Transportation Association of Canada

Understanding Goods Movement in Canada: Trends and Best Practices

February 2021

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Abstract This document is a presentation of trends and best practices for goods movement in Canada. The materials were developed through a review of Canadian and international literature, and of information from the public sector, industry and academia. The objectives of this work are to develop tools for goods movement planning, develop tools for interacting with goods movement stakeholders, and provide knowledge of goods movement planning best practices. This document contains three textbook modules (Freight Industry Overview; Planning Considerations; Trends and Disruptors) plus case studies and self-directed exercises. Upon completion of the course, the audience should be able to apply learned concepts to real-world examples.	**Keywords** Traffic and transport planning • Canada • Freight transport • Goods traffic • Layout • Mobility (pers) • Multimodal transport • Policy • Public participation • Rural area • Supply chain • Urban area	
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Executive summary

Despite the significant impact of goods movement on the road system and on the economy, there is a need to raise awareness and understanding of how goods are transported in urban areas and how to best plan for goods movement. There is a widely acknowledged gap in the training and education of urban and transportation planners, engineers, and other professionals on the subject of goods movement. Sharing best practices and learning how to best engage the goods movement industry in planning, engineering and policy development would benefit many professionals and help them anticipate future trends. It would also enhance understanding of the issues that have an impact on the industry and how they interface with the needs of other road users as well as how innovative approaches can address those issues.

The goals of this work are to provide the following knowledge of goods movement to transportation practitioners:

- Tools for goods movement planning – including an understanding of concepts, data and analytical skills
- Tools for interacting with goods movement stakeholders
- Goods movement planning best practices

Although this course is targeted primarily towards transportation planning staff at various government agencies, it may also be relevant to other transportation professionals, as well as staff and officials from other industries and public sectors. This course will allow for the development of a basic understanding of the planning considerations related to goods movement, and considers how aspects of goods movement will vary between urban, rural and inter-city scales, as well as the multimodal aspects of goods movement. Consideration is given to readers who have different technical or non-technical roles in their respective organizations, resulting in an audience with varied knowledge. Consideration is also given to how goods movement varies between urban, rural and intercity scales, as well as its multimodal aspects.

The course is structured to encourage engagement and knowledge sharing between participants. It includes three modules to help the audience develop a broad understanding of goods movement:

- **Module 1: Freight Industry Overview** – an overview of the goods movement industry in Canada, discussing its structure, the stakeholders involved and their responsibilities, the different modes available and their characteristics, and an introduction to supply chains
- **Module 2: Planning Considerations** – an introduction to a range of considerations made by governments and freight-related companies when planning, implementing, and evaluating projects
- **Module 3: Trends and Disruptors** – a presentation of emerging social, industry, and technological trends and advancements in the goods movement industry, and a discussion of the benefits they bring and the potential risks associated

It also includes a number of case studies and self-directed exercises that apply concepts learned and share best practices from other Canadian and international jurisdictions, including supply chains, urbanization and land use planning, and policy-making.

Module 1: Freight industry overview

This module provides a general overview of the freight industry, its structure, the major players involved and their responsibilities, and different modes. By the end of this module, the reader will better understand:

- The evolution, purpose, and dynamics of goods movement in Canada, as well as the economic drivers and infrastructure that shape Canada's national and global trade
- The different modes available for transporting specific goods, and trade-offs in selecting modes
- The different actors and industries that participate in goods movement, and the responsibilities of different levels of government with regards to goods movement
- The basic workings of a supply chain

Summary Points

- Three main corridors serve as the backbone of Canada's trade: The Western Asia-Pacific Corridor, the Ontario-Quebec Corridor, and the Atlantic Corridor.
- Canada has over 1.13 million two-lane equivalent lane-kilometres of public roads, 81 airports, 41,700 route-kilometres of rail track, and 559 marine port facilities.
- There are many factors that are generally considered when choosing a shipment mode, such as time and cost of shipping, availability of services, and legal and insurance considerations. Furthermore, there are several actors, from shipper and logistics providers to government agencies that participate in the shipment of goods.
- The basic premise of a supply chain involves moving supplies from a place of origin to a place of production, processing, warehousing, or distribution, and then to a place of consumption. In urban settings, goods movement takes place through one of three main channels: industrial production, retail distribution, or service provision.

Module 2: Planning considerations

This module introduces the audience to a range of considerations made by both governments and freight companies. Considerations should be made for selecting their projects and their components, how projects are evaluated, what data is available to use in planning, and freight sensitive strategies that are available for planners with regards to goods movement infrastructure. By the end of this module, the reader will better understand:

- The dynamics and components of project planning, as well as some of the considerations that should be made for freight when planning projects
- The means and tools available for data collection and management, including common sources of data, stakeholder consultation, and analyzing current and future needs
- Strategies for project planning that are freight-supportive, as well as an exploration into road and site design, and freight-inclusive demand modelling
- How to effectively evaluate a potential project to ensure it will provide the desired outcomes

Summary Points

- Project planning helps municipalities, planners, and engineers make informed decisions on ensuring the safe and efficient movement of freight, and its integration into the built environment. It starts by identifying problems, goals and objectives, and the required information to be analyzed.

- Data collection involves four primary types and sources of data: quantitative data, intelligence gathering and stakeholder consultation, site visits, and freight data. Part of the planning process also involves analyzing current and future trends, which includes a look at freight supply and demand, infrastructure, regulation and policy, enforcement, and future needs.
- There are many freight-supportive strategies available for various project undertakings, such as the development and identification of arterial and secondary routes; protecting corridors and employment lands through zoning by-laws or municipal plans; and building truck bypasses and parking facilities into current road networks.
- There are a wide range of tools that exist to evaluate the potential benefits of proposals, and the method selected depends on the stakeholder performing the assessment. The majority of available tools fall under three main categories: cost-benefit analysis, risk analysis, or SWOT analysis.

Module 3: Trends and disruptors

This module presents the results of research of emerging social, industry, and technological trends and potential risks in the goods movement industry. The overall purpose is to educate the audience on recent developments in the industry that they should be aware of, and have the potential to take advantage of, when planning and delivering projects. It is also meant to educate the audience on what the current and emerging trends exist within freight to raise awareness of how and why certain companies make their decisions. By the end of this module, the reader will better understand:

- Disruptors inducing the shifting behaviours of freight industry stakeholders, policymakers, and consumers, and their impacts on production, distribution, delivery and consumption
- Technological advancements that can be deployed throughout the freight industry, and the benefits, risks, and practical limitations that are associated with them
- Other external forces that may bring about risks and challenges to the freight industry

Summary Points

- Significant changes to consumer purchasing options (e.g. e-commerce and on-demand delivery services); the shift in culture towards recycling and returns; social and public involvement towards transportation investments; and the changing nature of freight logistics, infrastructure, and ownership are all emerging trends that have changed the freight and transport landscape.
- Additionally, advancements in technologies such as automation, intelligent transportation systems, and alternative fuels can lead to great opportunities to improve safety and efficiency, but come with significant risks and practical limitations. The limited adoption and scale today could mean that some of these technologies may not be realized in their full forms in the future.
- There are other risks that should be considered for freight, such as the infrastructure gap, an aging workforce, security, and policies surrounding cross-border freight traffic.

Case studies

This section presents four case studies that present real-world examples of goods movement-related activities, and that will help the reader to better understand:

- The dynamics and components of a supply chain through a case study of Apple's iPad
- How project planning is used, through exploring the development of Winnipeg's freight village, CentrePort
- How goods movement was incorporated into policy-making through MTO's off-peak delivery pilot
- How to develop a strategic plan and a strategic network for regional goods movement, using the example of the Region of Peel

The section also includes five self-directed exercises that test acquired knowledge.

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1. Module 1: Freight industry overview

This module provides a general overview of the freight industry, its structure, the major players involved and their responsibilities, and its different modes. Its major sections are:

- Canadian context
- Modal profiles
- Definition of actors
- Industry and commodity profiles
- Understanding supply chains

Key takeaways from this section include why companies select certain modes to transport specific goods, the responsibilities of different levels of government with regards to goods movement, and the basic workings of a supply chain.

1.1 Canadian context

1.1.1 Background information

Goods movement, or freight, is broadly defined as the wide array of activities involved in transporting goods (primary, intermediate, or finished) from producer/supplier to consumer. It is a derived demand driven by consumption and commerce. In other words, the demand for goods movement is a result of the demand for other goods. [1] Therefore, as demand for these goods increases, the demand for their transport will also increase. Goods can travel along a supply chain by one mode or a combination of them, including road, rail, marine, air and pipeline. Section 1.2 in this module has modal profiles that describe transport needs and characteristics by road, rail, air and marine. Section 1.4 contains industry and commodity profiles that describe the characteristics of the modes, goods they typically transport, and environmental considerations.

The Canadian goods movement sector encompasses various other sectors and subsectors – as classified by the North American Industry Classification System (NAICS) – including construction, manufacturing, and wholesale trade for example, while also interacting and providing transport services for a wide range of economic sectors that produce goods. Industries that fall within the sphere of goods movement include logistics, manufacturing and its specific types (e.g. animal food manufacturing), warehousing and storage, and various transportation industries such as rail, water and air transportation, and trucking. [2] These industries must effectively coordinate with each other (locally, nationally and internationally) along with producers, suppliers, consumers and government(s) in order to complete supply chains. The complex nature of supply chains is further described in Section 1.5.

Goods movement has always been an important part of the Canadian economy, and has been facilitated through the introduction of new technologies, methods and materials over time. One such example is the introduction of shipping containers in the 1950s. Containerization is the use of a single standard-size cargo container to load, transport and unload goods. [3] The containers are easily transloaded (transferred intermodally by crane from ships to trains or trucks, or vice-versa), and are typically unloaded and refitted into smaller standardized cargo units for air transport. Prior to the introduction of containerization, the unloading of ships at docks would take many labourers to complete, and generally required factories and intermodal facilities to be located near ports to facilitate land transportation. This was because most cargo prior to this time was transported in the form of bulk or break bulk. Bulk cargo (also known as general cargo) is a form of large, unpackaged commodity cargo that can be liquid or dry (e.g. crude oil or gravel). The cargo is typically poured or dropped directly into the receptacle used for its transport. [4] Break bulk cargo refers to goods that are loaded/unloaded individually and are typically stored in bags, boxes, crates, drums or barrels for transport (e.g. bagged cement, steel coil, oil and gas equipment). [5]

After the introduction of the shipping container, the method, frequency and cost of shipping goods locally, regionally and globally changed significantly. [6] The standardization of container size allowed for factories to relocate away from ports, towards smaller towns with cheaper land and lower wages, as they no longer needed to be located near ports to benefit from cheap transportation. This brought about the beginning of large industrial complexes in rural areas where there is more space to store goods. It also brought the development of international manufacturing companies with networks of warehouses or distribution centres, allowing firms to select the cheapest location to assemble and ship goods to market, which helped accelerate a change in the international economy towards the intensification of global trade.

As a result of the introduction of containerization to the shipping industry, as well as the development of free trade agreements (FTA) and other technological advancements, transportation and warehousing [7] have continued to increase as a percentage of gross domestic product (GDP), and accounted for 4.6% of Canadian GDP in 2017, while employing 905,000 individuals. [8] This sector is important to the overall health of the Canadian economy due to the abundance of natural resources within the country and access to global markets through ports in Atlantic and Pacific provinces. Overall, much of the resources and goods produced within Canada are eventually packaged and shipped internationally (with the United States accounting for 63% of total Canadian trade in 2017); however, a portion remains in Canada.

Finally, there are several current and planned government initiatives that may impact freight industry stakeholders. The roles and responsibilities of different levels of government are further described in Section 1.3 below. At the federal level, planners can look to Transport Canada for initiatives, consultations, and laws and regulations that affect the transportation sector, including the goods movement industry. For example, Transportation 2030 provides a strategic plan to make Canada's transportation system smarter, cleaner, and safer, with a focus on waterways and trade corridors to global markets. There is also the National Trade Corridors Fund (NTCF) which provides funding for strategic infrastructure projects that support the flow of goods and trade diversification, address unique transportation needs in the territorial North, and increase the flow of Canadian trade by all modes for example. Finally, a recent development is Bill C-49, or the Transportation Modernization Act, which affects rail and air transportation primarily. In part, the Bill seeks to increase transparency related to railway companies publishing tariff data and reporting information to the Minister of Transport, providing dispute resolution tools for shippers to hold railways accountable for their commitments to move products to markets, and requiring the Canadian Transportation Agency to set the interswitching rate. [9]

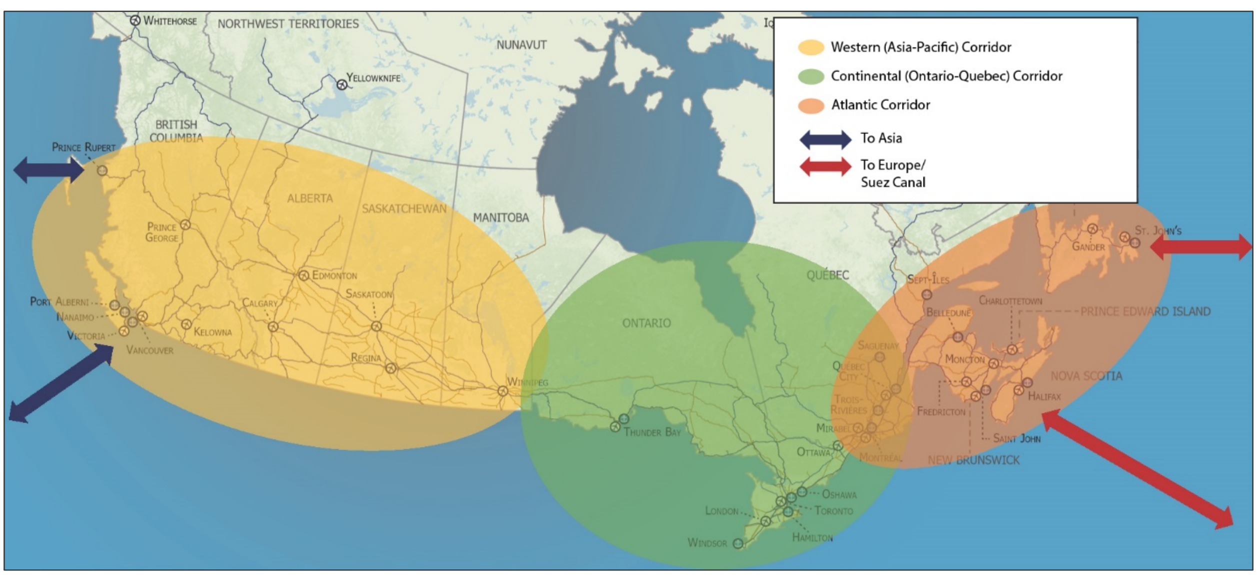
At the provincial level there are strategic plans, typically addressing horizons of five to ten years, that are released by some provinces or one of their ministries and affect the movement of goods within the provincial transportation system. These documents provide planned spending which can help planners understand what other projects are taking place within a province, or decide which projects to pursue based on where funding is allocated, if not already earmarked for a specific project. For example, the current Manitoba Capital Region Transportation Plan includes a section on goods movement; Nova Scotia's Five-Year Highway Improvement Plan 2018-2019 outlines current and planned projects up to 2023; British Columbia's Ten-Year Transportation Plan acts as a comprehensive road map for transportation investments and strategic policy actions; and Newfoundland and Labrador's Five-Year Provincial Roads Plan acts as a holistic and proactive plan to ensure the condition and longevity of transportation infrastructure.

At the municipal level, the majority of goods movement strategies, if any, can be found in transportation master plans where land uses, transport infrastructure, and freight corridors within the urban area are planned, and in by-laws. However, some municipalities have given a higher importance to freight, and have developed specific goods movement strategy documents recognizing the critical importance of goods movement for both the economy and quality of life (examples include Calgary, Edmonton and Peel Region). These documents can be used by planners in other municipalities as starting points for developing their own goods movement strategy and supportive policies in order to meet planning objectives like maximize efficiency and safety.

1.1.2 Primary regional corridors / trade routes and key characteristics

Trade routes within Canada are primarily on land (road and rail), and connect major hubs within the country to each other, as well as to coastal ports and land border crossings. These corridors are crucial to the nation in supporting the movement of goods and its planning, whether local, regional, provincial, or international. Figure 1.1.1 below shows Canada's three primary trade corridors, which connect to international trade routes.

Figure 1.1.1: Overview of Canada's trade corridors
(Source: Transport Canada, 2018)



As a geographically large nation that relies to a large extent on global trade (trade as a percentage of GDP peaked at 82.9% in 2000, and was 64.1% as of 2017) [10] with access to oceans on both coasts, internal trade routes that allow goods from all over the country to be transported efficiently are critical in ensuring the economic vitality of the nation. The federal government has acknowledged the importance of such trade routes, as made evident by the Trade and Transportation Corridors Initiative and the National Trade Corridors Fund, which helps fund projects that seek to make Canada's trade corridors more efficient and reliable. [11]

While the overall transportation system in Canada is connected across jurisdictions, there exist instances where there is a lack of coordination between government jurisdictions, which may cause problems for the movement of goods due to varying weight, time or size restrictions for example. The particular roles and responsibilities of different levels of government are further described in Section 1.3.

Western (Asia-Pacific) corridor

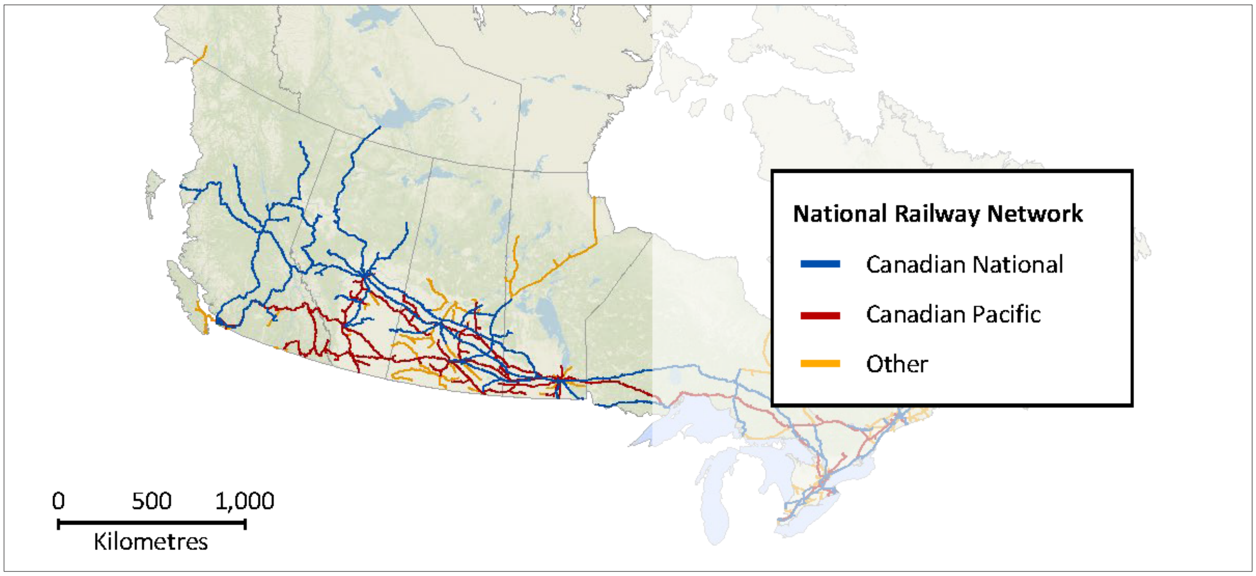
The Western Corridor serves Canadian bulk commodity exports such as crude oil, grain, coal, wood products, potash and copper, and operates primarily by rail or marine modes of transportation. These goods are destined primarily for North American and Asian markets. In 2016, goods exports valued at $101 billion flowed through this corridor. In addition, this corridor links container imports from Asia to Central Canada and the Midwestern U.S.

There are several ports along this corridor, with the two main marine ports located in BC – Port of Vancouver and Port of Prince Rupert. Figure 1.1.2 shows marine ports and inland terminals (also known as dry ports) in Western Canada along the Western Corridor. Canadian marine ports face competition from the U.S. ports of Seattle-Tacoma, Los Angeles, and Long Beach. Market share for the ports of Vancouver and Prince Rupert versus Seattle-Tacoma are 12%, 48.5% and 39.5% respectively. [12] The inland terminals serve as key regional and national hubs, particularly CentrePort, which is the topic of the second case study in Section 4.2, along with the Global Transportation Hub, Calgary Regional Inland Terminal, and Port Alberta – all of which are foreign trade zones (FTZs).

Figure 1.1.2: Western Canadian inland and marine ports
(Source: Johnston, Van Horne Institute, & Brown, 2015; Transport Canada, 2018)

Also included in the Western Corridor is a network of Class I and shortline railways that provide freight transportation. Figure 1.1.3 shows rail infrastructure in Western Canada. The primary Canadian operators of Class I freight lines are the Canadian National Railway (CN) and Canadian Pacific Railway (CP), and these Canadian companies are in competition with American companies such as the BNSF Railway Company (BNSF). Shortline rail infrastructure in Western Canada include 26 railways, each operated by its respective municipality, a private business, or a cooperative who purchased abandoned CN and CP lines. [13] These shortline railways transport goods such as agricultural products, fuels, and chemicals to businesses that are built directly along the railway.

Figure 1.1.3: Western Canadian rail infrastructure
(Source: Transport Canada, 2018)



Continental (Ontario-Quebec) corridor

The Continental Corridor is the busiest of Canada's three major freight corridors in terms of surface traffic, with road, rail and marine being its primary modes. Air, however, is also a significant mode within this corridor with Toronto Pearson International, Montreal-Mirabel International, and Montreal-Pierre Elliott Trudeau International Airports accounting for 54% of Canadian air traffic cargo in 2016. Goods shipped by air are typically high-value and time-sensitive merchandise such as pharmaceuticals and precious metals. For road infrastructure, the Continental Corridor includes Ontario's Highway 401, which is recognized as the busiest highway in North America. Highway 401 serves as the primary route for east-west travel within Ontario, and merges into Autoroute 20 at the Ontario-Quebec border, which is part of the Trans-Canada Highway. For intermodal terminals, the four largest facilities are located within the Greater Toronto Area (GTA) and Montreal, and serve as key hubs for the efficient movement of goods.

The Continental Corridor serves Central Canada, connects to the U.S. Midwest and Northeast, and moves goods internationally through the Great Lakes and St. Lawrence Seaway. The St. Lawrence River, through the Port of Montreal, provides direct access from the Atlantic Ocean inland, and represents the shortest route between Europe and parts of the U.S. Midwest. Some key exports that travel along this corridor include automotive products and parts, wood products, metals/minerals, coal, petroleum products and salt. The vast majority of Canadian exports travelling through this corridor end up in the U.S. (about 80%), with Europe, Asia and Mexico being the other markets. The corridor also acts as a transportation hub for the Western and Atlantic Corridors, as many of the goods entering or exiting the ports of Halifax and Vancouver are going to or coming from Ontario or Quebec. [14]

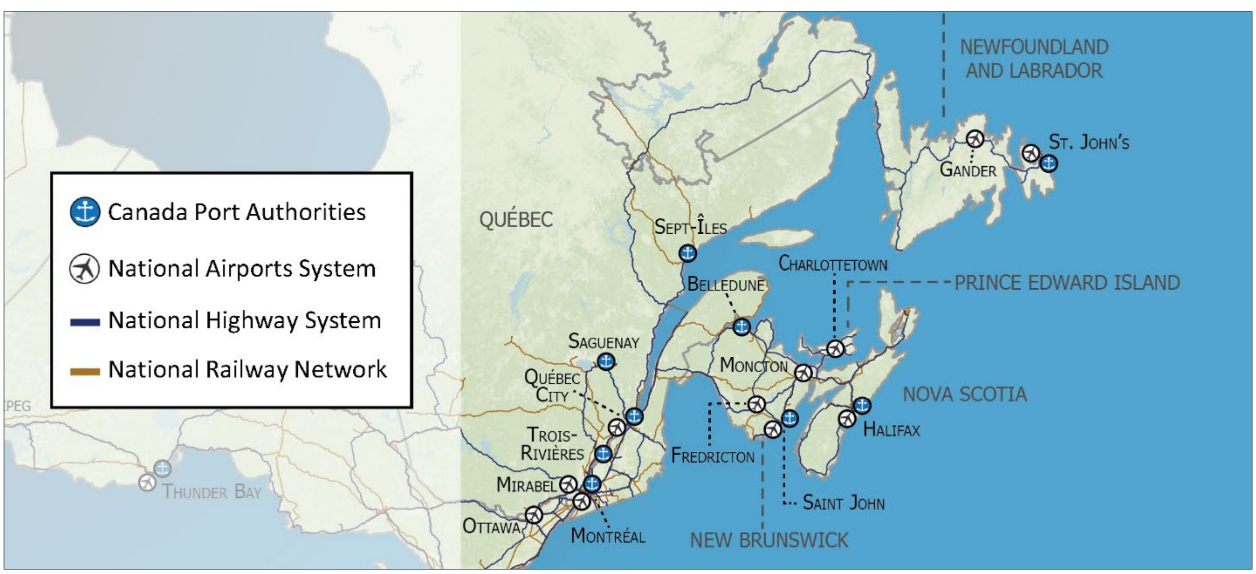
The major marine ports within this corridor include the Port of Montreal, Port of Thunder Bay, and Port of Sept-Iles. These ports compete with the Port of New York, as well as other Canadian river and marine ports for business in order to be the port of call in a specific corridor for the commodities that the specific port is capable of handling, since ports will vary based on the type of port (gateway, local, or transshipment), and commodities (container or liquid bulk). [15]

Atlantic corridor

The Atlantic Corridor is primarily a marine corridor for international market access; however, it also has key strategic airports, border crossings, and road and rail connections for access to major North American markets. [16] International markets served include the U.S., Mexico, Europe, the Caribbean, Latin America and Asia. As container trade continues to increase as a percentage of overall maritime trade, the Atlantic Corridor is well positioned to help Canada capture a larger share of trade flows between North America and international markets. This opportunity is a result of the region's transportation assets, which include transloading and logistics facilities and specialized distribution for example, to handle common and niche cargo.

