CARGOM
LOGISTIC AND TRANSPORTATION
METROPOLITAN CLUSTER OF MONTRÉAL

Scoping Paper

Intermodal freight & logistics and Intelligent Transportation Systems (ITS) in Canada

CargoM, 2020

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Introduction

The widespread of information and communication technologies (ICTs) combined with the expansion of computing power and data capture has created a favorable environment for integrated transportation solutions. Intermodal transportation, which forms the backbone of world trade, has a lot to gain with improvements in connectivity through enhanced transport infrastructure facilitating the movement of freight. This is particularly beneficial to the container shipping trade.

According to ITS Canada, the congestion and safety problems in Canada's transportation networks combined with continued growth, the fiscal reality of restricted budgets, and environmental and land use constraints have resulted in a shift in focus toward demand management and more efficient use of existing infrastructure. In addition, fulfilling the need for transportation systems which are economically feasible and environmentally efficient requires new ways of solving transportation challenges[1]. The application of intelligent transport systems (ITS) is therefore critical to achieving these goals.

Scope of work

This scoping document was conducted in March 2020 by CargoM on the behalf of Transport Canada, building on Transportation 2030, the Government of Canada's strategic plan for a safe, secure, green, innovative and integrated transportation system[2]. Its objective is to give a broad picture of ITS in the context of the movement of goods, more specifically the application of ITS in intermodal centres in Canada: today's intermodal centres and their relation to ITS, and going to the future, the opportunities given by new technologies. To conduct this paper, an extensive identification and review of organizations, web sites, resources, and documents was made, and select interviews with experts were conducted to validate the information collected.

According to the International Journal of Logistics Systems and Management, the relevance of ITS for transportation systems lies in their opportunities in terms of efficiency and effectiveness, safety and security, and environmental performance[3]. In fact, beyond the shifts in manufacturing, automation technologies in-port enable an increase in cargo-handling capacity and improve fuel consumption[4], helping hubs in the longer term secure a competitive advantage by minimizing operational costs and maximizing asset utilization. In parallel, automation has the potential to reduce variable costs associated with labour, with some estimates showing a reduction in on-port labour of 40% or greater once automation is more mature, an opportunity to respond to workforce shortages in the industry. At a more advanced state, predictive

[1] ITS Canada, 2020
[2] Government of Canada, 2020
[3] International Journal of Logistics Systems and Management, 2013
[4] FitchRatings, 2019

intelligence allows the anticipation of maintenance and costs, while reducing the possibility of bottlenecks at the hub. This anticipation is beneficial to the safety and security of transportation systems, and the visibility provided by ITS limits the liability of actors though the intermodal network by giving the information to identify dangerous circumstances as early as possible and avoiding health and safety issues, as well as providing instant notifications in situations of non-compliance allowing employees to concentrate on crucial tasks. In short, this increase in efficiency of vehicles and equipment drive environmental compliance by reducing green house gases though the network. Better monitoring also allows better utilization of resources, reducing waste and rebalancing resources in the network. Altogether, at their mature state, ITS have the potential to enable the commercially, competitively and politically neutral digital foundation which is crucial to innovation and to the sustainable growth of global trade[5].

Defined Concepts

Information and communication technology (ICT) applied to the supply chain is considered a tool for enhancing the performance of the chain. With several applications, ICT supports the integration of intermodal movement of goods. According to the International Journal of Logistics Systems and Management, ICT contributes to three main groups of function for freight transport: resource management, ports and terminals operations management, and tracking and tracing[6].

The growth of ICT, combined with the expansion of computing power and data capture, have led to Intelligent Transport Systems (ITS), defined by ITS Canada as the application of advanced and emerging technologies (computers, sensors, control, communications, and electronic devices) in transportation to the benefit of lives, money, energy, and the environment. The term “ITS” is multi-modal, covering road, rail, air and marine transport. ITS are dynamic systems, considering an interaction between the vehicle, the infrastructure and the user[7].

Canadian ITS Support Ecosystem

ITS Canada

ITS Canada is the national thought leader on advanced technologies and their application to the Canadian transport system, supporting their use by advocating their benefits, showcasing and demonstrating the expertise of its members, and providing the necessary tools and platforms for networking, learning and collaboration. ITS Canada is at the heart of the ITS ecosystem, working with the government and public agencies, academics, vehicle manufacturers and suppliers, transportation,

[5] World Economic Forum, 2020

[6] International Journal of Logistics Systems and Management, 2013

[7] ITS Canada, 2020

management and ITS consultants, transportation operators and carriers, traffic and toll equipment suppliers, IT hardware, software and telecommunications providers, and equipment suppliers[8].

