

Co-Modality: Opportunities and Barriers in the Greater Toronto Area

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

The Greater Toronto Area is said to be one of the fastest growing regions in Ontario experiencing many challenges due to the influx of population and the demand for goods and services. Amongst the challenges include externalities associated with the last mile delivery of goods such as traffic congestion, emissions of Green House Gases, and illegal parking of delivery vehicles posing as threats to active transportation.

The purpose of this study was to identify opportunities for combining both passengers and freight (parcels) in the same vehicle at the same time (co-modality) and barriers that might hinder such a practice in the city of Toronto. The study also sought to identify current co-modal practices in the Greater Toronto Area. The methodology employed for the research was the exploratory research design using semi-structured interview guides to collect valuable information from stakeholders in the city of Toronto through telephone interviews and face-face interviews. Again, information was obtained through literature review. The information collected from the interview process were analysed using the thematic framework analysis.

Findings from both the literature review and the collection of information from stakeholders revealed that there are indeed both environmental and economic benefits of co-modality. Shipper Bee and A-Way Express are two companies that practice co-modality in the Greater Toronto Area. Opportunities which exist in the city for co-modality included the willingness of the city officials to pilot new programs to reduce congestion, the growth of e-commerce in the city allowing businesses in the freight industry to adopt new business models, and the availability of public transit which can be utilized to move freight during off-peak periods. Barriers identified included a by-law which prevents the taxi industry from engaging in such a practice, conflicts with passenger schedules, the risk of high insurance rate premiums, and safety concerns.

Based on the findings of the study, there is, indeed a promise for co-modality in the city of Toronto. It is recommended that stakeholders must co-operate to the successful implementation of co-modality. Another recommendation is that the Municipal Licensing and Standard of the city of Toronto should review the by-law which prohibits co-modality in the taxi industry, taking a critical look at the business operation of Shipper Bee

company. Finally, the safety of passengers must be ensured through the scanning of parcels to reduce the safety and security risks involved in the movement of both passengers and freight.

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TABLE OF CONTENTS

Author's Declaration	ii
Abstract	iii
Acknowledgments	v
LIST OF TABLES	ix
LIST OF FIGURES.....	x
CHAPTER ONE: INTRODUCTION	1
1.1 Background to the Study	1
1.2 Problem Statement	3
1.3 Research Questions	4
1.4 Significance of Study	5
1.5 Structure of the thesis.....	6
CHAPTER TWO: LITERATURE REVIEW	7
2.0 Introduction.....	7
2.1 Urban Transportation Sustainability.....	7
2.1.1 Sustainable development.....	7
2.1.2 Sustainable Urban Transportation.....	9
2.2 The concept of city logistics	11
2.2.1 Traffic Congestion	13
2.2.2 Environmental pollution	14
2.3 Categories of City Logistics	15

2.3.1 Regulatory measures	15
2.3.2 Proximity Stations	16
2.3.3 Advanced Technology.....	19
2.3.4 Collaborative Urban Logistics.....	20
2.4 Evaluation of City logistics	21
2.4.1 Identifying specific problem	22
2.4.2 Determining goals and objectives	23
2.4.3 Defining criteria for evaluation.....	24
2.4.4 Methodologies to measure performance	25
2.5 Co-modality.....	27
2.5.1 Transport Integration	27
2.5.2 Intermodal Transportation	29
2.5.3 Multi-modal Transportation.....	29
2.5.5 Co-modal Transportation	30
2.5.6 Material Flows in a City	31
2.5.7 Vehicles promoting co-modality	33
2.6 Impacts of co-modality	37
2.7 Barriers of co-modality.....	38
2.8 Opportunities for co-modality.....	40
2.8.1 Population growth and urbanization	40
2.8.2 E-commerce growth	40
2.8.3 The desire for speed	41
2.8.4 Climate change and sustainability.....	41

2.9 Global implementation of Co-modality	42
CHAPTER THREE: METHODOLOGY	45
3.1 Introduction.....	45
3.2 Study Area.....	45
3.3. Research Paradigm and Design	47
3.4. Data sources, target population, sampling procedure and sample size.....	47
3.5 Research Instrument and data collection.....	48
3.6 Data Analysis.....	49
3.7 Ethics.....	50
3.8 Rigour, trustworthiness and quality.....	52
3.9 Fieldwork and related challenges	53
3.10 Conclusion	53
CHAPTER FOUR: RESULTS AND DISCUSSION.....	55
4.1 Introduction.....	55
4.2. Definition of co-modality	55
4.3 Potential impacts of co-modality	58
4.4 Integration of co-modality in policy documents	61
4.5 Existing co-modal practices in the GTA.....	63
4.6 Benefits of co-modality	67
4.7 Barriers of co-modality.....	69
4.7.1 Safety concerns	69
4.7.2 Conflict with passenger schedules	70
4.7.3 Technology (IT systems).....	71

4.7.4 Rise in insurance premium rates	72
4.7.5 Reluctance to shift from the traditional business model	73
4.8 Overcoming barriers of co-modality	74
4.8.1 Co-operation amongst stakeholders	74
4.8.2 Technological and financial investment.....	75
4.8.3 Piloting co-modal solutions.....	76
4.8.4 Security measures	77
4.9 Opportunities for co-modality in Downtown Toronto	78
CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS.....	80
5.0 Introduction.....	80
5.2 Summary of findings	80
5.2.1 Current practices of co-modality.....	80
5.2.2 Perceptions of co-modality	80
5.2.3 Barriers of co-modality	81
5.2.4 Opportunities for co-modality	81
5.1 Recommendations for Planners and Policy Makers	81
5.3 Limitation	83
5.2 Future Research.....	83
References	84
APPENDICES	93

LIST OF TABLES

Table 2.1: Opportunities and challenges of locker and service point.....	18
Table 2.2 provides a summary of the categories of city logistics.....	21
Table 2.3 Objectives and goals of stakeholders.....	23
Table 2.4 Summary of criteria for performance measures.....	25
Table 2.5: Vehicles promoting co-modality.....	34
Table 2.6 Co-modality between transportation modes.....	35
Table 2.7 Impacts of co-modality.....	37
Table 2.8 Barriers of Co-modality.....	39
Table 3.1 Phases of data analysis.....	50
Table 3.2 Ethical Issue Concerns.....	51
Table 4.1 Potential impact of co-modality.....	59

LIST OF FIGURES

Figure 2.1: Conceptual Framework.....	10
Figure 2.2: A three-wheeled motorcycle.....	36
Figure 2.3: Greyhound Courier Express.....	42
Figure 2.4: Yamato company using streetcars for low carbon parcel transport.....	44
Figure 3.1 Map of Downtown Toronto.....	46
Figure 4.1: A hive where parcels are stored for pickup.....	66

CHAPTER ONE: INTRODUCTION

1.1 Background to the Study

The Greater Toronto Area (GTA) is a very significant generator and distribution point of urban freight movement activities in Canada. The movement of freight in the GTA occurs day in, day out and as such, many businesses and personal consumers rely on the distribution of these goods. The effectiveness of the transportation network system and how freight is moved is very important to build and sustain economic prosperity both locally and nationwide.

The 2041 Regional Transportation Plan, a visionary transportation plan for the Greater Toronto Hamilton Area (GTHA), established in 2018, outlines effective transit and transportation solutions to strengthen global attractiveness, improve the quality of life, and protect the environment (Metrolinx, 2018). It highlights 9 priority actions to achieve its goals, amongst them a call for a comprehensive goods movement strategy in the GTHA. Consequently, an Urban Freight Study was conducted in 2011 which looked at freight transportation challenges in the GTHA. Amongst the action plans of the study to reduce freight transportation challenges are to explore opportunities to move freight on transit, using technology to optimise and manage the movement of goods, as well as improve and coordinate public outreach on urban freight.

According to Metrolinx's Regional Transportation Plan (Metrolinx, 2018), there is a continued need to improve the way in which urban freight is moved throughout the GTHA. This is because of the impacts of urban freight movement on the quality of life as well as the challenges of competing priorities on road infrastructure especially in downtown core areas. Again, they emphasize on a strong relationship between the movement of urban freight and passengers to maintain competitiveness of the regional economy.

The 1987 Brundtland Commission report on sustainability brought global attention to the concept of sustainable development and as a result, policy makers, urban planners, and urban research scholars have worked to include the principles of the report in the urban context (Childers et al., 2014). The report defined sustainability development as development that meets the needs of the present without compromising the ability of

future generations to meet their own needs. The concept of sustainable development has proven to be a very important issue which points policy in a clear direction yet can adapt to new emerging issues under technological and economic conditions, environmental, and social aspirations (Goldman & Gorham, 2006). Although this is the case, the transportation sector is one of the areas proven to be particularly difficult in the advancement of sustainable development policy due to current trends in the sector (Kennedy et al., 2005). Population growth and urbanization plays a major role in the challenges to making the transportation sector more sustainable thus, major cities around the world are facing challenges in meeting mobility demands and the movement of goods.

The concept of urban transportation sustainability, however, calls for the need to implement policies and plans to achieve a diverse and balanced mix of transport modes that enables conservative use of energy and funds to meet mobility and goods movement needs. The objectives of a sustainable urban transportation include increasing energy efficiency and emission standards of motorized vehicles, efficient use of the existing systems, and the reduction in travel demand by motorized modes by reducing the number of trips and trip lengths. Cities, however, are looking for sustainable and innovative strategies to meet these objectives to reduce the challenges associated with the movement of both passengers and freight.

Freight integration, a step towards sustainable freight movement, has been championed over the last few years to reduce the externalities associated with freight movement. (European Commission, 2006, Permala et al., 2009, Hanaoka & Regmi, 2011). As a result, researchers in urban freight movement have coined several phrases and concepts to communicate their idea of freight integration. However, transport integration policies continue to be an ambiguous concept and imprecise (Potter, 2010). These concepts seem to be inconsistent in terms of definition and explanation. Examples are, Veenstra & Franses (1997) in their research used the term co-integration, the European Commission (2006) coined the term co-modality, Trentini & Mahléné (2010) used the phrase Passengers and Goods Cohabitation, Cochrane (2012) in his research provided the term Freight on Transit, and Buldeo Rai, Verlinde, & Macharis (2018) used Crowd Logistics in

their research. The latter term is a reference to the increasing role that gig economy workers are playing in the last mile delivery segment of urban freight movement.

In this research, the focus will be on the concept of co-modality, as an example of freight integration in the GTA, intending to optimize efficiency in urban goods movement and to achieve both economic and environmentally sustainable goals. This study explains co-modality as the movement of freight alongside passengers in the same vehicle or different passenger and freight vehicles using the same transport infrastructure in order to obtain optimization within an urban context.

1.2 Problem Statement

The GTA is projected to be the fastest growing region in Ontario, accounting for over 65 per cent of Ontario's net population growth to 2041 (Ministry of Finance, 2018). The increased population, the growth in the use of ICT such as smart phones, and the development of e-commerce have increased parcel deliveries in urban centres (Ronald et al., 2016). Again, the increase in on-demand instant deliveries because of the growth of the 'platform economy' and the 'gig economy' continues in most large areas. According to Winnesota's Regional Transportation Plan, 60% of US consumers would pay more than \$10 to get furniture delivered on the day it was ordered (Region of Winnesota, 2017). The sustainability of urban logistics is becoming an even more important issue for rapidly growing cities in the region.

In freight transport, the last mile is the most cost intensive and experience several challenges due to the rising traffic congestion, growing urbanization, and e-commerce, thus, last mile logistics continues to be least efficient stage of the supply chain (Ranieri et al., 2018). Active transportation has broadly been encouraged in our urban areas with the introduction of bike lanes and bike racks, but the problem with last mile delivery is that during peak hours, there have been issues where delivering of packages poses threats to active transportation. For example, in downtown Toronto, there have been multiple scenarios with increasing frequency of illegally parked delivery vehicles, parking on bike routes and even sidewalks, and this contributes to slower traffic and increased risk of

accidents. The city reported that in 2016, there were 2.2 million tickets issued to vehicles on Toronto's roads including many delivery vehicles (City News, 2017). As a result, the city, in response to ease gridlock in the downtown core, has created a pilot project where fifteen courier delivery zones around the downtown core areas have been created to help in daily deliveries.

Congestion continues to be a major problem in the GTA to the extent that all levels of government in Canada have made substantial investments in transportation infrastructure, specifically urban transit in recent years (Urban Transit Task Force, 2010). Congestion in the downtown areas continues to be a challenge due to the rise of e-commerce which has contributed to increased deliveries, and is one of the impeding factors to achieve competitiveness and profitability of regions and industries (City lab, 2017; Global News, 2017). According to Global news (2017), Canada Post delivered about 1 million parcels per day during the Christmas season and this poses challenges regarding easy flow of traffic and active transportation. The social and economic cost of congestion in the GTHA are approximately \$6 billion to \$11 billion per annum (Rossi, 2018). Other externalities from freight transportation such as noise, road accidents, and air pollution continue to be a challenge for the region (Zimmerman & Wiginton, 2017).

It is therefore pressing to find more sustainable ways for efficient movement of goods in the region, but also to reduce the externalities associated with it. Stakeholders (the government, businesses and personal consumers) want to see efficient goods movement in the GTA (Ministry of Transportation of Ontario, 2004), and in so doing, a review of options available must be explored in order to make the region more competitive and allow for a more environmentally sustainable and efficient movement of freight in the region.

1.3 Research Questions

The following are the research questions that will be answered through this research study:

1. What is co-modality?
2. What are the potential impacts of co-modality?

3. What are the existing co-modal practices in the GTA?
4. What are the barriers and opportunities influencing the potential for co-modality in the GTA?

1.4 Significance of Study

Canada's 2nd Biennial Report on Climate Change projects that, nationally, freight emissions will eclipse passenger emissions in the year 2030 thereby neutralizing the efforts made to reduce emissions in the transportation of passengers (Plumptre et. al, 2017). This projection could be a standing block for Canada to meet its climate targets and live up to the Paris Agreement commitment. However, freight movement is also an essential component to the economy of Canada. Most industries and economic activities that consumers and producers depend upon – from grocery stores and restaurants to retail shops, office supplies, and construction – rely on the distribution of goods. It is thus essential to manage urban freight and its impact associated with it.

The concept of co-modality has been promoted in urban areas. There are numerous studies on the benefits of co-modality in urban areas (Giannopoulos, 2008; Rossi, 2012; Engstrom, 2013; Ronald et. al., 2016). According to Best Fact (2012), one major benefit of co-modality is that it can reduce from 20 – 40% the carbon footprint per freight movement. Co-modality makes room to reduce inefficiencies in the last mile delivery phase through the delivery of parcels on transit vehicles or taxis that are transporting passengers, leveraging the available vehicle capacity.

However, it is important to establish what is meant by co-modality because there are inconsistencies in the definition provided in literature. Co-modality presents opportunities to transport freight alongside passengers and accommodates the transporting of freight using the same transport infrastructure. Examples are the use of taxis transporting both passengers and freight on our roads or the use of the public transit vehicles to transport both freight and passengers. The main aim is to reduce the externalities associated with urban freight movement and to achieve greater optimization and efficiency.

1.5 Structure of the thesis

This thesis is structured in five parts. Chapter one is the introductory chapter which provides the background of the study, the problem statement, research questions and the significance of the study. Chapter two provides a review of the relevant literature on the concept of city logistics, categories of city logistics, background of co-modality, the potential impacts of co-modality and the opportunities and barriers of co-modality. Chapter three explains the methodology used in this study. This includes the study area, the research paradigm and design, the sources of data, ethical considerations and fieldwork challenges. Chapter four explores and discusses the results from the data collection which includes the potential impacts of co-modality, benefits of co-modalities, and the challenges of co-modality. Chapter five presents the recommendations and the conclusion to the thesis.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

This chapter of the thesis reviews the literature related to co-modality. The issues covered include the concept of urban transportation sustainability, the concept of city logistics, the categories of city logistics, the background of co-modality, the potential impacts, challenges, opportunities of co-modality, and examples of global implementation of co-modality. Co-modality emerged from the field of city logistics and this chapter of the thesis begins by explaining the concept of city logistics and the inception of co-modality.

