types de matières (valeur $, âge, types de composantes) que vous recevez de vos différents fournisseurs de matériel ? Comment, et pourquoi ? Qui vous fournit quoi ?
5. Quels autres types de matière que les DEEE traitez-vous ? Pourquoi et comment les traitez-vous ?
6. Quel pourcentage (en $ ou en masse) de la matière que vous traitez provient de DEEE, et quel pourcentage provient d'autres types de matières/choses ? Est-ce que ces % vous conviennent, où voudriez-vous que vos intrants soient différents ? Comment et pourquoi ?
7. Devez-vous payer des entreprises pour venir chercher de la matière que vous n'êtes pas en mesure de revendre ou de traiter ? Si oui, combien payez-vous et quelles sont ces matières ? Quelle proportion (en poids) ou en $ représente la dépense pour la gestion des matières invendues ?

8. Quelles matières/composantes/fragments sont génératrices de revenus, et quelles matières/composantes/fragments sont génératrices de dépenses ? Pourquoi, et en quelle proportion ?
9. Vos opérations de la région de Montréal couvrent-elle l'ensemble du processus de démantèlement/déchiquetage en amont du raffinage, ou devez-vous faire affaire avec d'autres entreprises avant de pouvoir transmettre les matières au raffinage ? Pourquoi ? Lesquelles ? Où sont ces entreprises ?
10. Parlez-nous de vos frais de transport. Pourriez-vous nous dire quelle proportion de vos dépenses sert à payer le transport (1. Pour acheminer la matière vers vos installations, et 2. Pour acheminer la matière de chez vous vers les raffineurs) ?
11. Pouvez-vous nous dire sur quels marchés vous revendez vos matières et où elles aboutissent, en général ? Québec, Canada, Étranger ? Europe ? Asie ? SVP spécifier par fraction/type de broyat/composante. Pourquoi vendez-vous sur ces marchés ? Quelles motivations ? Prix ? Qualité du broyat ? Partenariats ? Etc. ?
12. Vendez-vous de la matière aux raffineurs québécois, ou non, et pourquoi ? Avec quels raffineurs faites-vous affaires ? Est-ce à vous que revient la décision ou au « broker ». Pourquoi ? Pour quelles fractions/broyats ?
13. Combien de flux sortants avez-vous en partant de vos installations de Montréal ? Réemploi ? Enfouissement ? Raffinerie ? Broker? Consolidation ? Ferraille ? Etc. ? En pourcentage et en valeur ?
14. Si vous faites du réemploi, quels équipements/composantes arrivez-vous à revendre pour le réemploi ? Quelle fraction de votre revenu provient de la revente d'appareils ? À qui vendez-vous les appareils et comment, sur quelle plateforme ?
15. Comment décidez-vous quelle matière ira où, à la fin ? Quelles sont vos contraintes vos motivations ?

16. Cela change-t-il au fil du temps, comment, et pourquoi ?
17. Quels défis particuliers rencontrez-vous en lien avec vos flux entrants et sortants, et comment adressez-vous ces défis ?

Questions additionnelles pour les recycleurs partenaires de l'ARPE

1. Depuis quand l'entreprise est-elle certifiée par l'ARPE ?
2. Pourquoi vous êtes-vous joint à ce programme ?
3. Si vous aviez des activités similaires avant de joindre le programme, pouvez-vous nous dire si le fait d'être certifié a changé la quantité, la qualité ou le type de matière à laquelle vous avez accès ? Comment, et pourquoi ?
4. Comment le programme de REP a-t-il affecté vos activités et vos finances ? Vos revenus et vos marges bénéficiaires ? Comment et pourquoi ?
5. Comment le programme de REP a-t-il changé, les partenaires avec qui vous travaillez, et les flux de matière sortants de vos installations (ce que vous revendez et à qui) ? Comment ? Pourquoi ?
6. Le programme de REP a-t-il eu un effet sur comment vous traitez la matière ? Comment, et pourquoi ?
7. Comment croyez-vous que le programme de REP ait contribué au réemploi ou non ? Parlez-nous du réemploi des DEEE au Québec, avant et après la mise en place de la REP.
8. Quels défis rencontrez-vous dans vos activités, et comment ces défis pourraient-ils être gérés ? Pourquoi ?
9. Avez-vous d'autres commentaires concernant vos activités et la gestion des DEEE au Québec et à Montréal ?