Canadian ITS Centres of Excellence

Universities across Canada have ITS Centres of Excellence that provide ground-breaking research, with a goal of harnessing new technological innovations while providing tangible benefits to Canada's transportation systems[9]. These centres are linked to a global network of universities and provide a broad base and a comprehensive perspective on ITS research and development, working closely with public authorities and private organizations to identify today's most innovative solutions to transportation.

As an example, the University of Toronto's Transportation Research Institute currently conducts research around Adaptive Traffic Signal Control (ATSC), Freeway control, Congestion pricing, Traffic impacts of autonomous and connected cars, Video based traffic detection, Traffic flow prediction, Origin Destination (OD) flow estimation, and Integrative ITS platforms[10].

Other actors

By connecting industries, public authorities, and researchers, a considerable network of players allow leading-edge technologies applied to intermodal transportation to see the day. Scale ai, one of the five Superclusters under the Innovation Supercluster initiative of the Government of Canada, aims to boost economic development through the fast adoption and integration of artificial intelligence to the supply chain in industry-led projects[11]. The Supercluster has been working with Ray-Mont Logistics, a logistical service company which facilitates international trade by enhancing the container supply chain through a smart terminal project in collaboration with SimWell and Ivado Labs[12]. The decision support system developed allows more efficient operation planning, storage allocation, and crane scheduling. The Centech, École des Technologies Supérieures (ETS)'s accelerator, is another example of organisation which provides financial and mentoring support to entrepreneurs working on technologies to enhance supply chains performance. It is currently supporting an Internet of Things (IoT) project for cargo handling with the use of artificial intelligence which is presented in this document. Finally, organisations such as L'Institut d'innovation en logistique du Québec (IILQ), one of the 59 College Centres for Technology Transfer in Quebec, play a key role in increasing the performance and productivity of Quebec small and medium companies (SMEs) by strengthening their innovation processes to allow continuous improvements of logistics functions. These

[8] ITS Canada, 2020
[9] ITS Canada, 2020
[10] University of Toronto, 2020
[11] Scale ai, 2020
[12] Ray-Mont Logistics, 2020

organizations are crucial to prepare the freight transport and logistics sector for next-generation technologies, favoring a culture of transformative change.

Intermodal Freight & Logistics hubs

Characteristics

The Centre Interuniversitaire de recherche sur les reseaux d'entreprise, la logistique et le transport (CIRRELT) defines Intermodal transportation as the movement of freight from its origin to its destination by a sequence of at least two transportation modes. The transfer from one mode to the other is performed at intermodal terminals. The objective of intermodal transportation is to consolidating loads for efficient long-haul transportation (rail or large ocean vessels), while taking advantage of the efficiency of local pick-up and delivery operations by truck[13]. The integration of different modes (container ships, railways, trucks, barges, land bridges and barges) and services is done in a mean to achieve better efficiency of the whole supply chain (reduction of cargo handling, improvement in security, reduction in damages and loss, and improvement of speed).

Understanding the basic characteristics of the main components and users of the intermodal network allows identification of potential issues and opportunities for intermodal freight transportation. To do so, the CIRRELT's categorization of components and users was used:

- **Containers**: Containers are the unit of measure of goods in intermodal transportation and can be fitted with devices to facilitate the transfer between modes, these devices adding value when connected. Container terminal equipment and operating procedures have to be continuously enhanced to improve cargo growth and productivity, which allows an intermodal centre to compete in terms of cost and time with other intermodal centres. As an example, ports achieving better efficiency will be able to attract ocean shipping lines at the expense of their competitors;
- **Carriers**: In an intermodal chain, carriers provide a service that is either customized with the use of full-load trucking (the vehicle or convoy is dedicated exclusively to a particular customer), or consolidate the goods of several customers. According to the CIRRELT's definition, a consolidation transportation system is structured as a hub-and-spoke network, where shipments for a number of origin-destination points are transferred via intermediate consolidation facilities, the hubs (airports, seaport container terminals, rail yards, truck break-bulk terminal, and intermodal platforms). The hub-and-spoke network structure results in a more efficient utilization of resources and lower costs for shippers;
- **Shippers**: The shippers generate the demand for transportation, and determine the attributes of the service required for the shipments. Rates, transport time, reliability and safety are examples of attributes taken into account when choosing

[13] CIRRELT, 2007

the services of a carrier. Shippers expect intermodal services to be done efficiently in terms of speed, reliability and availability;

- **Intermodal terminals**: Intermodal terminals provide the space and equipment to load, unload, and store vehicles of various modes, with a goal of providing a seamless transfer of loads between modes. Terminals form the most critical component of the entire intermodal transportation chain, as the efficiency of the network highly depends on the speed and reliability of the operations performed at the terminals.