2.1 Urban Transportation Sustainability

The 2030 Agenda for Sustainable Development which has been adopted by all United Nations Member States in the year 2015 calls for action by all member countries to ensure the prosperity, peace, and the sustainability of people and the planet, now and into the future (United Nations, 2019). By 2050, 70% of the world's population will be living in cities and this makes it critical in achieving a sustainable future. Thus, it is not surprising that the one of the Sustainable Development Goals, specifically SDG 11, formulated by the UN includes making cities and human settlements inclusive, safe, resilient and sustainable (United Nations et al., 2014). One of the most important areas of sustainable development is the transport sector.

On one hand, the impact of sustainable development is characterized by economic, social, and environmental benefits and on the other hand, there is the dire need to mitigate the adverse effects of urbanization in our cities (Cheba & Saniuk, 2016). It is key to understand the concept of sustainability as well as to understand sustainability in the transport sector because of the relevance it plays in meeting the mobility needs and the movement of goods in our cities.

2.1.1 Sustainable development

The concept of sustainability in the transportation sector has over the past two decades gained numerous attention (Black, 2010, Nejad, Feyzi, & Sedigh, 2010). Transportation

planning, research, and policies have focused on a new paradigm, emphasizing on ways to improve the transportation system where people and goods can be moved at an efficient and faster rate without less impact on the environment. The motivation behind this, however, is global warming, which has posed a lot of challenges in our cities. Multiple lines of scientific based research has proven that the climate system is indeed warming Pachauri et al., 2014, Swim et al., 2009, Schmidt et al., 2009, and Pachauri et al., 2014).

The sustainability concept based on literature has highlighted numerous definitions, but most of these definitions refer to the Brundtland report's (Our Common Future) definition of sustainable development. The term sustainability became widely popular after the introduction of the report in 1987 (Black, 2010). In the report, sustainable development is defined as, "the development that meet the needs of the present without compromising the ability of future generations to meet their own need" (World Commission on Environment and Development, 1987). The report also highlighted three bottom-line themes which must be measured regarding sustainability or sustainable development. These themes are the economic, social, and environmental dimensions.

Schiller, Bruun, & Kenworthy (2010) communicated the three pivotal reasons why sustainability in the transportation sector has become a predominant topic. These three reasons are:

- the highway-oriented planning which emerged after the World War 2 because of the rapid growth of car owners especially in North America and Western Europe. This rational comprehensive planning was counterproductive as air pollution increased and neighbourhoods were torn down to accommodate the expansion of highways
- the knowledge that was realised from research proved that traffic in cities were reduced from traffic calming (traffic calming refers to the use of physical features and other methods to improve the safety of cyclists, pedestrians, and motorists on roads) and pedestrianization (pedestrianization refers to the complete dedication of a street to pedestrians, not allowing motorists to use that particular road).
- the Brundtland report which made sustainability become a core matter in major sectors of the economy.

The effort to define a sustainable transportation system has been attempted by various authors and commentators, but the similarity amongst these definitions fall under these themes:

- promoting increased access to goods and services without jeopardizing human quality
- perform at a higher efficiency rate based on available scarce resources
- achieving numerous environmental, social, and economic goals
- emphasizing on ways to reduce or reverse the harmful trends of transport facilities.

2.1.2 Sustainable Urban Transportation

A sustainable transportation system is one that contributes to economic growth and social equity of people without having a negative impact on the transportation infrastructure and the atmosphere (Behrends et al., 2008). May et al. (2001) in their research defined six objectives of sustainable urban transport which are based on the principles of sustainable development by the Brundtland's report. The principles are:

- livable streets and neighbourhoods
- protection of the environment
- equity and social inclusion
- safety
- contribution to economic growth
- economic efficiency

Urban freight transport, which is a fundamental component of urban life, includes the delivery of consumer goods in cities and suburban areas as well as the reverse flow of used goods in terms of clean waste (OECD, 2003). Most goods which are brought in urban areas are transported from different areas around the world, thus involves many processes to get to the final consumer. According to Behrends et al. (2008), the objectives of sustainable urban freight transport includes:

- the reduction in air pollution, GHG emissions, waste and noise to ensure that there are no negative impacts on the health of citizens
- to improve the resource and energy efficiency and cost effectiveness of the transportation of goods
- ensuring the attractiveness and quality of the urban environment through the reduction in accidents and minimizing the use of land.
- to ensure the accessibility offered by the transport system to all categories of freight transport

Figure 2.1 provides a conceptual framework of sustainable urban freight transport which must be considered for interventions in urban freight movement challenges.

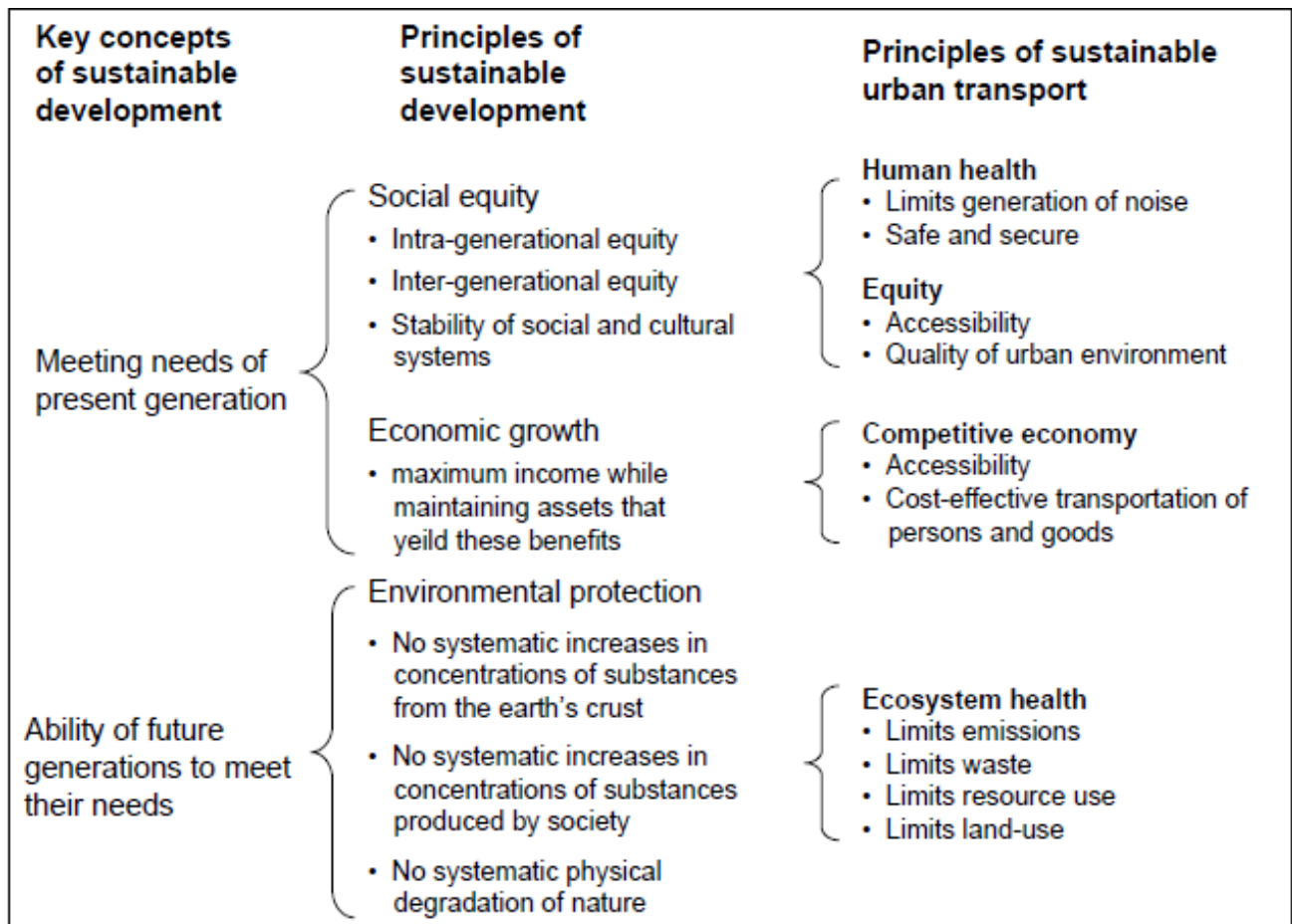


Figure 2.1 Principles of Sustainable Urban Transport

Source: Behrends et al. (2008)

Today, hundreds of cities are searching or pursuing strategies that are sustainable under the banner or as part of the broader sustainability initiatives. This is due to the externalities present in freight movement especially during the last mile. Sustainable urban freight movement policies seek to reduce these externalities. Many strategies and policies have been introduced in cities to mitigate these externalities and city logistics, which is a broad concept to move goods in a sustainable way, are amongst them.

2.2 The concept of city logistics

Cities are the concentrated locations of production and consumption. Urban activities are supported by and interact with the movement of bulk volumes of goods through supply networks that links major land uses such as warehouses and retail facilities or industrial companies and manufacturing facilities. These flows are usually concentrated around nodes such as ports, distribution centres, trucking depots, airports, and rail terminals (Cui et al., 2015). Last mile deliveries flows are dispersed in their nature with wide dispersion of recipients with a constrained time window or delivery as well as high possibility of delivery failure (Xiao et al., 2017). Freight movements are intricate and is growing in number in urban areas since urban population have increased substantially over the past decade (United Nations et al., 2014). The increased number of freight movements means an increase in the complexity of their operations and their impacts in urban areas.

The term “logistics” has been described by McKinnon et al. (2010) as a term widely dominant in freight studies regarding the moving, storing, and handling of goods as they are being transported from its natural form, through to processing, and then to the final user or stage. According to Rodrigue et al. (2017), city logistics refers to the strategies that can improve the overall efficiency and performance of freight distribution while mitigating their impact in urban areas such as traffic congestion and environmental externalities. Benjelloun & Crainic (2008) argues that the term “city logistics” has been devised to stress on the need for a systemic view of related negative consequences of freight movement within an urban context to sustain human life. The primary aim of city logistics is to alleviate the unsustainable practices in freight transportation and reduce the externalities associated with it.

As urban freight transport issues are complicated, city logistics require an integrated approach from different disciplines such as land use planning, information engineering, geography and social science, and transport planning (Taniguchi & Thompson, 2015). Through this collaboration among stakeholders, innovative schemes can be conceptualized and adopted to reduce environmental, social, and economic cost within urban areas. There are four main stakeholders in city logistics:

- a. Shippers and receivers,
- b. Administrators,
- c. Freight carriers and
- d. Residents.

Shippers and receivers include people and companies who hope to maximize delivery services available to receive or send their parcels through a fast and reliable freight transport process by choosing the appropriate freight carriers. They hope to do this at a lower cost. Administrators are the government or municipalities with the objective to promote economic development by providing the freight infrastructure in many cases. Freight carriers are organisations that aim to meet the demands of shippers usually through a time windows set by the shippers for the delivery of goods. Residents, however, are individuals who are concerned citizens in most cases in society who have the interests to reduce air pollution, congestion, and noise in their local areas but want to get their packages delivered on time. It is important to state that these stakeholders have different objectives and goals and as a result, smooth coordination amongst them becomes a hurdle.

The freight sector, although an important and crucial component of urban areas, has negative externalities associated with it. The phase where the products moves from the distribution centre or from a store or a depot to the customer comprises of one of the most costly and highest polluting sectors in the supply chain. This phase is known as the last mile delivery phase. The rise in e-commerce and the platform economy have increased the demand for goods, and the challenges of the last leg of delivery where parcels get to the consumer's destination has become a big problem (Brown & Guiffrida, 2014).

A survey of 5000 Canadian online shoppers which was done in the year 2016 for Canada Post found that one in four respondents spent more money online than they did the year before. The main reason being the convenience and the opportunity to compare prices of products (The Star Vancouver, 2018). City logistics seek to increase efficiency in the delivery of freight at the same time reducing the externalities caused by the transport of freight in the urban area. Many dense urban areas are hugely impacted by the externalities caused by urban freight. They include traffic congestion and environmental pollution which includes air pollution and GHG emissions.

2.2.1 Traffic Congestion

As urban population increases, challenges caused by densification and urbanisation have affected the performance of the transportation system. In last mile delivery, the most popular transport mode which is adopted is road, but this varies depending on the city's context. An increase in the demand for goods has caused more deliveries to be made and the last mile delivery phase has generated a significant amount of traffic volume with different logistics service providers and carriers all trying to reach the time windows provided by consumers (Ranieri et al., 2018).

During the Christmas season, it tends to be the busiest period for delivery companies because demand tends to be higher than normal. For example, during the festive season in 2018, Glum (2018) reported that Amazon paid people \$20 an hour to deliver packages using their own vehicles because demand for goods delivery was more than what they expected. The increase in delivery in urban areas contributes to congestion, and this reduces the efficiency of the transport system as there tends to be greater loss of time and money. One of the reasons for increasing congestion is linked to parking. Parking is a challenging factor for delivery vehicles especially when they are delivering goods in the downtown core. Finding spots to park has become a daunting task for delivery drivers and as a result some delivery vehicles park illegally, blocking traffic. This contributes to congestion in downtown areas and this affects the reliability of distribution within specific time-windows.

Another challenge due to illegal parking is the threat these delivery vehicles pose to active transportation. Delivery vehicles tend to park in bike lanes and pedestrian routes especially in downtown cores where active transportation has been encouraged (Amin, 2017).

2.2.2 Environmental pollution

Over the years, transportation plans and policies have included strategies and goals to reduce the impact of both passenger and freight movement in urban areas. According to Schliwa et al (2015), urban mobility contributes to 40% of all CO₂ emissions and up to 70% of other pollutants from transport. GHG emissions have a longer-term effect on the health of humans as well as the degradation of both the human and natural environment. Pollutants from diesel burning fuels such as oxides of nitrogen (NO_x) and Particular Matters (PM) triggers asthma attacks and causes respiratory diseases.

Recently, air pollution has become an even greater concern, particularly in Canada and in major cities such as the city of Toronto as this area of topic had received less attention in the past in most Canadian cities' transportation plans (David Kriger Consultants Inc. & CPCS, 2016). It has been projected in Canada's 2nd Biennial Report on Climate Change that freight movement will contribute to higher emissions as compared to passenger movement by 2030 (Environment and Climate Change Canada, 2016). In response to mitigate this projected impact, the Province of Ontario released its Climate Change Strategy and it envisions that by 2030 the demand for goods movement will be met via "road and rail vehicles powered by more efficient, low-carbon technologies" (David Kriger Consultants Inc. & CPCS, p.81, 2016). It also identifies other opportunities in reducing emissions for goods movement to reduce environmental pollution.

There is a popular connotation that freight vehicles are a nuisance in the urban environment, and they contribute to many externalities. However, the purpose of urban freight logistics is to not contribute to these nuisances, but to promote attractiveness, competition, and the sustenance of human activities. The success of urban areas depends on the effectiveness and the efficiency of urban freight logistics. It is therefore crucial to highlight some efforts being done by stakeholders regarding city logistics practices and their contributions to sustainable goals.

2.3 Categories of City Logistics

Metropolitan areas around the world are implementing innovations in city logistics to reduce the impact of urban freight movement. There have been extensive efforts by cities, courier companies, and the federal governments to help reduce the externalities associated with urban freight movement and this section of the research highlights them based on a review of the literature. They are categorised into 4 different components, namely Regulatory Measures, Proximity Stations, Advanced Technology, and Collaborative Urban Logistics.