The key marine port in this corridor is the Port of Halifax, the closest North American point of ice-free and minimal tide access to Europe and Asia. The Port of Saint John is another important port, which is the second largest port in the Atlantic Corridor. Figure 1.1.4 is a representation of the corridor and its marine and air ports, as well as rail and highway infrastructure.

Figure 1.1.4: Atlantic corridor ports, roads, and railways
(Source: Transport Canada, 2018)



Through this corridor, the key commodities exported include containerized petroleum products and seafood products. Key imports through this corridor include crude petroleum and automobiles. In 2016, $24 billion worth of goods travelled through (excluding pipeline exports) the Atlantic Corridor. Of these exports, 70% ended up in the U.S. and Mexico, while Europe and Asia both received 13%.

1.1.3 Economic drivers of trade

What economic factors drive trade? This is a key question to answer in order to understand what is responsible, at least in part, for the movement of goods within and between countries. In the case of Canada, one of the primary drivers of trade is the economic performance of Canada's top trading partners: the U.S., China, Japan, South Korea, Mexico and the European Union (EU). For example, after the 2008 global financial crisis, Canada's overall exports to its top trading partners dropped significantly. Another related factor is the value of a country's currency. For example, when Canada's currency drops relative to the Euro, it is more likely that European countries will buy more Canadian goods as they become less expensive. Another factor is commodity prices. If Canada's export commodity prices are cheaper than other countries, it is more likely that foreign countries will buy Canadian goods.

Free trade agreements are another factor that drives trade. As of March 2019, Canada was party to 14 free trade agreements [17] with other countries that are currently in force, which increases the likelihood of trading with these nations as the agreements substantially lower or even remove tariffs, increasing the attractiveness of global trade with Canada. Finally, the demand for goods must also be taken into consideration, since if there is limited demand, there will be limited trade.

Table 1.1.1 shows total Canadian exports for all industries from 2008-2017.

Table 1.1.1: Canadian exports to select countries, all industries, 2008-2017
(Source: Statistics Canada, 2019a)

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
United States	375,480	270,091	298,646	328,972	339,179	357,909	404,702	402,158	394,436	414,604
European Union	36,357	29,804	34,582	40,097	38,902	33,265	38,752	37,768	39,999	41,592
China	10,468	11,151	13,232	16,810	19,366	20,492	19,295	20,180	20,974	23,612
Japan	11,086	8,316	9,195	10,669	10,358	10,632	10,760	9,778	10,720	11,831
Mexico	5,844	4,803	5,008	5,486	5,386	5,435	5,652	6,641	7,632	7,853
Korea, South	3,837	3,529	3,711	5,093	3,715	3,501	4,177	4,019	4,379	5,306
Sub-total	443,073	327,695	364,374	407,128	416,906	431,233	483,337	480,545	478,139	504,798
Others	40,416	32,059	34,464	39,561	38,244	40,707	43,425	43,506	38,961	41,778
Total	**483,488**	**359,754**	**398,838**	**446,688**	**455,150**	**471,940**	**526,762**	**524,051**	**517,100**	**546,577**

1.1.4 Transportation infrastructure / network ownership

Who owns and operates air and marine port, road, and railway infrastructure? Generally, roads are owned by governments, railways are private, airports are run as not-for-profit, and marine ports have mixed ownership/operation.

Table 1.1.2 provides an overview of the level of ownership for goods movement infrastructure, while Section 1.2 provides more in-depth information for each mode. Section 1.3.4 defines the responsibilities of different levels of government, which includes ownership and operation.

Table 1.1.2: Public vs. private goods movement infrastructure (Source: WSP)

	Public	Private	Not-for-Profit	Mixed	Implications
Roads	X				Most roads are operated by provincial or municipal governments making infrastructure investments and policy decisions.
Rail		X			The major Class I operators in Canada (CN and CP) are publicly traded, allowing for decisions related to infrastructure investment to be decided by the stakeholders, not the government. They also operate in an oligopoly, as they are effectively each other's only Canadian competition.
Airports			X		Majority are owned by the federal government and operated by airport authorities (non-share, not-for-profit authorities), leaving capital improvements to them. Airport authorities are governed by boards of non-elected representatives nominated by levels of government, as well as by local business groups and other stakeholders. This allows for decisions to be made with direct input from public and private stakeholders.
Marine Ports				X	Marine ports are primarily owned and operated by port authorities which are overseen by the Federal Government, but independently operated and funded through harbour dues, fees charged to shipping companies, etc. Other, smaller ports are operated directly by Transport Canada.

1.2 Modal profiles[18]

1.2.1 Road

In Canada, road infrastructure is typically operated by provincial, territorial or municipal governments. Overall, Canada boasts over 1.13 million kilometres of two-lane equivalent lane-kilometres of public roads, approximately 40% of which are paved. Canada's National Highway System (NHS), formed in 1988 by the Federal/Provincial/Territorial Council of Ministers Responsible for Transportation and Highway Safety, is mainly a classification system for strategically significant routes, and is responsible for primary routes that support inter-provincial/territorial and international trade and travel by connecting a capital city or major provincial population or commercial centre in Canada with:

- Other major provincial population or commercial centres in the same or in an adjacent province
- Major ports of entry or exit with the United States
- Other transportation modes directly served by highways, such as ferry terminals[19]

The NHS encompasses over 38,000 lane-kilometres of highways as of 2015, managed by the provinces. The roads are divided into three categories, defined in Table 1.2.1 below, and displayed in Figure 1.2.1. The safety of these roads is jointly managed by the federal, provincial, and territorial levels of government. The federal level is responsible for safety standards for new and imported vehicles, tires, and restraining equipment for children and persons with disabilities. The provinces and territories are responsible for driver licensing, vehicle registration, and safe operations including size and weight restrictions, distracted driving, and speed limits.[20]

Table 1.2.1: NHS route classifications
(Source: Transport Canada, 2011)

	Core Routes	Feeder Routes	Northern and Remote Routes
Description	Key interprovincial and international corridor routes	Key linkages to Core Routes from other provincial and regional population and economic centres	Key linkages to Core and Feeder routes that provide the primary means of access to northern and remote areas, economic activities, and resources
Length	27,608 km	4,490 km	5,922 km

During the winter months, ice roads in northern provincial regions and territories connect remote communities to a permanent highway or railway system, from roughly mid-January until thaw in spring. These roads provide multiple benefits for remote and isolated communities which are often accessible only by air for a majority of the year. Some of the benefits of ice roads include: reduced costs of transporting consumer goods, fuels, and construction supplies versus air freight; more affordable and convenient access to primary health care and other services outside of the communities; and improved year-round access to these areas, helping the local economy in these communities through access to mineral resources for example.[21] Overall, Canada boasts over 5,300 kilometres of ice roads during the winter, with the longest single ice road at nearly 600 kilometres connecting Tibbitt in the Northwest Territories to Contwoyto in Nunavut.[22]

Figure 1.2.1: National Highway System
(Source: Transport Canada, 2018)

In 2016, the value of trucking traffic between Canada and the U.S. reached $418 billion, with the main commodities being automotive products, machinery and electrical equipment, other manufactured products, and agricultural products. Overall, road is the most popular mode of transport for freight traffic, and the most common commodity is manufactured goods.

Using data gathered from the Canadian Freight Analysis Framework (CFAF), Table 1.2.2 below presents the average distance goods travelled from all origins within Canada, to all destinations within Canada, and to the U.S. and Mexico. The framework only captures data for rail, air and for-hire truck. Data for marine and private truck was not available. This data helps to demonstrate the use of different modes. For instance, for-hire truck has the most total shipments, though its average value is much lower than air, while average distances are roughly equivalent, indicating that lower value goods are less time-sensitive and therefore can employ a less expensive mode for shipment.

Table 1.2.2: Average distance, total shipments, and average value of Canadian goods by mode (Source: Statistics Canada, 2019b)

Mode	Average Distance [23] (km)	Total Shipments [24]	Average Value [25] (2014 millions of CAD)
For-Hire Truck	5,776,435	58,931,518	$331.0
Rail	5,007,669	5,194,112	$87.3
Air	6,979,289	3,349	$1,386.7

As of December 2016, there were 66,751 Canadian businesses whose primary activity was trucking transportation. There are three main types of trucking activities: for-hire, courier and private carrier. For-hire trucking services carry goods from other companies and operate truckload or less than truckload trips; courier services specialize in transporting parcels; and private carriers are fleets owned and operated by businesses who ship their own goods. Companies select one of these three options depending on the size and weight of goods, and frequency and value of shipments.

As the most-used mode of transport by total shipments, for-hire truck transportation is a crucial goods movement channel that can have significant impacts on the Canadian economy, as well as the safety of the road transportation network. Urban congestion has a significant impact on the trucking industry, as drivers must meet shipment times while respecting their federally-mandated hours of service (HOS) limits on driving and requirements for off-duty time. Rigid HOS requirements often force drivers to take long breaks which at times do not align with driver levels of alertness. Further, for these breaks to fit into a driver's schedule, they must often drive during morning and evening peak periods. Flexibility for HOS would allow for drivers to spend less time on the road, while achieving the same travel distance. [26] It would also help to take trucks off roads during peak commuter times, increasing time savings for all road users. Municipalities can contribute to solving this issue by allowing for solutions such as off-peak delivery, and adjusting truck route time of day restrictions.

While it is important to understand road networks, issues in the for-hire trucking industry, and how companies ship their goods, environmental considerations are equally important. The 2016 Pan-Canadian Framework on Clean Growth and Climate Change includes a commitment from federal, provincial and territorial governments to develop a Canada-wide strategy for zero-emissions vehicles by 2018. Further, the federal government continues to work to implement emissions standards for heavy-duty vehicles and engines for vehicle model years 2014 and newer, in an attempt to establish strict standards to limit greenhouse gas (GHG) emissions and to set new standards for trailers through the Heavy-Duty Vehicle and Engine GHG Emission Regulations.

These standards come as a result of the state of emissions from the transportation sector, most specifically road transportation. Between 2005 and 2014, overall emissions from road use increased by 3% despite fuel efficiency improvements across all vehicle classes. The increase was due to a growth in both passenger and freight activity, and a shift to more GHG-intensive transportation such as heavy-duty trucks and larger passenger vehicles. During the same period, freight emissions increased 14%, from 48 to 55 megatonnes, while road freight activity increased 25% (when measured in tonne-kilometres). In total, in 2016 road transportation (including electricity) accounted for 38% of all Canadian GHG emissions. [27]

Trans-Canada Highway[28] [29]

The Trans-Canada Highway is the longest national road in the country, spanning from Victoria, British Columbia to St. John's, Newfoundland and Labrador. The highway's construction began in 1950 under the Trans-Canada Highway Act, and was completed in 1971, although it officially opened in 1962. It passes through all ten provinces, thought it does not pass through the territories. It provides linkages to the major cities in Canada, and currently includes several different routes that help to better connect cities than the original single route, which totals nearly 8,000 kilometres in length.

The project was funded on a cost-sharing basis between provinces and the federal government, and as such had to meet specific design standards set forth by the federal government. Many of the sections along the route had existed prior to the development of this highway, though they required upgrades to meet federal standards. While the funding of the project was shared between these levels of government, the provinces remain primarily responsible for the design, construction, safety standards, and financing of sections of the road under their jurisdiction. The only exception to this authority are the sections of the Trans-Canada Highway that are in national parks, which fall under federal jurisdiction.

The Trans-Canada Highway contributes to the economic development of Canada, strengthening ground transportation for goods to travel across the country, at a relatively inexpensive cost. Communities along this route have benefitted from increased regional and national connectivity. Further, these goods can travel closer to, and even directly through many major cities, without the need to load and unload at intermodal yards. As a result of this increased ease of national goods movement, the demand for goods like metal structures, concrete, bitumen, construction materials, gravel, and sand all rose. In addition, the highway also helped initiate a boom in the bridge and road construction industry, increasing access to local and international markets.

1.2.2 Air

Air freight transportation in Canada is managed by NAV CANADA, one of the largest air navigation service providers in the world by total instrument flight rules (IFR) flight hours, which manages the world's third-largest aerospace sector, at over 18,000,000 kilometres. Within the Canadian airport system there are 26 National Airport System (NAS) airports which manage both passenger and freight, 31 small and satellite airports without scheduled passenger services, 13 remote airports providing the only reliable year-round transportation link to isolated communities, and 11 arctic airports, including the three territorial capital airports counted in the NAS. Figure 1.2.2 below shows NAS infrastructure in Canada.

Airport authorities (operators of NAS airports) in Canada, as non-share and not-for-profit entities, have organizational structures that place the responsibility locally, rather than on the federal government. For example, the Greater Toronto Airports Authority (GTAA) which operates Toronto Pearson International Airport, has a board of directors including community members such as local boards of trade, the Law Society of Upper Canada, and Professional Engineers Ontario and municipal representatives. This helps to ensure that the airport operates in line with the objectives of local public and private stakeholders.

Air freight is used primarily for high-value commodities such as machinery, medical and electronic equipment, aircraft materials, precious metals and stones, and pharmaceutical products. Air freight is also used to supply general cargo to remote communities. In 2016, air freight loading and unloading at Canadian airports equaled roughly 1.2 million tonnes, with a value of approximately $125 billion.

In 2016, air freight transportation accounted for less than 1% of transportation-related emissions, expelling 0.41 megatonnes of CO_2 equivalent GHGs. Canada is a member of the International Civil Aviation Organization (ICAO), a specialized agency of the United Nations. In 2016, the ICAO agreed to a new CO_2 standard for airplanes, which is projected to cut global emissions by 650 megatonnes over 2020-2040.

Figure 1.2.2: Air transportation network (Source: Transport Canada, 2018)

1.2.3 Rail

There is approximately 41,700 route-kilometres of rail track which is owned primarily by CN (52%) and CP (31%) rail companies. There are also 19 intermodal terminals, which are operated by CN and CP, and 27 border crossings with the U.S. In maintaining this infrastructure, railway companies must reinvest roughly 20% of their profits into maintenance activities. Between 2011 and 2016, this 20% averaged roughly $1.8 billion annually. In 2016, total freight tonnage on rail was 297.4 million tonnes, with an international trade traffic value of $128.3 billion.

There are over 60 rail companies that operate on Canada's rail network. Railways are classified as either Class I or Class II (also known as shortline). Classification criteria and examples of the companies are provided in Table 1.2.3. It should be noted that for Class I railways, CN and CP are the only Canadian companies that operate. The remaining Class I railways are American but operate some lines in Canada on track owned by CN or CP.

Rail freight transportation specializes in bulk commodities and containerized traffic over long distances. The main imports that travel by rail are automotive products and chemical products, while the primary exports are the same as imports in addition to forest products and metals.

Table 1.2.3: Rail classes and companies
(Source: WSP)

Type	Class I	Class II
Definition	Companies that have earned gross revenues of $250 million or more for each of the previous two years	Small to mid-sized railway companies that operate over relatively short distances and have gross revenues of less than $250 million
Companies	CN, CP, BNSF, Norfolk Southern, UP, and CSX	Hudson Bay Railway, Keewatin Railway, and White Pass & Yukon Route Railway

In 2016, GHG emissions from freight rail totaled 6.3 megatonnes, representing 0.04% of total transportation-related emissions. The freight industry accounts for 98% of all rail GHG emissions, and emissions increased 14% between 2005 and 2014 due to a large increase in freight activity. In a move to standardize emissions within the greater North American rail system, Transport Canada and the Railway Association of Canada entered into a memorandum of understanding – originally between 2011-2015 and extended to the end of 2017 – to encourage voluntary emissions reductions by railway companies. Further, in 2017 the Locomotive Emissions Regulations entered into force, with the goal of limiting harmful emissions from locomotives operated by railway companies through mandatory emission standards and reduced idling.

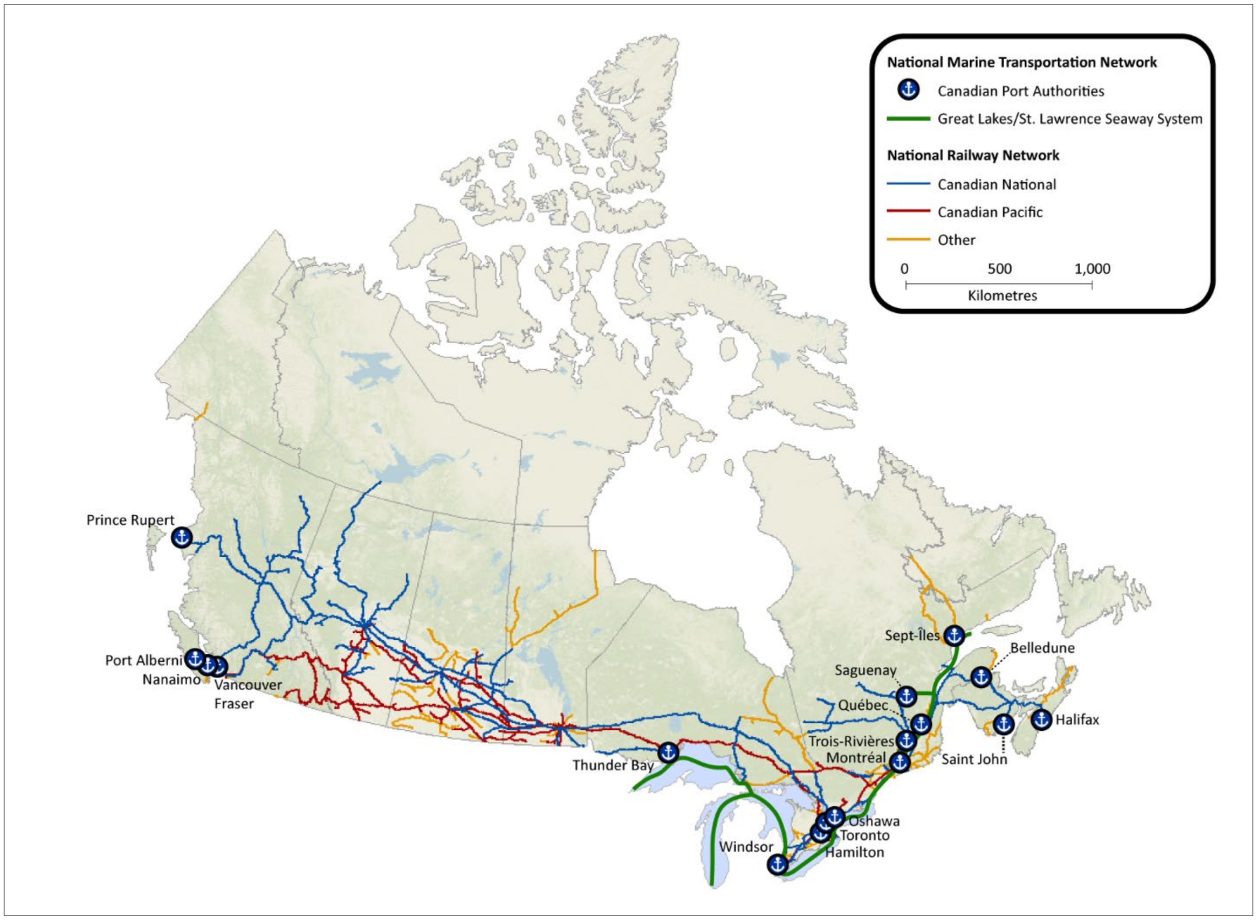
1.2.4 Marine

Marine infrastructure in Canada includes 559 total port facilities as of 2017. Transport Canada owns and operates 47 port facilities, and oversees port activities for remote, local/regional, and public ports throughout the country. Independent Canada Port Authorities (CPA) own and operate 18 major port facilities that are financially self-sufficient with their activities overseen by Transport Canada. Of these 18 ports, the most significant include Port of Vancouver, Port of Montreal, Port of Prince Rupert, and Port of Halifax.

Access points include the Pacific and Atlantic coasts, the Arctic/Northern region, the Great Lakes and the St. Lawrence River. In 2016, the total value of trade that passed through Canadian ports was $199 billion, $7 billion of which flowed through the Great Lakes and St. Lawrence Seaway. Contained within this Central Canadian marine system are 15 major international ports and 50 regional ports that connect to over 40 provincial or interstate (U.S.) highways and 30 rail lines. Primary goods carried through this system are grain, coal, iron ore, petroleum products, salt, gravel and stone. There is a close history of regulatory cooperation with the U.S. to facilitate cross-border flows of goods. Figure 1.2.3 shows an overview of rail and port infrastructure in Canada.

The Pacific coast marine activity caters to international and domestic trade, with trade to the U.S. occurring primarily between the States of Alaska, Oregon and Washington. Freight movement in this region includes general cargo for community resupply, wood products, gravel, stones, construction materials and coal.

Figure 1.2.3: Rail and port infrastructure (Source: Transport Canada, 2018)



The Atlantic coast has most of its trans-border trade with the U.S. operated by international marine carriers; however, there remains a strong presence of Canadian businesses and producers, especially those in the mining and petroleum sectors. The primary goods transported through this system include general cargo for community resupplies, petroleum products, iron ore and nickel.

In the Northern region, goods are moved to provide basic necessities from Southern Canada to remote communities in the three Territories, occurring seasonally as access is limited during the winter months. Similarly, resource projects in the Northern region rely on marine transportation to transport equipment and supplies from the south as well as shipping their products to southern markets. The four main marine systems that resupply northern communities are: Athabasca marine resupply system; Mackenzie River and western Arctic system; Inside Passage and Yukon system; and Keewatin/Hudson Bay and Eastern Arctic system.

In 2017, Canada's commercial registered fleet (vessels that transport 1,000 gross tonnes and more) comprised 189 vessels and a total of 2.3 million gross tonnes. This fleet includes dry bulk vessels, tankers, general cargo vessels, and ferries, but excludes tugs used for offshore resupply. Further, fleets of 510 tugs and 2,031 barges (both defined at 15 gross tonnes and more) operated primarily on Canada's Pacific coast. In addition, Canadians owned 362 ocean-going ships that trade internationally under foreign flags.

In terms of the marine mode's effect on public safety and the environment, the federal government introduced a $1.5 billion investment through the Oceans Protection Plan in 2016 which added regulations for safety and seeks to restore and preserve marine ecosystems, create opportunities for Indigenous communities to participate in shipping and the marine safety regime, and strengthen environmental protection. The goal is to combat GHG emissions (which decreased 2.6% between 2005-2014 as a result of shippers shifting to other modes) and oil spills. The National Aerial Surveillance Program flew 2,068 hours observing Canada's three coasts in 2016-2017, and found 246 oil spills totaling 2,870 litres of oil in the water. Some measures that have been implemented to strengthen environmental protection include $11 billion of funding to install shore power [30] at the Port of Vancouver and Port of Montreal in 2015, protection from invasive species through ballast water inspections, and other GHG and air pollutant emissions restrictions.

1.2.5 Modal choice rationale

Different modes are best suited for different types of shipments based on a number of different factors. Some general considerations for modal choice include:

- Type and size of cargo
- Cost of shipping and transfers
- Time factors
- Geographic location and availability/complementarity of modes
- Destination of cargo
- Distance
- Availability of services
- Past experiences/in-house expertise and resources
- Ease to organize
- Legal and insurance issues

After having selected the preferred mode for shipping the selected goods, a route must then be chosen. In selecting a route, carriers (defined in the next section) must consider cost-effectiveness, time sensitivity of shipment, optimized sequence of deliveries, and potential restrictions. In managing these constraints, carrier companies can use algorithms which deliver optimal routes based on their origins and destinations. [31]

Table 1.2.4 below provides an example of modal choice rationale, demonstrating which modes are best suited for certain types of shipments, while Figure 1.2.4 shows modal choice based on considerations for cost, volume of goods shipped, and value of time.

As presented in the figure and table on the next page, cost, value, and distance are interdependent. For example, time sensitive goods and low-volume goods such as medical equipment or precious gems will most likely be shipped by air, since their cost per unit is higher. These costs will then be absorbed within the sale value of the cargo. At the opposite end of the spectrum, the value of un-refined crude oil or iron ore will be lower per unit-weight and less time-sensitive but higher in volume, hence the use of the slower but higher-capacity transport modes.