Issues

The reliance of the different components of the network on the intermodal terminals demonstrates their strategic importance in terms of speed and agility. The hub-and-spoke model associated with intermodal transportation incurs a higher amount of delays and a lower reliability due to longer routes and additional operations performed at terminals such as consolidation.

At the network level, the main issues of intermodal transportation are:

- **Road congestion:** The flexibility, high frequency, and low cost of trucking transportation usually results in a bigger utilization rate of this mode in comparison with other modes of transportation, and these large truck flows lead to road congestion especially around terminals;
- **Environmental impact:** This congestion and use of road transportation is closely linked to a high level of greenhouse gases emissions, road transportation being less environmentally efficient then rail transportation;
- **Safety:** The use of different vehicles and the level of cargo handling is associated with high safety risks for the workforce on the network. The safety level of container transportation is fundamental to the concept of ITS;
- **Variations in travel times:** Especially in the case of maritime transportation, variations in travel times are more important, and travel loading/unloading times are longer compared to that of most land-based trips, which represents a challenge for operations planning;
- **Service performance:** In intermodal transportation, each mode of transportation and its carriers is in competition with other modes, with rail facing the biggest challenge in competing with trucking to provide shippers the level and quality of service they require. As an example, the performance of the service is usually measured by delays incurred by freight or by the respect of predefined performance targets. The different players constantly trade-off between operating costs and service quality.

At the operational level, issues of intermodal transportation involve several planning problems.

- **Planning problems:** Some examples refer to empty vehicle distribution and repositioning (fleet management), crew scheduling, the allocation of resources, and infrastructure conditions (breakdowns, accidents, congestion). The more efficiently these planning problems are addressed, the more seamless the

intermodal network is. At container port terminals, these planning problems are particularly important as these hubs usually have to cope with high variations in travel times. Some examples of planning problems are determining the berthing time and position of a container ship at a given quay (berth scheduling), deciding on the vessel that each quay crane will serve and the associated service time (quay-crane allocation) – this being associated with receiving/delivering trucks and trains from/to the land-side, and establishing the sequence of unloading and loading containers as well as the precise position of each container that is to be loaded into the ship (stowage sequencing). According to the CIRRELT, although booking systems tend to decrease variability in the demand, the stochasticity of the intermodal network is not completely eliminated by this solution deployed in many ports around the world. Regular operations tend to be disrupted by the fact that ships arrivals in container port terminals are not regularly distributed, and custom and security verification may significantly delay the release of containers. Appropriate information sharing, prediction, and container-release time mechanism may be solutions to these challenges.

Objectives

Intermodal transportation has proven to reduce cargo-handling, damages and loss, while improving security and transportation speed, but the performance of the intermodal transportation network directly depends on the performance of the key individual elements of the chain, as well as on the quality of interactions between them regarding operations, information, and decisions[14]. For terminals, the objective is to avoid unplanned delays, as well as the formation of cargo and vehicle bottlenecks. According to Fitch Ratings which has conducted a study of the technological implications for port infrastructure for the next 10 Years, international trade shows trends towards ever-larger vessels, as well as shippers that are growingly sensitive to operational efficiency at ports: they expect reliable processes, facilities accommodating larger vessels, and quicker turnaround times. These elements become selling points for customers[15], and the framework to address these objectives may be achieved with ITS.

According to ITS Canada, ITS are crucial to achieving many of today's transportation objectives in terms of efficient transportation and safety, but they also provide a financial base for new infrastructure through the monetization of assets, favor public-private partnerships, and are an effective tool for transportation demand management (through road pricing, transit, and High Occupancy Vehicles (HOVs)), which in turn can reduce greenhouse gases[16]. The ultimate objective for the freight transportation and logistics sector is to be able to move towards a fully integrated transportation management system.