2.3.1 Regulatory measures

Cities across the world are using regulatory actions as a fundamental tool to reduce urban freight externalities, particularly air pollution, noise, and congestion. Some of the regulatory measures are vehicle weight and size restrictions, restrictions on the vehicle type (truck, cargo cycle), low-traffic zones, time windows and off-peak deliveries, low emissions zones, road pricing, and loading areas (Russo & Comi, 2010; Dablanc et al., 2013; Cardenas et al., 2017). Regulations on delivery time windows within the downtown core in cities is one of the common measures implemented by cities, particularly for pedestrian zones. Although this regulation is a common measure implemented by cities, they require a sound surveillance system to prevent any violation of the rules.

For example, in Toronto, Commercial Loading Zones are being implemented for commercial vehicles and these vehicles can stop in these zones to load or unload parcels but must not park or leave the vehicle unattended while going into the building. This is under Schedule VI (Commercial Loading Zones) of the Municipal Code Chapters. Under Schedule IX (Delivery Vehicle Parking Zones) as well, few sections of the streets are marked with authorized signs as delivery zones and parking is permitted. However, parking while on delivery is limited to a specific time period, i.e. between 15mins to 30mins. This is a pilot project being implemented in the city (City of Toronto, 2018c).

In Rome, access and parking of freight vehicles are restricted by time windows in the downtown core. Heavy vehicles (more than 3.5 tonnes) are permitted parking and access

to the downtown core between 8:00pm and 7:00am. Light duty trucks (less than 3.5 tonnes) are granted permission between 8:00pm to 10:00am and 2:00pm to 4:00pm. Another measure is nighttime deliveries which was done for a trial period in Dublin in order to prevent congestion during the daytime (Russo & Comi, 2010).

The focus of these regulatory measures implemented by cities is to limit freight activities during peak times to reduce emission exposure to daytime populations which causes respiratory diseases, and to mitigate congestion. A similar regulatory measure was done in the city of London where congestion prices were introduced to reduce the emissions in the city core (Litman, 2017)

2.3.2 Proximity Stations

Internationally, about 114 Urban Consolidation Centre (UCC) programmes were identified in 17 countries (12 in Europe and 5 outside Europe). These programmes were either run through a trial period or being fully operational (Allen et al., 2012). UCCs are conceived as an infrastructure investment to mitigate the externalities associated with distribution of goods in the cities. According to Johansson (2018), UCCs have not only the potential to reduce negative externalities but also provides substitute distribution solutions by presenting new transshipment points. Due to high demands for goods by both businesses and consumers and the pressure to deliver goods at a faster rate, UCCs are therefore likely to meet this demand to reduce more trips in the downtown core (Lease et al., 2008). UCCs make room for products to be received from multiple suppliers, sorted out and then distributed to homes and stores. There are economies of scale because UCCs help to reduce the number of distributors in a city, i.e, rather than 10 distributors, only 1 UCC can function but consolidates shipments from various firms.

Another practice being introduced in cities are the creation of pick up point networks where customers can pick up their orders done online or through the phone. These networks have equipment that stores the packages until the customers come to retrieve them. They include locker banks, pack stations, and E-Boxes. These infrastructure are very common in Europe but not in North America (Savelsbergh & Van Woensel, 2016).

The design of pick up points needs to be strategically located in terms of ease of access by road users, pedestrians, or public transit users. Consideration of the type of locker boxes, the number, and station must be considered as well before they are implemented depending on the demand and the population density.

Parcels can also be shipped to either a shop, post office or a petrol station where customers can pick up their goods at their convenience. This type of proximation station is referred to as the attended service point. Parcels can also be sent to specific locations which have intelligent storing equipment and kept there for a while until customers pick up their parcels. This type of proximity station is referred to as the unattended locker point.

According to Weltevreden (2007), there are both opportunities and challenges associated to the implementation of both the locker and the service point. Table 2.1 provides a summary of the opportunities and challenges.

Table 2.1: Opportunities and challenges of locker and service point

Item	Opportunities	Implementation challenges
Locker points	<ul style="list-style-type: none"> • 24/7 self service • Little to no operational labour cost • Parcels are secured 	<ul style="list-style-type: none"> • Parcel size limitation • Requires some amount of planning and time to locate lockers • Possibility of increased use of vehicles for self-pick up
Service points	<ul style="list-style-type: none"> • Business growth for shop owners • Additional service provided (return of parcels) • Optional payments 	<ul style="list-style-type: none"> • Operational labour cost • Possibility of long queues • Possibility of increased use of vehicles for self-pick up

Source: Adopted from Weltevreden (2007)

Although home delivery reduces inconveniences by allowing parcels to be delivered at specific locations determined by customers, there are externalities associated to it during the last mile especially in peak seasons. Proximity stations can be used as an alternate to home deliveries and are being practised especially in countries such as Germany and the Netherlands by companies such as DHL and Tower24. According to Huang (2015), out of the 8.8 million parcels delivered in Germany in 2011, the second highest was the use of proximity stations at 43%.

There are certain factors to be considered before implementing proximity stations. According to Huang (2015), western countries where this has been a success have advanced in economy and well established infrastructure in both ICT and transportation sector. Demand for it must be available and per a survey done in Winchester in the UK, 83% of residents were in favour of the idea (Huang, 2015). Population density as well plays a role in determining the location of the proximity stations.

2.3.3 Advanced Technology

As a result of the improvements in ICT and technology, city logistics has witnessed new innovations introduced in terms of the vehicles used to distribute goods. Electric, Hybrid and Fuel Cell Electric Vehicles (FCEV) have been introduced in cities such as Quebec and they have the potential to reduce externalities associated with last mile delivery (Moultak et al., 2017). Electric trucks have been the most common direction for reducing the impacts of heavy and light duty trucks that run on diesel. Companies like Tesla have already made prototypes of electric freight vehicles which will be commercialized in 2019. During the winter seasons in North America and in some parts of Europe, truck drivers who go on long journeys leave their trucks to run all night due to the freezing weather (Plumptre et al., 2017). Again, if there is congestion in the downtown core, trucks that run on diesel tend to burn more diesel releasing toxics into the atmosphere.

Electric mopeds, motorbikes, bicycles, and other smaller vehicles with three wheels or four wheels have also been introduced as a sustainable method for delivery in urban areas. This is because they are smaller and their impact in terms of air and noise pollution is minimal. They are very useful and better in delivering smaller packages as compared to trucks or delivery vans. As well, autonomous electric vehicles are considered to be something that will be used to deliver goods in the future (Manyika et al., 2013).

Even though the advancement of ICT has led to the growth of e-commerce, ICT has also made it possible to easily collect data on pickup/delivery truck movements or their movements in general within the urban area. This is made possible through Global Positioning Systems (GPS) which are put in delivery vans and trucks, tracking their precise routes. There has been research done which shows the benefits derived from collection of data of delivery vehicle movements (Lin et al., 2013; Xu et. al., 2014). For instance, Lin et. al (2013) applied data mining techniques to discover routing patterns from past scenarios of delivery vehicles. Through that, they were able to design a real time mobile intelligent routing system, which could be installed on the driver's smart phone. The study produced results which stated that travel times within congested urban road networks could be reduced based on the data collected. Again, Teo et al. (2014) analyzed data of pick up delivery trucks with a multi-layered Geographical Information

System (GIS) in Osaka, Japan using a vehicle routing and scheduling model. The model considers the land use in the urban area based on existing urban land plans and then provides a better (faster and free from traffic) delivery operation route

2.3.4 Collaborative Urban Logistics

This approach is a relatively new method of city logistics in last mile delivery in urban areas. It focuses on efficiency in delivery and environmental sustainability. However, coordination among actors plays an important role in the success of collaborative urban logistics.

The main concept of collaborative urban logistics is the sharing or combination of resources, infrastructure, and transport vehicles to make last mile delivery. A variety of proposals have been developed whereby the delivery of medium to small sized goods for last mile should not be done by trucks or vans, but rather through public transit or taxis transporting passengers, and tricycles or bicycles which have space to accommodate small sized packages. The idea is to “kill two birds with one stone”. Ghilas et al., (2013) investigated the opportunity to take advantage of available spaces in a public transit vehicle which runs on a fixed schedule as part of the last mile delivery. They used a model formulation and their findings proved there could be savings in both operation costs, CO₂ emissions, and reduce dense traffic.

Delivery of goods through cycle logistics has been promoted by couriers such as UPS, DHL, and TNT for years now in Europe. Cycle logistics refers to the integration of bicycles including pedal-only cargo bicycles and electric assist cargo bicycles to move parcels within a congested area. Cycle logistics is well established and is growing particularly in Europe, and it has proven to be one of the solid means through which goods can be delivered in urban core areas while reducing negative externalities (Vijayakumar, 2017).

Table 2.2 Summary of the categories of city logistics.

Categorisation	Location	Measures
Regulatory	<ul style="list-style-type: none"> • London, UK • Sao Paulo, Brazil • Paris, France • Rome, Italy 	<ul style="list-style-type: none"> • Low emissions zones • Restrictions on vehicle type • Time windows and off-peak deliveries • Low traffic zones
Collaborative urban logistics	<ul style="list-style-type: none"> • Strasbourg, Germany • Helsinki, Finland 	<ul style="list-style-type: none"> • Cycle logistics • Using public transit to deliver freight
Advanced Technology	<ul style="list-style-type: none"> • Madrid, Spain • Tokyo, Japan • Beijing, China 	<ul style="list-style-type: none"> • Electric freight vehicles • Improvement in efficiency of traffic management systems through advances in sensing • Application of ITS and ICT (GPS, GIS)
Proximity Stations	<ul style="list-style-type: none"> • London, UK • Vancouver, Canada • Groninjen, Netherlands 	<ul style="list-style-type: none"> • Urban consolidation centres • Pick up locker/service points • Urban cross-docking

Source: Adopted from Manyika et al., 2013, Vijayakumar, 2017, Taniguchi & Thompson, 2015

2.4 Evaluation of City logistics

This section of the research highlights ways the on-going practices of city logistics are evaluated. Evaluation of city logistics considers a range of topics relating to the problems that they intend to solve. Evaluation of city logistics is important because it provides the opportunity to assess the impacts of the provided solutions for both local authorities who want to reduce externalities associated with freight transport and for market actors that want to run a profitable solution.

Due to the wide range of benefits and costs of city logistics initiatives for both the private and public sector, evaluation schemes include the consideration of a wide range of issues

to reduce externalities. A review of the solution is conducted in order to determine whether the scheme was successful in achieving the intended objectives as well as to highlight gaps for improvement. This is done by comparing the expected impacts and the realized outcomes.

To adequately evaluate city logistics, several related tasks must be done, and they include:

- Identifying specific problem
- Determining goals and objectives
- Defining criteria for evaluation
- Methodologies to measure performance

These parameters will be explained further to highlight the details on the evaluation criteria for city logistics.

2.4.1 Identifying specific problem

Stakeholders in urban freight have their own problems arising from their contribution to the sustenance of freight movement in urban areas. As stated early on, each stakeholder in urban freight movement have different objectives and goals and as such, encounter different problems and issues they want resolved.

For examples, freight carriers are expected to meet certain standards to deliver parcels and goods to customers within narrow time intervals and due to high demand, encounter problems such as unavailability of adequate parking facilities and conflicts with pedestrians. Administrators are faced with the issue of reducing externalities of freight movement in cities at the same time finding green solutions to encourage urban freight movement for the sustenance of cities. Most interventions require huge initial capital, and this can be a challenge due to scarce resources. Administrators often organise forums and roundtable discussions to bring all stakeholders on board to clarify issues and understand the specific problems of all stakeholders.

It is important to state that the behaviour of stakeholders can be used to determine the problems associated to each stakeholder. When city logistics measures are implemented,

the behaviour of stakeholders involved can be used to determine the adaptation issues due to the changes implemented (Taniguchi & Thompson, 2015)

2.4.2 Determining goals and objectives

The goals and objectives of urban freight movement must be done in the least social cost possible to reduce any externalities associated with freight movement. According to Kaszubowski (2014), the goals and objectives of any city logistic solution should encompass three bottom line principles. They include: mobility, sustainability, and livability. Mobility entails the ability to move goods. Sustainability entails the utilization of existing transport infrastructure, funds or space in a city, and livability entails the provision of optimal living quality for residents. At this stage, it is also important to determine the objectives and goals of each stakeholder and table 2.3 provides a summary of them.

Table 2.3 Objectives and goals of City Logistics stakeholders

Stakeholders	Goals and objectives
Shippers and receivers (customers)	<ul style="list-style-type: none"> • To send or receive goods in the quickest and convenient way possible through a reasonable price. • Successfully pick up items ordered
Carriers	<ul style="list-style-type: none"> • To minimize cost associated with delivering of goods to customers • To deliver goods efficiently and in the quickest way possible
Administrators	<ul style="list-style-type: none"> • To boost economic development through freight movement and increase employment opportunities • To reduce negative externalities associated with urban freight movement • To provide the conducive framework policies to regulate freight movements in cities.
Residents	<ul style="list-style-type: none"> • To reduce traffic congestion, noise pollution, and air pollution near residential and retail areas.

Source: Adopted from Taniguchi & Thompson (2015)

According to the Urban Mobility Package, the goals for a best practice review of any city logistic solution should include the following: modal shift, management of urban freight demand, efficiency improvement, and improved vehicles and fuels (European Commission, 2013). It is important to state that modal shift includes shifting to other modes of transport in dense urban areas when moving goods especially during the last mile phase is currently dominated by road transport. This requires administrators to provide conditions necessary to achieve such modal shift from road to other forms of transport.

2.4.3 Defining criteria for evaluation

It is important to define the criteria for evaluating city logistics initiatives because it is through this that the objectives of each stakeholder can be measured. According to SUGAR (2011), in order to characterize a good practice for city logistics initiatives, it must encompass the following key performance indicators:

- Environmental protection
- Energy and financial savings
- Political consensus
- Level of impact relating to transport operations

Table 2.4 provides a breakdown summary on the criteria used to evaluate city logistics initiatives based on the overarching key performance indicators.

Table 2.4 Summary of criteria for City Logistics performance measures

Criteria	Performance measures
Improving health and safety	<ul style="list-style-type: none"> • Number of crashes • Number of illegal parking • Day time noise levels • Night time noise levels • GHG emission releases from vehicles
Reducing freight operation costs	<ul style="list-style-type: none"> • Less travel times • Delay time • Freight vehicle volumes especially in peak time • Loading and unloading times • Travel speeds • Vehicle purchase/lease cost • Vehicle maintenance cost • Labour cost
Improving business or supply chain efficiency	<ul style="list-style-type: none"> • Total cost minimized • Amount of sale maximized
Agreement amongst stakeholders	<ul style="list-style-type: none"> • Complaints or concerns from each group of stakeholders

Source: Adopted from Taniguchi & Thompson, 2015 and Taniguchi & Qureshi, 2018

2.4.4 Methodologies to measure performance

Conducting surveys or interviews is one of the keyways to know if objectives have met through key performance indicators. According to Allen et. al (2012), there are many examples of structured and semi structured interviews that have been used in urban freight evaluation. They include matters relating to vehicle trip diary, traffic counts, vehicle observation, interviewing freight companies, interviewing drivers, tracking GPS and interviewing suppliers. The methods used included face to face interaction, observation, telephone calls, or automated data collection. Quantitative and qualitative data can be collected from urban freight owners and include topics such as vehicle age, size, type of fuels used, the average distance traveled during deliveries, fuel consumption, and emissions.

Measures of delivery performance can also be collected and include things such as waiting times, delivery times, travel times, number of failed and late deliveries. It is very important to understand the overall support of the city logistic initiative through interviewing key stakeholders including residents. Feedback from key stakeholders provides qualitative data that are crucial for guaranteeing the success of the scheme and to minimize any adverse impacts because of the intervention. Perceptions are important and efforts should be made to record them.