Figure 1.2.4: Modal choice based on cost, volume and value of time
(Source: Rodrigue, 2017)

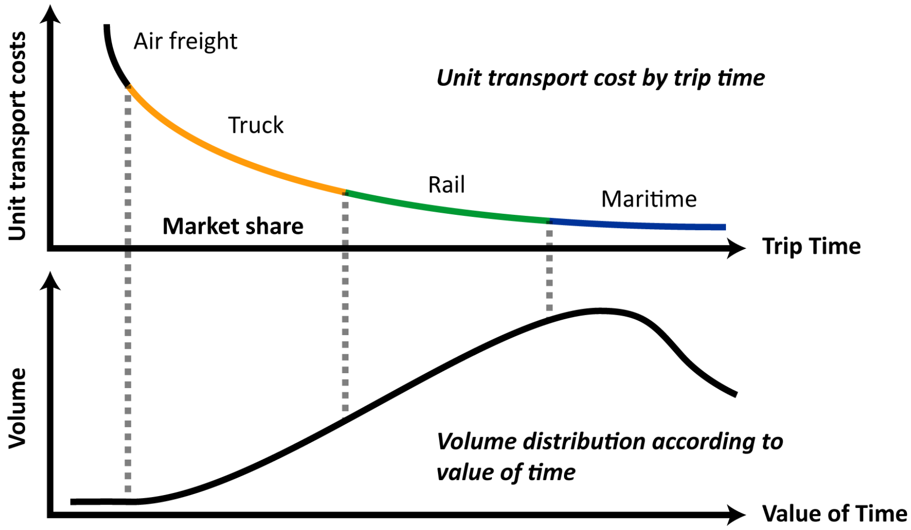


Table 1.2.4: Modal choice rationale
(Source: Freight Hub, 2018)

	Distance less than 400 km	Distance more than 400 km	Oversize or heavy loads	Special requirements (e.g. hazardous, refrigerated)	Cross-border	Overseas
Ocean		X	X	X	X	X
Air		X		X	X	X
Rail		X	X	X	X	
Road	X		X	X	X	
Multimodal		X	X	X	X	X

Determining total logistics cost

There are a number of factors that go into the total logistics cost of a supply chain. Below is a list of the primary determinants of total costs:

- Length of haul
- Weight of goods
- Packaging and product handling
- Number and size of shipments
- Customer preference
- Shipment value

1.2.6 Trade-offs in use

Selecting the most appropriate and cost-effective method of transporting goods is something that companies must do to ensure the efficient movement of their products. In this section, we present trade-offs between road and rail modes, and between courier, long haul and delivery methods of shipping. Table 1.2.5 shows trade-offs between road and rail.

Table 1.2.5: Road vs. rail
(Source: Bogdanski, 2017; WSP)

	Road	Rail
Advantages	• Flexible and convenient network • Available 24h • Often more affordable than other modes • Many specialized services for goods • Easy to organize and to find provider	• Faster and more reliable (less susceptible to weather or congestion issues) • Can carry larger volumes over greater distances • Reduced cost of units per kilometre through large volume
Disadvantages	• Traffic (congestion) and speed limit restrictions • Unpredictability of weather conditions • Empty returns • Less cost-effective for long distances greater than 800 kilometres	• Lack of flexibility and convenience • Does not provide door-to-door services • Dependent on the quality of terminal operations • Empty returns • Limited number of providers

1.3 Definition of actors

This section presents a range of actors in the freight transportation system including shippers, carriers and third-party logistics providers, and the roles and responsibilities of varying levels of government with respect to the different modes available.

1.3.1 Shipper / service user

A shipper is the person or company who is usually the supplier or owner of the goods that will be shipped. [32] They enter into contracts with carriers and provide them with goods to transport or arrange for and coordinate the shipment of goods to reach their chosen market.

1.3.2 Carrier / service provider

Carriers are companies that transport goods for shippers and service users by a selected mode. [33] They can be a shipping line, railway company, freight airline or a trucking company. These companies have possession of the goods while they are in transit. [34] In the case of road transport, carriers are further divided into private, courier and for-hire. Private carriers provide transportation services to firms that own or lease transport vehicles and do not charge a fee. For-hire carriers provide transportation services to the public on a fee basis. They select routes largely based on minimizing costs through optimization of routes. Costs for carriers sometimes increase when there are few truck stops along the route with direct and un-tolled highway access. Designated truck parking areas can help to keep costs low along the supply chain as drivers do not have to waste time search for adequate parking. They also ensure that drivers have safe locations to rest, adding to the overall safety of the road network.

1.3.3 Third-party logistics provider (3PL)

A third-party logistics provider (3PL) is a specialist in logistics who may provide a variety of transportation, warehousing, and logistics related services to buyers or sellers. These are tasks that are often performed in-house, but can be outsourced in certain cases. [35] 3PL companies handle the fulfillment and distribution functions of many retailers, and capitalize on economics of scale, particularly when direct retail fulfillment is not cost-effective.

1.3.4 Municipal, regional, provincial / territorial and federal governments

1.3.4.1 Municipal

Municipal governments typically do not own goods movement infrastructure, and instead coordinate with other levels of government to share information and data, establish a goods movement network and strategic plan, establish freight objectives and policies, set by-laws, and standardize approaches and norms in order to address issues faced by the city and freight operators. [36, 37] Municipalities are also involved in regulating land use, overseeing development and site design, and managing road design and operations. This includes setting route and time of day restrictions for freight, developing curbside loading/unloading zones, and enforcing parking restrictions.

Finally, municipalities are also involved in some rail expenditures, though railways are owned by private companies. Expenditures are typically related to commuter rail operations or public safety investments. [38] Overall, the role of the municipal government is focused on planning, oversight and safety. This is ultimately done through planning and policy documents that help to guide the development of an area and efficient use of resources. Examples include transportation or freight master plans, official plans, zoning by-laws, and other land use documents.

In northern communities in Ontario for example, there are some areas that are uncategorized, where there is no municipal organization. In these communities, local service and road boards are created to deliver basic community services to the residents. The province maintains its maintenance duty on these roads as well. Additionally, some non-remote and non-NAS airports are locally or provincially owned and operated, either by local airport authorities, the province, or municipalities themselves. These airports tend to be smaller, primarily serving the immediate community with commercial and passenger transportation, as well as private jet storage, medical emergency evacuation support, recreational flying, and even skydiving.[39]

1.3.4.2 Regional

Regional government roles include creating guidelines for freight, establishing goods movement regional strategic plans, planning through crown agencies and regional municipalities, and coordinating with other regions and municipalities.[40] In addition, pilotage (a service where marine pilots take control of a vessel and navigate it through local waterways)[41] through Canada's coastal and inland waterways is provided on a for-fee basis by four regional pilotage authorities which are crown corporations: Atlantic, Laurentian, Great Lakes, and Pacific Pilotage Authorities.

1.3.4.3 Provincial/territorial

Provincial (and territorial) government departments own and manage the majority of two-lane equivalent roads within their respective borders and develop highway traffic acts to regulate vehicle and driver use on these roads, including licensing and road and vehicle safety regulations (such as vehicle dimension and weight regulations, and truck driver hours of service). This includes the majority of provincial routes within the National Highway System (e.g. 400-series highways in Ontario, Provincial Trunk Highways in Manitoba, and the Autoroute network in Quebec), the Trans-Canada Highway, as well as the majority of other roads. They are also involved in:

- Guiding transportation infrastructure investments, policy, and strategy[42]
- Creating and managing crown agencies (e.g. regional transportation authorities) to plan, build, and manage infrastructure[43]
- Managing the freight sector through ministries of transportation, infrastructure, environment, and economic development[44]
- Developing strategies to manage and enhance transportation infrastructure, reduce emissions, and increase goods movement network capacity
- Coordinating policy with municipal and federal agencies
- Applying environmental standards to provincial transportation infrastructure

Territories in Canada are also involved in airports as each territorial government owns and operates (or contracts operations for) their own NAS airport. The airports these governments are responsible for are Yellowknife Airport, Iqaluit Airport, and Erik Nielson Whitehorse International Airport.[45] In Northern Ontario, the Ontario Ministry of Transportation's (MTO) Remote Northern Transportation Office operates the 29 remote northern airports in the province. All but two of these airports (Pickle Lake and Armstrong) serve Aboriginal communities which lack all-weather road access and rely on air transportation for the delivery of goods and passenger transportation. The safe operation of these airports is crucial to the livability and economic vitality of these communities.[46]

1.3.4.4 Federal

The roles and responsibilities of Canada's federal government are divided by mode for the purposes of this section, as their involvement varies and responsibilities are often shared or divided between the federal government and lower levels.

Road

The Alaska Highway and some parts of the NHS within national parks are owned and managed by federal departments. The federal government participates in highway infrastructure development, which is generally funded through Infrastructure Canada and/or Transport Canada. Transport Canada, in addition to funding certain projects, also promotes highway safety throughout the country, develops policy for the NHS, and acts as the regulatory body for interprovincial and international freight and passenger carrier industries.

Rail

The federal government's primary role with relation to rail is the regulation of service, rates, network rationalization, and overall safety of railways within its jurisdiction, under the Canada Transportation and Rail and Safety Acts.

Air

The primary role of the federal government for air travel is infrastructure related. The majority of large Canadian airports have been transferred to local authorities, however the federal government maintains ownership of the land and buildings, and also acts as a regulator. Smaller airports (non-NAS) have generally been sold to provinces or municipalities.

As part of the regulatory framework, Transport Canada develops policies, guidelines, regulations, standards, and educational materials to advance civil aviation safety in Canada. It also verifies that the aviation industry complies with the regulatory framework through certifications, assessments, validations, inspections, and enforcement.

Marine

Transport Canada administers certain remote ports; however, as described above in the modal profiles section, major ports are operated by Canada Port Authorities – crown corporations operating at arm's length from Transport Canada, governed by a board of directors selected by port users, and the municipal, provincial, and federal government. Transport Canada is also encouraging the divestiture of core fishing harbours to non-profit harbour authorities to manage and maintain operations. It is also involved in policy development, services to commercial and recreational mariners, and maritime safety and security.

1.4 Industry and commodity profiles

1.4.1 Understanding industry vs. commodity

Goods movement, as defined in Section 1.1.1, is broadly the wide array of activities involved in transporting goods from producer/supplier to consumer. It is a derived demand driven by consumption and commerce. In other words, the demand for transport is a result of the demand for other goods or services.

Goods movement industries are categorizations of inputs of production for the output of an intermediate or final product, to be used in other industries. Industries produce the commodities that other industries use by adding value to raw materials or assembling multiple intermediate goods. Industries are classified by the North American Industry Classification System (NAICS), six-digit codes at their most detailed level, and divided into twenty larger sectors by the first two digits.

While commodities and industries are heavily intertwined and rely upon each other, they are distinct terms with specific requirements of their own. Commodities can be raw materials or primary agricultural products (e.g. timber, copper, halibut) or intermediate or finished goods (e.g. electronics, motorized vehicle parts, pharmaceuticals). Depending on the commodity, it will enter the supply chain at a different stage as either an input to production for another goods movement industry or as the final output of production of a goods movement industry. All commodities can be shipped, and interact in some way with the transportation network. Most often, commodities are used as inputs in the production of finished goods and are classified by Standard Classification of Transported Goods (SCTG) five-digit codes. The first two digits of the codes group the commodities into forty-two Harmonized Commodity Description and Coding System-based categories.

1.4.2 Industry profiles

Six goods movement industries are identified below based on NAICS two-digit codes, as follows: agriculture, forestry, fishing, and hunting (11); mining, quarrying, and oil and gas extraction (21); construction (23); manufacturing (31-33); wholesale trade (41); and retail trade (44-45). Table 1.4.1 presents industry profiles with associated two-digit NAICS codes, typical modes used, and their characteristics.

Table 1.4.1: Industry profiles
(Source: WSP)

Industry Type	NAICS Two-Digit Code	Typical Modal Choice	Industry Characteristics (high, medium, low)		
			Value	Volume	Necessity for Transportation Network Reliability
Agriculture, forestry, fishing, and hunting	11	Rail, road, marine, and air for perishable goods	Low to medium	Medium to high	Low to medium
Mining, quarrying, and oil and gas extraction	21	Rail and road primarily, and some pipeline	Medium to high	Medium to high	Low to medium
Construction	23	Road, rail, marine, and air	Low to medium	Medium to high	Medium to high

Industry Type	NAICS Two-Digit Code	Typical Modal Choice	Industry Characteristics (high, medium, low)		
			Value	Volume	Necessity for Transportation Network Reliability
Manufacturing	31-33	Road, rail, marine, and air for time-sensitive shipments and depending on source location	Low to high, depending on subsector (e.g. wood manufacturing is low but computer and electronic product manufacturing is high)	Medium to high	Medium to high
Wholesale trade	41	Road, rail, marine, and air for time-sensitive and perishable products and depending on source location	Medium to high	Low to medium	Medium to high
Retail trade	44-45	Road, rail, marine, and air for time-sensitive and perishable products and depending on source location	Low, medium, or high depending on commodities (e.g. motor vehicles and parts are high, whereas sporting goods is low)	Low to medium	Medium to high

Municipalities and provinces/territories use NAICS codes to organize industry information when conducting employment surveys. The above goods movement industry profiles are therefore useful information in understanding how these industries interact with each other and the transportation network. Further, it is of particular use to planners, as this information can help with the understanding and development of future employment surveys.

1.4.3 Commodity / economic sector profiles

SCTG codes classify commodities by their transportation characteristics, and commodities can be further classified by their value and time sensitivity. For example, precision instruments and apparatus (38) are considered high-value and time sensitive commodities, whereas cereal grains (02) are considered low-value and less or non-time sensitive.

Commodities can be linked to industries at two levels. First is by the propensity of an industry to ship certain commodities. This first measure would indicate what percent of shipments from each industry are a particular commodity. Second is by the proportion of industries shipping certain commodities. This measure indicates which industries are responsible for the majority of shipments of a given commodity. Table 1.4.2 provides commodity profiles. Due to the large number of two-digit SCTG codes, nine two-digit categories have been grouped to present examples.

Table 1.4.2: Commodity profiles
(Source: WSP)

SCTG Two-Digit Code Group	Group Name	Typical Modal Choice	Commodity Group Characteristics		
			Value	Volume	Necessity for Transportation Network Reliability
01-05	Agriculture products and fish	Road, rail, marine, or air depending on time sensitivity	Low to medium	Medium	Typically low, but medium for perishable goods
06-09	Grains, alcohol, and tobacco products	Road and rail primarily	Low	High	Low
10-14	Stones, non-metallic minerals, and metallic ores	Road, rail, and air	Medium to high	High	Low to medium, depending on time-sensitivity of shipments
15-19	Coal and petroleum products	Rail, pipeline, road, and marine	Medium to high	Low to medium	Typically medium, but higher for pipeline transport
20-24	Basic chemicals, chemical, and pharmaceutical products	Air, rail, road, and marine	Medium to high	Low to medium	High
25-30	Logs, wood products, and textile and leather	Rail, road, and marine	Low	Medium to high	Low
31-34	Base metal and machinery	Rail, road, marine, and air	Low, medium, or high depending on commodity (e.g. jars are low value, whereas turbo-jets are high value)	Low to high, depending on the commodity (e.g. nails and screws are high volume, whereas boring machinery is low volume)	Medium to high, depending on time sensitivity and modal flexibility of commodity
35-38	Electronic, motorized vehicles, and precision instruments	Road, rail, marine, and air	Medium to high	Medium to high	Medium to high
39-43	Furniture, mixed freight, and misc. manufactured products	Road, rail, marine, and air	Low to medium	High	Low to medium depending on modal flexibility of commodity

1.5 Understanding supply chains

In this section, we present the components and considerations for forming supply chains, how they relate to local and intercity freight issues, and then present a case study to demonstrate the flow of goods through a supply chain.

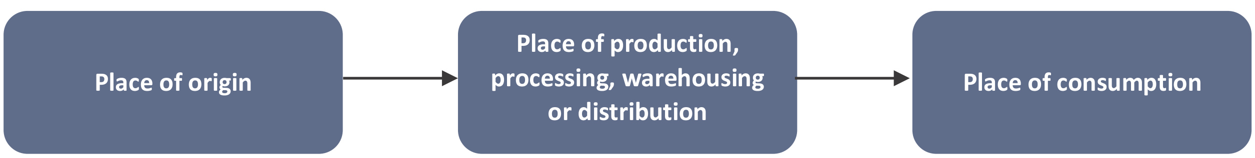
1.5.1 Supply chain creation

To begin, there are a few important general factors that must be considered when forming a supply chain. The first factor is speed to market. Products that spoil easily or have higher value require faster speeds to market compared to low-value, non-perishable goods for instance. For fresh foods, there is typically a window of only a few days from farm to market to ensure they are still safe for consumption. For high value products like pharmaceuticals, they must be delivered before their potency date expires. There are also products like ready-mix concrete that must be poured within hours of leaving the plant.

The second factor is cost-effectiveness. Companies try to ensure that the supply chain for a product is setup in the most cost-effective manner to limit costs to the company, and costs pushed along the chain to customers. Typically, the efficiency of the overall supply chain plays an important role in ensuring the costs remain low.

The third factor is reliability. Firms want to ensure their products are being delivered on time and in good condition. Modal selection and route rely heavily on reliability, as a firm would not reasonably select transporting perishable foodstuffs, such as eggs or fruits, by sea unless this is the only mode of access to the market. This is because marine travel takes the longest amount of time and refrigeration costs increase with transportation time.

The basic route of a supply chain is shown below:



Along this chain, each arrow represents transportation of the goods by the mode selected by the organizer or the chain. Figure 1.5.1 to Figure 1.5.4 below are some examples of supply chains, which demonstrate where the materials/goods are produced, where they travel to, and by what mode, along with their SCTG codes.[47] They include the commodity movement and include value added services in the supply chain which result in the commodities being manufactured into finished products. Figure 1.5.1 is the related legend that describes flows and modes.

Figure 1.5.1: Supply chain icon legend
(Source: WSP, 2018)

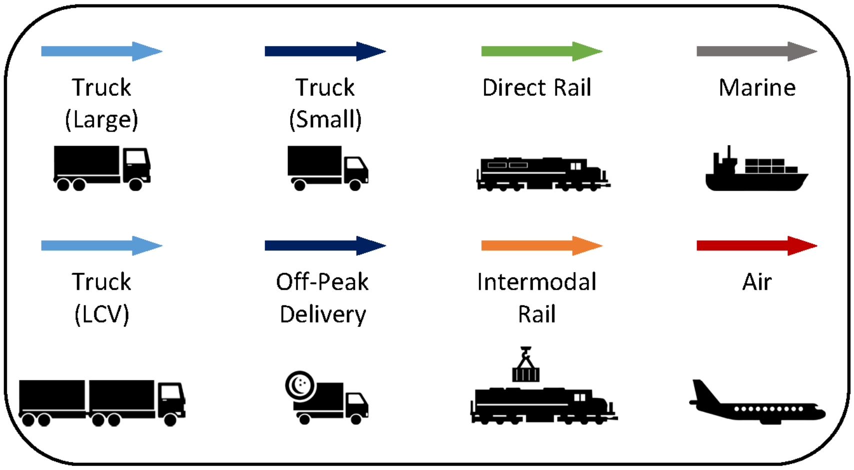


Figure 1.5.2: SCTG 7 – Prepared foodstuffs not elsewhere classified and fats and oils
(Source: WSP, 2018)

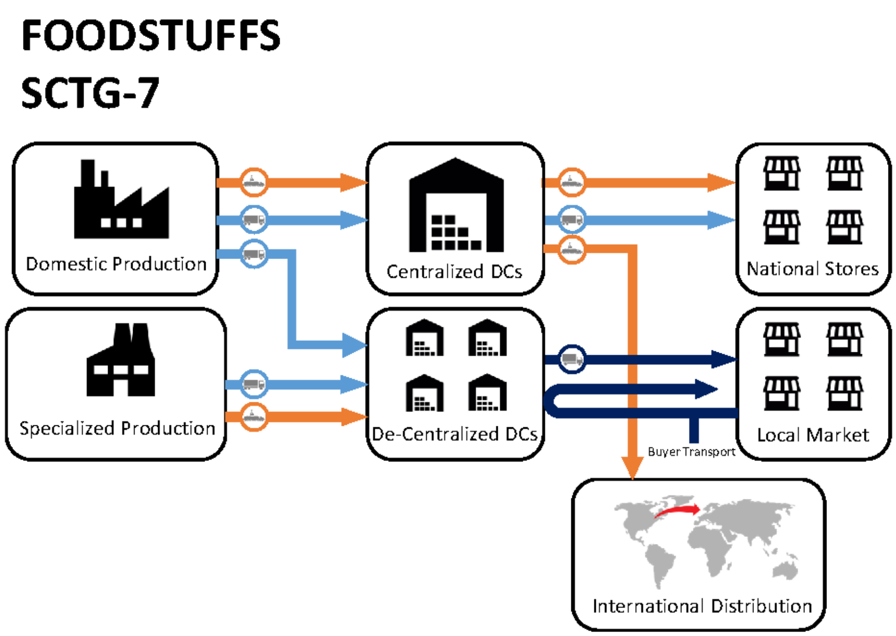


Figure 1.5.3: SCTG 36 – Motorized vehicles
(Source: WSP, 2018)

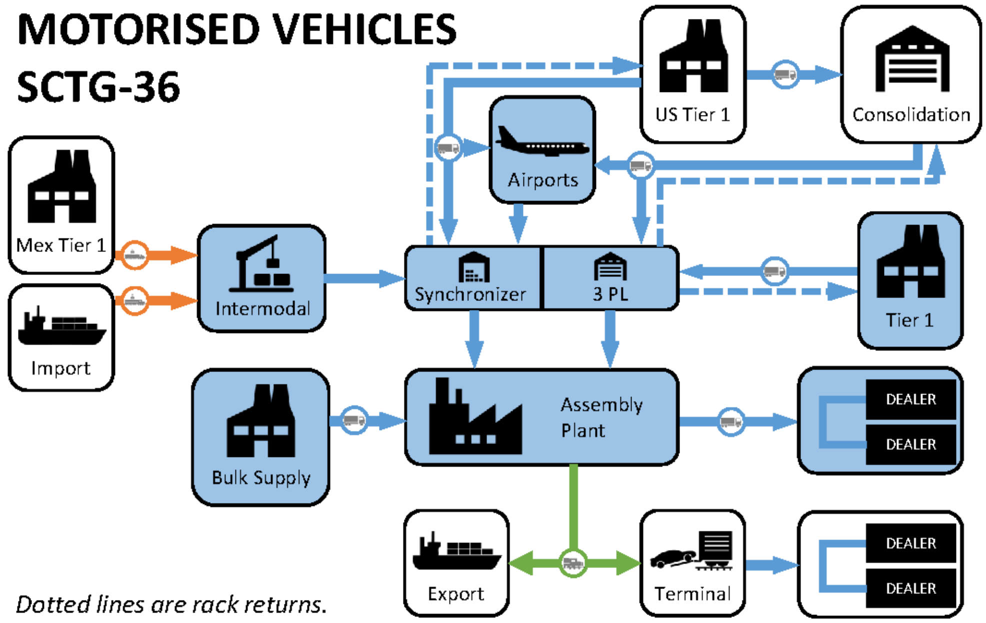
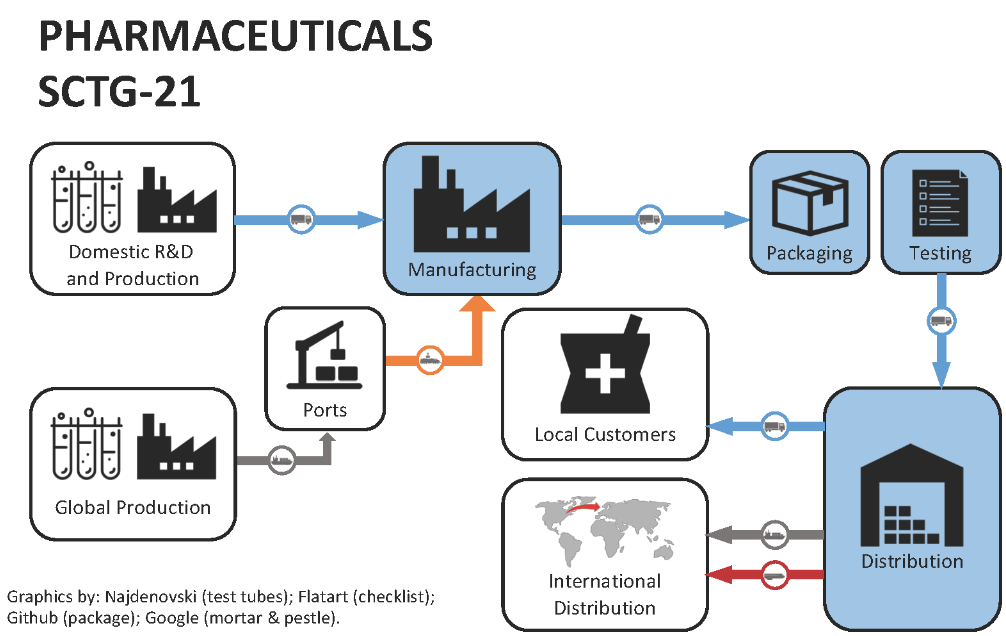


Figure 1.5.4: SCTG 21 – Pharmaceuticals
(Source: WSP, 2018)



1.5.2 Principal channels for urban goods movement

In urban settings, the movement of goods primarily takes place though one of three channels:

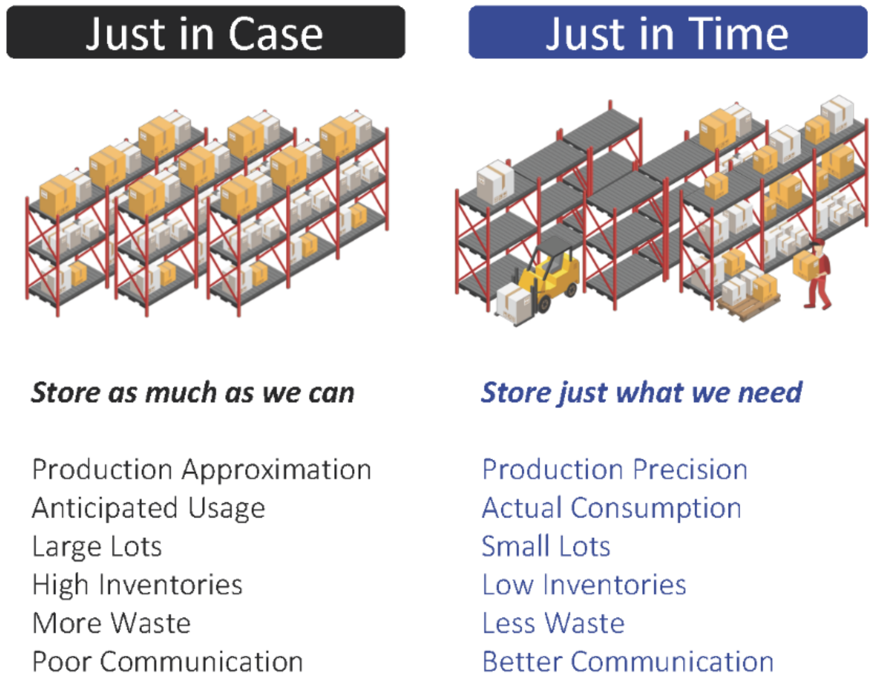
- **Industrial production** – This involves the manufacturing of heavy and light goods bound for businesses and retail outlets. These shipments are typically products for input for another business or finished products for retail distribution.
- **Retail distribution** – This channel is for businesses that distribute consumer products like food, electronics, publications, and housewares through wholesale and store-front facilities. These products can be purchased by consumers at storefronts, or ordered online via e-commerce and delivered directly to their homes.
- **Service provision** – This channel targets service-oriented businesses supplied with, or handling, goods for their engagements such as constructing facilities, caring for health, mounting exhibitions, moving household goods, and removing waste.