[14] CIRRELT, 2007
[15] FitchRatings, 2019
[16] ITS Canada, 2020

ITS for intermodal freight & logistics

ITS currently involves a broad range of technologies that affect the design, construction, management and operations of transportation systems[17], whether contributing to moving freight more efficiently from one mode to another with an important part of these technologies addressing safety (driver assistance, electronic logbooks) and the environment of the vehicle (radars, early warnings, cruise control), or contributing to automation which enhances human capacity in handling intermodal operations. According to ITS Canada, ITS vary in technologies applied, from basic management systems such as car navigation, signal control systems, container management systems, variable message signs, automatic number plate recognition and speed cameras, to monitor applications such as security CCTV systems and to more advanced applications that integrate live data and feedback from a number of other sources such as parking guidance and information systems, weather information and bridge de-icing systems. Predictive techniques are currently being developed to allow advanced modelling and comparison with historical baseline data. In fact, according to ITS Canada, the majority of ITS applications and user services are currently mainstream solutions under deployment, but there is a resurgence in research related to new technologies driven by advances in ICTs including data integration, connected vehicles, and geo-referenced knowledge capability. According to WSP, ITS is transforming the way data was previously collected with costly infrastructure and based on historical data, and is now allowing new, richer data sources and analysis that can be undertaken by systems delivering intelligence through real-time data analytics. As an example, road user choices that were previously influenced only through road signs can now be influenced through a wide array of publication channels such as mobile devises and in-car systems[18]. These technologies are particularly valuable in the context of the last-mile delivery which refers to the movement of goods from a transportation hub to the final destination (consumer), a critical link in today's and tomorrow's intermodal transportation, with revenues generated within the retail e-commerce market expected to grow from 25,4 billion US dollars in 2019, to 33 billion US dollars by 2024 in Canada[19]. With more customers living in dense urban centres, the challenge is to deliverer faster and cheaper, while minimizing negative externalities such as noise and greenhouse gases emissions. Along with the rising importance of the last-mile delivery, reverse logistics, a rising trend addressing climate change concerns which refers to operations associated with the reuse of products and materials, represents a logistical challenge for companies involving more steps and more actors in the supply chain. The speed of deployment of ITS is therefore critical to responding to these growing trends. In addition to these technologies, more advanced ITS have begun to emerge, addressing a series of issues until now difficult to address, and opening the door to more opportunities.

[17] ITS Canada, 2020
[18] WSP, 2020
[19] Satista, 2020

Automation in Ports and Autonomous Guided Vehicles

Fitch Ratings' study suggests that automation has a significant possibility to reshape the way cargo movements are managed in the next ten years, but the nature of these changes and the speed of their adoption remains to be seen. At the moment, autonomous Guided Vehicles (AGVs) are already deployed at terminals in Singapore, Rotterdam and LA/Long Beach, and Singapore's next generation port Tuas will use automated cranes in addition to rolling stock[20].

In Canada, terminals in Vancouver and Prince Rupert are operating at 80-90 percent of capacity, making the automation or semi-automation of some operations very likely in the mid to late 2020s according to the Journal of Commerce. The speed of transformation is dependant on many factors, the human factor being central in this case (the contract agreement between the workers and the terminal operators). On the technological aspect, automation/semi-automation's main benefit is to capture the growing container volumes demand at the port. In comparison, there are two fully automated terminals in Los Angeles/Long Beach and three semi-automated terminals on the East Coast, one in New York/New Jersey and two in Virginia[21].

In Quebec, in the context of a $18.5 million grant from Transport Canada's National Fund for Trade Corridors, the Port of Montreal is working on the development, in collaboration with the City of Montreal, of an intelligent transportation system for port trucking to gain a better understanding of the origins and destinations of trucks outside the port territory[22]. The Port of Montreal is also working on the use of various message boards to inform truckers in real time. In addition to these initiatives, the Port is working in collaboration with its partners on the development of solutions to modulate the influx of trucks at entry points based on the optimized services offered by the terminals.

Experts suggest that given the current state of autonomous vehicles technology, fully automated depot-to-depot which includes city driving is not viable. The most interesting study cases of autonomous vehicles are currently long-haul highway driving, which have the potential to concretely impact truck utilization level, and consequently impact insurance risk management and workforce usage. The hub-to-hub model associated with ITS could gain from autonomous vehicles technology with the usage of autonomy only on highways, and the first and last miles done by local drivers. Waymo and Ike are companies currently pursing these models. But the main challenge remains matching the cognitive abilities of a human driver. To answer this challenge, Starsky Robotics has suggested a tele-driving model, following the model of autonomous vehicle drone operations which remotely provide human intelligence. Overall, experts agree that autonomous convoys, presented later on in this document,

[20] FitchRatings, 2019
[21] JOC, 2019
[22] Port of Montreal, 2019

is the solution which is the most ready to be deployed and which has significant advantages on utilization and safety matters[23].