Another form of methodology that can be adopted to measure performance is through data modelling. Computer-based models are used to predict the effects of city logistics solutions. There are many complex models adopted to measure the performance of city logistics initiative in freight movement. According to Taniguchi & Thompson (2015) modelling can be used to predict the behaviour of freight stakeholders, describe traffic flows of freight vehicles and passenger cars on urban roads, and quantify the changes in costs of logistics activities, GHG emissions, and noise levels. There are three different types of models used in city logistics namely demand models, impact models, and supply models. With supply models, traffic demand and traffic congestion are needed to forecast the travel times and delays in the urban traffic network. Impact models are used to determine the effects of environmental, economic and social schemes through city logistics. Demand models are used to forecast traffic links and truck flows based on the origin and destination patterns as well as the goods generation and vehicle production.

According to Anand et al. (2016) and Taniguchi et al. (2007) there have been interest in agent-based models that can predict the behaviour and communication amongst stakeholders in city logistics. They argue that such models can predict the unforeseen effects of city logistics or urban freight policies introduced by administrators.

Another common model used in city logistics is vehicle routing and scheduling models and this model is used to foretell the impact of new vehicle types introduced to reduce the externalities of city logistics (Hassall & Thompson, 2011).

2.5 Co-modality

The movement of freight occurs in every urban centre. Most industries and economic activities that consumers and producers depend upon – from grocery stores and restaurants to retail shops, office supplies, and construction – rely on the distribution of goods. Freight movement has become an essential component in sustaining the economy of cities.

Nonetheless, the issues associated with freight movement in cities, being one of the source of carbon emissions, has often been overlooked (Wiginton, 2017). It has been projected in Canada's 2nd Biennial Report on Climate Change that freight movement in Canada will contribute to higher emissions as compared to passenger transport by the year 2030 (Environment and Climate Change Canada, 2016). Other externalities such as noise and traffic congestion have also increased alongside.

Historically, planning for freight and passenger transportation has been viewed as two separate entities, and this presented its challenges. Consequently, transport integration, i.e., incorporating both passenger and freight movement when planning for transport, has been widely championed yet it remains a vague and not clearly defined concept. (Potter, 2010). Due to this, many definitions have emerged to promote and understand an integrated transport system, which seeks to address environmental and economic goals. Integration aims to combine different modes of transport (eg. rail and bus services) to convey both passenger and freight. Concurrently, the terms which have emerged to promote integration in freight movement are used interchangeably (Givoni & Banister, 2010), but for purpose of this research, a clear and definitive explanation of these terms will be provided, and a clear distinction will be made.

2.5.1 Transport Integration

The concept of transport integration has been featured in European transport policies since the 1980s (Geerlings & Stead, 2003). This integration principle in the transport sector has had legislative force since the 1986 Single European Act and the Maastricht and Amsterdam Treaties which were signed in 1992 and 1997 respectively, strengthening

the integration concept. The idea of including environmental awareness into the European Union's transport sector appeared in various EU Environmental Action Programs and Policies (Givoni & Banister, 2010). Amongst these policies are the 1990 Green Paper on the Urban Environment, the 2001 Sustainable Development Strategy, the 2005 review of the Sustainable Development Strategy, and the 2004 Thematic Strategy on the Urban Environment.

In the Canadian context, the Canadian Transportation Act Review identifies priorities and actions that will promote Canada's long-term economic well-being in the transportation sector (Transport Canada, 2015). There were several public consultations held and recommendations given which sought to promote the integration in the transportation sector. In the year 2016, there were public stakeholder consultations which sought to seek the views and aspirations of Canadians on how to make the transportation system better, safer, and cleaner. The Transportation 2030 policy document has many key themes to improving the transportation industry in Canada and one of the key themes in this document is a Green and Innovative Transportation System which aims at planning for a safe, secured, innovative and integrated transportation system in Canada (Transport Canada, 2013)

Freight and passenger movement integration has witnessed different terms coined by different transport researchers. Veenstra & Franses (1997) in their research used the term **Co-integration**, the European Commission (2006) coined the term **Co-modality**, Trentini & Mahléné (2010) used the phrase **Passengers and Goods Cohabitation**, and Cochrane (2012) in his research provided the term **Freight on Transit**. These are some examples of the terms that have popped up from research in passenger and freight movement integration. In addition to the terms presented, there are more traditional terms such as **intermodal**, **multimodal**, and **co-modality**. It is essential to understand co-modality in the context of other traditional terms related to freight integration

2.5.2 Intermodal Transportation

According to Bektas & Crainic (2007), intermodal transportation seeks to integrate different modes and services of transportation to improve the efficiency of the distribution process, contrary to these transportation modes working in an independent manner. They define intermodal transportation as the moving of **people or freight** from one point to the other by a sequence of at least two transportation mode. Transferring from one mode to the other are performed at intermodal terminals. In their explanation of freight intermodal transportation, they argue that freight intermodal transportation is, however, not restricted to containers and intercontinental exchanges. They provided an example such as the transportation of express and regular mail delivery, which sometimes involves air and land transportation through truck or rail, as well as local pick and delivery operations by truck.

According to DeWitt & Clinger (2000), “intermodal” has been applied in many instances for passenger transportation and the containerization of freight. They argue that intermodal freight transport refers to the use of multiple modes of transport to convey a shipment from origin to destination.

Crainic & Kim (2006) also argues that intermodal freight transportation refers to the movement of a person or a load from its source to its endpoint by a sequence of at least two transportation modes, the transfer from one mode to the next being performed at an intermodal terminal. However Crainic & Kim (2006), stresses on the importance of intermodal terminals and how goods are transported over various modes (rail, road, air, sea) and various carriers without any handling of the goods (sorting and grouping) during these transfers.

2.5.3 Multi-modal Transportation

The term “multimodal” has different meanings and interpretations in transportation literature. The Government of Ontario (2001) in the Greater Toronto Transportation Authority Act states that multimodal refers to “the availability, provision or use of more than one mode of transportation, such as automobiles, walking, cycling, buses, rapid

transit, including subways and transitways, rail, including commuter and freight rail, and trucks”. Litman (2017) also refers to “multimodal” as the transportation and land use planning that includes varied transportation options such as cycling, public transit, automobile, and walking, and accounts for land use factors that affect accessibility.

Goh et al. (2008), in their research, refer to multimodal as the integration in the transport sector where freight is moved between two or more modes usually operated by one carrier or under the ownership of one operator. Dua & Sinha (2015) also state that multimodal transportation refers to the inclusion of different transportation modes and nodes in global supply chain with the aim of providing goods all over the world at an optimum cost. They also stress on the fundamental aim of multimodal transportation as achieving economies of scale in the long-haul distance travel.

Besides the movement of goods, multimodal transportation also involves the movement of people from one place to the other. The Canadian Chamber of Commerce (2009) has highlighted a Multimodal Transportation Infrastructure Strategy which seeks to make Canada a competitive gateway for inbound and outbound trade and travel. This strategy involves:

- Connections between the public transit systems to international and domestic airports
- Air, rail, marine, and rail infrastructure connecting to major economic hubs and boarder points.
- A high-speed rail network that fits within this multimodal transportation system.

2.5.5 Co-modal Transportation

Co-modality, a notion introduced by the European Union, refers to the process of combining alternative mode of transports to improve the efficiency and promote sustainability of transportation systems (European Commission, 2006).

Giannopoulos (2008) in his research to appraise the progress of development of co-modal freight centres in Greece likened the term to multimodal. He explains co-modality as the

development of infrastructure and services that will promote the optimal combination of individual transport modes. According to de Stasio et al. (2011), co-modality refers to the “use of different transportation modes on their own and in combination in order to obtain an optimal mobility outcome in terms of travel effort as well as transport sustainability and supply efficiency”. Taniguchi & Thompson (2002) argues that co-modality can be met when a combination of passenger and freight transport services are integrated using either public transit or private transport for carrying freight alongside passengers. Rossi (2012) also argues that co-modality differs from intermodal transportation in its focus on optimisation: the use of cleaner and less polluting vehicles.

2.5.6 Material Flows in a City

In urban studies, “freight” refers to produce or things that are being transported through water, land, and air with a commercial gain or financial benefit derived from it. From literature, cargo is used interchangeably with freight. “Goods” refers to tangible materials that satisfy human wants and provide utility (Macintyre, 2011). Goods movement relate to the transportation of products which does not have specific charges attached to the movement or monetary transaction gained from it. According to Metrolinx (2016, p.7), goods movement refers to “the movement of a physical product (e.g., food, gasoline, furniture or clothing) materials that are used to make other things (fabric, rubber, lumber, precious metals, etc.)”.

The major difference between the definition of freight or goods movement is the monetary benefit derived from their transportation. For example, when a person goes to the convenience store right around the neighbourhood with his vehicle and purchases grocery items, the movement of these groceries from the convenience store back home refers to goods movement because no services were hired to transport the groceries bought from the store to the destination. On the other hand, once a carrier is hired or even a friend is paid to transport the groceries to the destination, this is referred to as freight movement.

Regarding material flows in a city, there are two main types of specific freight flows in an urban centre. They are the consumer-related distribution and the producer-related distribution.

The consumer-related distribution includes the retail sector and the supply of goods to the final consumer, usually as parcels originating from distribution facilities intended to be transported to residential homes or commercial facilities. They include:

Independent and chain retailing: Chain retail shops are located in central areas such as downtown core, and these stores are usually associated to a common brand. These stores rely on the knowhow of third-party logistics for sourcing of their products. They have their own warehouse facilities where restocking takes place.

Small retail shops which constitutes the informal street markets and stalls forms the independent retailing category. In most developing countries, small scale stalls supply goods in an informal fashion where they own delivery vehicles and transport fresh products (eg. farm produce, freshly laid eggs, etc) to consumers (Rodrigue et. al., 2017).

Food deliveries: Grocery stores and restaurants in urban areas can receive about 15 to 30 deliveries within a day, especially the large ones (Rodrigue et. al, 2017). This is because most food products are perishable and as such, food products must be distributed to these stores and restaurants often. Delivery of food items constitutes one of the main urban freight distributions in cities.

Parcel and home deliveries: Ronald et. al, (2016) make a point that the development and growth in the use of ICT such as smart phones, efficiency in supply and distribution, and the growth of e-commerce have increased the selling and buying of products over the internet. This has increased parcel and home deliveries in urban centres. Also, Rodrigue et al., (2017) argues that globalization and the setting up of regional and head offices have also contributed to the growth of parcel deliveries in cities. It is now very convenient from the comfort of one's home to purchase a good online and pay for that good to be delivered to their doorstep. Due to this, there have been many innovative platforms created and courier companies set up to deliver goods to their final consumers. This

courier delivery system provides efficient ways through which parcels can still be delivered in heavy congested urban areas.

The second form of urban freight distribution includes producer-related distribution and they include:

Construction sites: Often than not, most urban centres constantly witness new buildings being put up or renovated. These activities require materials to be transported to the construction sites for the renovations or building to take place. Materials such as wood, glass, iron rods, etc. are needed in order to put up the building.

Industrial waste collection: The waste generated from industrial communities can be both hazardous and non-hazardous. There is the need to ensure that both hazardous and non-hazardous waste components are collected, transported, transferred, recycled, and disposed well in order to maintain compliance with environmental sustainability regulatory laws.

Industrial and terminal transport: Ports, airports, and railyards are locations in urban centres which allow for freight to be distributed to other geographical areas. This process is called containerization where cargo is transported and can be interchanged between trains, trucks, and ships without the handling of the contents itself. Industrial companies usually use this process to obtain their raw materials for production.

2.5.7 Vehicles promoting co-modality

The vehicles used in the transportation of freight can serve as a single purpose or a dual purpose. Single purpose vehicles are those vehicles that only transport freight from one location to the other, but the dual-purpose vehicles are those ones that can carry both freight alongside passengers from one location to the other. The vehicles which have dual purposes are those that can promote co-modality in an urban context.

Table 2.5: Vehicles promoting co-modality

Single Purpose Vehicles	Dual Purpose Vehicles (co-modal)
Trucks	LRTs, subway trains.
Charter planes	Motorcycles
Freighter airbus	Bicycles
Tank cars	Vans
	Cars
	Buses
	Ferries
	Passenger planes

Source: Author's construct, 2019

Transportation modes basically refers to the means through which passengers and freight attain movement. Every transport mode travel either through water, land or air. Table 2.6 depicts the various transportation modes of both passenger and freight as well as areas where they are co-modal (sharing alongside the same transportation infrastructure or the same vehicle).

Table 2.6 Co-modality between transportation modes.

Road			Air			Rail		
Infrastructure								
Freight	Passenger	Co-modal	Freight	Passenger	Co-modal	Freight	Passenger	Co-modal
Truck only	Small vehicles only	Shared roads	Cargo only terminals	Passenger airports	Terminal operations	Freight tracks only	Passenger tracks only	Freight and passenger tracks
Vehicles								
Road			Air			Rail		
Trucks	Cars	Trunks of cars	Charters	Scheduled airplanes	Belly hold of airplanes	Tank car	LRT	Trailers attached to passenger rail vehicles
	Vans	Back of vans	Freighter airbus			Rail box car	Subway trains	One or two components of the vehicle used for holding freight
	Motorcycles	Three-wheel motorcycles					Monorail	
	Bicycles	Cargo bicycles						
	Buses	Belly hold of buses						

Adopted from Rodrigue et al., (2017)

Figure 2.2 depicts the three-wheel motorcycle that can carry both passenger and freight alongside.



Figure 2.2: A three-wheeled motorcycle

Source: https://www.ecplaza.net/products/jialing-jh150zh-2-air-cooled-150cc_3629448

It is evident to say that in certain urban jurisdictions, the idea of shared vehicle in transporting both passenger and freight alongside is not practiced although there is the practice of shared transport infrastructure. An example is in the Toronto Region, where the GO trains are solely purposed for transporting only passengers whereas the CN Railway trains are also meant for transporting only freight. However, they share the same rail tracks which qualifies as being co-modal, but in other urban jurisdictions like Paris, the Tram Fret carries both passengers and freight alongside but in different compartments.

This shows the levels of co-modality which are practiced in different urban context depending on the transport laws and regulations governing that urban context.

2.6 Impacts of co-modality

An efficient freight transport system is very crucial to the economy of cities and is a requirement for both economic and environmental development. Although such is the case, freight transport is also connected to several negative impacts. Issues such as safety and security must be acknowledged and addressed. According to Paddeu , 2017 and Taniguchi & Qureshi, 2018, there are both environmental and economic impacts of co-modality in cities. Table 2.7 below provides a description of the impacts of co-modality.

Table 2.7 Impacts of co-modality

	Positive Impacts	Negative Impact
Environmental impact	<ul style="list-style-type: none"> • Reduced air pollution • Reduced traffic congestion • Reduced noise pollution • Reduced GHG emissions 	-
Economic impact	<ul style="list-style-type: none"> • Reduced number of transport movements and deliveries per retailer (reduced operational cost) • Improved productivity and efficiency of logistics service providers • Another business model for shippers to take advantage. 	<ul style="list-style-type: none"> • Using public transport vehicles for co-modality requires extra handling costs due to transshipment

Source: Peixoto Neto et al. 2008, Taniguchi & Thompson 2015, and Paddeu, 2017

Public transport organisations can generate revenue in the sense that they can take advantage of underutilised capacity of transit vehicles especially during off-peak periods to transport freight as well as passengers. In return, this revenue generated can be used to cover other operational costs associated with moving both people and freight together.

Looking at the environmental impact, reduction in air pollution, traffic congestion, noise and GHG emissions were dominant through literature on co-modality. However, little to no negative environmental impact were identified.