1.5.3 Factors and trends affecting supply chain processes

There are several local and intercity freight issues that must be considered when forming a supply chain. These issues affect the modes chosen and order, costs of the overall chain, and the time it takes to deliver goods. For example, just-in-time deliveries have become increasingly prevalent in the past few decades as businesses attempt to minimize spending and boost competitiveness.[48] Just-in-time is an alternative to a just-in-case model where businesses have large lots and inventories in anticipation of demand. Figure 1.5.5 presents a brief look at differences between these two models.

Just-in-time involves the suppression of stock in warehouses, low inventories in stores, a fragmentation of shipments, fast turnaround times in production areas and distribution centres, and coordination between industries, modes, and carriers. It is a truck and resource extensive model that requires integration between many productive units; however, this model results in a made-to-order system with minimal stock levels and lower warehousing costs than just-in-case.

Figure 1.5.5: Just-in-case vs. Just-in-time delivery
(Source: Macrovector, 2019; Market Business News, 2019)



Just-in-time helps to combat other issues that are faced along supply chains, particularly those related to large delivery trucks, including: lack of curbside delivery space; parking and route restrictions, and narrow streets or turning radii; zoning and land use restrictions faced by distribution centres, primarily in urban areas; and last-mile delivery in urban areas, especially in central business districts or for home delivery. Just-in-time may not, however, be applicable for all types of goods (e.g. food production).

There are also trade-offs between shipping goods by courier, long haul, or delivery methods. Table 1.5.1 below presents characteristics for each shipping type.

Table 1.5.1: Courier vs. long haul vs. delivery (Source: WSP)

	Courier	Long Haul	Delivery
Characteristics	• Door-to-door delivery using specialized mailing company • Good for infrequent and/or small/specialty orders • Fast and hand delivered – less likely to damage or lose product • High costs • Size limits for shipments	• Good for long distances • Use specialized shipping networks • Less than load (LTL) provides efficiency and cost sharing with other clients • Full load (FTL) is costly unless shipping high volumes of goods regularly	• Covers the last-mile for consumers • Provides regular supply to retail stores

2. Module 2: Planning considerations

The purpose of this module is to introduce the audience to a range of considerations made by both governments and freight companies. Considerations should be made for how projects are selected and evaluated, what data is available to use in planning, and freight sensitive strategies that are available for planners with regards to goods movement infrastructure. Its major sections are:

- Project Planning
- Data Collection and Management
- Stakeholder Consultation
- Analysis of Current and Future Needs
- Developing Strategies
- Evaluation Tools
- Integration with Other Disciplines
- Road Design
- Site Design
- Demand Modelling

At the end of this module, the audience should have an understanding of what considerations should be made for freight when planning projects, as well as how to effectively evaluate a potential project to ensure it will provide the desired outcomes.

2.1 Project planning[49]

Project planning is an economic development tool used to assist municipalities, planners, and engineers in making informed decisions to enable the safe and efficient movement of freight and its integration in the built environment. The objectives of the process include identifying locations where freight activities are generated or attracted (either currently or in the future), operating constraints, and stakeholder dialogue. Planning of this variety is useful because it helps to identify issues affecting local freight movements, and establishing priorities to support the movement of goods.

Potential problems

The planning phase of a project begins with project setup, which involves defining problems faced that the project is seeking to solve, establishing the goals and objectives of the project, defining a project timeline, and identifying staff and financial resources. Some potential problems to tackle include:

- Congestion
- Pollution
- Water, noise, and air quality
- Interaction between trucks/trains/ ports and neighbouring residents
- Interaction between trucks and pedestrians/bicycles/cars

- Safety
- Accessibility[50]
- Truck transit during roadwork
- Competition for land use
- Lack of transport infrastructure
- Lack of transport services

Potential goals and objectives

In a traditional planning process, goals and objectives of the project are then defined. They respond to the problems identified that the project will hopefully solve, and are therefore project- and context-specific. Some potential goals and objectives are:

- Remove truck traffic on local streets
- Improve existing/build new road infrastructure
- Increase capacity of networks/terminals
- Decrease negative impacts of transport interaction with the population
- Increase accessibility
- Reduce congestion
- Improve safety
- Increase service performance
- Reduce costs
- Generate value and revenues
- Requalification of land[51]
- Modal shift

Required information

After the problems and goals/objectives of a project have been clearly identified, the information required for the project must be collected for future analysis. This information is based on defined problems, staff, and resources available. Some examples include:

- Major goods movement facilities and corridors (employment areas and uses)
- Principal freight corridors and secondary feeder routes, including traffic volumes and patterns
- Contribution by the freight industry to the local economy
- Traffic activity by mode
- Route constraints (e.g. geometric considerations at intersections, signal timings, speed limits, vehicle exclusions, lane widths)
- Operating constraints (e.g. loading acres, time of day restrictions, street furniture)
- Other relevant factors of interest to the public
- Applicable regulations (e.g. overweight or size limits)
- Enforcement practices, including ticket violations and compliance rates
- Areas of conflict

- Road construction and maintenance

The amount of information required to be collected will be a function of the size of a community, whether a freight issue exists that requires resolution, and the amount of data that is needed to address and solve the particular problem or set of problems.

Finally, priorities must be established to support the safe and efficient movement of goods. The overall goal of project planning is to identify the type of information to collect for analysis and how the information is going to be collected. Once problems are identified, goals and objectives are defined, and the required information to be analyzed is identified, the data must then be collected and will be discussed in the next section.

2.2 Data collection and management

Data collection involves four primary types and sources of data, depending on the scope of the project: quantitative data, intelligence gathering and stakeholder consultation, site visits, and freight data. This section will briefly describe these types and sources.

Quantitative data collection

Quantitative data includes information related to freight volumes and trends. Some examples when looking at freight movement by truck include:

- Traffic volumes by vehicle class on major roads, along key freight corridors, and/or at cargo origin points
- Freight movements by economic sector, including origins and destinations
- Land use in terms of freight generators and attractors

Intelligence gathering and stakeholder consultation

Consultation with local stakeholders should be pursued to identify characteristics of freight in an area and land use issues affecting freight. Intelligence gathering should consist of two or more components, namely stakeholder surveys, and workshops or public meetings. Stakeholder surveys should be conducted to obtain data for the number of truck movements in and out of a facility (ideally by time of day and day of week), key truck access and exit routes to a facility and issues along those routes, operating hours (reception and expedition of goods), position in the supply chain, operational issues and concerns, and plans for expansion where applicable. Workshops and public meetings should involve stakeholder consultation to identify freight transportation issues.

Site visits

Site visits are an effective way to collect data on physical infrastructure and freight needs. They should identify entering and exiting truck volumes for major transportation facilities during peak trucking hours, areas of conflict for truck movements, illegal transit trough residential areas, respect of speed limits, double-parking, high volume trucking routes, and multimodal interaction issues identified in stakeholder consultations.

Freight data

Finally, there are a few sources of freight-specific data that can be drawn upon in order to help effectively plan a project. The sources include:

- Automatic traffic recorder counts
- Origin-destination surveys
- Statistics Canada's Trucking Commodity Origin and Destination Survey
- Statistics Canada's Canadian Freight Analysis Framework (CFAF)
- American Transportation Research Institute (ATRI) truck GPS data
- Ontario Ministry of Transportation's Commercial Vehicle Survey
- Canadian Centre on Transportation Data
- StreetLight Data Inc.

Data collected can serve various functions in the project planning process. For example, it may help to identify and measure the impact of freight on transportation infrastructure, or it may help with integrated transportation planning that considers the needs of freight as a part of an overall multimodal passenger and freight transportation system.

While there exist a number of sources for freight data, much of it comes from surveys that companies voluntarily respond to – there is no obligation to provide data. Further, data can be inconsistent depending on what private sector companies choose to disclose, and their methods for gathering and presenting information. [52]

2.3 Stakeholder consultation

Stakeholder consultation is a vital part of project planning and involves first identifying the stakeholders, then assessing which tactic or set of tactics are best for engaging them. Public sector stakeholders include federal, provincial/territorial, and regional governments, local municipalities, as well as elected officials and other government regulatory agencies. Private sector stakeholders are more numerous and varied, and include manufacturers, farms, retail stores, offices, freight facility operators, shippers, carriers, 3PL companies, rail companies, and air and marine port authorities. Other stakeholders of relevance include Indigenous peoples and local community members. Tactics to engage stakeholders include online surveys, public open houses, in-person interviews, site visits, and workshops.

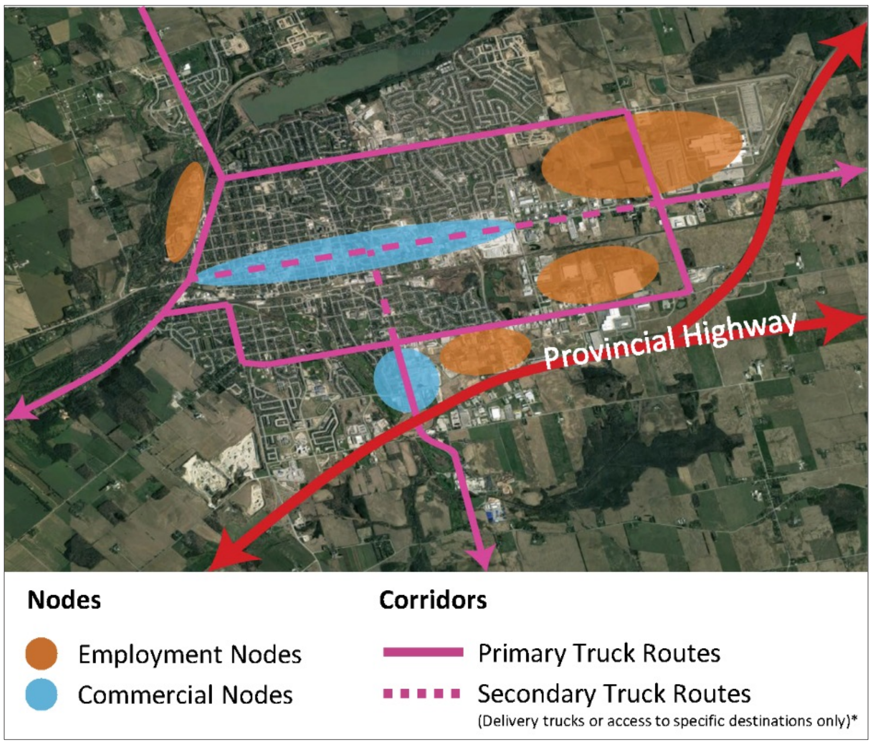
2.4 Analysis of current and future needs

Part of the project planning process involves understanding the current and future needs of the goods movement network that will be affected. This analysis allows planners to better understand how their projects will impact the overall movement of goods in an area, region, and beyond. The analysis includes a look at supply and demand, infrastructure, regulation and policy, enforcement, and future needs.

2.4.1 Freight facilities – Supply and demand

The first step in this analysis involves identifying areas where the demand for freight services is located. This includes locating employment areas, employment uses, commercial or mixed-use areas, and truck traffic. Next, the organization of specific supply chains should be understood in terms of the types of resources involved, production methods and locations, consumption and distribution areas, major players involved, and mode split of the area. This culminates in an analysis of current needs. GIS mapping is recommended based on the data collected to show the location of freight assets (i.e., nodes and freight centres), freight corridors, special facilities (i.e., warehouses, rail yards, intermodal centres, and air/marine ports), and actual or planned infrastructure investments. Figure 2.4.1 below provides a basic example of the results of mapping. GIS can also be used to analyze how many of these components interact with one another from a spatial perspective.

Figure 2.4.1: Local freight mapping
(Source: Ontario Ministry of Transportation, 2016)



These first steps allow for planners to understand the demand for freight and thus the supply of goods required to meet demand. Projects can then be targeted to limit the gap between supply and demand and increase support of freight through further investment or policy changes to support safe and efficient freight movements.

2.4.2 Infrastructure

Next, an analysis of existing infrastructure should be undertaken. This includes the number of lanes, bottlenecks, functional classification of roads, connectivity and discontinuity. This analysis should consider the strengths and weaknesses of the current transportation system. After determining the strengths and weaknesses, consideration should be made for developing a strategic freight or truck route network. The infrastructure analysis should include a review from capacity, network and geometric perspectives, allowing planners to obtain a holistic understanding of the capabilities and limitations of a given freight network, and will further allow them to identify priority projects that would address any issues identified.

2.4.3 Policies, regulations and by-laws

To complete any project, planners and other stakeholders must understand not only the regulations in the jurisdiction where the project is planned, but also those in neighbouring jurisdictions as they can have an impact on the movement of goods across municipal, provincial and national borders. For example, overweight/over-dimension restrictions, special seasonal allowances, and policies that address freight movement needs and issues such as by-laws, can affect goods movement. Another example of applicable by-laws are the time-of-day restrictions for delivery in urban centres or commercial avenues.

2.4.4 Enforcement practices

Associated with understanding policy and regulation is knowledge of the enforcement of these regulations, not only towards freight but also to other road, air, rail and waterway users. It is important to identify enforcement and violation issues in order to find appropriate freight-supportive solutions. The intensity of violations and enforcement are also key pieces of information in this procedure. This information is required to better understand problems faced by freight, and to identify potential solutions.

For example, parking restrictions on road freight corridors and the intensity of their enforcement are important pieces of information when developing a project as considerations should be made to ensure that the level of enforcement is effective where restrictions exist, new restrictions should be considered in the case where none exist to support the efficient movement of goods. Stakeholders and the public (and site visits) can help to identify areas where conflicts may occur between freight and other road users or land uses through consultation and data collection tactics presented in Section 2.3.

2.4.5 Analysis of future needs

Finally, with all this information gathered, an analysis of future needs can be undertaken. This analysis involves an understanding of the information gathered showing current needs, and an identification of planned capital investments. Once current needs are understood, forecasting can be undertaken for employment and population growth. These forecasts can then be used to anticipate future trade patterns and capacities on transportation networks through modelling activities described in Section 2.10, thus informing what projects should be undertaken based on the anticipated needs of the transportation system.

2.5 Developing strategies[53]

This section provides strategies for a number of project undertakings that are freight-supportive. Considerations are made for both rural and urban applications, and the overall impacts of freight and delivery on urban environments is briefly examined.

2.5.1 Developing strategic truck route networks

In developing a strategic truck route network, there are a number of useful strategies that can be drawn upon which help to better understand the network, its components, and the requirements for development/improvement. A strategic truck route network should be continuous and integrated with adjacent municipalities to the greatest extent possible. The network itself should promote multimodal connectivity for goods movement and include corridors that seek to expedite freight movements through strategies such as increased speed limits, longer left turn lanes, and permissive signaling. The network should also define different categories of truck routes including primary or major, secondary or alternative, and restrictive routes. Finally, it is important to identify how the network will fit into the existing major transportation trade corridors, as identified in Module 1. Strategies to develop the overall network include:

- Develop a functional classification of roads (e.g. expressway, arterial, collector, local)
- Identify primary and secondary truck routes based on the functional classification and character of the road, as well as the location of freight generators and receivers
- Develop a coordinated truck route that:
  - Efficiently links current and planned freight intensive land uses to key inter-regional transportation facilities
  - Provides access to commercial and employment areas within the municipality
  - Remove trucks from local and residential areas
  - Aligns with truck routes in neighbouring municipalities
  - Accounts for special freight needs such as accommodating long combination vehicles (LCV) or exceptional load movements
- Recognize that variations will exist for freight needs depending on land use types in an area
- Identify context-sensitive strategies for complete streets that include considerations for freight
- Identify areas where truck traffic should be discouraged or limited due to sensitive land uses such as residential areas
- Avoid or mitigate conflicts between truck routes and transit or cycling routes

2.5.2 Protecting corridors and employment areas

As the flow of goods by truck and rail increases, the importance of protecting, maintaining and enhancing supporting infrastructure also increases. Interregional truck routes and corridors are key links in providing businesses and consumers with just-in-time deliveries and door-to-door service from freight distribution centres. Further, employment areas require freight connectors and new ones should be located near existing freight networks and facilities.

Figure 2.5.1 below provides a theoretical example of employment areas with relation to freight networks.

Figure 2.5.1: Employment area locations
(Source: Ontario Ministry of Transportation, 2016)

Strategies for protecting corridors and employment areas include:

- Identify and assess demand for freight infrastructure and potential infrastructure improvements
- Include a policy section in a municipal official plan, transportation master plan, or secondary plan that provides support and direction for local freight movement
- Include provisions in local zoning by-laws including setbacks, loading zones, and ingress and egress to support the needs of the freight industry
- Identify and protect existing and planned freight corridors and facilities in planning documents to increase the efficiency and quality of these routes
- Prepare consistent and coordinated mapping of all major freight facilities and truck routes/corridors within jurisdictional boundaries, including GIS layers for analysis
- Protect industrial and/or commercial lands located near identified freight corridors to allow for future freight movement facilities
- Establish priority routes for freight movement, where feasible, to facilitate the movement of goods into and out of significant employment, industrial and commercial sites
- Discuss possible changes to local freight facilities and corridors or major trucking destinations with freight stakeholders and neighbouring jurisdictions to receive input, ensure plans are kept current, and allow for coordinated infrastructure investments where possible

- Collaborate with neighbouring municipalities and freight stakeholders
- Consider freight needs of all sites and identify uses that are freight-intensive
- Coordinate major changes to inter-regional and international routes that affect neighbouring municipalities, identify new routes, and agree on them before the projects that rely on the change are approved

2.5.3 Increasing enforcement

Enforcement of restrictions, regulations, policies and by-laws is an important factor in ensuring the safety and efficiency of a goods movement network within and across jurisdictions. By-law harmonization is a key strategy that can help ensure a healthy freight network as it creates a consistent environment for freight operators, enabling them increased ability to plan routes and reducing unexpected costs and delays. Some examples of by-laws include loading/unloading area time limits, parking time limits and area restrictions, and zoning for freight supportive land uses. It is also recommended that signage be provided to indicate restrictions and corridors to help ensure routes, requirements, and restrictions are clearly defined, increasing the likelihood they will be effective.

2.5.4 Truck bypasses

Truck bypasses are another feature in transportation networks that help ensure the safety and efficiency of the overall system. They provide accommodation for right turning trucks, and provide additional right-turn capacity without having to add lanes or roundabouts. On highways, truck bypasses separate freight and passenger vehicles, thus reducing lane changing conflicts between faster moving cars and slower moving trucks.

2.5.5 Truck parking

Truck parking is another important feature of the transportation network, also helping to ensure road safety and operational efficiency. It was ranked as the fifth critical issue in the trucking industry in 2018 by ATRI.[54] Truckers, particularly those on long-haul trips or completing local deliveries, often have difficulty finding available designated parking areas. Over 60% of truck drivers routinely have trouble finding parking or places to rest while operating in Canada, often resulting in them violating HOS rules or parking illegally.[55] With truck volumes growing, and parking supply already below demand, it is important for provinces/territories and municipalities to explore options for increasing the availability of truck parking off highways and on local roads.

ATRI identifies three strategies to help combat the lack of designated truck parking. First is identifying strategic locations on the NHS for new or expanded truck parking. Specific actions that can be taken after identifying locations include: re-opening closed facilities, investing in new facilities, and repurposing vacant urban and suburban lots. The second strategy involves educating the public on the safety consequences that result from a lack of designated truck parking facilities. When drivers are not able to safely park to rest and perform other tasks, they risk spending more hours on the road and are more likely to be involved in a collision. Finally, the third strategy involves researching the role and value of real-time truck parking information availability and truck parking reservation systems. Leveraging intelligent transportation systems (ITS) can help truck drivers better plan their routes and ensure that they are able to find suitable and safe parking when they experience fatigue or in emergency situations.

2.5.6 First-and last-mile delivery and impacts on urban environments

Truck transportation is vital to the Canadian economy, as the majority of economic activities rely on the movement of goods between locations. The "first and last mile" in freight refers to local pick-ups and deliveries at businesses or residences. They are the first and last steps in the delivery process of a supply chain, moving goods to carriers or couriers and customers as first- and last-mile respectively, and often involve freight vehicles navigating dense urban environments. Increases in consumer choice for goods (see Section 3.1.1) through increased availability online has led to increases in the sizes and frequencies of shipments, due in part to the fact that online orders are often unrestricted by geographic location or time of day. In addition, delivery timelines are increasingly shortening as some companies have begun offering next-day or even same-day delivery.

First- and last-mile issues have grown in recent years due to factors including the growth of online orders. Four primary issues with the first and last mile in freight relate to the volume of deliveries, the geographic dispersion of pick-up and delivery locations, truck route restrictions, and cost of delivery. A given business or residence can receive multiple deliveries a day from multiple sources. Small deliveries to many dispersed destinations can generate complex routing issues, particularly when trucks face route, time-of-day and parking restrictions. This may result in freight vehicles parking illegally or blocking access/egress points. Further, home deliveries for small products are inefficient as they can be transported by smaller vehicles, are in direct competition with the local delivery industry, and have a high frequency. Failed deliveries are also common, and often require the delivery vehicle to return the next day if there is no local distribution or pick-up facility. The typical result of this combination of issues is an increase in congestion, particularly during peak periods and on major roadways where trucks face no restrictions, and increases in travel time and overall costs for all road users, as well as increases in pollution which negatively impacts public health.

In order to help combat these issues, freight villages (discussed in Section 3.1.6) and urban consolidation centres (UCC)[56] can allow for the consolidation of pick-up and delivery locations, increasing efficiency and decreasing the total time required to fulfill orders and therefore cost. UCCs are similar to freight villages, though they are typically located near urban centres. Another potential way to address these problems includes employing ITS and wayfinding to help drivers and carrier companies plan better routes through real-time information. This is discussed further in Section 2.8. Strategies such as off-peak delivery (discussed in Section 3.1.2) can also be explored to help ease road network and environmental impacts such as congestion, as well as helping carrier companies and drivers plan the most cost-effective routes during varied times of day. Finally, there are a number of other urban goods movement strategies that can help to reduce the strain on the road network and negative impacts on urban communities such as: use of delivery bikes (cargo cycles), scooters, and drones (ground or air); underground delivery tunnel networks; increasing truck curb access and moving bus lanes away from curbs; creating low emissions zones in select urban areas; vehicle redesigns that use smart technologies; right-sizing of delivery vehicles; and vehicle retrofitting to increase driver visibility.

2.6 Evaluation tools[57] [58]

A key part of the overall project planning process is the evaluation of the proposed network investment. There are a wide range of tools that exist to evaluate the potential benefits of proposed, and the method selected depends on the stakeholder performing the assessment, as each value different types of benefits. Some potential benefits include transport equity, accessibility, travel time savings, and monetary savings.

The first step for those evaluating projects should be an assessment of the benefits that project stakeholders are interested in realizing. Next, an identification of potential tools should be conducted. Table 2.6.1 below shows a select number of categories and different types of tools available within. The majority of available tools fall under three main categories: cost-benefit analysis, risk analysis, or strength-weakness-opportunity-threat (SWOT)[59] analysis.

Beyond the list of tools in the below table, there are also some documents that can be drawn upon for further information. These include, but are not limited to, the National Cooperative Freight Research Program's Reports 12[60] and 22,[61] and the Victoria Transport Policy Institute's *What's It Worth? Economic Evaluation for Transportation Decision-Making*[62].