Internet of Things (IoT) and 5G

The automated operations presented above will be facilitated by the use of Internet of Things (IoT), a technology rapidly evolving with the growing need of transparency and higher expectations of the consumer. The digitalization of freight transportation systems are gradually transforming the supply chain from a traditional linear chain to an interconnected, open system of operations: as an example, data flows from a port's authority, through the terminal operator, and to the shipping line in a dynamic way, with the use of data-enabled technologies, IoT, which represents a convergence between the physical and digital words, using data and artificial intelligence (AI) as a source of value[24].

In Quebec, CanScan has developed an adaptable autonomous artificial intelligent system which checks shipping containers to speed up operations. The AI driven system developed uses existing infrastructure to optimize container handling processes and speed-up the workflow. This example of IoT demonstrates the possibilities for ITS: for terminal operators, this technology is safer and more efficient, limiting the workforce operations to identify non-compliant containers while maintaining a tight schedule. The use of AI allows to get the most of the current infrastructure, in this case the camera network[25]. For container depots, the technology allows more reliable management of containers in yards. Since inspections and validation of containers can be costly for operators, with any error adding costs, IoT allows automatic evaluation of the conditions of containers that enter the site, alerting workers of non-compliant or severely damaged containers[26].

The connectivity needed to scale up IoT and other advanced technologies could be supported by the 5G technology, with its rollout in Canada beginning in 2020 and onwards. To leverage technology in a 5G context, technologies will have to be fully embedded at the core of organizations, with a culture that embraces the disruptive environment required.

Drones

In the context of intermodal transportation, drones are currently being used for mapping/photography assignments, security and surveillance manner, and search-and-rescue missions that would otherwise require a human pilot. In Los Angeles, the

[23] Forbes, 2020
[24] Port technology, 2019
[25] CanScan, 2020
[26] CanScan, 2020

Port Police and Harbour Department use drones to conduct training exercises. In Singapore, drone-drops are already in use for the deployment of small timely items needed onboard vessels anchored at the port. Although policies limit the amount of goods to be shipped, drones have the potential to speed up shore-to-ship deliveries as much as six times and reduce costs as much as 90%, while eliminating the safety risks associated with human deliveries[27].

In Canada, Air Canada is partnered with Drone Delivery Canada, a leading drone logistics company helping businesses improve their operational efficiency by delivering time-critical cargo. Drone Delivery Canada's Transport Canada approved and compliant Sparrow drone offers a payload of up to 4.5 kilograms and a range of about 30 kilometers. According to a member of the Air Canada Cargo team, larger cargo drones are currently undergoing certification and will be rolled out in the coming months. Researchers insist on the importance of policy and regulation to prepare the industry and capture the most of drone's value for intermodal transportation.

Blockchain

Blockchain is experiencing rapid developments and has the full potential to revolutionize current ITS models by being used to manage data more efficiently and establish a secure, trusted and decentralized ITS ecosystem. Blockchain can be used as a basis to integrate other technologies, as it allows a better usage of the legacy ITS infrastructure and resources and is especially effective to integrate crowdsourcing technology. The relevance of blockchain in the context of intermodal freight transportation is mostly associated with blockchain-enabled record keeping since the intermodal network involves a series of operations. These operations generate an important flow of information, such as the certificate of origin, a commercial invoice, an insurance certificate, the booking of a carrier/third party logistics provider, etc. to move a container from point A to B. With blockchain, this information is stored in a blockchain and made available to the carriers and other actors along the chain to use for their own purpose, the blockchain being populated with additional operations information as each actor performs a task and updates the information in real-time. Combined to this technology, the use of sensors allows automatic input of operations information in the blockchain.[28]

At the international level, a leading initiative was conducted in July 2019 by Samsung SDS, Dutch bank ABN AMRO and the Port of Rotterdam who successfully completed a tracked shipment from South Korea to the Netherlands. The platform called DELIVER was co-developed by the organizations and therefore allows shipments to be instantly financed, tracked and conducted paperlessly[29].