2.7 Barriers of co-modality

The recent growth of e-commerce which has led to a substantial increase in more direct orders to consumers especially in urban areas has generated the last mile challenges which are dominant through literature. Co-modality seeks to curb these challenges but experiences barriers in financial, social, and technical areas. It is important to state that social, cultural, economic, and geographic circumstances affect city logistics and people's perception of issues related to city logistics (Savelsbergh & Van Woensel, 2016). To make it simple, attitudes towards city logistics differ in jurisdictions such as in Europe and North America.

To be able to anticipate or be ready for future challenges of co-modality, there is the need to recognize the barriers that hinder co-modality in urban areas. Through literature, there were 3 categories of barriers namely financial, social and technical barriers. Table 2.8 provides a summary of these barriers identified under the 3 categories.

Table 2.8 Barriers of Co-modality

Barriers	
Economic	<ul style="list-style-type: none"> • Initial funds needed to start (budget restrictions) • Uncertain availability of ready market
Social	<ul style="list-style-type: none"> • Scepticism to new delivery systems • Competitiveness (not willing to share resources with competitors) • Low interests from SMEs as compared to bigger companies to adopt a different business model
Technical	<ul style="list-style-type: none"> • The need for some software development • The need for ICT personnel to operate the software

Source: Paddeu , 2017, Rossi, 2012 & Zografos et al., 2012

In freight companies, which includes small, medium to large scale enterprises, small transport companies often do not have the budget resources for training and education of their staff to adopt a new business model. This may hinder efficiency improvements and the willingness to adapt to new business models which might improve optimization and effectiveness. The economic situation especially with SMEs may hinder them from investing in new technologies which will require personnel to operate them. They might rather want to improve the existing technologies or business models they have rather than investing in a totally new model. The uncertainty around the acceptance of a new model from customers tends to be a major factor.

Scarcity of resources from regulators as well tends to be a major factor. As stated by Zografos et al., (2012), prioritization of investments in freight transportation tends to be lower as compared to passenger transport. Local and national politicians tend to prioritize passenger transport because of the direct evidence of benefits. Limited number of public funds are therefore allocated to the development of freight transport.

2.8 Opportunities for co-modality

From literature, there are 4 broad areas which creates room for co-modal practices to be adopted and implemented by cities and the private sector in the freight industry. (Savelsbergh & Van Woensel, 2016, Taniguchi & Thompson, 2015, Taniguchi, 2014). The dominant drivers which creates opportunities for co-modality are the advances in technology and the rise in e-commerce growth which has generated the gig economy. (Green et al., 2018). The 6 broad areas include:

- Population growth and urbanization
- E-commerce growth
- The desire for speed
- Climate change and sustainability

2.8.1 Population growth and urbanization

Blanco & Fransoo (2013) are of the point view that urbanization mostly in the highly dense areas in big cities experience logistics challenges. This is because of the rise in population in urban centres and the constant demand for goods and services. The increase in population in cities will continually rise and this has been predicted by the United Nations (United Nations et al., 2014). As a result, cities around the world are findings solutions to curb challenges that come with urbanization including logistics issues. This creates an opportunity for co-modality to be tested, proven, and adopted to reduce urbanization the externalities associated with freight delivery.

2.8.2 E-commerce growth

The rise in e-commerce and online sales has generated the growth in many business models in both passenger and freight transport. A report from E-commerce Foundation (2015) has estimated that e-commerce sales worldwide reached about 1.9 trillion dollars which shows a double in sales as compared to the report in 2011. This shows that e-commerce growth is projected to increase even more as time goes by. This is as a result

of the penetration of technological advancements such as the internet, mobile phones and other technologies.

Thus, it is important to recognize the fact that customers who order things online would want their packages to get to their homes rather than to the retail stores. As a result, couriers want to find ways to achieve this and thus create an opportunity for co-modality in an environment where urbanization is on the rise.

2.8.3 The desire for speed

The desire of customers to get the packages they order as quick as possible is very common these days. As a result, freight carriers provide same-day delivery options for customers to receive or even a 3-hour delivery option. This has generated fierce competition amongst couriers and the taxi industry to meet the demand of customers and retailers. The desire of customers to get packages in time would open an avenue for business to consider other business models such as co-modality to meet the high demand of customers.

2.8.4 Climate change and sustainability

The rise in freight activities in urban areas has contributed to already existing complications such as traffic congestion, noise pollution, and GHG emissions. City regulators are focusing on sustainable ways which will ensure that increased urban freight activities do not have negative impacts on the attractiveness or the quality of life of the urban area (Savelsbergh & Van Woensel, 2016). There is therefore the desire to reduce the negative impact of freight activities in most major urban centres especially in the downtown area. In reducing these impacts, city officials tend to find ways which are supposed to be environmentally friendly and cost effective. This provides the opportunity for co-modality as the concept also aims to achieve environmental benefits as well as optimization.

2.9 Global implementation of Co-modality

This section of the thesis presents some examples of practices of co-modality around the world. It shows how cities across the world are putting in efforts to curb externalities associated with the delivery of goods in the last mile phase. Below are some of the examples:

- Greyhound Courier Express (USA and Canada): The Greyhound company provides intercity services to locations in the United States of America and in Canada. They operate a passenger service as well as offering a freight delivery service called Greyhound Package Express in the USA and Greyhound Courier Express in Canada (Cochrane, 2012). The company no longer operates the package delivery services. This freight service was provided through luggage bays or in trailers attached to the bus. Figure 2.3 shows the greyhound courier express service which depicts an example of co-modality.



Figure 2.3: Greyhound Courier Express

Source: <https://www.flickr.com/photos/133105966@N05/36259355502>

- A-Way Express (Canada): The A-Way Express provides couriers or packages via public transit on the same day within locations served by Toronto Transit Commission. The company started operations in 1987, and it boasts of protecting the environment using public transit as a mode of freight delivery in Toronto. The company is in partnership with the City of Toronto and utilises the subways, buses, and the streetcars available in Toronto to deliver freight (Akingbola et al., 2015) .
- Intercity State Transport Corporation (Ghana): The Intercity State Transport Corporation (STC) coaches provide both intercity destinations in Ghana and across the border destinations in West African cities such Lomé (Togo), Abidjan (Cote d'ivoire), Ouagadougou (Burkina Faso), and Cotonou (Benin). The intercity STC coaches also provide a package and parcel express delivery service where they carry packages in the various bus compartments (belly holds) alongside transporting passengers. The company delivers large, medium and small parcels to destinations in and around their service stations.

The Yamato Transport Company (Japan): The Yamato Transport Company which is a big parcel-delivery company in Japan partnered with a local railway called Keifuku Electric Railway Co. to use streetcars for parcel transportation. This was announced on May 17, 2011 and the purpose was to reduce carbon dioxide emissions in the Kyoto City. The operational service of this form of co-modality is that the company charters a single streetcar, load it with container dollies bearing parcels, and delivers them to Arashiyama Station and Randen-Saga Station. In Arashiyama station, drivers unload the dollies, reload them onto carriers pulled by electric bicycles and then deliver the parcels to customers (Japan for Sustainability, 2011).



Figure 2.4: Yamato company using streetcars for low carbon parcel transport

Source : https://www.japanfs.org/en/news/archives/news_id031255.html

There is, indeed, a complementarity between freight and passenger transport systems. Rodrigue et al., (2017) stresses that this complementarity occurs when both freight and passengers are **carried in the same vehicle**, for example, when cargo is stored in the belly hold of passenger flights and transported to their destinations; or when different vehicles have been developed to transport either freight or passenger but **share the same transport mode infrastructure**.

It is imperative to state that although there have been interests to use different vehicles to operate on the transit network infrastructure, especially rail, to move freight, it presents several advantages and disadvantages. Some advantages are the transit infrastructure such as railway lines can be used for the movement of both passenger and freight, reducing operational costs, the maintenance cost involved can be spread over a wider base. The disadvantages include priority will be given to passenger traffic when routes are shared. Another is that locations of demand rarely match since freight flows are usually spatially separated from passenger traffic

CHAPTER THREE: METHODOLOGY

3.1 Introduction

This chapter of the research describes the approach, technique and methods that were used to collect and analyse the data. It covers the study area, research paradigm, target population, sampling procedure, and sample size. It further looks at the research instruments, data analysis, and ethical issues.

3.2 Study Area

The city of Toronto is Canada's largest city, home to a diverse population, and is the fourth largest city in North America. The population in Toronto was estimated to be 2,929,886 in July 2017 and over the next 25 years, the population in the downtown is expected to double (City of Toronto, 2018b). The city is the anchor of the Golden Horseshoe surrounding the western end of Lake Ontario. The City of Toronto covers an area of 630 square kilometers with a maximum north-south distance of 21 kilometers and a maximum east-west distance of 43 kilometres. The city also has 46-kilometer-long waterfront shoreline, on the northwest shore of Lake Ontario. The city's borders are formed by Lake Ontario to the south, the western boundary of Marie Curtis Park, Steeles Avenue to the north and the Rouge River and Scarborough-Pickering Townline to the east (City of Toronto, 2018a).

Specifically looking at the downtown area, the downtown area is located within the district of Old Toronto. It is approximately 17 square kilometers in area, bounded to the west by Bathurst Street, to the east by Don Valley, to the north by St. Clair Avenue, and to the south by Lake Ontario. There are about 27 neighbourhoods in Toronto. Figure 3.1 shows the map of downtown Toronto.



Figure 3.1 Map of Downtown Toronto.

Source : <https://www.torontoneighbourhoods.net/neighbourhoods/downtown>

Downtown Toronto was selected because the movement of goods in the city plays an important part of the economy. The Region's Board of Trade has projected that it contributes about \$171 billion annually to the GDP of the region, thus, very fundamental to the functioning of the economy (Wiginton, 2017). Goods movement involves key stakeholders which include both public and the private sector entities such as Metrolinx, Ministry of Transportation Ontario, ports and harbours, taxi, and courier companies, and the city of Toronto itself. The density of activities and the presence of mobility providers and freight couriers also led to the selection of downtown Toronto.

The city of Toronto is experiencing exceptional growth which is evidenced by the competition for curb side space as well as traffic congestion due to the rise of e-commerce and its related delivery systems (City of Toronto, 2018a). Due to these demands and the introduction of new technologies to reduce the externalities associated

with the movement of goods, the city looks to focus on innovation, sustainability and safety to come up with a goods movement strategies in order to support the City's Official Plan and reduce the externalities associated with goods movement. This makes Toronto an ideal location to conduct a study on co-modality.

3.3. Research Paradigm and Design

The research paradigm underlying this study was interpretivism because it is a paradigm that advocates the use of qualitative methods in research. It tends to help researchers gain a deeper understanding of a phenomenon and its complexity in its unique context instead of trying to generalise the base of understanding for the whole population (Creswell, 2007). Research designs are the plans and procedures that guide the research decision-making (Creswell, 2014).

The study employed the exploratory research design to achieve new insight into the concept of co-modality. This research design is applied when there are few studies to which references can be made for information (Akhtar, 2016). The research questions for this study which are exploratory were inclined to adopt the qualitative approach.

The research explores the externalities associated during the last mile delivery of goods especially in the downtown area and it attempts to understand the possibility of integrating both passengers and freight in the same vehicle during the last mile through interviews with city officials, taxi companies and courier companies.

3.4. Data sources, target population, sampling procedure and sample size

This research made use of both primary and secondary data. The primary data was sourced from participants involved in the study while the secondary information was sourced from articles, journals, books, and other written documents. The study examined the views and ideas of the stakeholders involved in the movement of goods in the city of Toronto. These stakeholders include officials from the Ministry of Transportation, Metrolinx, Toronto Transit Company, Transportation Services of the city of Toronto,

Municipal Licensing and Standards of the city of Toronto, Envoi (a courier company), Greyhound, Grand River Transit, Waterloo Taxi, and Beck Taxi.

To understand the context of the research, preliminary investigation was done through websites and other available sources of information regarding courier and taxi companies which operate in the downtown area in Toronto. This was done to identify potential sources of inquiry to interview. The sampling techniques that was adopted for this study was the purposeful sampling. The purposeful sampling according to Gentles et al. (2015) is adopted when a researcher wishes to include only people who meet a specific criteria. The purposeful sampling lies in information-rich cases for in-depth study. In this study, the researcher's goal was to identify and interview taxi and courier companies which operate in the downtown area, engage in the last mile delivery of goods, and will be willing to be interviewed. Another goal was to interview officials from Metrolinx, Toronto Transit Company and the Transportation Services in the city of Toronto to understand their policy direction towards last mile delivery in the downtown area, and the potential impact of moving both passengers and freight in the same vehicle in the downtown area.

A total number of people contacted for the interview were 15 officials. However only 10 officials responded back to the emails and phone calls made. These officials were first contacted via email to provide a background of the research, the objectives of the research, and the significance of the study. Also, the email sought to know the willingness of these officials to participate in the interview. Follow up phone calls were made to officials who did not reply to the emails.

For the first interview, which was a face-to-face interview, an official letter containing the information of the study was provided to the official from the city of Toronto. Details of the research were fully explained to the official and the official signed the consent forms before the interview took place. The other interviews were done over the phone.

3.5 Research Instrument and data collection

A semi-structured interview guide was used to solicit data from participants. The questions from the interview guide was prepared based on a review of literature. The first

section of the interview guide looked at the potential impacts of co-modality in the downtown area. The next section looked at whether the concept of co-modality was available in the policy documents of the stakeholders involved in freight movement. The last section of the interview guide looked at the potential benefits and challenges of co-modality in the downtown areas and ways challenges can be reduced. The questions asked were opened ended to ensure that the interview process would allow more room to collect additional information about an unanticipated or unknown evidence

Qualitative data collection methods are exploratory and mainly concerned with gaining insights and understanding of a phenomenon (Creswell, 2014). Qualitative tools were solely employed for this research. Specifically, the tools which were employed for the data collection for this research was entirely through interviews. Interviews were employed to gather data for the research.

Before the interview took place, the respondents were provided a summary sheet containing the details of the study and were as well given assurance about ethics clearance and principles such as confidentiality and anonymity. The purpose of this was for respondents to provide honest opinions of questions that were asked. At the end of the interview, the interviewees of the study were thanked for their participation and asked if they wanted to make any additional comments. This was important because it made room for interviewees to address issues they thought were not asked by the interviewer.

3.6 Data Analysis

This research study adopted Braun & Clarke's (2006) six phase approach of thematic framework analysis. The goal of thematic framework analysis is to identify themes and patterns in the data that are relevant to the research questions and are used to address the research questions. It also helps to identify other thematic areas which can be relevant to the analysis of the study as well. Once the data for the study was collected via audio recordings, it was transcribed into a textual form verbatim. After transcription, the data was organized based on the objectives of the research. This was done using tables. The research objectives of the study were put in a table and then the transcribed data was

assigned to each objective. Coding of the data is another important part of the data analysis process. Coding of the data ensures that the data that was collected on the field are given meaning. It involves the classification of the data into patterns and concepts. The codes that were used in the analysis of the data were collected from the field based on the research objectives, theories and other research findings from literature. Table 3.1 provides a summary of the analysis of the data that were collected from the field.

Table 3.1 Phases of data analysis

	Phases	Description of Analysis Process
1	Familiarising with the data	a. Narrative preparation, i.e. transcribing data b. (Re-)reading the data and noting down initial ideas
2	Generating initial codes	a. Coding interesting features of the data in a systematic fashion across entire data set b. Collating data relevant to each code
3	Searching for themes	a. Collating codes into potential themes b. Gathering all data relevant to each potential theme
4	Reviewing themes	a. Checking if themes work in relation to the coded extracts b. Checking if themes work in relation to the entire data set c. Reviewing data to search for additional themes d. Generating a thematic “map” of the analysis
5	Defining and naming themes	a. On-going analysis to refine the specifics of each theme b. Generating clear definitions and names for each theme
6	Producing the report	a. Selection of vivid, compelling extract examples b. Final analysis of selected extracts c. Relating the analysis back to the research question, objectives and previous literature reviewed.