Questions additionnelles pour les recycleurs qui ne sont pas partenaires l'ARPE

1. Êtes-vous familiers avec le programme de l'ARPE ? Pouvez-vous nous indiquer pourquoi vous n'êtes pas certifié par l'ARPE ?
2. Si vous aviez des activités similaires avant que soit développé le programme de l'ARPE, pouvez-vous nous dire si l'existence du programme a changé la quantité, la qualité ou le type de matière à laquelle vous avez accès ? Comment, et pourquoi ? Et cela, même si vous ne faites pas partie du programme…
3. Croyez-vous que l'existence du programme a eu un effet sur vos sources de matière (qui vous fournit la matière) ? Comment ? Pourquoi ?
4. Est-ce que l'existence du programme a affecté vos décisions/processus pour le traitement de la matière ? Faites-vous les choses différemment ?
5. Est-ce que l'existence du programme a affecté vos décisions/processus pour la revente et/ou la disposition des matières traitées ? Avez-vous changé les entreprises, raffineurs, revendeurs (ou lieux d'enfouissement, ou autres) où vous envoyez votre matière ? Comment, pourquoi ?
6. Favorisez-vous le réemploi de certains appareils/équipements/composantes ? Si oui, lesquels ? Comment, et pourquoi ? Quelles sont vos motivations/défis à l'égard du réemploi ?
7. Si vous faites du réemploi, quelle fraction de votre revenu provient de la revente d'appareils ? À qui vendez-vous et comment, sur quelle plateforme ?
8. Quels défis rencontrez-vous dans vos activités, et comment ces enjeux pourraient-ils être réglés ?
9. Avez-vous de commentaires concernant le programme de REP pour la gestion des DEEE et comment il pourrait être amélioré ?
10. À quelle condition seriez-vous prêts à adhérer à ce programme ?
11. Comment pensez-vous que le réemploi et/ou le recyclage pourrait être améliorés au Québec, et à Montréal ?

12. Avez-vous d'autres commentaires/critiques concernant la gestion des DEEE au Québec et à Montréal et comment cela pourrait être bonifié ?

VI. Employés universitaires (techniciens et gestionnaires)

1. Qu'est-ce qui enclenche l'acquisition des équipements TI (disponibilité budgétaire, remplacement programmé à partir de l'âge des équipements, etc.) ?
2. Qui décide des spécifications techniques du matériel à acheter, selon quels critères ?
3. Comment les acquisitions sont-elles faites ? Par quel mécanisme (plateforme en ligne, bon de commande ?)
4. Qui décide de la distribution ou de la répartition du matériel au sein des équipes, et selon quels critères ?
5. Gardez-vous un inventaire des équipements ? Qui fait la saisie de données initiale, qui maintient cet inventaire et s'occupe de sa mise-à-jour ?
6. Pouvez-vous réutiliser du matériel existant plutôt que d'acheter du nouveau matériel ?
7. Dans un monde idéal, comment l'acquisition des TI se ferait-elle à l'Université ? Quels changements devraient être apportés pour ce que flux de matière soit amélioré et plus durable ?
8. Qui entretient ou fait les mises à jour les équipements TI dans votre département ou à votre université ?
9. L'équipement peut-il être partagé ?
10. Qui décide si un équipement doit subir une mise à niveau (ajout de mémoire, ou autre), et qui effectue ce travail ?
11. Si vous avez un inventaire, tenez-vous compte de la condition des appareils ?
12. Tenez-vous compte de l'utilisation des appareils, dans le but d'optimiser leur usage ?

13. Dans un monde idéal, comment l'usage et l'entretien des TI de l'université pourraient-ils être améliorés ? Quels changements voudriez-vous voir ?
14. Qui décide qu'un appareil de TI est désuet ou en surplus, et sur la base de quels critères ?
15. Comment les données sur les équipements sont-elles effacées et qui s'occupe de cela ?
16. Quelle est la destination des appareils désuets, en surplus ou en fin de vie et qui décide de cette destination ?
17. Si vous avez un inventaire, est-il mis à jour pour refléter le retrait d'un équipement lorsque celui-ci est donné/vendu/ ou envoyé au recyclage ?
18. Garez-vous des équipements en surplus pour le réemploi ? Qui s'occupe des communications et de la logistique pour soutenir le réemploi ?
19. Si les appareils sont offerts pour le réemploi, qui peut en bénéficier, et selon quels critères ?
20. Permettez-vous la cannibalisation des appareils, ou le prélèvement de composantes pour les combiner à d'autres équipements, et si oui, qui peut faire ça (avec quelles autorisations) ?
21. Comment la gestion des équipements de TI usagés ou en fin de vie utile serait-elle améliorée ?