In Canada, the Canadian Pacific (CP) has recently joined the Blockchain in Transport Alliance (BiTA), looking to support improvements in supply chain technology through blockchain with an objective to facilitate the transactions that occur between the

[27] American Shipper, 2020
[28] Port Economics Management and Policy, 2020
[29] Cointelegraph, 2019

shippers and carriers along its network. According to experts, to scale up blockchain technology, the active participation of transportation leaders will be required and will facilitate the trust and comprehension around data sharing and the technology in the transportation sector.

Platooning

Truck platooning uses wireless communication and automation to create a platoon of two or more trucks, which follow closely behind one another on the road, with each truck using the information from its vehicle sensors and data it receives wirelessly from the first truck in the line. The truck measures and adjusts in real-time its position in line based on the speed of the first truck.

In Canada Blainville, Transport Canada's Innovation Centre is testing new trucking technologies with an objective to reduce emissions and improve safety, two important benefits of platooning[30]. According to Transport Canada, studies show that reducing the space between moving vehicles in a convoy reduces the aerodynamic drag of trucks. This has a direct environmental benefit with each vehicle using less fuel. In fact, Transport Canada's test and demonstrations of this technology show a range of fuel savings between 4.5 and 18 percent.

Although some companies such as Peloton Technology in the United States have market ready solutions, platooning is at an early development stage in Canada, with each truck currently being operated by a professional driver who controls steering and can take over accelerating and braking at any time. In addition, the technology is currently deployed for long, mostly straight drives with few obstacles, and experiments with the wood industry in Quebec show several technical issues specific to the industry and to the Quebec region that remain to be addressed. Despite these challenges, at its mature state, platooning could become a concrete solution for drivers shortage, with one driver operating three trucks at a time. According to a specialist on the subject, automated truck platooning may be the first use-model break-through of autonomy technology considering the economic, technology and risk dimensions[31].

ITS Infrastructure for vehicle electrification

Environmental and energy concerns are an important issue to address in the transportation sector, with transportation representing 24 percent[32] of greenhouse gases emissions in Canada in 2017, the second highest sector in emissions. At the moment in Canada, the segment for electric vehicles for the movement of goods is mainly trucks for medium distances, with the Lion Electric company in Quebec as an important leader.

[30] Transport Canada, 2019
[31] Forbes, 2020
[32] StatCan, 2017

Its Lion8 is a class 8 urban truck, 100 percent electric, which represents a reduction of 80 percent of energy costs[33].

The current main obstacle to the use of electric trucks for longer distances is vehicle autonomy. As part of this autonomy, energy management is an integral part of plug-in vehicles and is central in achieving optimal performance of electrification. For this autonomy to be achieved, the optimal performance of energy management algorithms depends strongly on the ability to forecast energy demand from the vehicle, information available about the environment (temperature, humidity, wind, road grade, etc.) and traffic (density, lights, etc.). In addition to information available from telematic and geographical information systems, knowledge of projected vehicle charging demand is necessary to build an intelligent energy management controller for plug-in hybrid and electric vehicles and control/schedule charging through a communication based distributed control[34]. Looking into the future, for electrification to be deployed at a larger scale for the movement of goods, charging infrastructure will need to be available in key locations to respond to the private sector's needs and support the system.

Challenges in operationalization and success factors

To conclude, many hurdles remain for the full integration of these technologies, especially with the level of automation in ports complicating their widespread adoption, combined with the difficulty in assessing the timing and magnitude of their roll-out. According to Fitch Ratings, automation in container terminals in North America is currently in the early stages, with 3% of global container port terminals being automated[35]. Along with the digitalization and automation of intermodal hubs as drivers for integrating these technologies, changes in business models will facilitate their deployment. The transition from vehicle ownership to mobility as a service (MAAS) as a platform could facilitate the efficiency of changes from one mode of transportation to another. According to Transport Canada, addressing data and legal issues, along with decisions regarding deregulation/regulation will have an important weight in facilitating their adoption. A focus will also need to be placed on end-users and not just on the technology[36].