Table 2.6.1: Potential evaluation tools
(Source: Cambridge Systematics et al., 2011)

Strategic Planning Tools	Carrier Cost and Performance Analysis Tools	Shipper cost and Performance Models	Traditional Benefit Cost Tools	Economic Development Impact Models	Financial Impact Accounting Tools	Risk Assessment Tools
Long-term transportation plans Long-term asset management strategies Travel demand forecasting and network optimization	Routing tools Railroad operations tools Airport operations tools Marine port operations tools	Modal diversion models Total logistics cost models Intermodal transportation and inventory cost model Spreadsheet logistics model Market share models The Uniform Rail Costing System model	Cal-B/C model microBENCOST Surface Transportation Efficiency Analysis Model Highway Economic Reporting System StratBENCOST BCA.Net GradeDec.Net	Jobs and Economic Development Impact models Economic impact analysis Regional Economic Model for Highway Systems Transportation Environment and Land Use Model	Fiscal impact models Pro forma models	Economic demand estimation and forecasting Technical advisory Financial models Risk allocation matrix

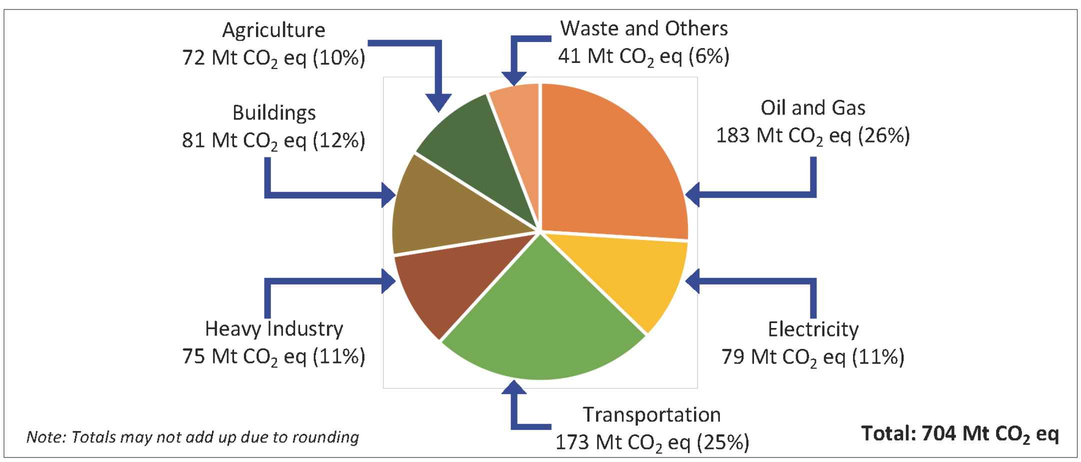
2.7 Integration with other disciplines

Goods movement does not exist in a vacuum. As such, there is a necessary amount of integration with other disciplines in order to ensure the safe and efficient movement of the network and interactions with other disciplines are positive and constructive for the overall network. The primary disciplines that integrate considerations for goods movement are public health and environment, economic development, emergency services and education.

Public health and environment

The integration of goods movement into the public health and environment discipline relates mainly to emissions. In 2015, the transportation sector (including freight and passenger) in Canada accounted for roughly 24% of overall GHG emissions in the country, and freight by rail, road, marine or air accounted for 10.5% of total emissions in Canada. Freight transportation is expected to surpass passenger transportation emissions by 2030.[63] Figure 2.7.1 below shows a breakdown of emissions by economic sector. Staff in the planning process can look to the National Inventory Report of GHG Sources and Sinks, Canadian Environmental Sustainability Indicators, and the Ministry of Environment and Climate Change's GHG emission regulations for example, in order to collect data on freight emissions and understand the regulations surrounding emissions that impact the sector.

Figure 2.7.1: Breakdown of Canada's emissions by economic sector (Source: Environment and Climate Change Canada, 2018)



The safety of freight is also important, as unsafe practices from loading cargo to driving on roads can have negative impacts on a range of individuals. Spills of hazardous materials are an example of unsafe practices. Further, the healthcare system relies on the movement of goods to receive medical equipment for patients. Without a safe and efficient goods movement network, the healthcare sector may face risks of undersupply.

Economic development

Freight is also integrated into the economic development account in Canada, as the transportation and warehousing industry not only contributes approximately four percent of overall GDP,[64] but it also interacts with nearly all other industries, as each rely on goods to be transported for that industry to function. For example, the manufacturing industry contributes just over 10% of total GDP, but could not without an effective goods movement network around it that allows for these manufactured goods to be shipped within the country and to international trading partners. Freight also contributes to GDP through import and export trade. Ensuring that goods can travel efficiently to port facilities within the country to be exported internationally, and to bring international products to the Canadian market, is important in ensuring the economic strength of the country.

Emergency services

Goods movement is also integrated into the emergency services discipline, primarily through safety, specifically collision rates.[65] Planners should look at these rates and select for the types of vehicles involved in order to understand how to improve the network through investment decisions, or other mechanisms, that seek to improve the overall safety of the goods movement industry.

Education

Finally, goods movement is integrated with education. There are a number of safe driving programs in Canada that seek to improve road safety and provide transport-related training to prospective drivers, mechanics, dispatchers, and logistics experts. The Canadian Automotive and Trucking Institute, and Transport Training Centres of Canada both offer courses to this effect.

2.8 Road design

When considering freight in the design of roads, considerations are similar in many respects to public transit buses as the sizes of these vehicles and freight trucks are often comparable. There are three primary categories that should be understood in order to better plan for, and enable the efficient movement of goods: access and intersections, corridors and wayfinding.

Access and intersections / corridors

When incorporating freight into the design and operation of transportation infrastructure, specifically as it relates to access and intersections, the acceleration and deceleration rates of trucks, how they maneuver through off-ramps and curves, and how they handle downgrades should all be considered. There are a number of strategies that can be drawn upon to help better incorporate truck requirements into road design. For example, due to the slower acceleration and deceleration rates of trucks, intersections should, where possible and justified by sufficient truck movement, have signal timings that are adjusted to be sensitive to acceleration and deceleration requirements. This can be done by updating signal timings for left turn phases, calculating signal timings using delay-based passenger car equivalents, providing longer minimum phase timings for green and amber signals to accommodate longer and fully-loaded trucks, and designing intersections to be located a minimum of thirty metres away from railway tracks so that road vehicles do not extend onto them. Turn restrictions should also be considered and should not restrict movements to main entrances of freight hubs, distribution centres, and other areas with high freight volumes.

Acceleration lanes, off-ramps, and curves also require special considerations for freight vehicles due to their speed and size. These include providing longer acceleration lanes based on truck weight-to-power ratios, through traffic speeds, truck speed upon entering the lane, and roadway geometry and installing rollover and ramp advisory speed signs on curves and off-ramps.

Wayfinding

Wayfinding is another important element of road design that must consider freight. Municipalities should establish truck routes that are as integrated as possible with neighbouring jurisdictions, and provide clear and easily identifiable wayfinding tools for truck drivers. This can help to create a safer and more efficient truck network, regardless of network complexity, density, or traffic volumes. Municipalities and provinces/territories should seek to introduce truck routing information systems that employ ITS technologies to disseminate truck routing information, including designated truck parking areas. This includes static and dynamic signs, to be strategically placed throughout the network to permit drivers to make routing changes, as seen in Figure 2.8.1 for example. Finally, signage that provides guidance should be placed in positions to provide drivers with information when and where it is needed in their journeys. The information should be repeated to ensure that it is noticed and should be given in small digestible amounts to not distract drivers and maintain road safety.

Figure 2.8.1: Variable message sign
(Source: Ontario Ministry of Transportation, 2016)

Truck movement along corridors can be supported in a number of ways, and should seek to increase reliability and improve safety. Some strategies related to improving travel time and reliability, capacity and connectivity, all of which contribute to increasing safety and the reliability of operations of the truck route network, include:

- Provide paved shoulders to accommodate truck off-tracking.[66]
- Add capacity and improve safety by restriping lanes where possible.
- Incorporate vehicle loop detectors and classifiers into signals on high-speed corridors to give trucks priority and reduce number of stops.

- Identify commercial truck routes for access to warehouses, distribution centres, intermodal facilities, manufacturing facilities, quarries and other facilities involved in goods movement.
- Increase bridge strength capacities and vertical clearances, and direct trucks away from low-clearance areas.
- Employ variable message signs and travel time displays for example, particularly ahead of on-ramps for expressways to convey travel times and unexpected delays and incidents.
- Minimize the use of strategies and infrastructure that place lane restrictions on trucks.

2.9 Site design[67] [68]

This section will explore guidelines and strategies for site design that are common to most sites and therefore widely applicable. The primary land uses of relevance include industrial, office, retail, institutional, urban areas, and rural sites. There will also be attention paid to trucks and their interactions with other modes within these sites.

2.9.1 Common elements for all sites

The first design element that is common to most sites is crime prevention through environmental design (CPTED). This is a design philosophy that promotes safety and crime prevention through proper design and effective use of the built environment.[69] Incorporation of these design principles can help to provide natural deterrents to crime including threats to people, damage to private property, and theft.

The next set of strategies relate to site access. In order for truck movements to flow efficiently, proper access arrangements from external roads to all sites must be provided. Some key strategies to ensuring accommodation of the anticipated types of trucks to particular sites include:

- Design accesses to accommodate the turning radii requirements of trucks, and provide adequate lane widths on site.
- Provide adequate driveway lengths for access and egress of trucks.
- Locate accesses appropriately in relation to intersections and consider providing exclusive turning lanes for access where possible.
- Provide signage on external roads to notify drivers of possible truck traffic and truck access/egress points.

Loading docks and yards require additional considerations for truck movements as they are the arrival and departure points for the ground transportation of goods. Determining the loading demands of the site is an important first step in designing a facility and should include considerations for the types of trucks required to meet the shipping needs of the site, frequency of shipments, truck time spent loading/unloading, and building security issues. Some strategies for design of loading docks and yards that should be considered are as follows:

- Provide a ramp from the truck parking area up to the loading dock to facilitate deliveries from smaller trucks, vans, and other vehicles.
- Install bumpers on either side of the loading dock to prevent damage to vehicles and facility.
- Cover open loading docks with a roof extending beyond the dock to protect goods and people from poor weather.

- Provide enough space for all required waste bins.
- Separate loading docks from public entrances by locating them at the side or back of building.
- Provide ample turning area to allow a truck to complete a three-point turn.
- Provide a separate entrance where possible for smaller deliveries that do not require loading bays.
- Provide parking stalls for tractor trailer storage where required.
- Ensure that the staging area is large enough.
- Provide buffers around the loading dock yard in the form of walls, screens, and other landscaping elements to shield the area from public view, reduce noise and light pollution, and enhance security.

The final set of strategies relates to garbage facilities. These facilities should be accessible while maintaining a level of discretion in order to reduce their impact on the surrounding areas. Strategies include:

- Design facilities with enough horizontal and vertical space to accommodate movement of modern vehicles such as front-end loading vehicles.
- Locate waste collection areas in the back of buildings or away from the street and main entrance of building.
- Centrally locate shared waste facilities in order to limit the number of facilities required on a given site.
- Provide buffers in the form of landscaping, screens, or walls to limit impacts on adjacent land uses.
- Employ CPTED principles to ensure safety of the facility.

2.9.2 Urban and rural areas

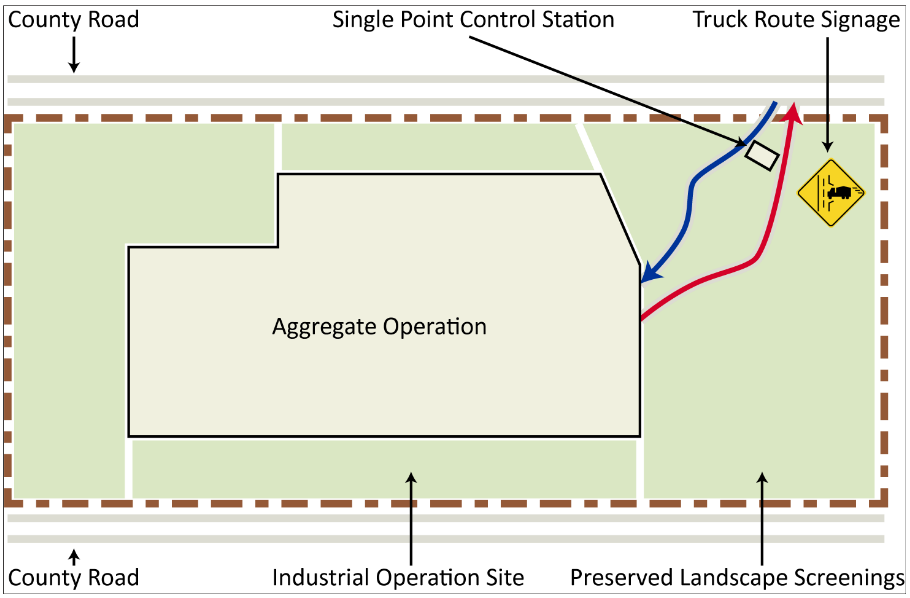
In urbanized areas there are many facilities that require freight, courier, and garbage services in order to operate effectively, such as for retail shops, strip malls and mixed-use developments. Ensuring that these services are able to serve urban locations can be challenging due to delivery requirements and physical space restrictions, especially in historic downtown areas with narrow roads, tight turning radii, and laneways. There are opportunities to create shared loading facilities in some high-density urban areas to improve land use and freight efficiency. Example strategies to improve truck movements to allow for the efficient and safe movement of goods in and out of the area are:

- Create designated loading zones on-street when there is insufficient space for rear loading dock yards.
- Avoid the use of loading zone lay-bys (temporary parking areas) on streets with defined cycling lanes.
- Provide signage along streets indicating truck accesses.
- Consider freight facility improvements as part of a community improvement plan.
- Locate loading areas underground or at the rear of buildings, and make them accessible through alleyways or low-volume side streets where possible to avoid conflicts with other modes.

- Avoid conflicts with other modes by restricting truck parking on bike lanes and sidewalks, or at transit stops.

In rural areas, site design should maintain the rural character of the surrounding area wherever possible. This can be accomplished by setting facilities appropriate distances away from roads, using colours that match the surrounding landscape, and adding buffers and landscaping. Signage notifying drivers of possible truck movements, and turning lanes that provide access to rural sites will help to reduce delays and improve safety. An example of site design in a rural area is provided in Figure 2.9.1.

Figure 2.9.1: Example of site design in a rural area
(Source: Ontario Ministry of Transportation, 2016)



2.9.3 Interaction with other modes

Site design must not only consider land uses and design principles, but also the interaction of trucks with pedestrians, transit vehicles, cars, cyclists, and all other modes that use the road transportation network. Truck access, parking, and all other movement should not restrict the movements of other modes. On the other hand, trucks must also be able to safely and freely access facilities, at times involving crossing transit or cycling lanes and pedestrian paths. Ensuring trucks can navigate the network may involve creating turning lanes for left turns and U-turns, especially when transit is grade-separated in the median of the road, providing off-road cycling paths where truck traffic is common along designated cycling routes, and setting sidewalks away from curbs on roads with high truck volumes. Balancing the needs of trucks and other modes is ultimately required to ensure that the entire network operates efficiently. Some strategies that can be employed when considering interactions with other modes on roads include:

- Separate transit stops from truck parking areas to avoid conflicts.
- Maintain adequate lane widths and curb radii at intersections for trucks to travel and turn.
- Use far-side (after intersection) transit stops where possible to accommodate for truck turns at intersections.

- Provide bike lane markings, pavement markings, and signage to alert vehicles of bike routes.
- Install truck access signs near major access points that may be hidden from the view of cyclists or other road users.
- Provide a buffer between the curb and sidewalk to increase pedestrian safety along truck routes.
- Install traffic signals, crosswalks, and pedestrian crossing signals at site access points that generate high volumes to reduce conflicts between pedestrian and vehicular traffic.

Figure 2.9.2: Dedicated bike lane
(Source: Ontario Ministry of Transportation, 2016)

In addition to the on-road strategies, there are also some on-site strategies that can be employed to further improve the ease of interaction between modes:

- Locate transit stops away from loading dock yards.
- Provide signage on-site to identify pedestrian paths to transit stops.
- Ensure visibility for all road users is maintained at driveways and intersections.
- Separate truck access routes from pedestrian and bike access routes.
- Provide signage and ground markings to indicate on-site bike routes and parking.
- Locate bike parking near entrances and in high-visibility areas away from loading areas.
- Provide on-site pedestrian walkways.
- Provide curb cuts at pedestrian crossings to ensure mobility along a path for all.
- Ensure maximum visibility for trucks exiting facilities by providing mirrors and audible signals to alert pedestrians of truck movements, and avoid designs that limit visibility.
- Provide well-defined pedestrian crosswalks by using painted pavement markings, differentiated pavement types, and pedestrian-oriented lighting.

2.10 Demand modelling[70] [71]

Travel demand modelling is a forecasting tool used to estimate travel behaviour and demand within a given area and timeframe. Historically, travel demand models have focused largely on passenger movements, despite commercial travel being an important activity for governments to understand in order to prioritize infrastructure improvements and develop effective policies that encourage freight traffic, while also limiting negative externalities. Recently, more consideration has been made to incorporate freight into models as more data is becoming available for use, though many assumptions still need to be made when developing models.

2.10.1 Uses of demand models

Demand models can be used by planners and policymakers to conduct an array of analyses to help inform infrastructure improvements, land use and rezoning requirements, and policy for example. Types of analyses that can be conducted using travel demand models include travel time and reliability analysis, mobility pricing analysis, time of day and off-peak analysis, and commodity flow analysis. Each type serves a different purpose, and can be employed by planners based on their needs.

2.10.2 Required data

The data required in order to successfully run a demand model are freight parameters of primary interest. They include truck productions and attractions by land use, sector or trip purpose; truck trips per day by truck type; truck trip lengths by truck type; truck trip time-of-day distributions; origins and destinations; and truck volumes. These data, however, are not always readily available, and the data required for a particular case is dependent largely on the type of model selected, the analysis to be conducted, and location.

2.10.3 Types of models available

There are many model types available to employ to conduct the chosen analysis. Simple growth factor models for example, forecast changes in freight demand due to changes in the level of economic activity or other related factors. These can be classified based on historical traffic trends, or based on forecasts of economic activity. Simple growth factor models based on historical trends can employ linear or compound growth, depending on assumptions made on how freight flows grow.

Another type of model is a four-step travel forecast, which can be used to directly estimate road vehicle travel or commodity flows. The four main steps in these types of models are: production and attraction, distribution, mode split, and network assignment. In a road vehicle travel estimate, the mode split step is typically omitted as the mode is already selected. In commodity flow estimates, truck conversion is an optional added step that converts the commodity tonnage for road shipments into vehicle flows. A sample flowchart of the two types of four-step models can be seen in Figure 2.10.1.

A third example is the cross-cascades model. Using spatial input-output modelling involving a household and economic activity event, land use component, and transportation component, this model simultaneously develops forecasts generated iteratively, of modal passenger and freight traffic volumes on the transportation network, modal splits, population, and employment.

Finally, there are other categories of models, each with a few model types, presented in Table 2.10.1.

Figure 2.10.1: Truck trip and commodity flow four-step model frameworks
(Source: Sharman, 2014)

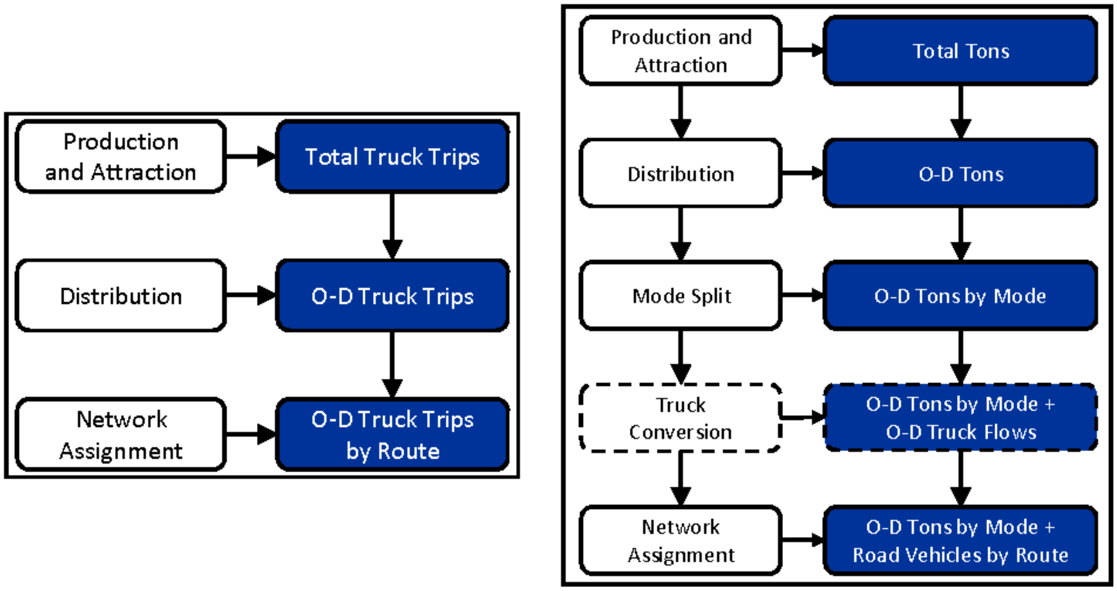


Table 2.10.1: Other types of models available
(Source: Sharman, 2014)

Supply Chain Models	Urban Logistics Models	Tour-Based Models
INTERLOG model FAME model Logistics framework for Norway and Sweden freight transportation models	GoodTrip model Tokyo model	Calgary tour-based urban freight model Ohio statewide disaggregate commercial model Discrete choice tour generation model Entropy-based tour formation model

2.10.4 Data sources

As previously mentioned, data for use in freight demand models are not always easily available. However, recently there have been improvements in data collection and dissemination within Canada that can be drawn upon. Examples include the Ministry of Transportation of Ontario's Commercial Vehicle Survey, GPS data, the Canadian Freight Analysis Framework, and Statistics Canada's transportation data and information hub and Canadian transportation economic account.

2.10.5 Controlling factors affecting demand analysis and forecasting

There are many controlling factors that impact the demand analysis and forecasting of freight flows. For example, economic structure, types of industries, personal consumption, changes in demographics, industry diversification, and trade flows have a direct impact on how many freight shipments are required and their frequency. Industry supply chains and logistics networks also have an impact through the spatial distribution of networks, interactions between logistics players, and supply chain and logistics trends both nationally and globally. Freight infrastructure also plays a role, based primarily on the characteristics of supply, demand, and shipments. Freight traffic flows play a role and can affect forecasting depending on the measurement and representation of flows, which can be by number of vehicles, twenty-foot equivalent units (TEU), weight or value of shipments.

Public policy and the private sector also have an impact that must be acknowledged. Key private-sector decision makers play a critical role in contributing to decisions about what, how, when, and where transportation services are used to move goods across the supply chain. Regulations such as safety, land use, hours of service, and environmental regulations all impact freight flows. They may set restrictions of routes, truck and load sizes and weights, and types of equipment used. Ultimately, the factors that impact freight flows must be known to planners and modellers to enable performance of accurate demand analysis and development of reliable forecasts for planning purposes.

2.10.6 Limitations

There are limitations to using travel demand models. The first and most important is data availability and quality. Much of the data required is not generally available to planning agencies as it is owned by trucking and logistics companies. Current and historical data on freight, especially truck movements, are limited, though as the importance of the availability of this data is better understood, it is anticipated that more sources will become available in the future. Model complexity is another limitation. Often times, models are highly complex, require substantial data that may not necessarily be available, and take a long duration to run. Finally, when using GPS data, there is a risk that the collection of data may miss some shorter trips due to imprecision of the data.

3. Module 3: Trends and disruptors

This module presents the results of research of emerging trends and potential risks in the goods movement industry. The overall purpose is to educate the audience on recent developments in the industry that they should be aware of, and have the potential to take advantage of when planning and delivering projects. It is also meant to educate the audience on what the current and emerging trends are in freight to raise awareness of how and why certain companies make their decisions. Its major sections are:

- Emerging Trends
- Technological Advancements
- Risks

At the end of this module, the audience should be aware of advancements in the freight industry, the benefits they bring, and the potential risks associated.

3.1 Emerging trends

The first category of interest explores some emerging trends related to the shifting behaviours of freight industry stakeholders, policymakers, and consumers, and their impacts on production, distribution, delivery and consumption.

3.1.1 Consumer options

Traditionally, consumers would shop at storefronts where goods are typically delivered through traditional supply chains, during peak or off-peak hours. These traditional supply chains involve producing and acquiring raw materials, transporting them via any combination of air, road, marine or rail modes to warehousing, production and/or distribution centres, delivery to a brick-and-mortar storefront, ending with consumer purchase.

With the rise of the internet, e-commerce has become a new option for consumers, shifting traditional supply chains. Through e-commerce, consumers can make purchases that are not constrained by time or geography – the primary requirement is an internet connection. This results in consumers being able to order goods at any time, and have them shipped typically within a week, sometimes as early as within the same day, requiring distribution centres that can manage large volumes of orders coming in 24/7 and can process and send them out for delivery within a day.