Source: Adopted from Braun & Clarke (2006)

3.7 Ethics

Creswell (2014) does very well to provide ways to address ethical issues during any research work. He provides the stages during the research work where ethics should be

addressed and the type of ethical issue concerns. Based on this approach, table 3.2 were the type of ethical concerns that were addressed.

Table 3.2 Ethical Issue Concerns

Stage	Type of ethical issue	How to address the issue
Before conducting the study	<ul style="list-style-type: none"> • University approval • Negotiating authorship for publication • Examine professional association standards 	<ul style="list-style-type: none"> • Submitting a proposal for approval from the university • Giving credit for work done on the project
Beginning the study	<ul style="list-style-type: none"> • Disclosing the purpose of the study • Respecting norms and rules of organizations • Being sensitive to respondents who will not want to use a specific data collection tool 	<ul style="list-style-type: none"> • Contacting respondents and informing them of the purpose of the study • Finding out the appropriate work times to contact respondents • Obtaining consent and presenting different data collection tools to the respondents
Collecting data	<ul style="list-style-type: none"> • Avoid collecting harmful information • Deceiving participants 	<ul style="list-style-type: none"> • Staying to questions stated in the interview protocol • Avoiding leading questions, discussing the purpose of the study
Analyzing data	<ul style="list-style-type: none"> • Siding with respondents • Privacy and anonymity 	<ul style="list-style-type: none"> • Reporting multiple responses from respondents • Respecting respondents who do not want to provide their personal information through using fictitious names
Reporting and sharing data	<ul style="list-style-type: none"> • Plagiarism • Sharing data with others • Duplicating publications • Communicating in clear, concise language 	<ul style="list-style-type: none"> • Using the APA guidelines and not copying and pasting • Providing copies of the final report to stakeholders and respondents

		<ul style="list-style-type: none"> • Refraining from using the same material for more than one publication • Not using unbiased language.
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Source: Adapted from Creswell (2014)

Ethics are very important when a researcher is conducting a study. Issues such as honesty, respect for intellectual property, social responsibility, discrimination, objectivity, and many others are to be considered. This study was reviewed and received ethics clearance through the University of Waterloo Research Ethics Committee (ORE #40950). For the general ethical considerations, all participants of the study were duly informed to notify the researchers of the study via email within one year of data collection for their data to be withdrawn if they did not want their input to be considered in the study.

Through out data collection, one key thing that was looked at was the fact that participants did not feel pressured to participate out of a sense of duty or out of goodwill. To deal with this issue, the researcher ensured that participants of the study read the consent forms and signed them according to their will. The researcher also informed the participants that their feedback was going to be entirely anonymous to protect their identity. Names of participants and the positions in their organisations did not appear anywhere through out the thesis.

3.8 Rigour, trustworthiness and quality

Many steps were taken into consideration to ensure that there was credibility and rigour through out the study. Rigour refers to the process of establishing the fidelity or credibility of a researchers work as well as having confidence in the findings (Denzin & Lincoln, 2005). Trustworthiness involves the validity of the research, related to the research quality and the transferability of the results (Dillon, 2003). This aspect of the research is very important because qualitative researchers must demonstrate the ability in their research that the studies are credible, and this depends solely on the efforts and ability of the researcher. Documentation of the research and the use of several methods of data collection were the approaches that were adopted. These were through face-to-face and

telephone interviews. Data collected from the interviews were recorded and transcripts were done for the analysis and discussion.

To ensure the quality of the research, the interview guide was pre-tested to identify the practical problems regarding data collection instruments. The idea for the pre-testing was to detect potential errors in word ambiguity, the technicality of sentences, and any possible flaws in the interview guide. Since I was going to be interviewing officials who one way or the other contribute to the movement of freight in the city of Toronto, I pre-tested the interview guide with a Master's student whose speciality is in Transportation Planning. Through that, the estimated time length of a full interview was known, and any repetitive questions were identified.

3.9 Fieldwork and related challenges

Despite best intentions, there are always challenges that a researcher encounters when collecting data for a study. Thus, it is important to point out these limitations in fieldwork as well as to highlight the various mitigation strategies that were employed to minimize their impact. As far as the study was concerned, there were two main challenges that were encountered.

The first limitation were the inconsistencies by the target population in sticking to the appointed schedule times for phone interviews. Due to the busy nature of interviewees, follow up emails had to be sent to reschedule the time for the interviews to be done. This, however, prolonged the data collection period.

The next limitation was the difficulty in recruiting respondents for the study. Initial emails which were sent did not get immediate response from the target population. Follow up emails had to be sent as well as phone calls had to be made to get participants to interview.

3.10 Conclusion

This chapter of the thesis explained the methodological process of the study. It described the study area, research paradigm, sampling procedure, sample size, data collection,

ethical considerations, and limitations of the study. The next chapter of the research talks about the research results from the data collected.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Introduction

This section of the thesis looks at the results of collection of valuable information from both the literature review and the information collected from stakeholders. The results intend to provide connections to the research questions that guided the thesis. The results section categorizes the findings under the four main research questions. Other thematic areas were also discussed further in the results section and this is because the data collection process revealed other important areas connected to the research questions. This chapter also discusses the results of the data collected in relation to the literature that was provided in chapter two. The discussion part of the thesis addresses our understanding of co-modality, the potential impacts of co-modality in the GTA, the existing co-modal practices in the GTA as well as the barriers and opportunities influencing the potential for co-modality in the GTA.

4.2. Definition of co-modality

Co-modality, which is a concept very popular in Europe, has the basic aim of combining resources together to reduce externalities associated with the last mile delivery of goods. Rossi (2012) is of the view that the gains of practicing co-modal solutions can reduce total logistics costs for supply chains and single firms in terms of transports costs. Based on the literature reviewed, different definitions were coined for the explanation of co-modality. To highlight them, the following are the definitions found through out literature:

“The use of different modes on their own or in combination to obtain an optimal and sustainable utilisation of resources. ...co-modality is not related to what mode or modes that are being used to fulfill the transport demand, but it rather deals with how to improve and make the best possible use of the resources in the transport system to satisfy the logistic demands...”

Engstrom (2013)

“Co-modality refers to the use of different modes on their own and in combination in order to obtain an optimal mobility outcome in terms of travel effort as well as transport sustainability and supply efficiency. Co-modality recalls the principle that public transport operates most successfully when it is planned as a unified network to support seamless multi-destination travel rather than as individual lines catering to single trips”

de Stasio et al. (2011)

“The concept of co-modality includes the efficient use of different transport modes at any time for passengers and freight. Therefore, co-modality allows multiple uses of roads, rails, coastal shipping, inland waters, and bicycles in the geographical domain and the time domain. The use of tramways, electric vans, and cargo bikes in Kyoto for freight transport by Yamato is a good example of co-modality for city logistics.”

Taniguchi & Thompson (2002)

“A combination of passenger and freight transport can be realized using buses or taxis for carrying goods as well as passengers. Passenger transport companies can benefit from carrying goods by utilising space on less crowded vehicles and shippers benefit by having a convenient courier service as an option.

...integrating passenger and freight transport is becoming more feasible due to recent developments in Information and Communication Technologies (ICT) such as smart phones and Global Position Systems...”

Ronald et al., (2016)

The findings from the literature review provided different definitions for what co-modality is. The concept of co-modality originated from the European Union in 2006 in the field of transport policy when the European Union wanted to find an approach in the globality of transport modes and of their combination in order to achieve optimization and sustainable utilization in freight transport. This concept was coined mainly because of the aim of

transport integration which was to be rooted in their policy documents. Through out the definitions that were identified, one common thing that was recognized was the achievement of efficiency in goods movement using different modes in combination or on their own. Another key area that was identified as well was the combination of passenger and freight services to achieve optimisation. From the various definitions, co-modality requires integrated approaches and the use of technological and management innovations. ICT plays an important role in the successful implementation of co-modality

Different authors had different opinions of the definition of co-modality. From the various definitions, I agree with the definition of Taniguchi & Thompson (2002) which includes the fact that co-modality can be met when a combination of passenger and freight transport services are integrated using public transit or private transport for carrying freight alongside passengers. I agree with Rossi (2012) who argues that co-modality focuses on optimization and that includes the use of cleaner and less polluting vehicles during the last mile. Overall, the definitions identified, and the understanding ascertained all have sustainability components which is key in the implementation transport integration.

From the interview process, stakeholders were not directly asked what the definition of co-modality is from their point of view simply because the term “co-modality” is not something that is popular out there. The interesting thing is that stakeholders had an idea of such a concept and were able to speak towards it. It was clear from interactions with the various stakeholders that this concept is not popular in cities in North America as compared to many European cities. From the various interactions with stakeholders, they alluded that co-modality includes the use of the same transport mode infrastructure (road, rail) without interrupting the services of the passenger transport during the last mile delivery phase. This, however, draws the attention that co-modality does not only involve the use of unused space of public or private vehicle but also the use of the infrastructure itself for the last mile without any form of interruptions to the normal passenger service.

The first objective of this thesis was to define what co-modality is. This research sought to identify the various definitions from researchers and what stakeholders in the freight industry knew about the concept. From the synthesis from both publications and the

responses from stakeholders, I have provided my own definition for co-modality in simple terms:

Co-modality refers to the combination of both passengers and freight (parcels) in the same vehicle at the same time through the use of the same transportation infrastructure by either public transportation (Light Rail Transit, street cars), semi-public transportation (taxis) and a privately owned vehicle to achieve optimization and environmental goals in the last mile delivery. The key terms in the definition are the combination of parcels and passengers, the sharing of the transport infrastructure as well as the sustainability component. Another important part of the definition is the fact that co-modality is focused in the last mile stage because of the inefficiencies incurred at this stage as rightly stated by Ranieri et al. (2018).

4.3 Potential impacts of co-modality

An efficient urban freight system is important to the functioning of urban transport network which concurrently are vital for meeting the demands of city firms and residents. An effective urban freight system will be vital to supporting the success and liveability of cities. Cities are thus, looking for ideas and strategies that can help them to achieve this goal of a successful urban freight system with minimal impact on the environment, the economy, congestion, and residents.

The research sought to identify the potential impacts that will come about through the introduction of co-modal practices in the downtown area. There were both positive and negative impacts that were identified through the interview process. They were categorized under the following: Environmental impact and economic impact. Table 4.1 summarises the potential impact of co-modality in downtown Toronto.

Table 4.1 Potential impact of co-modality

Category	Positives	Negatives
Environmental Impact	<ul style="list-style-type: none"> • Reduction in GHG emissions • Removing more cars from the roads 	<ul style="list-style-type: none"> • Inducing demand which will in effect increase vehicles on the road
Economic impact	<ul style="list-style-type: none"> • Reduction in operational cost • Another method of delivery for shippers (reducing monopolies) • Jobs will be created to design, construct and operate the technology associated with co-modality • Revenue stream for transit agencies 	<ul style="list-style-type: none"> • The need for large subsidies for initial investment • Non-availability of ready market • Insurance rates might increase

Source: Fieldwork, 2019

There is a growing understanding of the need for a more effective utilization of available transport capacity in both passenger and freight transport. Co-modality seeks to achieve this in freight transportation especially during the last mile. Traffic safety, congestion, environmental and transportation costs are aspects that are relevant when looking at the potential impacts of co-modality.

From the literature reviewed, it was identified that there are 2 categories of potential impacts of co-modality when adopted by cities. Not only are there positive impacts of co-modality, there exists negative impacts as well (Peixoto Neto et al. 2008, Taniguchi & Thompson 2015, and Paddeu, 2017). From the results section, it was identified as well that there are two categories of potential impacts which were provided by stakeholders in the freight industry in Toronto. i.e., environmental and economic impacts. This, however, shows the agreement with literature.

Looking at the environmental impact, this was one of the potential areas that majority of the stakeholders alluded. They were of the view that once co-modal solutions were adopted, there would be less trips made and less vehicles on the roads meaning GHG emissions would be less. This is a positive impact towards co-modal solutions. Looking at it from another viewpoint, one stakeholder was of the view that even though there are environmental benefits towards co-modality, it might cause a situation where demand would be induced and as a result, would lead to more vehicles being needed for deliveries. In effect, the aim of reducing vehicles on the road especially in the downtown area would not be achieved. The stakeholder made this statement:

*“I think where you might see more opportunities in the near-term would be kind of like the uber model or people who are carpooling for packages. I will be going wherever and so in part of my trip; I will be delivering a package in doing that to make some money along the lines at smaller scale. **Although this is a good venture, the risk in this is that you might end up inducing demand and congestion on the street.**”*

Stakeholder 2 (Fieldwork, 2019)

One important thing which was identified through the interview process and is in contrary to what literature said is the fact that a negative annotation was associated to the potential environmental impacts of co-modality. A stakeholder alluded that co-modality would induce demand and will bring about more vehicles on the road if it becomes a successful venture. People nowadays want their packages to get to them as quick as possible and as a result would patronize companies that will promise them quick delivery. Consequently, some freight companies promise same day delivery to customers and the induced demand will create more vehicles on the roads to meet the expectations of customers. The stakeholder mentioned that the motive of co-modality is to reduce the number of delivery vehicles in the downtown area and not to promote it which seems to be the likely case when adopted especially with the taxi industry. As a result, the aim of reducing externalities such as GHG emissions and traffic congestion would not be met if more vehicles are involved in co-modality

Looking at the economic impact, a stakeholder from the taxi industry was of the view that the operational cost for running the business will be minimal. This is because there wouldn't be the need to have two vehicles on the road either picking up passengers and taking them to their destinations or picking up parcels and delivering them. One vehicle can be used for both services and as a result, will reduce the need for fuel costs and labour costs. The stakeholder said taxi companies are always looking for means to reduce cost and as a result will be willing to have such a business model provided there aren't any risks involved to people and to the company itself.

There are some of the economic impacts identified through the interview process which were similar to what was discovered in literature. A stakeholder from the taxi industry was also of the view that if such a concept was to be adapted and included in the policy documents of the city of Toronto, there would be the need for huge financial investment in terms of mapping software, travel information systems, car sharing services, tracking information and the likes. The repercussion, however, the stakeholder said taxes might increase or insurance prices might increase.

From the positive impacts, the results section highlighted the economic impacts including reduction in operational cost, creation of jobs, revenue stream for transit agencies, and the provision of another business channel for customers reducing monopolies. These impacts provided from stakeholders agrees with Paddeu (2017) in terms of the reduction in operational costs. The non-availability of ready market and the rise in insurance rates are two negative impacts which were highlighted through the interactions with stakeholders.

4.4 Integration of co-modality in policy documents

The principle of co-modality within transport policies aims to achieve the efficiency in the modal distribution of transport and their related services through the optimal and efficient use of each mode of transport in accordance with the requirements of the transportation aims and objectives in each jurisdiction. In Europe, co-modality seems to be the focus

when it comes to goods movement because in 2006, the European commission, in their transportation policies, moved from the traditional way to adopting co-modal solutions in goods movement.

Generally, the stakeholders interviewed described co-modality as something new which needed to be investigated more to be able to be inculcated in policy documents. Talking to some of these stakeholders, the following are some of the statements that were made:

“No, not at all. It is an interesting concept that you brought to my attention and I am kind of intrigued as to how we can actually do that. We are kind of a little behind time as compared to some other jurisdictions, especially the European countries, so anything that can evolve all of this, in terms of a model, that we can emulate and promote will be great.”