The biggest challenge ahead remains transparency. The data is most certainly there, but no framework for what, how, and how much to share with third parties exists to respond to the private sector's diverse needs. In the context of its Sustainable Mobility Policy 2030, the Government of Quebec has elaborated its intervention framework for intelligent transportation systems[37]. In collaboration with stakeholders of the private and public sectors, three challenges have been identified and need to be addressed. Although these challenges have mostly been identified for the mobility of people, their foundation applies to transportation systems of goods: the availability of consistent

[33] Compagnie Électrique Lion, 2020
[34] Oil & Gas Science and Technology, 2012
[35] FitchRatings, 2019
[36] Government of Canada, 2017
[37] Government of Quebec, 2018

information services that meet the transportation needs of all users (carriers, shippers, terminal operators, enterprise management system providers, and law enforcement agencies), the interoperability of systems and applications in support of transportation, and the capacity to master technology innovation. Interesting business cases currently exist that favor data sharing and aim to accelerate digitalisation of transportation hubs, with Five Logistics Internet (global trade identity, shared visibility, port call optimisation, financial flow, and customs cross border interoperability) being an example which has several benefits such as an increase in efficiencies and reduction of costs for businesses and trading partners[38]. As presented in an article by the World Economic Forum, by extending the current internet with foundational, logistics-specific features, the Five Logistics Internet allow the replacement of the current one-to-one connection with an internet-like paradigm of connect once, which is shared with others. Anyone can innovate and build value-adding services on top of Logistic Internets, which contributes to increasing the innovative capability within logistics.

CargoM's fluidity and innovation working group is a place of opportunity to identify success factors for the deployment of new technologies for the logistics and transportation sector. The work of the cluster on concrete projects has been key in identifying priorities for decision makers in the form of recommendations. For the adoption and deployment of ITS to succeed, regulators and policy makers will need to direct the sector towards the most appropriated investments, establish long-term financing solutions, and ensure that the workforce is ready so that the market can fully embrace their potential.

1. **Orientation**
   Firstly, small and medium players need programs which have a clear orientation, and which are long term oriented. The possibilities of ITS will only happen if administrations have a clear and considered strategy for bringing existing disparate systems, services, and operational approaches together over time[39]. In parallel, the private sector's tendency to not share information is associated with a reluctance to adopt these new technologies. The success of ITS will come with the buy-in of all stakeholders involved, combined with the elaboration of standards for communication (systems compatibility). Regulators and policy makers will have to address the safety concerns associated with data and privacy, and demonstrate to the private sector that its commercial information is not jeopardised in a context of data sharing. In addition, companies will have to be convinced that the cost of digitalizing their operations and processes brings enough efficiency or security to justify the endeavour. In fact, as mentioned by an expert consulted in the context of this document, data is today's new oil and companies lacking the ability to embrace its potential will fall behind.

2. **Long-term financing**
   Secondly, in addition to a clear orientation favoring the adoption of technologies for ITS, the funding programs to support their deployment will need to be elaborated with a long-term perspective. As an example, the financing of a truck

[38] World Economic Forum, 2020
[39] WSP, 2020

fleet needs 5 to 10 years to completely cover the fleet management cycle. Financing programs that lack the relevant amount of time for the private sector to fully integrate these technologies will unfortunately discourage their adoption, or contribute to the abandon of the project or its postponing indefinitely.

3. **Workforce training**

   Thirdly, preparing the workforce for these transformative changes will also be key to their success. Training programs that are adapted for the future needs of the logistics and transportation sector will have to be properly operationalized inside companies. Proper training within a good timeframe will give companies and policy makers the time to address challenges associated with worker's perception of the technologies on their work. As an example, at the Prince Rupert Port Authority, longshore unions view automation as a development that can potentially reduce jobs by 40-70 percent, but the reality is that automation also creates new jobs involving computer programing and technology which enhance worker's productivity. These unions will want to ensure that if automation occurs at a terminal, the jobs that are created will fall under their jurisdiction and that union members will be trained to handle the work[40].

The success of the adoption and deployment of ITS will come by steps, with concrete field pilot projects as an important tool in favoring the approval of the sector. CargoM, with its 57 members, can be a key player in facilitating integration between companies to deploy a project demonstrating ITS. At last, policies and regulations that are able to support the speed at which these technologies evolve remains a challenge in every parts of the world, but also an opportunity for policy makers to position themselves as leaders in embracing these changes.

[40] JOC, 2019

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Collaborations

This scoping document was realised with the precious collaboration of Michael De Santis, President of Lynx Technology and contributor to STI Canada, and Daniel Olivier, Director of Business Intelligence and Innovation at the Port of Montreal. The input of Scale ai, the Centech and Canscan inc. were also key in understanding the Canadian ecosystem and identifying current projects.

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