The continued rise of digital technologies has led to even more options for consumers, who can shop via multiple channels (e.g. online websites, mobile phones, scanning barcodes, telephone orders). Promotions and membership perks (e.g. Amazon Prime) are used to stimulate sales by offering limited-time only deals during specific periods (e.g. Black Friday, Cyber Monday, Boxing Day), but also provide the opportunity to receive the merchandise within the next 24 hours, creating higher volumes of transport and deliveries during these periods. The supply chain after an order has been placed is effectively identical to an e-commerce supply chain, with products being transported to warehouses and/or distribution centres, then to smaller trucks for last-mile deliveries. This consumer purchase scheme requires a high level of integration between distribution, promotion and communication channels, as purchases made from one location have the ability to be either picked up at the original location, a secondary location, or delivered.

Ultimately, more consumer choice for ordering will likely lead to increases in the frequency of shipments and/or larger shipments, putting increased stress on road infrastructure, and contributing to congestion and pollution.

3.1.2 Off-peak delivery[72]

Off-peak delivery (OPD) is an urban freight strategy that aims to alleviate congestion and road conflicts caused by deliveries during peak periods, by moving them to off-peak periods, usually between 7:00 p.m. and 6:00 a.m. This strategy is not applicable in all jurisdictions, as some have delivery or noise restrictions during certain overnight hours and near residential areas. However, where it can be tested or implemented, OPD can:

- Provide congestion reduction, particularly during rush hours in urban areas and on highways
- Allow increased speeds when collecting/dropping off goods as loading bays are less busy
- Increase quality of life for drivers who experience less driving-related stress
- Increase the availability of parking and curbside space, resulting in a reduced likelihood of parking tickets and increase in unloading options
- Increase productivity for the receiving business as staff can be brought in early to stock shelves before opening

Typically, shippers with large, high-volume customers who have the ability to receive shipments at night are attracted to using OPD to fulfill their orders. However, small commercial, pedestrian, or touristic streets in historic centres or downtowns also benefit from this strategy. This strategy requires receivers to have overnight or early morning staff before opening hours, or technology to receive shipments without staff present, both of which could have high costs – with staff costing more in the long run than technologies – and therefore best suited for large shippers and receivers. Further, OPD is best suited for non-perishable goods, rather than foodstuffs that can spoil. It is therefore useful for businesses such as hardware stores or service stations.

Some difficulties and restrictions related to OPD include municipal noise restrictions; change management issues (e.g. confusion with delivery times, switching warehousing staff to night shifts); operational adjustments to deal with changes in working environments (e.g. requiring additional lighting at receiving business, potential for unfavourable encounters with strangers); and a lack of a guarantee of reduced travel times due to traffic signal timings and some areas maintaining relatively high volumes of traffic throughout the day and night, particularly in urban cores.

OPD was piloted in the Greater Toronto and Hamilton Area during the Pan/Parapan Am Games in 2015 by MTO. Forty municipalities and over 100 retail, food and grocery businesses participated in the pilot that resulted in approximately 18,400 off-peak deliveries during the Games. These diverted deliveries are equivalent to the removal of approximately 4,500 truck trips or 240,000 truck vehicle-kilometres travelled (VKT) from peak periods. While some noise complaints were received, the overall noise impact was minimal. The study also found that minimal changes or costs are associated with businesses using OPD, though this largely depends on the selected delivery schedule and current operating environment of the business.

The application of OPD will affect freight movement by reducing the number of vehicles travelling at peak periods in urban settings and potentially on long haul trips as well. It may also help shippers meet delivery deadlines better as there is less congestion to manage when planning routes.

3.1.3 Reverse logistics[73]

Reverse logistics is identical to traditional logistics, except with the activities operating in reverse order. It can therefore be defined as the process of planning, implementing and controlling the efficient, cost-effective flow of raw materials, in-process inventory, finished goods, and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal at the end of the life cycle of the product. This includes processing returned merchandise due to damage, seasonal inventory, restock, recalls, recycling and hazardous materials programs, and obsolete equipment disposition, and is based on the retail industry's "return policy." Reverse logistics enable businesses to retain more customers with "no-hassle guaranteed" and extract any remaining value from returned products by reconditioning or recycling goods.

Reverse logistics affects the movement of goods by creating a continuous cycle of commodity flows that may increase the amount of trucks on roads due to increases in demand for returns. Further, it can contribute to stimulating further purchases which requires additional trips or heavier loads.

3.1.4 Increased terminal and truck / train / ship size

As global population continues to grow and people increasingly move into urban areas, digital communications and technologies continue to connect people and businesses across the globe. As global demand for goods increases, freight ultimately must keep pace and be able to transport the ever-growing amount of goods within and between countries. In order to keep pace, the sizes of ships, airplanes, and port facilities, and the length of trains have all increased[74] – an example of which are the expansion activities at the Port of Prince Rupert which are planned and/or are underway.[75] These size increases contribute to changes in the processing and delivery patterns to and from major logistics hubs such as marine ports, airports, and intermodal facilities, based on their capacity, forcing smaller locations to try and increase their sizes to meet demand and stay competitive or risk terminating operations. Moreover, due to physical constraints (depth of rivers and channels, available land-size, or proximity to urban centres), a new hierarchy of marine port and airport terminals emerges into global hubs or gateways, which can accommodate the largest ships and planes (for examples, the ports of Hong Kong, Singapore, Rotterdam, Hamburg, New York/New Jersey; the airports of Tokyo, Shanghai, Doha, London, Atlanta) who concentrate most of the trade and passenger volumes. Second-tier hubs are dedicated to regional or national markets.

As sizes for port and intermodal facilities grow, so do their impacts on land use. This poses problems, particularly in regions like Metro Vancouver and for its ports, as the demand for industrial land is exceeding the inventory, which could potentially be exhausted in the near future.[76] It is therefore imperative that land use planning be integrated with the transportation system in order for the necessary growth in transportation facilities to be managed in a way that is sensitive to local and regional development goals, and that zoning decisions are made with considerations for future demand for varied land uses, including industrial lands.[77]

Further, there have also been recent developments in maximum truck weights, with Manitoba for example, increasing the maximum weight for semi-trailer tridem axles by 1,000 kilograms on select routes within the province.[78] While measures like this are helpful in ensuring both coordination across jurisdictions, and the ability of Canada's transportation network to handle the increasing demands of consumers, there are also implications for wear and tear on roads that must be understood and considered by planners and policymakers when updating regulations.

With regards to container ships, there has been a trend towards increasingly larger mega-ships which require increasingly large mega-ports in order to offload. While the ability to carry more goods seems good for carriers, and the ability to handle and offload large volumes is attractive for port facilities, the overall cost savings for larger ships is actually decreasing as ship sizes increase, and costs to build and maintain mega-ports are high. Approximately 60% of mega-ship cost savings are derived from more efficient engines, not scale- and size-related fixes to existing infrastructure like bridges, waterway widths/depths, canals, locks and other port infrastructure. Finally, mega-ships can lead to decreased supply chain resilience through reduced carrier choice, and service and cargo concentration. Port facilities and governments could take a few steps to help cover these increasing costs by making more balanced decisions on accommodating mega-ships, aligning incentives and costs to public interests and recover costs of mega-ships, provide policy support to ports to enhance supply chain productivity and innovation, consider collaboration at a regional and cross-port level, and stimulate discussion between shippers and transport stakeholders to better align on the use of mega-ships and optimize supply chains.[79]

Increases in sizes of travel modes and associated infrastructures is likely to increase the overall amount of goods that can be shipped and received. This may make last-mile deliveries more difficult if truck sizes are not decreased, or if more trips need to be taken. Long haul deliveries could however reduce in number as larger trucks, trains, ships, and planes will be able to handle more goods with fewer trips.

3.1.5 The changing role of actors

The ownership and operational structures of transportation assets, including infrastructures, differs between modes, and is subject to change. The basic ownership structure for each mode is presented in Table 3.1.1 below, and is discussed in more detail in Module 1, Section 1.2 Modal Profiles.

Taking marine ports as an example, we see that some (e.g. remote, local/regional, and public) ports are owned and operated directly by Transport Canada,[80] whereas Canada Port Authorities are Crown agents that operate at an arm's length from government. Canada Port Authorities are also financially self-sufficient, strategically significant to Canadian trade, linked to major rail or highway infrastructure, and diverse in traffic.[81] These arm-length authorities have effectively depoliticized the decision-making ability of these entities, increasing their ability to make and provide locally-sensitive decision and solutions.[82]

Table 3.1.1: Basic ownership and operational structures of freight infrastructure (Source: WSP)

Road			Ports			Rail	
Local	Regional	Highway	Intermodal	Air	Marine	Class I	Class II
Municipal/ provincial	Municipal/ provincial	National Highway System (federal)	Inland intermodal ports connected to marine ports have the same structure; dry ports / intermodal hubs are privately owned and operated.	Owned by Transport Canada and operated by third parties	Transport Canada owns and operates remote, local/regional, and public ports; CPAs own and operate other ports at arm's length from government.	CN and CP (private sector, publicly traded)	Typically owned by a government entity, but often operations are contracted out to a third party.

With the case of dry ports or intermodal facilities, using CentrePort in Winnipeg as an example, we see the facility is privately owned and operated, yet still maintains a partnership with regional and provincial governments.[83] Partnerships between private entities and the public sector are important for limiting the uncertainty that comes with development projects due to factors such as funding sources.

Changes in these ownership/operational structures can have significant socioeconomic impacts. For example, changes in ownership often lead to changes in priorities that may affect operations and planned projects, as well as funding structures and access to capital, which could result in necessary projects being cancelled, which may damage not only the local economy but the broader provincial/territorial or national economies as well. On the other hand, transferring of ownership from government to private companies could have positive impacts as investments no longer need to come primarily or entirely from government budgets, which may have conflicting priorities, and much of the risk is transferred to the private sector through contractual obligations to design, build, finance, operate, and/or maintain roads on behalf of the government.[84] This shift to private financing helps to not only shift risk but also to alleviate the public of their burden to cover capital costs of building and improvements, though without strong partnerships with government, it is difficult to pursue capacity improvements that involve expropriation of land.[85]

As the roles and responsibilities of actors in the goods movement sector changes, the operation of the overall networks can be affected in many ways. Depending on where responsibilities are shifted and the resources that a particular entity has to accomplish these tasks, they may be easier and increase the efficiency of the network, or may have the opposite effect.

3.1.6 Freight villages

A freight village (sometimes referred to as a dry port, inland port or intermodal facility) is a centrally managed intermodal transfer point located at the nexus of multiple modes. At these locations, cargo from different modes can be reloaded, compiled, and prepared for transportation. The concept of a 'village' is derived from the fact that multiple modes, transport companies, supplementary services, and industrial and trading companies are all located in a cluster, promoting the division of labour on site. There should also be access to shared facilities, equipment and value-added service.

The benefits of freight villages can include:

- Synergies in logistics processes
- Synergies in infrastructure
- Reductions in wasted movements and fewer transport links
- Economies of scale
- A firm basis for coordinated urban distribution
- Encouragement of intermodal movement

The disadvantages of freight villages can include:

- Co-located firms may not interact with each other, thus maintaining vertical supply chains as opposed to horizontal coordination
- Coordination between levels of government is at times difficult
- Risk of over-supply if there are too many
- Government subsidies in freight villages may not see positive returns
- Villages may increase congestion in the area, as opposed to reducing it which is a stated goal

Finally, when firms choose their warehousing or distribution centres, they take into account a number of considerations. Below is a table representing what firms believe is of high and low importance when determining their location.

Table 3.1.2: Important factors when determining freight facilities
(Source: International Journal of Transportation Research)

	Low Satisfaction Factor	High Satisfaction Factor
High Importance	**Push Out Factors** • Land costs/tax rates • Availability of skilled workers • Business regulatory environment • Land available for expansion • Number of dock doors	**Retain factors** • Access to major suppliers • Ability to operate 24/7 • Proximity to highways • Trailer parking • Access to major customers
Neutral Importance	• Public transit availability	• Truck staging area
Low Importance	**Neutral Effect** • Long combination vehicle accessibility • Marine port access	**Slightly Retain** • Proximity to similar businesses • Highway visibility • Airport access • Rail intermodal access • Availability of unskilled workers

Freight villages allow for the consolidation of freight activities, which can contribute to effective land use management. Further, goods movement stakeholders like shippers and carriers are better able to interact with each other, reducing the number of empty runs between dispatching and picking up a load at a distribution centre for example.

3.1.7 Social / public involvement

In recent years, there has been increasing social action and participation from local community groups, individuals, and private-sector coalitions across the democratic world, exercising their rights of association and freedom of speech in order to attempt to influence particular transportation investments. This has resulted in protests, lobbying, rallies, and calls for action, the organization of which has been facilitated by social media and the internet more broadly. In Canada, associations like Trajectoire Québec, Transport Action Canada, and CargoM work with industry and the public to influence transportation policy decisions, in efforts to increase environmental and consumer protection and industry growth.

Examples can be noticed from national to local scales. In France for example, the 'gilets jaunes' (i.e., yellow vest movement, a group of primarily working-class protesters) began protesting increases in fuel tax, rallying supporters in all of France, arguing that it is putting undue stress on their budgets and accessibility within their regions.[86] In Toronto, there have been local communities of active citizens, sometimes referred to as NIMBYs (i.e., not in my backyard),[87] objecting to mixed-use development projects, and ultimately urban intensification, attempting to influence the development of their neighbourhoods.[88] Elsewhere across Canada, national, provincial, and territorial protests against the Trans Mountain Pipeline, a key piece of infrastructure ensuring Canadian oil can continue to be exported and increase the competitiveness of its price against other countries' oil, have taken place primarily to criticize the potential environmental impact of the continued use of fossil fuels and potential environmental damage.[89]

Ultimately, land use, economic development and urbanization are intertwined and can have a significant impact on the movement of goods and other aspects of the freight industry. Social, environmental, and economic impacts of planning and investment decisions must therefore take these all into account, weighing costs and benefits, and articulating these clearly to the public in order to gain the needed support to see a project through. Further, social involvement can help to sway public policy or private enterprises towards a particular action. For example, OPD might be pushed by policymakers; however, if the public is not supportive, they have the potential to pressure the government to remove this policy. This is particularly effective for urban freight but less so for long haul, as long haul typically involves less interaction with the public.

3.1.8 Vision zero[90] [91] [92] [93] [94]

Vision zero is a term originally coined by the Swedish government in 1977 when it launched its program to eliminate death and serious injury from its roads. Since then, a number of organizations and governments have adopted the term and launched their own plans to reduce or eliminate road-related injuries and deaths.

The transportation sector (passenger and freight) accounted for roughly 2,000 annual deaths and approximately 28,000 annual hospitalizations in Canada between 2010 and 2016, with large trucks having a fatality rate double that of all other vehicles. By 2017, the number of fatalities per 100,000 population was five – the lowest on record. Within the trucking industry, many drivers and other stakeholders feel that many of the accidents and fatalities involving trucks are a result of long shifts, inadequate pay, and inadequate training.

In part as a result of the success seen in Sweden, who cut road deaths in half over twenty years, jurisdictions across the world are beginning to implement their own Vision Zero policies in an attempt to see the same success. The Swedish model for Vision Zero as it relates to planners involves creating a safe systems approach, rather than a shared responsibility paradigm in which education, enforcement, and engineering are the structural pillars. Under the safe systems approach, the government (the entity that designs the system) assumes full responsibility in developing infrastructure, vehicle regulation, and speed limits that are designed to protect all road users, and particularly those at higher risk such as pedestrians.

In Canada, Vision Zero was officially adopted nationally in 2016 as part of Canada's Road Safety Strategy 2025. As of 2019, Vision Zero has been implemented across the country at varying levels of government. Toronto, British Columbia, London, Montreal, Edmonton, Strathcona County, the Canadian Council of Motor Transport Administrators, Manitoba, Durham, and Peel Region have all implemented some form of Vision Zero in their jurisdictions. Other jurisdictions across the country are considering or preparing to implement their own Vision Zero policies as this strategy is increasingly recognized as the international best practice for road safety.

Strategies that can be employed to ensure that a safe systems approach is taken include: focusing on what causes safety rather than what causes accidents; implementing road safety improvements in bundles rather than as individual measures; ensuring the road network is safe at all points, and improvements are not only targeted at high risk points; and embracing multimodal transportation.

3.2 Technological advancements / freight disruptors

There are a number of technological advancements that can be deployed throughout the freight industry, from vehicles to infrastructure to warehousing, to increase safety and efficiency. However, while promising, these technologies also come with risks and practical limitations that must be understood and explored in order to help inform policy for how to allow the testing and application of these technologies.

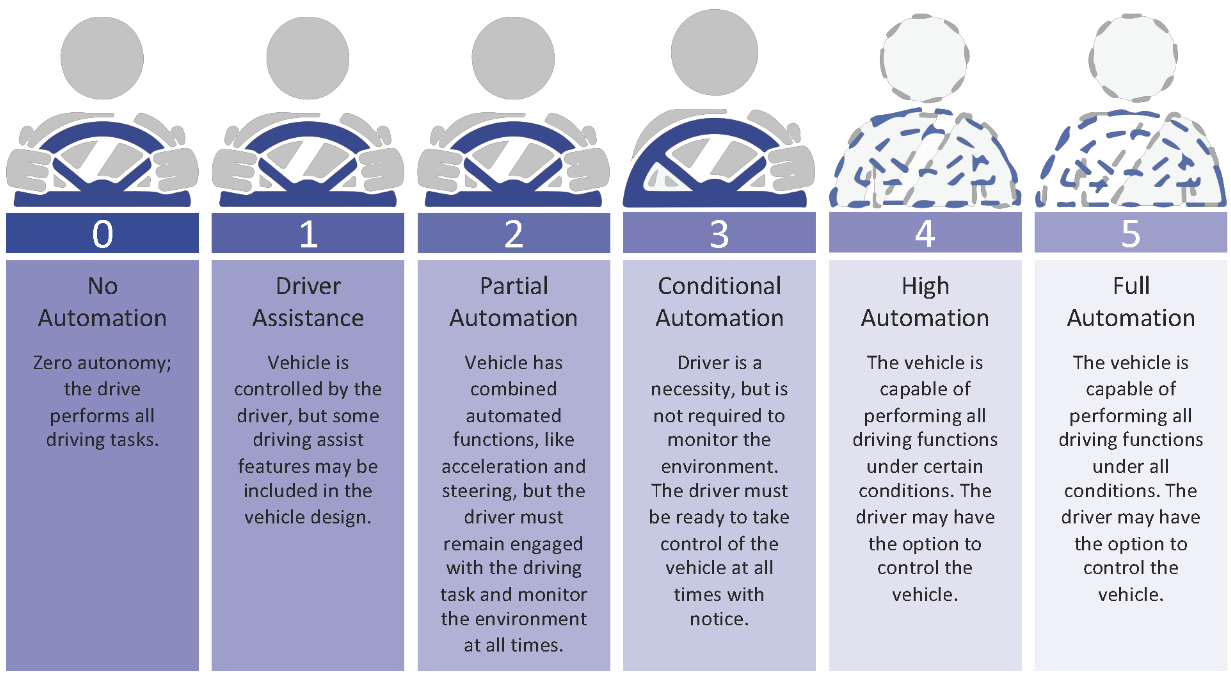
3.2.1 Connected and automated vehicles (CV/AV)[95]

Connected vehicles (CV) use various forms of connectivity to extend a vehicle's awareness beyond its physical limits and enable communication between vehicles, transportation infrastructure, mobile devices, and cloud computing platforms. It is important to note that the connectivity of the vehicle does not necessarily imply that it is controlling vehicular movements. In the majority of cases with CVs, the connectivity manifests itself as data-sharing between vehicles, pedestrians and infrastructure, sharing information like vehicle speed, safety, signal timing and environmental conditions.

Automated vehicles (AV) are capable of using sensors, camera systems, artificial intelligence, and global positioning systems to sense their environments and navigate without the need for human input. The Society of Automotive Engineers (SAE) has defined six levels of automation for driving systems. The six levels span from no automation (level 0) to fully automated operation (level 5), and are described in Figure 3.2.1. A specific vehicle can have systems that span multiple automation levels, depending on which systems are enabled.

The implementation of CVs and AVs, particularly in association with each other, is believed to result in safer, more efficient road networks due to increased communications between users and the elimination of human error. While in theory, a fully connected and automated transportation network would likely improve efficiency and safety while reducing the need for new major infrastructures, this reality is still many years away. In reality, these technologies are slowly being adopted and integrated into a still human-centric road transportation network, and are still not ready to be fully deployed across all road and weather conditions. There are also medium-term risks of increased private vehicle ownership, which will put more cars onto the road and increasing congestion levels. There are however, other applications of these technologies, including for maintenance and warehousing, that are likely to realize greater benefits sooner than the overall road transportation network.

Figure 3.2.1: SAE levels of vehicle automation
(Source: National Highway Traffic Safety Administration, 2019)



CV/AV testing is being pursued in Canada, with a major testing hub located in Stratford, Ontario. The Autonomous Vehicle Innovation Network (AVIN) is a demonstration zone and research and development facility that focuses on testing AVs in real-world scenarios. AVIN's core objectives include commercialization of CV/AV technology, building awareness of the technologies and their place in Ontario, and encouraging collaboration and innovation.[96] Land- and air-based AVs are also beginning to be explored for farming applications such as seeding and crop analysis respectively in Alberta.[97]

3.2.2 Platooning

Platooning is defined as linking two or more vehicles in a convoy, using connectivity and automation technologies, to enable safe high-speed travel of what are effectively road freight trains. The application of connectivity and automation allows the head of the platoon to act as the leader, while the trailing vehicles adapt to changes in its movement by wireless sensors, but ultimately regulate their own speed, distance, and movement based on the head vehicle. Drivers are able to take control of their vehicles at any time to detach from the platoon to exit a highway and continue to a distribution centre for example. The Government of Canada is in partnership with industry and other jurisdictions to test a vehicle-to-vehicle-based cooperative truck platooning system.[98] Platooning has already been tested on public highways in Canada, with the first two-vehicle heavy-duty transport truck test having taken place between 29 October and 2 November 2018 on highways around Montreal, La Tuque, Trois-Rivières and Blainville, Quebec.[99]

Platoons are an opportunity for truck drivers to increase their productivity as they can perform other tasks while part of the platoon, increased safety through immediate and automatic braking, and reductions in emissions and fuel consumption. On the other hand, there are safety risks that come with any connected or automated vehicle technology, specifically related to their vulnerability to hacking, which could ultimately result in vehicles being remotely controlled by hackers. Further, as with most technologies requiring the development of complex algorithms that respond to real-world inputs in real-time, there is the potential for a malfunction, which could result in platoon vehicles losing connection and colliding with each other or other road vehicles.

3.2.3 Long combination vehicles[100] [101]

Long-combination vehicles are trucks that are between 25-40 metres long and haul two full-sized trailers. They are meant to replace two 23-metre tractor-trailers in order to reduce GHG emissions and VKT, and increase safety, while also allowing retailers and manufacturers to bring goods to market at a lower cost. Though not an entirely new solution, the adoption of LCVs in the trucking industry has been slow due to mixed sentiments primarily surrounding the safety of their operations.[102] Others within the trucking industry cite a lack of enforcement of regulations and public skepticism for sharing roads with increasingly large freight vehicles.[103]

Governments in Alberta, British Columbia, Ontario, and Quebec are supportive of their use, and have set up regulations related to routes, speeds, the nature of loads carried, and additional driver qualifications. There is also a Memorandum of Understanding (MOU) Respecting a Federal-Provincial-Territorial Agreement on Vehicle Weights and Dimensions signed between all provinces and territories and Transport Canada to ensure the standardization of heavy-duty vehicle size regulations across the country. This helps ensure that truck drivers can operate seamlessly between the provinces and territories. This MOU is actively amended by the Council of Ministers Responsible for Transportation and Highway Safety to respond to changes in jurisdictional regulations and advancements in technology.[104] There is also an MOU between the Provinces of Ontario, Quebec, Nova Scotia, and New Brunswick to harmonize permit conditions for LCVs.[105]

As a result of these MOUs, provinces who have historically not allowed LCVs, or have limited their operations, have begun running pilot projects to assess their operational safety on their respective highways.[106] [107] Further, there are opportunities to combine CV/AV technology in LCVs to further improve their safety and efficiency, though there are limited examples of these two trends being combined and tested.[108]

3.2.4 Alternative fuels[109] [110]

Alternative fuel vehicles are those whose engines are not powered solely, or at all, by petroleum. Government and private-sector vehicle fleets have increasingly been using alternative fuels in order to lead the way domestically in promoting a shift away from fossil fuels, and general consumers have also begun to slowly make the shift, with the sales of electric vehicles in Canada growing 68% between 2016 and 2017.[111]

There are a wide variety of alternative fuels including biodiesel, electricity, ethanol, hydrogen cell, compressed and liquified natural gas, and propane. Some benefits of these different types include significant reductions in emissions; increased safety of using, handling, storing, and transporting these fuels as compared to gasoline; increased power and performance of fuels like ethanol with higher octane ratings than gasoline; increased energy efficiency; and improved engine life and reductions in cold-start problems with propane. There are, however, concerns related to capital costs, retrofitting or renewal of fleets, increased concentration of emissions with natural gas, and most importantly range of these vehicles, specifically electric vehicles.