Stakeholder 1, (Fieldwork, 2019)

“I don’t want to say we are thinking small. We haven’t heard anything like that before from the stakeholder engagements we hold. The industry stakeholders haven’t brought that up to our attention. Their main concern is, you know, protected routes so that they can move their larger vehicles efficiently. Getting curb access, getting certain permitting systems in place that helps them to reduce their cost”

Stakeholder 2, (Fieldwork, 2019)

“I am not sure that that concept is really something that is on the table for us. I think if we were looking into that, then our business model will change, and we are not doing that on demand because we would have to have X number of parcel deliveries. I am not sure if it is something that we plan to do. I am not sure that we will have enough parcels going to the same direction at the same time that will result in combining both passengers and parcels.”

Stakeholder 7 (Fieldwork, 2019)

It is quite interesting to see how regulators interviewed in the freight industry did not have or planned on having such a concept to be involved in their policy documents. The Big Move, a transportation plan which involved stakeholders from the freight industry in the GTHA, called for a comprehensive goods movement strategy and in that, formulated action plans. An urban freight study was conducted as a result of the plan to identify and reduce the challenges of urban freight. Again, the urban freight study sought to discover opportunities to move freight on transit using technology to optimise and manage the movements of goods (Metrolinx, 2011). Even though this was the case from literature, regulators interviewed wanted to pilot the concept first to realize the benefits and challenges before they could be involved in policy documents. In the private sector, a stakeholder interviewed made it known that changing the Business as Usual model would be difficult because they do not have such a business model to be implemented even in the short term and implementing such a concept was going to have an impact on the way they run their business.

4.5 Existing co-modal practices in the GTA

One of the key areas through the study was to identify, through the interview process, any co-modal practices in the GTA from the stakeholders. Interactions with stakeholders revealed that they were not aware of any courier or taxi company that provides such a service. One of the stakeholders, however, was aware of the courier services Greyhound used to offer. One of the stakeholders said:

“I have heard from a staff person of mine that in the Middle East, the taxis pick up parcels and pick up passengers, drop of something and do another thing. Its kind of a common thing there. That’s where I have heard this but beyond that, I have read about it occurring in Europe. I don’t have all the specifics in around it, but it seems to be a picking up steam in Europe. It seems to be functioning and operating well in Europe. I haven’t seen anything like that over here though”

Stakeholder 1 (Fieldwork, 2019)

Another stakeholder had this to say:

“I know that greyhound used to offer such service where you could use the greyhound bus service for co-modality. You could be able to ship a package on the greyhound bus to a different city so that might be one area to look into, what greyhound is doing and what have been done in terms of co-modality there”

Stakeholder 2 (Fieldwork, 2019)

It was identified through literature that Greyhound was one of the companies which used to practice co-modality in Canada. They moved parcels along with passengers on trailers attached to their buses (Cochrane, 2012). From the interviews, it was known that Greyhound no longer provided this service anymore and this was because of the experiences they had. Greyhound generated a fair amount of revenue from this delivery business, but the costs outweighed the benefits and as a result, led to the termination of that business model. From interviews with officials from Greyhound, the following reasons were provided:

- With the issue of September 11th in the United States of America, it was determined to be high risk to ship parcels that have not been scanned. Unscanned parcels were no longer allowed by city regulators due to the security risk involved.
- Although customers signed that there weren't sending anything illegal or dangerous, often than not, the packages had illegal components in them
- Many packages sent through the service were not picked up by recipients
- Packages were separated from each other (i.e. 3 parcels were shipped and only 2 of the packages arrived)
- People's expectation of delivery and reality did not always match. That is, if a bus broke down and had to be towed or the belly of the bus carrying the packages was full, the shipment wouldn't go out. The package would be taken off the bus until a replacement bus came along. If this was done outside of hours, it didn't get shipped until the next available bus would be available.

- Traffic congestion, storms especially during winter, and road accidents often caused delays in delivery
- Food which was sent out often decayed from delays
- Some recipients did not bring IDs to receive parcels. Therefore, the parcels couldn't be released to them
- Operators (drivers) refused to take certain packages due to the weight and size of the packages.

Currently, there are two co-modal practices which are being practiced in the downtown. They are: A-Way Express and Shipper Bee.

- Shipper Bee

Shipper Bee is a crowdsourced parcel delivery system which makes use of the space available in vehicles heading to a destination to deliver parcels. It began as a pilot program which was done in Guelph, Kitchener, Cambridge, and Waterloo. The company has an app where people sign up as a driver to deliver parcels.

The way the business operates is parcels are picked up from businesses by a local driver and placed in a local hive. A hive is a mini station where parcels are stored for a pickup. A commuter driver picks up a parcel from the hive while on their way to a destination and then transfers the parcels to another mini station network where another driver picks it up to deliver it to its destination. The second kind of driver is called the endpoint driver. The endpoint driver logs into the app, provides his or her time availability, picks up parcels from the hive and then delivers them to homes.

The argument the company makes is that they are eliminating added greenhouse gasses into the environment because the driver is already driving to that area and has unused space in the vehicle. Specifically, they argue that they save 77 per cent in greenhouse gases per parcel. Again, the company conducted a market survey and found that 83 per cent of people who commute more than half an hour would want to carry parcels and make extra cash along. This shows that people would want to be engaged in the gig economy to earn some extra revenue.



Figure 4.1: A hive where parcels are stored for pickup

Source : <https://www.shipperbee.com/post/10-cool-facts-about-shipperbee-hives>

Another thing that came up during interviewing stakeholders was that the city of Toronto does not permit such a concept to be practiced in the taxi service industry. Specifically, the stakeholder from the taxi industry which operates in the downtown area in Toronto said:

“No, I’m not familiar with any company. Like I said, in our municipal by-law, it wasn’t allowed. That is something that wasn’t allowed. We are a municipal regulated service, and the city, for the sake of liability, wants to protect themselves and therefore, do not allow such a concept”

Stakeholder 3 (Fieldwork, 2019)

The by-law (Toronto Municipal Code 546), which governs the operations of the taxi industry and private transportation companies specifically details out that such a business model was not permitted. The by-law states that:

“A vehicle-for-hire driver operating a taxicab may carry parcels, letters, or documents without carrying a passenger at the same time, provided that:

... (3) No passenger is accepted by the vehicle-for-hire driver while he or she has been engaged to deliver such parcel, letter, or document.”

4.6 Benefits of co-modality

In a general sense, co-modality has benefits. This was identified through the interviews with the stakeholders involved in goods movement in downtown Toronto. Generally, the stakeholders described the benefits in two broad categories- environmental and economic. Regarding the environmental benefit, co-modality has the tendency of reducing the number of delivery vehicles in the downtown area thereby reducing congestion and GHG emissions from vehicles. To buttress the environmental benefit of co-modality, some stakeholders made the following statements:

“The one thing that comes to mind is you are reducing the number of vehicles on the road, potentially. Where you need two vehicles, one to do passenger delivery and another one to do parcel delivery, it can be combined into a single vehicle, potentially, to reduce congestion and pollution in the downtown.”

Stakeholder 1 (Fieldwork, 2019)

“Well, I guess the obvious benefits are you can use the vehicle that is already in motion to carry additional goods in hopes of reducing additional vehicles on the roads.

“...benefits for society is that we can hopefully reduce the number of vehicles on our roads and GHG emissions and stuff like that”

Stakeholder 4 (Fieldwork, 2019)

The comments made by the stakeholders relating to the benefits of co-modality such as the reduction in vehicles on the roads as well as the reduction in GHG emissions tends to agree with Giannopoulos (2008) and Engstrom (2013) who have similar arguments on the environmental benefits of co-modality. In addition to these benefits, some stakeholders alluded that the environmental benefits through the reduction in GHG emissions will help reduce air related diseases as well as reduce the impact of climate change.

In other jurisdictions such as Kyoto, Japan, Yamato Transport had set up a set of objectives known as the “Yamato Transport Global Warming Prevention Objectives” to reduce the total carbon emissions to 99 percent below the 2002 percent levels. The company is actively working on this objective introducing new innovations as discussed above as well as the introduction of hybrid cars and eco-friendly vehicles.

Looking at the economic benefit of co-modality, stakeholders alluded that this method could provide a cheaper option for shippers (customers) to use in goods delivery in the downtown core. This is because of the use of less crowded space in transit vehicles which could be utilized to move parcels as well during off-peak periods. Although stakeholders said this, it is not clear if such will be case because from literature.

Again, another key thing that prevailed was the fact that one vehicle could be used to deliver packages which will in turn reduce operational costs and labour costs. Specifically, some stakeholders made the following statements:

“Well, I think the primarily benefit will be more efficient use of the potential capacity, that is out there. ...there are times of the day where our vehicles are not as used and certainly anything else that could take more advantage of it, more efficient use of the vehicle moving through the city but without having any sort of impact on the service will be good.”

Stakeholder 5 (Fieldwork, 2019)

“It could reduce their cost. This is hypothetical but if I can get my parcels delivered through a particular route and put a location on where things can be picked up at that location; obviously, I don’t have to invest in my own vehicle, travel cost, drivers to drive those vehicles because you have those transit operators driving those vehicles. So, potentially, money will be generated by reducing extra cost.”

Stakeholder 6 (Fieldwork, 2019)

4.7 Barriers of co-modality

To support the shift to co-modal solutions, it is necessary to understand the barriers of promoting co-modality in the GTA. Although the benefits of co-modality have been highlighted in the previous sections of the thesis, it is good to understand the complexity of such a shift for both shippers and service providers. Results from the interview section revealed that safety concerns, rise in insurance rates, ICT, conflict with passenger schedules, and reluctance to shift from the traditional business model were the barriers to co-modality. Conflict with passenger schedules and the rise in insurance rates is something new that was identified through the interview process which was not seen in through out literature. The other barriers identified through the interview process agreed with Paddeu (2017), Rossi (2012), and Zografos et al. (2012). The following section explains the barriers.

4.7.1 Safety concerns

Discussion with some stakeholders revealed their concern about how safety issues could be a huge barrier to co-modality. The following are some of the statements made by the stakeholders:

“One is probably a risk of safety. If you are sending a package in the mail or you are sending a package through a courier, you have this perception that it is going to sit amongst other packages and just one driver for every hundred or thousand packages or whatever. If you knew you were sending

a package and it is going to be on vehicle with a hundred or fifty or thousand passengers on it, and you were a person with negative intentions like some sort of terrorist intentions, then that provides new opportunities for you.”

Stakeholder 6 (Fieldwork, 2019)

“The risk to passengers, I don’t see that there’s a risk to passengers other than in terms of safety to passengers. Obviously, the nature of the parcel will matter that we wouldn’t move any sort of hazardous materials, certainly with people and with other packages.”

Stakeholder 5 (Fieldwork, 2019)

Stakeholders alluded to the fact that this concern of safety is very crucial because if passengers cannot be guaranteed the safety of riding with packages, the whole notion of co-modality cannot be promoted. Interactions with some stakeholders revealed that some passengers or riders may be skeptical to ride along parcels especially if they do not know the content of the package and this case is in line with Ronald et al. (2016) where they argued that such safety scepticisms could hinder passengers from riding with parcels. This boils down to the preferences of passengers and their attitudes towards the concept.

4.7.2 Conflict with passenger schedules

Through the interview process stage, another key thing that was revealed which can be a barrier to co-modality is the conflict with passenger schedules. One stakeholder made the following statement:

“The biggest challenge is the kind of business model we operate on is pretty much the schedule service. What that means is that you have boxes running around a route trying to maintain a service schedule or headway, so there isn’t really a kind of opportunity to stop the vehicle and have the driver locate the parcel and do a delivery because, again, people are expecting the bus to come along and pick them up to wherever they are going. Also, because

we are operating 40 or 60 fleet buses in a dense urban environment, it is kind of problematic to just leave a bus and go deliver something.”

Stakeholder 5 (Fieldwork, 2019)

“In terms of the risk to our company, we would be taking on additional risk in terms of trying to encourage people to not get to their destination as quickly as they would like because maybe we are dropping off a parcel on the way. Actually, the risk ends up following more on drivers, more on the company because people may not use the service if they are not delivered right away.”

Stakeholder 6 (Fieldwork, 2019)

When it comes to the movement of both passengers and freight together at the same time, a conflict arises as to who gains the priority initially. Most passengers who patronise transit or taxi services have a time schedule they go by and must get to their destination on time. If taxi drivers or transit operators are to go for parcels and deliver them while passengers are in the vehicles, these passengers might not get to their destination on time. Consequently, riders or passengers may refuse to patronise such services because of the delay in getting to their destination. The reliability of such a service becomes questionable and again the question as to who gets the priority when co-modality is being practiced becomes a burden on service providers.

4.7.3 Technology (IT systems)

The positive role of ICT in improving the performance and communication between freight industries, taxi services, and transit operators has been recognised by the various stakeholders. ICT plays an important role through network design scheduling, technologies for loading/unloading, and scheduling.

As compared to European cities where co-modal practices are picking up steam, ICT plays an important role in this achievement. Stakeholders alluded that to achieve a

successful implementation of co-modality, robust IT systems must be put in place. Some stakeholders made the following statements:

“Well, the challenges will include software development. I think if we were looking into that, then we would need to have some sort of road mapping software”

Stakeholder 6 (Fieldwork, 2019)

“The impact of technology opens up to make this concept more feasible. You have to check, what are the origin and destinations of parcels? And then you must match that on the computer and then you must look at the time, so its space and time. That commuter needs to get to that destination by that time and the freight also wants to get to the destination by another time”

Stakeholder 4 (Fieldwork, 2019)

Regarding the robust IT systems required, one key barrier to this is financial aspect is the ability or commitment towards the purchase of these complex technologies. This is because of the large investment requirements, the managing and maintenance costs, and the large investment required. When you consider stakeholders from the private industry, for instance, taxi companies, it is relevant to highlight that some of them operate on a small to medium scale. As a result, they do not have huge capital to invest in such a technology and as such would prefer to stick to the traditional business model.

4.7.4 Rise in insurance premium rates

Companies, especially from the private industry, will be reluctant to adopt the idea of co-modal solutions and this is because of the probability of insurance rates going up. Through the interview process, it was made aware that, insurance companies could potentially increase their rates solely because of the potential risks and safety concerns associated with the co-modality.

One of the stakeholders made this statement:

“With other industries, it might have an impact on the labour force associated with the industry. This will be a concern in the freight industries because the entity that will take on that dual role transporting passengers and goods, there could be insurance concerns associated to that. You must look at those risks, and those potential risks must be addressed early on because for the companies, insurance rates can go up. This is because you haven’t demonstrated to them the model is entirely safe.”

Stakeholder 5 (Fieldwork, 2019)

The rise in insurance premium rates, as said early on, was an area that was identified in the interview process. Although there are benefits associated to co-modality, it might be something which stakeholders, both from the regulatory and operational side, might deliberate constantly before including them in policies. Before co-modality is accepted and implemented, both regulators and operators of co-modal solutions may have to conduct pilot tests to convince insurance companies of ways such a delivery method will have a low risk to passengers or riders in terms of safety. One key thing to point out is the fact that underwriters and actuaries price insurance on a new type of risk. They do this based on the fact that there aren’t enough data out there and as a result, increase premium rates based on liability risks.

4.7.5 Reluctance to shift from the traditional business model

The idea to shift to or include a different business model especially from stakeholders in the private industry will pose as a barrier to co-modality. A stakeholder from the taxi industry saw the whole co-modality concept as an avenue to prevent passengers or riders from getting to their destination on time since multiple parcels had to be picked up or delivered at the same time. Specifically, the stakeholder when interviewed had this to say:

“In terms of the risk to our company, we would be taking on additional risk in terms of trying to encourage people to not get to their destination as quickly as they would like because maybe we are dropping off a parcel on the way. Actually, the risks end up following more on the company because

people may not use the service if they are not delivered the right way at the right time.”

Stakeholder 1 (Fieldwork, 2019)

The stakeholder was of the view that they had a business model in terms of moving people and goods, but never combined the two together. This is because this might slow down the speed at which riders get to their destination. As a result of this, the stakeholder said they would be reluctant to adopt the concept because the risks that might bring to their company. Also, the stakeholder stressed on the fact that they had to be sure that there was market (subscribers) for such a service to be introduced.