VII. Employés ou gestionnaires municipaux (questions supplémentaires au questionnaire en ligne)

22. Parlez-nous des ressources que vous mobilisez pour la gestion des DEEE sur votre territoire (camion, entreposage, main-d'œuvre) ?
23. Comment la mise en œuvre de la REP a-t-elle changé vos activités en lien avec les DEEE ?
24. Qui s'occupe de quoi, entre les arrondissements et la ville centre (s'il y a lieu) ? Est-ce que chaque arrondissement a la même approche ?
25. Y a-t-il encore des enjeux avec la gestion de cette matière ?

26. Quels changements voudriez-vous voir mis en œuvre ?
27. Comment percevez-vous que cela fonctionne pour vos citoyens ?
28. Êtes-vous satisfaits de votre bilan pour la gestion de cette matière, et quels changements voudriez-vous voir être mis en œuvre ?

Appendix 3: Summary of online questionnaire for municipal stakeholders (in French)

Q. 1. Quelle est la population (approximative de votre municipalité ? Veuillez choisir une réponse parmi les options suivantes.

Option de réponses : 18 intervalles mutuellement exclusifs allant de moins de 1000 habitants à 500 000 habitants et plus.

Q. 2. Veuillez identifier quelles situations s'appliquent à la gestion des déchets d'équipements électriques et électroniques (D3E) sur le territoire de votre municipalité. Cocher toutes les réponses qui s'appliquent à votre contexte. Vous pouvez ajouter des commentaires au besoin.

Options de réponses :

- Nous avons un/des point(s) de dépôt municipal permanent (éco-centre ou autre) où les citoyens peuvent venir déposer leurs D3E.
- Nous tenons des évènements de collecte ponctuels, tels qu'au jour de la Terre, ou pendant la période de déménagements, pour que les citoyens puissent venir déposer leurs D3E.
- Nous faisons la collecte, en bord de rue, des D3E de nos citoyens. Ce service est offert sur appel.
- Nous faisons la collecte, en bord de rue. Ce service n'est pas offert sur appel. Ramassage ad hoc, en passant.
- Les activités de collecte de D3E sont gérées en collaboration avec notre MRC, ou en association avec d'autres municipalités.
- Nous avons d'autres moyens de collecte de déchets électriques et électroniques (veuillez spécifier).

Q.3. Êtes-vous familier(ère) avec la Responsabilité Élargie des Producteurs (REP) et le programme réglementé de gestion des D3E (Ex. : Programme de l'ARPE Québec).

Options de réponses :

- Je ne connais pas le programme de l'ARPE Québec.
- Je connais un peu le programme de l'ARPE Québec.
- Je connais bien le programme de l'ARPE Québec.
- Je connais très bien le programme de l'ARPE Québec.

Q.4. Est-ce que votre municipalité participe/collabore avec le programme de l'Association pour le recyclage de produits électroniques (ARPE) Québec, pour le ramassage et le recyclage des déchets électroniques de vos citoyens ? Vous pouvez ajouter des commentaires, plus bas, au besoin.

Options de réponses :

- Oui, directement. Notre municipalité participe au programme de l'ARPE et nous laissons cet organisme, ou ses mandataires, venir ramasser les D3E dans nos installations municipales (cours de voirie, dépôt ou centre de tri de matières dangereuses, éco-centres, évènements ponctuels).
- Oui, indirectement. Nous participons au programme en collaboration avec la MRC ou avec d'autres municipalités et les D3E sont ramassés par l'ARPE ou ses mandataires.
- Non, nous ne participons pas au programme de l'ARPE et nous n'acheminons pas de D3E à cet organisme. Ni cet organisme ni ses mandataires ne récupèrent de D3E de nos installations municipales.
- Je ne sais pas, ou je suis incertain de la réponse.

Q.5. Votre municipalité garde-t-elle une trace des quantités de matière (D3E) qu'elle récupère et envoie au recyclage ou au réemploi (avec l'ARPE, ou autres) ? Suivez-vous cette information ? Vous pouvez inclure d'autres réponses, plus bas.

Options de réponses :

- Oui, nous avons les données concernant les quantités de D3E que la municipalité récupère et nous faisons le suivi des quantités d'une année à l'autre.
- Oui, nous avons les données concernant les quantités de D3E que la ville récupère, mais nous ne faisons pas le suivi pour comparer d'une année à l'autre.
- Non, nous n'avons pas de données concernant les quantités de matière que nous récupérons, mais nous pourrions l'avoir en demandant à nos fournisseurs de service (ARPE, recycleurs ou autres organisations).
- Non, nous n'avons pas de données concernant les quantités de D3E que nous récupérons et nous n'avons aucun moyen de savoir ce qu'il en est.