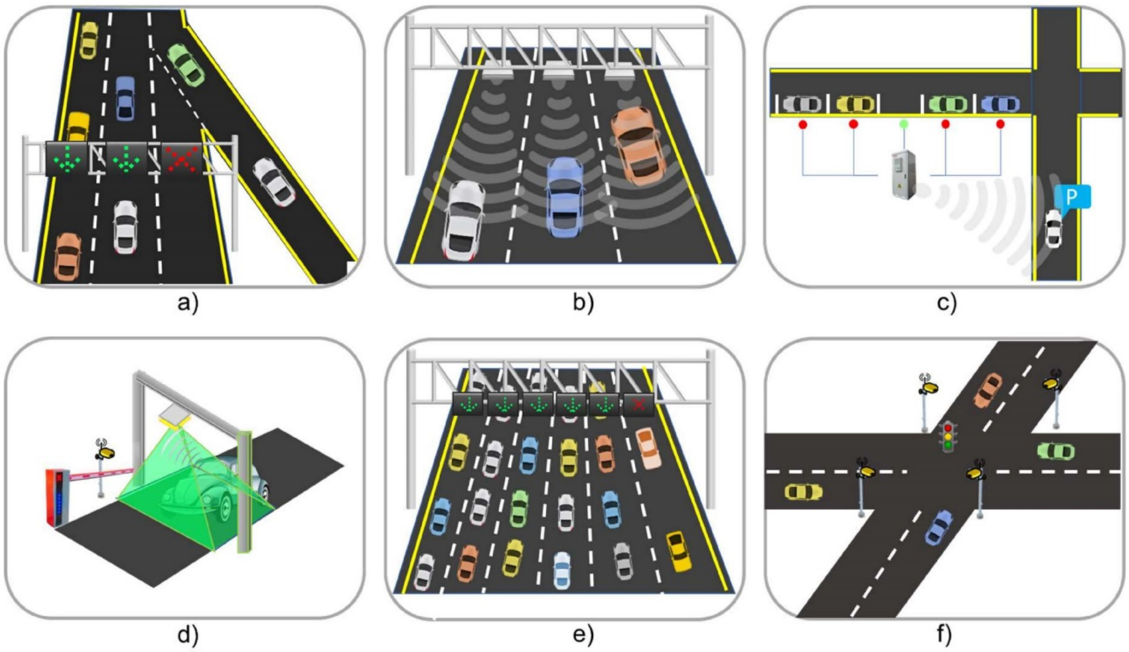
While there are many alternative fuel sources available, and production of vehicles that do not run on gasoline is increasing, the freight industry has not adopted this trend in a large way as of yet. There are, for example, electric trucks being produced in Canada,[112] and select Canadian companies like IGA and Fortigo Freight Services Canada are testing electric trucks and delivery vans.[113] [114] UPS Canada is also involved in the adoption by converting its fleet to alternative fuels and testing plug-in electric delivery vehicles, with a goal of reducing its global GHG emissions 12% by 2025.[115] [116] Finally, Petro Canada offers alternative fuels at select stations across the county.[117]

With relatively low fuel prices, however, the incentive from the trucking industry to begin upgrading fleets is low especially when there are no subsidies available, as capital costs are high. Similarly, though it is unlikely that alternative fuels will reach air and marine freight, rail freight has seen increases in electrification, which is a suitable fuel source when the electricity comes from renewable sources.

3.2.5 Intelligent transportation systems[118]

Intelligent transportation systems (ITS) are a combination of information and communications technologies used in transportation and traffic management systems to improve the safety, efficiency, and sustainability of transportation networks, reduce traffic congestion, and enhance drivers' experiences. ITS provides information to road users, enabling them to use routes most efficiently, and can be integrated with CV technology in vehicle platoons. Other applications include travel time displays, alternative routing options, time restrictions, and construction/collision information disseminated to road users. Figure 3.2.2 provides six examples of ITS applications for traffic, lane, parking, and intersection management. With this information increasing in availability to the freight industry, and more specifically to truck drivers, the possibility to enhance the safety, productivity, and mobility of ground transportation while also reducing negative impacts like pollution and congestion, ITS can have a significant positive impact on the freight industry.

Figure 3.2.2: Example applications of ITS technologies for lane use (Source: Guerrero-Ibáñez, Zeadally & Contreras-Castillo, 2018)



Governments responsible for road transportation are increasingly applying ITS to their networks to solve problems and meet their own goals. Further, ITS Canada, in collaboration with the National Research Council of Canada and other stakeholders are in the process of developing a Canadian ITS ecosystem, citing ITS as the nervous system of the transportation sector.[119] In Alberta, ITS is employed through various technologies including the Smart Roadside Inspection System, which identifies high-risk commercial vehicles from the side of the road.[120] ITS is also being further implemented in the Northwest Territories as part of their Intelligent Transportation System Plan. This five-year implementation plan with a budget of $3.5 million will deploy traffic counters, road weather information systems, road web cameras, and variable message signs (see Figure 2.8.1) for example. The plan also includes the development of programs to support and improve data collection and management of goods, including dangerous goods.[121] Finally, the Government of Canada announced an investment of $6.9 million in the modernization of ITS along Yukon's trade corridors. Technologies include Road Weather Information Systems and commercial vehicle operations support.[122]

While ITS has many perceived and proven benefits, there are also some challenges to its deployment. As with many other emerging technologies, the primary driver of ITS is data – this involves the collection and distribution in order to inform the system. As a result, there are privacy implications, potential issues with data formats and interoperability between different stakeholders, and rural and suburban applications. Ultimately, if the data cannot be successfully standardized and secured, the application of ITS systems to help solve transportation issues and create a more integrated network may not be fully realized.

3.2.6 Electronic logging devices [123] [124]

An electronic logging device (ELD) is a piece of hardware that is attached to a commercial motor vehicle engine in order to record driving hours. It captures data on whether the engine is running, whether the vehicle is in motion, total distance driven, and duration of engine operation. Transport Canada and the Canadian Council of Motor Transport Administrators developed a set of technical standards for ELDs, with an initial version of the applicable regulations being released in 2017. It is expected that the full Canadian mandate will largely mirror that of the U.S. to promote interoperability between the countries, and is expected to require compliance by the end of 2020.

The move to mandate ELDs in Canada is aligned with the mandate in the U.S., which was fully implemented at the end of 2017. The goals of these mandates are to increase industry safety, productivity, and prevent driver log errors. While there are fleet and driver benefits associated with the implementation of ELDs in the trucking industry including increased productivity and accountability through eliminating paperwork for example, there are also perceived issues. ATRI's annual trucking industry survey ranked the ELD mandate in the U.S. as the fourth most important issue of 2018. This is due to data collection and use concerns voiced by drivers who are unsure if and how the data collected will be used beyond logging hours of service.

3.2.7 3D printing and warehouse automation [125] [126]

A significant technological advancement in the manufacturing and warehousing sectors is automation, specifically automated processes of production, assembly, storage, and distribution. 3D printing, also known as additive manufacturing, is an extension of automated manufacturing allowing for micro-manufacturing or large-scale manufacturing of products, supporting local growth, and reducing VKT through decreased need to transport many different materials to a single location for production or assembly.

The 3D printing process is relatively simple – a digital model is created, the materials are fed into the printer, and the printer produces the desired object. Some key advantages include shorter lead times; the freedom to design and manufacture complex and customizable products particularly in the medical equipment industry; a lower number of production steps in design, prototyping, and manufacturing; potentially faster delivery times due to on-demand and decentralized production; reduced logistics and production costs; and potentially lower environmental costs as production is efficient in material and energy use. On the other hand, disadvantages and challenges to the efficient use of 3D printing include the high cost of the printers, a limited number of suitable materials for production, limited suitability for mass production, and job losses in the manufacturing sector. The University of New Brunswick created a Marine Additive Manufacturing Centre of Excellence in 2017. It is focused on the research and development and commercialization of parts, and is the first facility of its type to use 3D metal printing to manufacture certified parts for the marine industry. The technology itself can help to address some unique challenges of the marine sector including corrosion and time-sensitive access to complex and critical spare parts. The facility ultimately seeks to help revolutionize the industry and allow Canadian fabricators to manufacture components on demand and simplify supply chains. [127]

Warehouse automation is the use of automated equipment during the production and storage processes, including shelving, inventory checks, classification, and preparation for delivery. Automated warehouses help to increase safety, efficiency, and accuracy of operations due to reductions in human error. It is effectively an optimization of warehousing procedures and can affect most aspects of operations. While increases in safety, efficiency, and accuracy can lead to reductions in long-term costs, there are also drawbacks from the application of this technology. For example, automation will result in job loss as machinery will replace people for many tasks, and short-term capital costs for introducing new machinery or building new automated warehouses is often high. Sobeys, one of the country's largest supermarket chains, began the automation of its distribution centres in 2010. As of 2018, the company operates four automated distribution centres in Vaughan, Montreal and Calgary. According to Sobeys, one robot in its automated facility can do the work of four humans. [128]

Ultimately, pairing both warehouse automation and 3D printing with freight villages has the ability to increase their overall efficiency, especially when dealing with on-demand and decentralized production, as is the case with many new business models. This will allow for products to reach markets quicker, and increased accuracy can result in less frequent trips for product returns for example, reducing freight VKT and emissions.

3.3 Risks

3.3.1 Reconstruction of infrastructure

In many transportation networks across Canada, the physical infrastructure is deteriorating and needs to be rehabilitated or reconstructed in order to not only maintain current operations, but also to be able to handle future demand. While infrastructure upgrades may seem initially like the most obvious and easiest ways to meet current and future demand, or minimize negative impacts that sections of the network may be having on society, this is not necessarily the case. Government agencies are operating with limited budgets, government priorities can change before and after elections depending on the results, and major projects require extensive planning over many years and coordination between various actors throughout the process. [129] This then presents problems related to finding funding sources for projects, which will also have some negative impacts on the network during the construction period.

Government programs that provide incentives or subsidies, like Transport Canada's National Trade Corridors Fund, help to prioritize major investments and make the most effective use of resources in order to improve Canadian freight corridors which help ensure access to markets both within and beyond Canada. However, there is a limit on how much new infrastructure can be built, due to conflicting land uses. Other forward-thinking and innovative congestion and emission-control methods, like mobility pricing, should be explored for future use.

3.3.2 Aging workforce and retirements

Across the Canadian workforce and broader population, the average age is increasing and the number of retirees is increasing. Fifty years ago, there were 6.6 workers for every retire; currently that ratio is four to one, and in another 20 years is expected to drop to roughly two to one. [130] In the trucking industry, it is anticipated that there will be a shortage of roughly 33,000 drivers by 2020, reflecting both an increase in the demand of truckers and a decrease in their supply. [131] The trucking workforce is aging more rapidly than the overall Canadian workforce, with a projected average age of 49 years by 2024, up from 44 years in 2006.

As the workforce ages, younger generations of workers find themselves more attracted to other employment opportunities. The trucking industry is often synonymous with long-hours, stress for meeting delivery schedules, time lost in chronic traffic, health and back problems, and being away from home for long periods and, unless there is a significant shift in the actual paradigm of production and consumption as mentioned previously in the shifting behaviour section, there is a real threat to the industry and broader economy as an insufficiently sized workforce can result in delays in deliveries. There are, however, opportunities presented by new trends and technologies like automation, platooning, and LCVs that can help to ensure the same amount of goods can be transported using less drivers.

3.3.3 Competition[132] [133]

Competition in the freight industry is well-pronounced, as maritime ports, intermodal hubs, and airports all contribute to the economic development of the region in which they are located and infrastructure can supply superposing hinterlands (i.e. regions laying inland from the coast or far from urban areas). For example, the Port of Montreal, with 60% of its rail cargo moving to the U.S., is in direct competition with ports like New York/New Jersey, Norfolk, and Charleston in the eastern seaboard hinterland. As a result, local and regional authorities are frequently seeking to increase their capacities to be able to handle more goods and drive more calls to the port. Competition is not only local or regional to attract major freights players and investments, but also national or global.

Some actions that ports have taken include providing cargo-handling services, investing in operating terminal equipment and other technological upgrades, and directly employing dock labour to attract routes from major shipping lines. On the local scale, logistics companies are also starting to move their operations closer to these hubs where possible, creating freight villages, allowing them to take advantage of other supply chain services, putting neighbouring cities in competition for tax incentives, land provision, or direct access to highways, as seen by the 2017-2018 case of the competition to attract the future Amazon headquarters in North America. Local and regional authorities should seek to ensure that there is adequate industrial land for these villages and hubs to develop to better support the local and regional economy.

Further, there have been increases in the involvement of global actors in port and railway activities such as transnational terminal operating companies and international shipping lines. This has resulted in part in the ports which they interact with increasing their value and volume of goods handled, and with efficient railway services that can extend their geographical coverage and offer continental transport solutions, putting traditional gateway ports and cities in competition – such as New York/New Jersey, Norfolk, or Savannah in the eastern U.S.

The increase in competition has also led to a rise in the creation of hubs, freight villages and the like, in order for regions to be able to better compete globally, as international trade is a major component of goods movement in our increasingly interconnected and global supply chains. Hubs and major players (e.g. shipping lines, terminal operators, railways) may lead to the loss of control by local authorities on the overall operations, and declines in local participation. Further, multinational corporations may be able to buyout operations in certain smaller regions, which is at times attractive to governments as it implies a new source of revenue and reductions in annual operating costs, as well as increases in their competitive standing against other ports. Ultimately, it seems that competition between ports, airports and cities is increasingly characterized by competition between transnational operating companies who have the resources to increase throughput with investments in equipment and technologies, and with efficient delivery systems and national coverage, which can choose to supply markets from outside their original infrastructure location.

3.3.4 Externalization of costs and benefits

Externalized costs and benefits (also called externalities) are unintentional outcomes resulting from the use or consumption of a given service. These costs and benefits are external because they indirectly affect those other than service users. In terms of external costs, it is important that planners understand the different costs associated with investment decisions, and use policy and other tools to ensure that users and industry players pay their fair portion of the impact they leave on the environment and society. It is becoming increasingly important to share the costs and benefits within communities as more governments explore the concept of equity in transportation.

External costs from freight include pollution (uncovered environmental costs), congestion and delays (delays/time costs imposed on others), and infrastructure wear and tear (uncovered infrastructure costs), each of which are attributable primarily to road transportation, as this is the dominant mode for freight and the one that interacts most with actors from beyond its own industry.

Table 3.3.1 provides a simple classification of the costs of transport. In market economies, it is important for policy makers and planners to know the external costs of decisions, because if market prices do not accurately reflect the true social costs, there should be mechanisms in place in order to better distribute the externalities.

External benefits from transportation include productivity and economic growth, and depending on the mode and fuel source used, could also have neutral or positive impacts on the environment and public health due to potential reductions in VKT, road wear, emissions or increases in active transport for example.

Tools to combat negative externalities include user-based charges, toll roads and other road pricing mechanisms, [134] taxation (such as fuel or vehicle characteristic taxes), [135] and carbon market and pollution permits (similar to a cap-and-trade system). [136] There is no single tool that is effective at capturing all externalities and internalizing them, nor is any tool that works well in one region necessarily good for another region. Each must be studied and applied contextually in order to internalize as much costs and benefits as possible, which will then contribute to influencing consumer and industry behaviour.

Table 3.3.1: Classification of transport costs
(Source: European Commission, 1995)

Cost Categories	Social Costs	
	Internal/Private Costs	External Costs
Transport Expenditure	Fuel and vehicle costs, tickets/fares	Costs paid by others (e.g. free provision of parking spaces)
Infrastructure Costs	User charges, vehicle taxes and fuel excises	Uncovered infrastructure costs
Accident Costs	Costs covered by insurance, own accident costs	Uncovered accident costs (e.g. pain and suffering imposed on others)
Environmental Costs	Own disbenefits	Uncovered environmental costs (e.g. noise disturbance to others)
Congestion Costs	Own time costs	Time costs imposed on others

3.3.5 Security

There are a number of security risks within the broader goods movement sector that exist locally, nationally, or in combination. All transportation modes face considerable security and safety risks, with some being shared between modes, others being unique to a particular mode, and others that are linked specifically to a given technology.

For instance, the transportation of dangerous or oversized goods in urban areas, particularly building materials and gasoline, poses significant risks to the local community and environment should there be an accident resulting in a gasoline spill.[137] Dangerous goods are often also transported by rail, which has in the past resulted in derailments, spills, fires and explosions. In response, Transport Canada has removed many of the least crash-resistant tank cars from service and introduced new safety standards.[138]

Air and marine modes are especially susceptible to crime and terrorism events, particularly at port facilities. Transport Canada's Transportation Security Clearance Program aims to prevent unlawful acts of interference within the operations of freight by these modes, in order to minimize the potential risks. There are also numerous roadside inspection stations for trucks to ensure that they are not carrying illegal goods, and are following other regulations including weight and size restrictions.

Planners should be aware of local and national security risks when evaluating projects, and should always seek to employ CPTED principles and the highest possible safety requirements while not inhibiting operations, in order to ensure the highest level of safety and security.

3.3.6 Cross-border freight traffic[139]

The next risk relates to freight that must cross international borders to access its intended market. Due to trade agreements like NAFTA (replaced by USMCA), CETA and CPTPP; increased interconnectivity between producers and consumers from different countries; and the ease of movement between countries by various modes, cross border freight traffic has increased in recent years. The result is that more goods need to cross international borders, and carriers/shippers must then efficiently and successfully navigate complex customs procedures, or else risk fines, delays and lost revenues. Further, operational differences between countries result in shippers needing to understand many different structures to ensure their goods can reach their intended location.

On the other hand, in 2018 there was an increase in tariffs from some countries including the U.S., which increases costs for Canadian companies and consumers, and could reduce the overall volume and value of cross-border freight traffic in the future if they remain or intensify.

In order to help mitigate these risks, new markets should be explored and trade corridors identified in Module 1 should be targeted to increase efficiency and links to favourable trading partners for example.

3.3.7 Urbanization

Urbanization represents a shift of populations from rural to urban areas, particularly cities, and therefore includes the intensification of urban areas. In 2018, 55% of the world population lived in urban areas, compared to 82% of the North American population.[140] Increased intensification of urban areas can result in increased wear and tear of transportation infrastructure, rezoning of lands to increase housing but decrease industrial lands, and increased demand for the delivery of goods, thus potentially increasing emissions and pollution through increased VKT.

Increasingly, large urban centres with adequate resources, space, and economies are becoming global city regions – vast urban logistics hubs with broad global reach. These may incorporate freight villages to serve logistics needs in a centralized location, and include immediate access to port facilities, intermodal hubs, and rail and road corridors.

While global city regions are a potential benefit of urbanization when managed correctly, urbanization still poses significant risks to the freight industry, particularly as it relates to the concentration of activities in congested areas and last-mile deliveries. It is difficult for trucks and other large vehicles to navigate often crowded and narrow streets present in urban cores, and the volume of consumers and their demands must be able to be met now and into the future as they increase. There are, however, opportunities for alternative delivery methods in urban areas like drones, bike couriers, and sidewalk delivery robots that seek to solve the last-mile challenge of cities in a sustainable manner.

3.3.8 Climate change[141] [142] [143] [144]

Climate change has become a defining global challenge for the 21st century, impacting individuals on every corner of the planet. There is a growing global consensus that human activity from the Industrial Era to the present has been the primary cause of the increased GHG emissions that are associated with climate change. In Canada in 2017, the transportation sector (passenger and freight) accounted for roughly 24% of national GHG emissions, with freight accounting for approximately 41% of all transportation-related emissions.

Climate change has been recognized by global institutions like the United Nations and World Bank as a problem requiring collective action, and governments like Canada’s are taking steps in order to reduce emissions and limit the negative impacts. Some of these impacts include: rising sea levels; decreased water level in navigation channels lakes, and rivers; increased surface temperatures; loss of permafrost; increased wildfires, droughts, and heatwaves; infrastructure failures; and the intensification of natural disasters. These impacts can have adverse negative effects on the broader transportation system, and freight specifically. For example, as all transportation is climate-sensitive, isolated communities in the north are particularly at risk for adverse climate effects as the supply of consumer goods and construction materials may be interrupted. This can be caused by the melting permafrost and increased surface temperatures for example, which can limit the viability of winter roads, cutting a key resource supply route for these communities. Moreover, decreases in river water levels will have an impact on depth and, therefore, the size of ships that can access inland ports through the St. Lawrence Seaway. There may, however, be some positive impacts of climate change in northern regions. This is particularly related to increased marine access with the melting of icebergs, and the future opening of the Northwest Passage, potentially cutting travel time for sea shipping from Europe to Asia and increasing the use of the Port of Churchill as a hub for ships in the area. This increased access as a result of rising water levels can, however, cause a number of other problems.

Elsewhere in Canada, floods and wildfires can also have impacts on the state and accessibility of goods movement infrastructure. This may result in goods not arriving at their destinations, or changes in supply chains to other modes which can increase costs and/or the time it takes for goods to reach their destinations.

Overall, climate change in Canada can have a severe negative impact on the country's overall economic vitality, as well as negatively impacting the population and their ability to access goods for affordable prices, or at all in certain regions. Some strategies to help mitigate the negative impacts on residents and the economy that can be employed by planners include ensuring that roads are built using more heat-tolerant pavements; incentives and/or taxes to reduce gas consumption with the use of electric vehicles; expanding drainage capacity for infrastructure; increasing maintenance activities such as clearing debris from culverts to reduce flooding, and clearing snow to preserve permafrost and ice stability; and changing infrastructure design requirements to include climate change considerations.

4. Case studies and exercises

This section presents four case studies and five self-directed exercises. The case studies present real-world examples of goods movement, while the exercises are meant to test knowledge acquired. The topics of the case studies relate to supply chains, urbanization and land use, policy-making, and regional project planning. The topics of the exercises relate to supply chain illustration, distribution centre/warehouse development, goods movement policy-making, and strategic and network planning.

4.1 Case Study 1: Supply chain – Apple iPad[145] [146] [147]

Case study concepts include competition, organization of supply chain, outsourcing, international trade, just-in-time, last-mile delivery, advantages, and challenges.

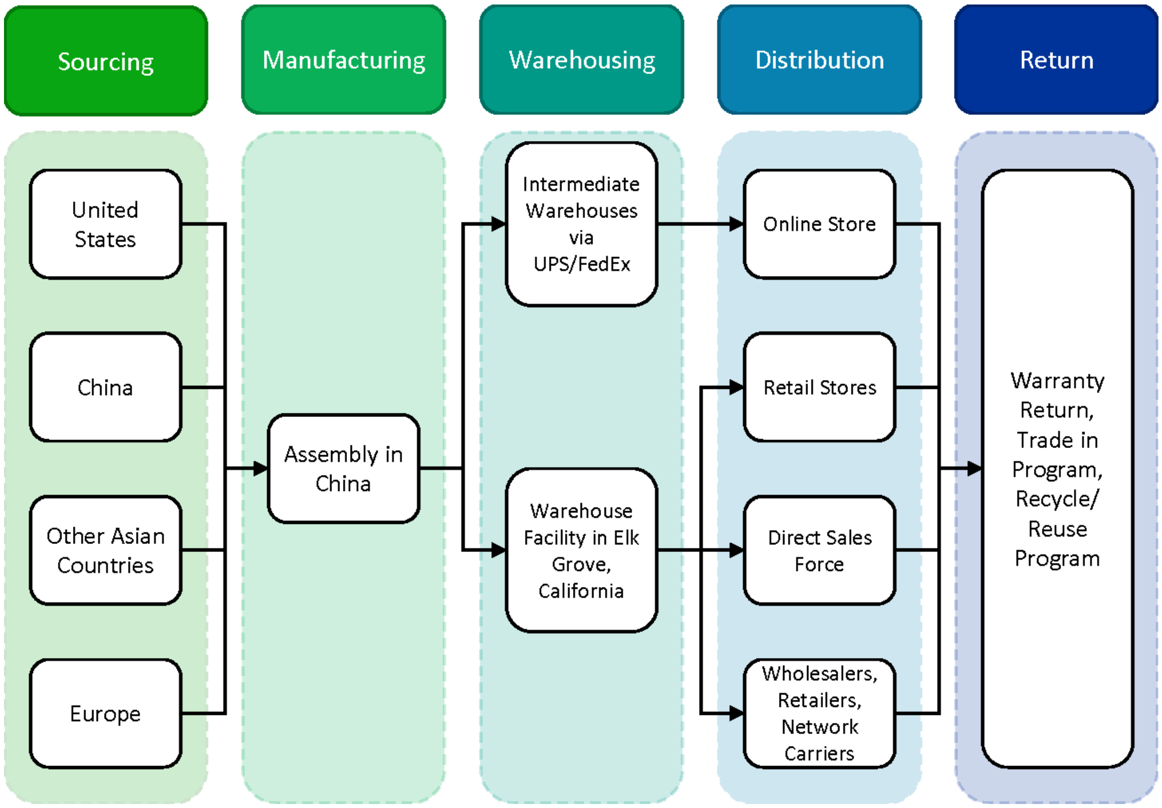
This first case study provides a simple example of how Apple's iPad supply chain functions. Apple has a competitive advantage against most other companies for sourcing components for its products, as it can place orders so large that backlogs operations of the supplier, eliminating the possibility of any other company of placing orders due to lack of supply. This dominance has resulted in Apple's reputation for having the world's best supply chain. This supply chain involves four primary steps and a fifth additional step of reverse logistics: sourcing, manufacturing, warehousing, distribution, and return. The supply chain is spread across multiple countries including Singapore, Taiwan, China, the U.S. and some European nations. Figure 4.1.1 is a simple illustration of the supply chain, not including modes.