The fear of not knowing if this business model will be accepted by people will prevent courier companies and the taxi industry from engaging in this business model. Paddeu (2017) highlighted that scepticism to a new delivery system as a form of a social barrier could potentially affect the acceptance rate and patronage of this business model. Resources are scarce and companies want to go into business ventures which are profitable.

4.8 Overcoming barriers of co-modality

It was interesting to find that the stakeholders involved in the last mile delivery in downtown Toronto had suggestions in terms of overcoming the barriers that could hinder the smooth implementation of co-modality. From the stakeholder interactions, 4 main areas were identified as the potentials to overcoming the challenges of co-modality in downtown Toronto. They include co-operation or partnership amongst stakeholders, technological and financial investment, piloting co-modal solutions, and security measures.

4.8.1 Co-operation amongst stakeholders

Stakeholders from the interview process highlighted the importance of partnership or co-operation amongst various stakeholders to achieve the aim of co-modality. A stakeholder

was of the view that the freight industry needed partnership amongst each as well as partnership with the city for co-modal practices to be adopted. The stakeholder said this:

“In downtown Toronto, it’s a matter of building those relationship and really you have to partner with someone else. The freight industry cannot do it all alone. They need support from others. Building those partnerships is what is very important.”

Stakeholder 7 (Fieldwork, 2019)

Co-operation between and amongst public and private partners can bring value to the freight industry. The fear of competition amongst stakeholders especially in the private industry has allowed for lack of information sharing. Because private companies are always in competition in the market to increase their subscribers, they usually find it difficult to share information even with regulators. Information sharing is seen as a glue which holds business structure together. Co-modality requires the collaboration between all levels of government, the freight industry as well as academia to able to bring it into fruition and this is something that was relevant through the interview discussion with stakeholders.

4.8.2 Technological and financial investment

Technology plays an important role in co-modality. Information Technology systems is seen as a vital core which must be established to support co-modal solutions in order to determine the optimal distribution without delaying vehicles devoted to commuter transport. A stakeholder from the taxi service said that they needed some sort of road mapping software to determine routes where drivers could pick up packages as well as passengers without disrupting the priority of delivering passengers to their destinations in the quickest way possible, all things being equal. Having some sort of algorithm in the software to ensure that when picking both people and parcels up at the same time will be efficient and cost effective is very key.

With the need for technology being brought forth through the interviews, one key thing to support it is the demand for financial investment to be able to purchase or implement such technological advancements. Financial investment must be committed from decision makers as well as from commercial actors to provide a sort of technology like road mapping software or an algorithm software to ensure that packages will be identified for pickup on passenger routes in proximity.

4.8.3 Piloting co-modal solutions

Decision makers, before committing financial resources to a new project, often are skeptical to invest unless the project has been piloted and proven to be capable of achieving its intended goals and objectives. Piloting a program before implementation is important because the challenges will be brought forth and then based on the challenges, refinements can be made. The following are what some stakeholders from the interview process had to say:

“I know there are regulatory challenges when introducing new technologies, new piece of equipment in the delivery of those last mile but we are here to lobby the province to kind of support certain things. So, we are willing to try certain things out. We are not going to say no straight away. We would like to pilot whenever we can to learn a little bit more, see where we can refine the process and bring some awareness, bring some reassurance even to our Council from looking into introducing something new, whether there require some policy directions or council approval, we are willing to do that at all times”

Stakeholder 3 (Fieldwork, 2019)

“In terms of the commercial feasibility, I think you would have to research some of the pilot programs, or some other things where people have tried grouping their deliveries; multiple courier companies grouping their deliveries and how they get them into buildings”

When new projects are being piloted in the city of Toronto, some form of regulations are put in place. A typical example is the setting up signages in areas where the project is being piloted. Through the interview process, a stakeholder from the government said these signages were of little cost when asked if they get any financial support when piloting a new project. The stakeholder said piloting programs are self sustaining because “things pay for itself” whenever people violate the rules they put on the ground.

4.8.4 Security measures

In the interview process, security concerns were raised because some stakeholders believed that combining both passengers and parcels together in the same vehicle could increase potential risks to riders of the service. At airports and some high-speed rail stations, the presence of CCTV cameras, security checks, and advanced screening equipment are present to scan through luggage of passengers before they are brought onboard. This helps to reduce the possibility of any hazardous content which can harm passengers.

A stakeholder made such a statement when interviewed:

“Maybe, there can be some sort of screening process that should be done when you are doing co-modality. Packages are screened just like the way they do it in the airport where they go under the x-ray by looking at what is inside the package.”

The statement above from the stakeholder interviewed was directed towards the taxi industry if such a practice of including both passengers and parcels together in the same vehicle were to be adopted in downtown Toronto. Such a practice being done in

downtown Toronto. Currently, the city of Toronto has the vehicle for hire by-law which prevents taxi companies from engaging in a business model that involves the picking up of both people and parcels at the same time. One of the main issues why such by-law exist is because of the safety concerns attached to such a business. The city also does not want to incur any liability issues and as a result, will do anything possible for that to happen. Screening parcels before they are moved could be a start to reducing safety concerns in co-modality.

4.9 Opportunities for co-modality in Downtown Toronto

The need for a more sustainable transport system applies to both passenger and freight transport and even though they share the same transport infrastructure such as railways, roads, air space and ports, they have different systems which they run more so in terms of policy and planning. Recently, there have been the need for more sustainable and environmentally friendly ways of transporting both passengers and freight in urban areas. In freight transport, the last mile of freight delivery is where there are many challenges experienced. As such, cities are finding opportunities to reduce such existing challenges to make the last mile stage more sustainable and economical.

The growth of e-commerce is an opportunity that stakeholders brought up during the interview process. This opportunity identified agrees with Savelsbergh & Van Woensel (2016) where they also pinpointed the growth of e-commerce as an opportunity for city logistics practices. The rise of online sales has generated many business models, and this is because of the increased penetration of the internet, ownership of cellphones, and other relevant technology. As a result, courier companies have the objective of making sure that parcels which are ordered online are delivered to customers as swiftly as possible. The desire for speed from consumers has created the avenue for an on-demand delivery service and most courier companies and the taxi industry try as much as possible to do that. This opens opportunities to practice co-modality starting from a small scale. The growth in e-commerce links to the fact that urbanization and population growth has been on the rise and as a result has presented many opportunities for delivery companies to take advantage of.

Through the interview process, stakeholders were asked if there were opportunities for co-modality in the downtown area and a stakeholder said that one of the opportunities for co-modality is the willingness of the city to pilot new programs to identify the benefits and challenges and ways they can be improved upon to reduce the externalities during the last mile delivery. The city is always willing to try new things and the stakeholder made it very clear. The city during the PANAM games in 2015 piloted the off-peak delivery program and the stakeholder said this:

“We did pilot the off-peak deliveries during the PANAM games with the Ministry of Transportation and it was successful but maybe we want to expand the program in certain areas. One of the challenges around that is the noise associated in deliveries at night because the trucks make noise whenever they are backing up (that beeping noise). We are looking to support the industry in any way that we can”

Stakeholder 8, (Fieldwork, 2019)

Another opportunity that was identified through the interview process is the availability of public transit in the city of Toronto. A stakeholder said that an advantage is the fact that the urban transit lines cover long distances and the location of the subway stations are right under the downtown core. Although the stakeholder stressed on the importance of piloting it first, he said there could be an opportunity there where unused component of the transit vehicle can be utilized to carry the parcels.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

The main purpose of this study was to answer the 4 main research questions that guided the entire research: what is co-modality? What are the potential impacts of co-modality? What are the existing co-modal practices in the GTA? and what are the barriers and opportunities influencing the potential for co-modality in the GTA? This chapter of the thesis provides the recommendations or implications for policy makers and planners as well as the concluding remarks for future studies.

5.2 Summary of findings

This section of the research will provide a summary of the findings from chapter 4 and this will be done based on 4 themes: current practices in co-modality, perceptions of co-modality, Barriers of co-modality, and the Opportunities of co-modality.

5.2.1 Current practices of co-modality

From the findings, it was identified that there are two current practices of co-modality. They are Shipper Bee and A-Way Express. Shipper Bee is a crowdsourced parcel delivery system which makes use of the space available in vehicles heading to a destination to deliver parcels. A-Way Express is a courier company which champions the use of public transit in downtown Toronto to deliver packages to customers by foot. These two companies have the aim of reducing externalities such as traffic congestion dominant in most cities today.

5.2.2 Perceptions of co-modality

From the interview process and literature reviewed, it was identified that people are open to the idea of co-modality so far as it has been piloted and proven that there are no safety concerns associated with it. Stakeholders interviewed who are regulators or government officials had little knowledge about such a concept although they had heard of it being popular in Europe. Regulators interviewed are welcoming to the idea of co-modality

because of the potential impacts but want to know if truly it will have an immediate positive impact on congestion and on Green House Gas emissions

5.2.3 Barriers of co-modality

There were barriers which were identified which can hinder the promotion of co-modality in the GTA. They include safety concerns, conflict with passenger schedules, initial funds required to invest in the technology, potential rise in insurance premium rates, and a reluctance by private firms particularly to shift from their traditional business model. These were genuine concerns provided by stakeholders interviewed that could be potential barriers to co-modality in the GTA. One other thing identified was that there is currently a by-law which prevents taxi companies from practicing co-modality in Toronto.

5.2.4 Opportunities for co-modality

The growth of e-commerce especially in Toronto provides avenue for co-modality to be implemented. Another opportunity identified through the interview process is the willingness of the city to pilot programs which have the potential of reducing externalities associated with delivery of goods especially congestion in Toronto. The last opportunity identified is the availability of the public transit in many cities in the GTA.

5.1 Recommendations for Planners and Policy Makers

The main purpose of this thesis was to understand the concept of co-modality and how implementable it is in the Greater Toronto Area in large specifically focusing on the downtown area in city of Toronto. Overall, the findings from this thesis can be utilised by policy makers and planners to gradually shift to co-modality. The following are the recommendations provided through the findings:

- Municipal Licensing and Standards should review the by-law (Toronto Municipal Code 546) which prevents the taxi service industry and private transportation companies from engaging in businesses which allows them to move both people and parcels together at the same time in the same vehicle. In reviewing the by-

law, the city of Toronto could use Shippers Bee company and A-Way Express as case studies to learn the operations of their businesses. In so doing, they will know how feasible the application of co-modality is in the downtown area specifically, as well as identify the challenges to its successful implementation.

- Co-operation and partnerships amongst stakeholders must be a key topic of discussion amongst stakeholder meetings. Co-operation and partnerships amongst stakeholders aim to increase productivity by optimizing vehicle capacity utilization of public transit, reducing empty mileage and cutting down on operational costs thereby increasing efficiency and competitiveness of logistic networks. This is a vital area and without this, co-modality cannot be achieved. Stakeholders involving city regulators must be sensitized on the benefits of such a concept in order to bring everyone on board.
- The need to pilot co-modal practices in the city of Toronto is crucial. Piloting co-modal solutions will help identify the benefits and implementation challenges. When accepted by city council, a policy document must be created to guide the execution of co-modality. The major challenge is on how to harmonize the design, execution, follow up, supervision and assessment of policies that will maximize the impact on development. The need to develop and incorporate indicators for monitoring the strategies will be key for policy supervision and the assessment of progress if co-modality is accepted by city council. Through this, it will be known if the variables for determining progress need to re-adjusted or not.
- Safety of riders and the security of parcels must be ensured to reduce the potential for transportation of illegal or harmful products. X-ray scanners must be purchased and employed to scan packages before they are transported to ensure that both riders and drivers are safe from any harmful products. Again, people must be sensitized to be aware of such a concept being done. In so doing, skepticism will be reduced amongst people and patronage of such a concept will be increased.

5.3 Limitation

There were two limitations that were encountered through the research. The first limitation were the inconsistencies by the target population in sticking to the appointed schedule times for phone interviews. Due to the busy nature of interviewees, follow up emails had to be sent to reschedule the time for the interviews to be done. This, however, prolonged the data collection period.

The next limitation was the difficulty in recruiting respondents for the study. Initial emails which were sent did not get immediate response from the target population. Follow up emails had to be sent as well as phone calls had to be made to get participants to interview.

5.2 Future Research

Ride-sharing providers such as Uber and Lyft are demonstrating that innovative use of technology can transform mobility of human beings in cities. Uber for example is an American multinational ride-hailing company which offers services that include food delivery, peer-to-peer ridesharing, ride service hailing, and a micro-mobility system with scooters and electric bicycles. Uber which started with the peer to peer ridesharing have revolutionized the perception of transportation since its incorporation and have even gone into the business of food delivery. One limitation of this study was the inability to get a representative from Uber to know if co-modality is in their short term or long-term policy documents here in Canada. Another thing as well is to identify if there are mechanisms which allows drivers to deliver food and pick up people at the same time along the same routes (switching between Uber Ride and Uber Eats) in order to achieve optimization.

Another area of research will be to interview potential riders or passengers of co-modal practices to get a sense of their perception about such a practice. Perceptions will include safety, whether they will ride with a parcel next to them at a cheaper cost. This will help get a sense of acceptance rate amongst riders or passengers if the concept of co-modality is implemented on a large scale and included in policy documents.

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APPENDICES

Interview Guide for Courier and Taxi Companies

1. How long has this company been operating in the downtown area?

2. What is your role in this company?

3. What are the responsibilities of the company?

4. Does your company move both parcels and passengers together at the same time?

- 5a. If yes, what was the rationale for starting this practice? How long have you done this?

- 5b. What proportion of your business does it represent? How often do you practice it?

6. If no, have you discussed this as a future possibility? why not?

7. In your opinion, what do you think can be the benefits of such practice?
 - Do you think moving passengers and parcels together at the same time can be another source of revenue for the company? Can you tell me more?

- Do you think moving passengers and parcels together at the same time can reduce externalities such as air pollution? Do you think this can help you reach the sustainability goals as an organization?
- Are there benefits to your clients/customers when using this practice?

8. In your opinion, what do you think can be the challenges to such practice by your company?

- What are the potential risks for the company? (\$\$, legal, logistical)
- What are the potential risks to customers/clients/passengers?

9. In your opinion, what would it take to overcome the challenges you mentioned?

10. What do think are the impacts of widespread adoption of this practice on other/allied industries?

11. Are there any additional comments you will like to add concerning the movement of both passengers and parcels?

Interview guide for Regulators in the Freight Industry

1. What is your role here at

2. What are the responsibilities of the

3. In your opinion, do you think the movement of both passengers and parcels together in the same vehicle can reduce externalities such as congestion in downtown Toronto? If no, why not?

4. What is your policy direction towards the sustainable and efficient movement of freight? Do you have the integration of both freight and passengers in the same vehicle in your policies? If no, why not? Do you think that will be possible in the future?

5. In your opinion, what do you think are/can be the benefits of moving both passengers and parcels together in the same vehicle?

- Do you think moving passengers and parcels together at the same time can reduce externalities such as air pollution? Do you think this can help you reach sustainability goals as an organization?
- Do you think moving passengers and parcels together at the same time can be a source of revenue for freight companies? Can you tell me more?

6. What are/can be the challenges to such a practice being done in downtown Toronto?

- What are the potential risks for freight companies? (\$\$, legal, logistical)
- What are the potential risks to customers/clients/passenger?

7. In your opinion, what do you think can be done to overcome the challenges you mentioned?

8. What do think are the impacts of widespread adoption of this practice on other/allied industries?

9. Are you aware of any courier/ taxi company that moves people and parcels together in the same vehicle at the same time? If yes, can you provide their names?

9. Are there any additional comments you will like to say regarding the moving of both passengers and parcels in the same vehicle?