Q. 6. Question ouverte. Si vous avez répondu que votre municipalité suit les quantités de D3E qu'elle récupère sur son territoire, pouvez-vous SVP nous donner une idée des quantités approximatives ramassées, par année (en tonnes métriques).

Q. 7. Votre municipalité a-t-elle une entente officielle avec l'ARPE ? Pouvez-vous spécifier la nature de cette entente ?

Options de réponses :

- Oui, nous avons une entente directe avec l'ARPE.
- Oui, nous avons une entente indirecte avec l'ARPE (via notre MRC).
- Non, nous n'avons pas d'entente avec l'ARPE.

Q.8. Si vous avez répondu « oui, nous avons une entente directe » à la question précédente, nous aimerions savoir quels facteurs ont incité votre municipalité à participer et collaborer au programme de l'ARPE. Vous pouvez cocher plusieurs réponses.

Options de réponses :

- Ristournes (remboursement/paiement pour la matière).
- Avantage de collectes (gestion efficace).
- Gestion du risque pour la réputation de la municipalité (assurer un traitement responsable de la matière).
- Parce que c'est le programme officiel reconnu par le gouvernement du Québec.
- Autres raisons ? Veuillez spécifier.

Q.9. Si vous entretenez une collaboration directe avec l'ARPE-Québec, pouvez-vous nous indiquer si vous avez une entente financière (ristournes de l'ARPE), pour compenser votre effort de collecte/tri/entreposage de la matière ? Nous ne vous poserons aucune question quant au contenu de cette entente, mais nous voulons savoir si plusieurs municipalités du Québec se sont prévalues de cette option, ou non. Avez-vous une entente financière avec l'ARPE Québec ?

Options de réponses :

- Oui, nous avons une entente financière avec l'ARPE-Québec.
- Non, nous n'avons pas d'entente financière avec l'ARPE-Québec.
- Je ne sais pas.

Q.10. Question ouverte. Si vous avez répondu précédemment que vous avez une entente financière avec l'ARPE Québec, pouvez-vous nous dire si vous trouvez cette entente bénéfique/équitable ? Par exemple, trouvez-vous que vous êtes suffisamment compensés pour vos efforts logistiques de collecte, de tri et/ou d'entreposage ? Cet arrangement est-il pratique pour vous ? Nous ne cherchons pas de détails financiers, mais nous voulons comprendre votre perception des avantages ou inconvénients de cette entente. Est-ce généralement bénéfique pour votre municipalité (oui, non, pourquoi, et comment) ?

Q.11. Si vous avez répondu précédemment que vous ne collaborez pas avec le programme de l'ARPE, veuillez, SVP, nous indiquer pourquoi. Veuillez cocher la ou les réponses qui s'appliquent à votre cas. Vous pouvez ajouter d'autres informations au besoin.

Options de réponses :

- Nous ne connaissons pas l'ARPE.
- Nous ne sommes pas intéressés à collaborer avec l'ARPE.
- Nous avons déjà d'autres entreprises ou organismes qui viennent
- chercher les D3E que notre municipalité récupère.
- Cette décision relève de notre MRC.
- Autres raisons, SVP expliquer.

Q.12. Question ouverte. Si vous connaissez l'ARPE Québec, mais votre municipalité ne collabore pas avec cet organisme pour la collecte des D3E, pourriez-vous nous dire quels facteurs pourraient vous faire changer d'idée ? Quelles sont vos préoccupations à ce sujet ?

Q.13. Nous aimerions savoir comment votre municipalité gère ses propres appareils électriques et électroniques usagés ou en fin de vie utile (les vieux appareils issus de l'administration). SVP, cochez les scénarios permis/observés dans votre municipalité.

Options de réponses :

- Les appareils de notre municipalité vont à l'ARPE-Québec.
- Les appareils usagés de notre municipalité sont vendus sur le marché.
- Les appareils de notre municipalité sont vendus ou donnés aux employés.
- Les appareils de notre municipalité sont donnés à un organisme à but non-lucratif ou un organisme de bienfaisance.
- Autre.

Q.14. Le règlement sur la Responsabilité élargie des producteurs (REP) définit la liste d'appareils électriques ou électroniques qui doivent être récupérés (notamment par l'ARPE-Québec). Plusieurs petits appareils électriques et électroniques ne sont pas couverts par le programme actuel (ex. : petits électroménagers, jouets, brosses à dents électriques, drones, lumières de Noël). Pouvez-vous nous indiquer comment vous gérez ces D3E sur votre territoire ? Plusieurs choix possibles.