Apple purchases raw materials and components from various sources and has them shipped to an assembly plant in China. After the products are assembled and ready for market, they are shipped to warehousing or distribution facilities (located primarily in China and the U.S., with others in the Czech Republic, Japan, Singapore and the United Kingdom), and then either directly to consumers who purchase online, or to retail stores. When the product's life comes to an end, it can be returned to a retail store, where the process of reverse logistics is initiated and the product is recycled.

In addition to Apple's competitive advantage in sourcing products, there are also other advantages to its supply chain. Apple has fewer key vendors compared to other companies like Amazon for example, allowing them to work closely with these vendors and increasing the potential for favourable pricing. In addition, Apple owns only one warehouse facility, located in Elk Grove, California, allowing costs to remain low and not permitting the company to hold large amounts of unsold inventory at any given time. Remaining warehousing facilities are owned by carrier services like UPS and FedEx, and serve as intermediate warehouses for Apple.

There are, however, challenges related to their supply chain. For example, Apple's reliance on international trade makes it susceptible to changes in the global economy and trade relations. Some of their components are also obtained from a single source, decreasing the resilience of the overall chain. Moreover, Apple's performance relies heavily on the reliability of the integration of its two main modes: sea and road organized in a just-in-time supply chain. Finally, finding suppliers who sell high volumes of parts is another challenge, as Apple sells between approximately 43 to 71 million iPads annually, requiring many more millions of parts for assembly.

Figure 4.1.1: Apple's simple supply chain
(Source: SupplyChainOpz, 2013)



4.2 Case Study 2: Urbanization / land planning – Winnipeg Centreport[148] [149] [150]

Case study concepts include land use, policy-making, strategic location, multimodal transport, local, national, and international trade.

The second case study explores the development of Winnipeg's freight village. CentrePort in Winnipeg is Canada's first and largest tri-modal[151] inland port with direct access to national and international rail, truck, and air cargo operations. The facility covers 20,000 acres and includes the Winnipeg James Armstrong Richardson International Airport, and houses manufacturing and assembly, warehousing and distribution, agribusiness, food processing and packaging, and multimodal transportation-related logistics companies, offering greenfield development space for these businesses.

The port area, before the development of the freight village, was already home to numerous freight companies due to its location adjacent to the airport. In order to facilitate the long-term development of the inland port and fast track investment and economic development decisions, the Government of Manitoba passed the CentrePort Canada Act in 2010. The province was mandated to create a Development Plan that includes comprehensive transportation, infrastructure, and land use plan for the approximately 20,000 acres of land around the airport that the port lands occupy and was required to support the 24-hour operation of the airport. Finally, the Act mandated that future development plans of planning districts or municipalities be consistent with the province's Development Plan for the hub.

Currently, CentrePort is home to over 800 companies, and is in the process of developing a 665-acre rail park to connect to Canadian Pacific Railway's main line, with access also given to Canadian National Railway and BNSF totalling international access to three Class I Railways. Other land uses on site include a logistics park, open recreation space, airport, business park, industrial park and a residential area. The hub has access to many domestic and international trade corridors, including the Atlantic Gateway, the Asia-Pacific Gateway, and the Mid-Continent Trade & Transportation Corridor. There is also access to Europe, the Middle East, North Africa, the Mediterranean, Asia, the United States and Mexico. CentrePort is also a gateway to other ports including Thunder Bay, Montreal, Halifax, Metro Vancouver, Prince Rupert, Houston, New Orleans, Manzanillo and Lazaro Cardenas, and faces competition from other prairie centres such as Port Alberta and the Global Transportation Hub in Regina. Figure 4.2.1 below shows the main corridors and gateways served by CentrePort.

CentrePort is also Canada's first foreign trade zone (FTZ), and as of 2018 there were nine across the country. FTZs are designated regions within a country where barriers to trade such as tariffs are substantially reduced, or eliminated and bureaucratic requirements are lowered to attract foreign investment and international business. CentrePort's FTZ will permit companies to defer duty and GST payments on imported goods that are being warehoused and redistributed to the international market.

4.3 Case Study 3: Policy – MTO off-peak delivery[152] [153]

Case study concepts include policy-making and by-laws, last-mile and delivery, road congestion, data collection, environmental and social impacts, role of local actors.

The third case study relates to policy, and looks at the Ministry of Transportation of Ontario's (MTO) off-peak delivery (OPD) pilot in 2015 during the Pan/Parapan Am Games, hosted in the Greater Toronto and Hamilton Area (GTHA). The pilot had two key objectives; to reduce traffic demand and congestion on highways and key corridors that was anticipated as a result of delivery-related trucks and the traffic management tools (e.g. priority high-occupancy vehicle lanes) employed to optimize travel to and from Games venues, and to identify the potential for longer-term implementation of OPD.

MTO rolled the pilot out in two phases. The first was a small-scale pilot in Toronto's downtown core in August 2014, and the second phase coincided with the Games. Participants in phase one included the City of Toronto, five carrier companies, and more than thirty businesses (customers of carriers). The participating carriers and businesses shifted their delivery schedules to off-peak hours – between 7:00 p.m. and 6:00 a.m. To enable this, the City of Toronto exempted participants from noise by-laws, and MTO collected data related to noise impacts, travel time, and participant's experiences. Phase one resulted in few noise complaints and carriers experienced some travel time savings, with two companies saving up to one hour. Further, OPD helped to reduce fuel consumption for delivery vehicles as well as greenhouse gas emissions.

The second phase took place during the Games and participants included forty GTHA municipalities, sixteen carrier companies, and over 100 retail, food and grocery businesses. MTO collected data related to deliveries diverted off-peak, noise impacts and participant experiences. The result of the pilot was the diversion of 18,400 deliveries off-peak, the equivalent of approximately 240,000 truck vehicle-kilometres travelled. Some key success factors, according to MTO, were the minimal noise impacts of

OPD, minimal changes or costs required for businesses to participate, and a permissive regulatory environment. Further, the success of OPD depends on sufficient uptake, which is only possible if OPD aligns with business models and needs.

After the pilot, the Cities of Toronto and Mississauga extended their OPD schemes an extra month. The pilot demonstrated some advantages and limitations of OPD and added to other successful OPD experiences in Vancouver, London and New York, ultimately encouraging other areas to pilot OPD in their jurisdictions, or to extend their OPD pilots like the Region of Peel.

Figure 4.2.1: CentrePort Gateways map
(Source: CentrePort Canada, 2010)

4.4 Case Study 4: Regional planning – Goods movement strategic planning in the Region of Peel[154 155 156 157 158 159]

Case study concepts include planning, policy-making, regional governance, economic vibrancy, road congestion, strategic networks, environmental and social impacts.

The final case study looks at the Region of Peel, a significant hub for freight activity in Canada. Peel is uniquely situated directly to the west of the City of Toronto and is composed of the City of Brampton, the Town of Caledon and the City of Mississauga. Peel is home to the Toronto Pearson International Airport, Canada's busiest airport in terms of freight (and passenger traffic), and the CN Brampton yard, Canada's largest intermodal terminal. A large portion of the Greater Toronto Area's (GTA) goods movement industry is located within Peel Region due to the proximity to these facilities and the historical availability of industrial land.

The clustering of goods movement-related industries in Peel Region have led to some unique circumstances:

- There was an estimated daily total of $1.8 billion worth of commodities travelling to, from, and through the region in 2014. This resulted in the highest truck volumes in North America passing through the region on several major highways.
- There are over 2,000 trucking companies in Peel, some large corporations and some small businesses, each of which contributes to the economic wellbeing of the Region.
- Four out of every nine jobs in Peel Region are within goods movement-related industries, which creates around $29 billion in annual income and contributes 48% of all industrial and commercial taxes within the Region.
- Overall, goods movement contributes $49 billion to the Peel Region GDP, which accounts for 21.1% and 9.7% of the goods movement-related GDP in Ontario and Canada, respectively.

Managing this vitally important industry and its many effects on the region is essential to ensuring that the economic benefits it creates are sustained without compromising the resident's standard of living. One adverse side effect of the healthy economy is the congestion seen on roadways throughout Peel Region. Residents want to be able to travel uninterrupted within the region, but they also expect e-commerce goods to be delivered to their door within a day. The industry employs a large number of residents but is beginning to see decreases in the available labour force. The nature of many jobs in the industry are also beginning to change due to technological advancements like automation and robotics. An active goods movement industry also has impacts on the safety and environment of the region. These issues affect truck drivers, stakeholders in the industry, and the public at large.

To properly manage the freight movement in the region, a 2012-2016 Goods Movement Strategic Plan was developed. A 2012-2021 update was later released, with a Goods Movement Long Term Plan in early stages of development. The strategic plans are intended as five-year blueprints to outline specific actions that should be taken by the Region of Peel to properly manage goods movement. Although the plans are designed for a five-year time period, they address both current problems and the Region's long-term vision for goods movement. Considerable stakeholder consultation was required for the development of these policy documents, in addition to the data analysis and research required to properly define the action items. Combined, the original and updated strategic plans outline thirty-two action items that the Region should complete before the end of 2021. These action items can be seen in Table 4.4.1.

Table 4.4.1: Peel Region Goods movement strategic plan action items (Source: Region of Peel, 2017; Region of Peel, 2012)

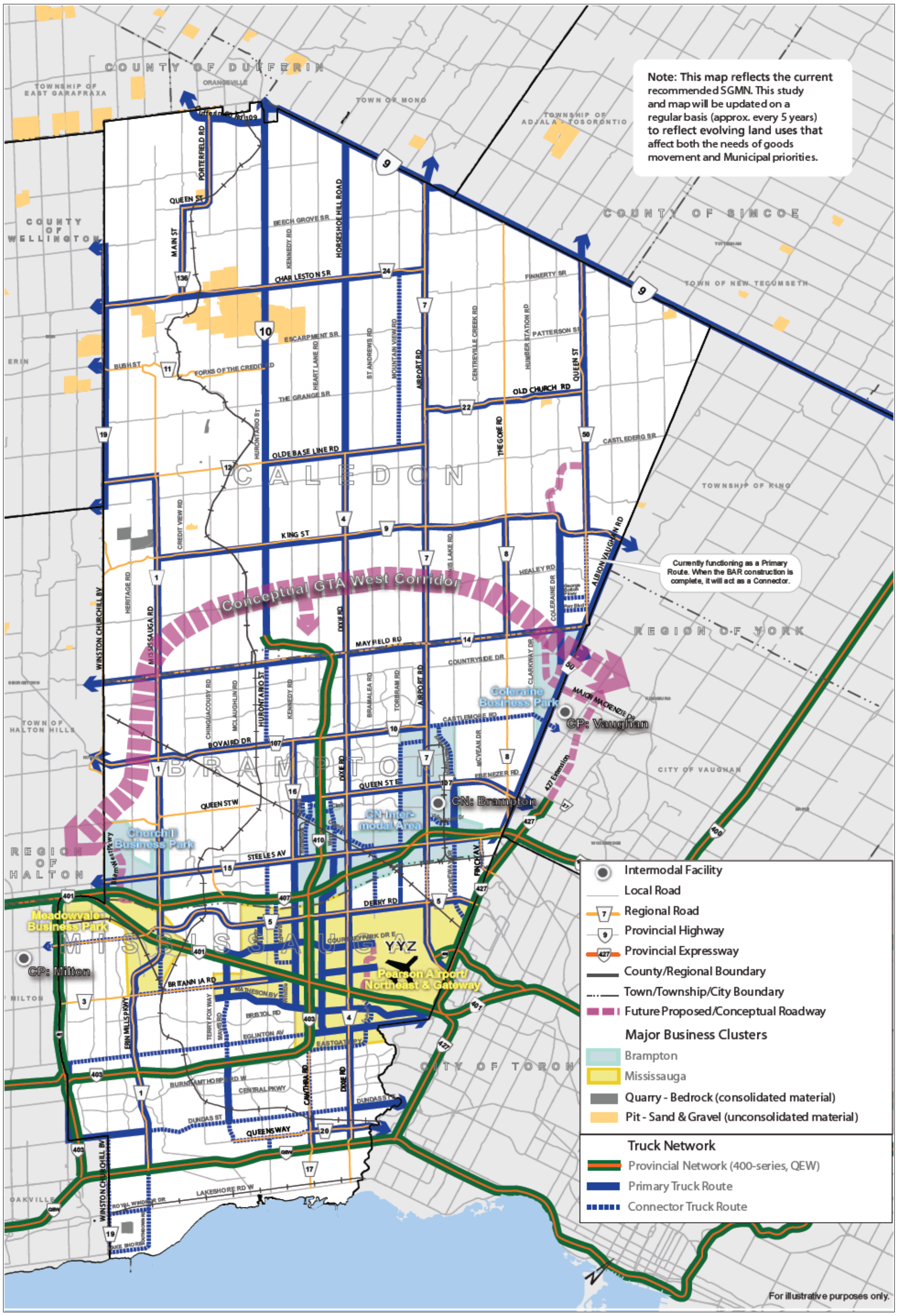
2012-2016 Action Items
1. Prioritize intersection improvements to increase truck traffic flow on key corridors 2. Identify and implement access improvements to Toronto Pearson Airport 3. Identify and implement access improvements to CN Brampton and CP Vaughan Intermodal facilities 4. Prioritize improvements to at-grade rail crossings 5. Research truck-only lanes and implement a pilot project 6. Advocate for improvements to border crossings 7. Advocate for changes to the employment density targets that support the freight industry 8. Advocate for improved provincial and federal goods movement planning and greater inter-regional co-operation 9. Identify additional federal and provincial funding sources for the 400-series highways with the 401 as a high priority corridor 10. Advocate for streamlining and expediting the Environmental Assessment process 11. Identify opportunities to strengthen connections between government and private-sector industry 12. Develop a data sharing program between the government and industry 13. Enhance traffic signals to accommodate and increase better traffic flow along key goods movement corridors 14. Develop and implement a backhaul freight matching program and pilot project 15. Create a Peel truckers' map that employs GPS and includes routes and by-law references 16. Develop and implement a Regional ITS Strategic Plan and Network 17. Develop an enforcement mechanism for road construction projects 18. Improve incident management 19. Advance Freight Transport Management recommendations 20. Develop and implement a Strategic Goods Movement Network 21. Develop an economic case for freight villages 22. Quantify the economic benefits of freight to Peel's economy 23. Support the establishment of a goods movement Centre of Excellence
2017-2021 Action Items
1. Goods movement and logistics planning coordination 2. Foster industry innovation through a connected automated vehicles (CAV) corridor pilot project 3. Increase capacity with convenient and feasible off-peak deliveries 4. Adapt to advancements in the e-commerce shift 5. Expand and encourage the use of long combination vehicles (LCV) 6. Understand and manage aggregate movements and its impact on communities 7. Mainstream goods movement transportation through education and outreach 8. Pursue alternative fuels and fuel efficiency initiatives 9. Demonstrate and advance Peel's national role and importance in freight fluidity

Peel Region has been active in achieving these action items within the designated time period. The action items represent a collection of studies, projects, and initiatives that take varying amounts of resources, both time and money, to complete. These items were tailored to improve specific issues identified in the region, some of which are regional problems and others are larger in scale. One notable action item that has been achieved is the implementation of the Smart Freight Centre, a goods movement centre of excellence created as a partnership between the Region and academic institutions to conduct evidence-based research and obtain decision advocacy to coordinate transportation infrastructure, land development, regulations, technology, tools, and resources. The regional council approved the establishment of the Smart Freight Centre as they recognized the influence of goods movement on the economic and social wellbeing of the region. Various other action items, including the off-peak delivery pilot and an analysis of e-commerce trends in the region, are being achieved through the Smart Freight Centre.

The Region has also designated a strategic goods movement network as directed in the 2012-2016 Goods Movement Strategic Plan. This project was completed to optimize the use of existing infrastructure and minimize the impact of the additional vehicular capacity occupied by freight. In order to develop this strategic network, the technical review examined best practices, land use, planning policies, current truck route networks, volumes, truck origins and destinations, and overall network connectivity. This project relied heavily on the results of the regional Road Characterization Study which classified six types of roadways that exist in the region: rural roads, industrial connectors, suburban connectors, commercial connectors, rural main streets, and urban main streets. The Region used various types of roads, including provincial and municipal roads, to compose the strategic goods movement network. The various route links were designated as either strategic truck routes, primary truck routes, or connector truck routes, with varying levels of accommodation for freight vehicles. The strategic goods movement network is shown in Figure 4.4.1.

Peel Region has invested a significant amount of effort into goods movement strategic planning. The region can be used as a good example of the development and implementation of a regional/municipal goods movement program. As outlined in this case study, it is important to compliment the other various transportation studies and plans in any goods movement planning. This holistic approach will ensure that the key objectives of a region are not lost in goods movement related initiatives.

Figure 4.4.1: Region of Peel's strategic goods movement network (Source: Region of Peel, 2013)



4.5 Self-directed exercises

4.5.1 Illustration of a supply chain

Pick your favourite household product and describe its supply chain. You can find inspiration in the example of Apple's iPads presented in Case Study 1. In your example, describe its sources and origins of raw material, all steps in the supply chain, transport modes involved, advantages and challenges.

4.5.2 Development of a distribution centre / warehouse

Scenario: Amazon wants to open a fulfillment centre in your region/municipality.

What do you need to consider in order to determine if this is viable, desirable, and an economically and environmentally sound decision? In your example, describe its land use and space requirements, logistic organization, the main clients, its location, and its integration in Amazon's global scheme of distribution.

4.5.3 Goods movement policymaking

Scenario: There is a corridor within your region/municipality with high volumes of trucks, and resident opposition to trucking and the various effects it has on the immediate community. You have a limited ability to make any infrastructure changes, and major investments in infrastructure upgrades are not an option.

What types of policy options are at your disposal, and how would you assess which one(s) to use? Provide examples of policies that you would implement in order to alleviate the concerns of area residents.

4.5.4 Strategic plan for regional goods movement

Scenario: Your region/municipality has been tasked with the development of a five-year Goods Movement Strategic Plan.

What types of action items should be included in this plan? What are the main challenges your region/municipality faces in relation to freight? Who are the key stakeholders who should be consulted for this study? In your example, try to link your action items to the challenges you have identified and to specific stakeholders who will be affected by the action item.

4.5.5 Strategic network for regional goods movement

Scenario: After the completion of your Goods Movement Strategic Plan, your region/municipality has decided to designate a strategic goods movement network.

What are the main origins and destinations of the goods that are being moved through your region/municipality? Which of these origins and destinations are within your region/municipality, and which are outside? What unique challenges will you face in designating a strategic goods movement network? Are infrastructure upgrades necessary to improve the movement of goods in your region/municipality, or can policy and bylaw changes alone improve overall efficiency without negatively impacting the quality of life of your residents?

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Glossary

Break bulk cargo – Goods that are loaded/unloaded individually, and are typically stored in bags, boxes, crates, drums, or barrels for transport (e.g. bagged cement, steel coil, and oil and gas equipment).

Bulk cargo – Also known as general cargo, a form of commodity cargo that is transported unpackaged in large quantities, can be liquid or dry (e.g. crude oil or gravel), and the cargo itself typically poured or dropped directly into the receptacle used for its transport.

Carrier (service provider) – A company that transports goods for clients, by a selected mode. Carriers can be a shipping line, railways, freight airlines or a trucking company. These companies have possession of the goods while they are in transit.

Containerization – The use of a single, standard sized cargo container to load, transport, and unload goods.

Derived demand – The demand for goods movement is a result of the demand for other goods.

Electronic logging device (ELD) – Electronic hardware that is attached to a commercial vehicle's engine to record driving hours.

Foreign trade zone (FTZ) – A designated region within a country where barriers to trade such as tariffs are substantially reduced or eliminated, and bureaucratic requirements are lowered to attract foreign investment and international business.

Freight village – Sometimes referred to as a dry port, inland port or intermodal facility, a centrally managed intermodal transfer point located at the nexus of multiple modes.

Goods movement – Also referred to as freight, the wide array of activities involved in transporting goods (primary, intermediate, or finished) from producer/supplier to consumer.

Hinterland – A region lying inland from the coast, or remote rural areas far from urban centres.

Hours of service (HOS) – Regulations that govern the working hours (driving and performing other tasks) of individuals operating commercial vehicles.

Industry – Goods movement industries are categorizations of inputs of production for the output of an intermediate or final product, to be used in other industries. Industries produce the commodities that other industries use by adding value to raw materials or assembling multiple intermediate goods. Industries are classified by the North American Industry Classification System (NAICS), six-digit codes at their most detailed level, and divided into twenty larger sectors by the first two-digits.

Instrument flight rules – The U.S. Federal Aviation Administration's (FAA) Instrument Flying Handbook defines IFR as: "Rules and regulations established by the FAA to govern flight under conditions in which flight by outside visual reference is not safe. IFR flight depends upon flying by reference to instruments in the flight deck, and navigation is accomplished by reference to electronic signals."

Interswitching – An operation performed by railway companies (carriers) where one carrier performs the pickup of cars from a customer (shipper) and hands off these cars to another carrier that performs the "line haul" (the majority of the linear distance of the overall railway movement). The interswitching arrangement is made in cases where a shipper has immediate access to a single carrier, but is within a defined distance (zone) to one or more of the competing carriers.

Just-in-case delivery – A delivery model where businesses have large lots and inventories in anticipation of demand. Goods are stored in warehouses for extended periods of time until orders are made. Shelves are then restocked.

Just-in-time delivery – A delivery model that involves the suppression of stock in warehouses, low inventories in stores, a fragmentation of shipments, fast turnaround times in production areas and distribution centres, and coordination between industries, modes, and carriers. It is a truck and resource extensive model that requires integration between many productive units; overall, this model results in a made-to-order system with minimal stock levels and lower warehousing costs than just-in-case delivery.

North American Industry Classification System (NAICS) – A classification system used in Canada, the United States, and Mexico to identify businesses by their type of economic activity, or industry.

Off-peak delivery (OPD) – An urban freight strategy that aims to alleviate congestion and road conflicts caused by deliveries during peak periods, by moving them to off-peak periods, usually between seven p.m. and six a.m.

Sector – Commodities can be raw materials or primary agricultural products (e.g. timber, copper, halibut, etc.) or intermediate or finished goods (e.g. electronics, motorized vehicle parts, pharmaceuticals, etc.). Most often, commodities are used as inputs in the production of finished goods and are classified by Standard Classification of Transported Goods (SCTG) five-digit codes. The first two digits of the codes group the commodities into forty-two Harmonized Commodity Description and Coding System-based categories.

Shipper (service user) – The person or company who is usually the supplier or owner of the goods that will be shipped. They enter into contracts with carriers and provide them with goods to transport or arrange for and coordinate the shipment of goods to reach their chosen market.

Standard Classification of Transported Goods (SCTG) – A classification system used in Canada and the United States to classify commodities based on transportation characteristics, commodity similarities, and industry-of-origin considerations.

Supply chain – The sequence of processes involved in the production and distribution of a commodity.

Third-party logistics provider (3PL) – A specialist in logistics who may provide a variety of transportation, warehousing, and logistics related services to buyers or sellers. These are tasks that are often performed in-house, but can be outsourced in certain cases.

Transloading – The process of intermodal container transfer from ships to trains or trucks, or vice-versa, by cranes.

Twenty-foot equivalent units (TEU) – A unit of cargo capacity to describe the capacity of container ships and terminals based on the volume of 20-foot-long intermodal containers. A 40-foot-long intermodal container is equivalent to two TEUs.

Urban consolidation centre (UCC) – A logistics facility located in close proximity to a city centre, or any kind of dense commercial area, from which consolidated deliveries are carried out and in which a range of other value-added retail and logistics services are provided.

Acronyms

3PL – Third-party logistics	**ATRI** – American Transportation Research Institute
AVIN – Autonomous Vehicle Innovation Network	**CETA** – Comprehensive Economic Trade Agreement
CFAF – Canadian Freight Analysis Framework	**CPA** – Canada Port Authority
CPTED – Crime prevention through environmental design	**CPTPP** – Comprehensive and Progressive Agreement for Trans-Pacific Partnership
CV – Connected vehicle	**ELD** – Electronic logging device
FTA – Free trade agreement	**FTL** – Full load
FTZ – Foreign Trade Zone	**GHG** – Greenhouse gas
GIS – Geographic information system	**GPS** – Global positioning system
HOS – Hours of service	**ICAO** – International Civil Aviation Organization
IFR – Instrument flight rules	**ITS** – Intelligent transportation systems
LCV – Long combination vehicle	**LTL** – Less than load
MOU – Memorandum of understanding	**MTO –** Ministry of Transportation of Ontario
NAFTA – North American Free Trade Agreement	**NAICS** – North American Industry Classification System
NAS – National Airport System	**NCFRP** – National Cooperative Freight Research Program
NHS – National Highway System	**NIMBY** – Not in my backyard
NTCF – National Trade Corridors Fund	**OPD** – Off-peak delivery
SAE – Society of Automotive Engineers	**SCTG** – Standard Classification of Transported Goods
SWOT – Strength, weakness, opportunity, threat	**TEU** – Twenty-foot equivalent unit
UCC – Urban consolidation centre	**USMCA** – United States Mexico Canada Agreement
VKT – Vehicle-kilometres travelled	

Endnotes

[1] Goods movement definition developed as a joint effort by Metrolinx and WSP.
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