Options de réponses :

- Les petits appareils électriques ou électroniques qui ne sont pas couverts par le règlement sont mélangés avec la matière qui va à l'ARPE ou aux autres recycleurs.
- Les petits appareils électriques ou électroniques qui ne sont pas couverts par le règlement sont triés/séparés et acheminés au recyclage séparément de la matière visée par le règlement.
- Je ne sais pas.
- Autre. Veuillez préciser.

Q.15. Constatez-vous que des ferrailleurs ont des activités (rémunérées, ou non) de collecte de D3E dans votre municipalité ? Ces ferrailleurs travaillent à leur propre compte (ni pour la municipalité ni pour l'ARPE-Québec). Veuillez choisir la/les réponses les plus pertinentes, en fonction de vos observations et ajouter des commentaires, au besoin.

Options de réponses :

- Oui, il y a beaucoup de ferrailleurs dans notre municipalité et ils récupèrent des quantités importantes de D3E.
- Oui, il y a des ferrailleurs dans notre municipalité, mais ils récupèrent des quantités peu importantes de D3E.
- Oui, il y a des ferrailleurs dans notre municipalité, mais nous ne savons pas quelles quantités de D3E ils récupèrent.

- Non, il n’y a pas de ferrailleurs dans notre municipalité qui récupèrent les D3E.
- Je ne sais pas.

Q.16. Question ouverte. Que pensez-vous des activités des ferrailleurs dans votre municipalité ? Avez-vous des observations particulières ou des commentaires à ce sujet ?

Q.17. Comment percevez-vous le travail des ferrailleurs qui ramassent des D3E pour leur propre compte et revendent les métaux aux recycleurs ? Veuillez ajouter vos commentaires, au besoin. Plusieurs choix possibles.

Options de réponses :

- Ces ferrailleurs sont de concurrents des services municipaux et des services de l’ARPE.
- Ces ferrailleurs rendent service à la population en contribuant à la récupération des métaux.
- Ces ferrailleurs contribuent à la protection de l’environnement.
- Ces ferrailleurs nuisent à l’environnement.
- Ces ferrailleurs devraient être mieux encadrés.
- Ces ferrailleurs devraient pouvoir continuer leurs activités sans entraves.
- Je n’ai pas d’opinions.
- Ma municipalité ne se préoccupe pas des activités des ferrailleurs.
- Ma municipalité se préoccupe des activités des ferrailleurs.

Q.18. Question ouverte. Enfin, dites-nous si vous avez d’autres commentaires concernant la Responsabilité Élargie des Producteurs (REP) pour la gestion des D3E ou concernant le programme de l’ARPE Québec. Aimeriez-vous voir des changements apportés à ce programme ? Aimeriez-vous voir des améliorations apportées à la réglementation ? Si vous n’avez aucun autre commentaire, veuillez inscrire « non ».

Appendix 4. Quotable quotes from interviews

These participants' comments caught my attention and provided rich details about some of the social, economic, and environmental dynamics at work in the urban e-waste collection and recycling scene in and around Montréal.

A young man and new curbside scrap metal collector

> "I am having the best time ever! I have no boss to report to, I have my own schedule, and every day is like a treasure hunt. I am making hundreds of dollars each week, and I can be in my pajamas in front of the television at 3:00 p.m. relaxing and stripping cables. I am currently doing this with a friend because he has a car, but soon I will buy my own car and be fully independent."

A scrap metal collector bringing mixed appliances to a big scrap metal recycler

> "It doesn't matter what it says on the sign (regarding refrigerant gases), this guy will still take old fridges, even if they still have their compressors. Heck, this guy will take anything. If your dead grandmother has a few golden teeth, he'll take her as well!"

A man and his wife dismantling computers and air conditioners by the curb, near a big scrap metal recycler's premises

> "This is what my father taught me to do, that is all I know."

A small scrap metal collector

"I used to be a really bad boy when I started collecting scrap metal a few years ago. A few times, I pilled up scrap copper cables under a highway overpass and put it on fire. That is the fastest way I know to get rid of the plastic casings. I stayed a few blocks away, and would watch the firemen go by and light out the fire. They left the copper there so I just had to go pick it up. Then, after a few times, I saw all the black smoke from the fires and thought of the firefighters and the trouble I was causing. I figured this wasn't responsible, so I stopped. I don't know if other people do this. If I didn't know any better and if I lived way out in the country it could be tempting, because it is faster and gives you top-grade copper for reselling."

A small e-waste collector with refurbishing and reuse operations

"There is no way I'll ever join the Producer Responsibility Organization's program. It is way too strict, too much paperwork, and they won't support reuse. I heard the government wants to crack down on people doing recycling outside of the program, and I guess they'll either put me out of business or force me to join the official program. That won't be good for reuse. My business supplies all the spare parts to the small repair shops in Montréal."