



Montreal Port Authority

CargO₂ai

IAPH/WPSP 2022 Sustainability Awards



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1. The Port of Montreal

The Port of Montreal is the second largest port in Canada and a diversified transshipment centre that handles all types of goods: containerized and non-containerized cargo, liquid bulk and dry bulk. The only container port in Quebec, it is a destination port served by the largest shipping lines in the world. With transshipment ports in Europe, the Mediterranean and the Caribbean, the Port of Montreal is connected to more than 140 countries around the world and offers the most direct route between Northern Europe and the industrial heartland of North America. It is also an intermodal hub with a service offering that is unique in North America, featuring its own dockside rail network connected to Canada's two national rail networks.

Driven by values of sustainable development and social responsibility, the Montreal Port Authority is committed to the community and takes solid action to reduce its GHG emissions, integrate harmoniously into the urban landscape and ensure responsible management of its infrastructures. Placing innovation at the heart of its vision, the MPA is developing numerous innovative initiatives with a view to efficiency, safety, transparency and improving its competitiveness, and is positioning itself advantageously in the new technological era of logistics.

2. Background

The Cargo₂ai project was launched in the context of the COVID-19 pandemic. As the economic engine of Quebec, the Port of Montreal and its partners wanted to help fight the pandemic. As stockouts were feared, particularly for medical supplies in high demand, such as gloves, masks and sanitizers, the CargO₂ai project was designed to optimize the efficiency of the supply chain for these items in particular, so that they could be removed from containers as quickly as possible and delivered to the people who needed them. The initiative is not for profit, but rather to encourage supply chain stakeholders to work together to help frontline responders in the fight against COVID-19.

With the help of Ivado Labs, a leading AI solution provider, the Montreal Port Authority (MPA) aimed to develop an AI-enabled solution with a dashboard to exhibit views on incoming critical cargo and predict the estimated time of arrival (ETA) of vessels to optimize coordination and enable fast cargo movement in and out the Port of Montreal.

The AI module is based on Natural Language Processing (NLP) techniques for cargo identification at the container level. This solution is now used as a single source of information by the MPA operations team, at both tactical and operational levels for coordination with its stakeholders (rail and terminal operators). Additionally, the data facilitates the sharing of critical information for workers moving cargo when it is unloaded. The solution also provides tracking of the cargo until it departs from the Port. In the first phase that ended December 2020, a fully deployed POC (proof of concept) of the solution was released. In January 2021, a MVP (minimum viable product phase) was started to enhance visibility and allow flexibility within the solution. This second phase to the project enables features such as a mass upload of official critical lists from various governments and organizations, such as the World Health

Organization (WHO), Canada Border Services Agency (CBSA) and the Government of Quebec, and critical keywords management interfaces allowing for a more efficient identification of critical units transiting at the Port.

3. Goals and objectives

Goals

In the spring of 2020, during the COVID-19 pandemic, the Port of Montreal was concerned about the risk of outages of medical and protective equipment due to the upswing in demand and the resulting supply problems. It was also made aware of the importance of rapid delivery of priority goods and the potential danger of delays in delivery.

That is why the MPA and its partners rallied to develop a solution that would make it possible to move critical materials in record time. The goal was to be able to proactively identify containers carrying priority goods, such as personal protective equipment, medication, and sanitizers, and reduce the time required to process and expedite those containers at the Port.

One of the main challenges in carrying out the project was to successfully navigate the complexity of the logistics chain. Many logistics partners operate at the Port and are involved at different levels of the supply chain, making it a challenge to coordinate information. Two terminal operators, six shipping lines, two railroads and numerous trucking companies had to and must still align their respective operations to ensure fluidity of critical goods.

After several months of honing the project's technical details, the Port of Montreal and its partners deployed the CargO₂ai solution throughout the port's container facilities. A call went out to stakeholders within the supply chain—trucking companies, shipping lines, terminal

operators, railway operators, even federal and provincial governments –to help in leveraging this solution to its maximum potential.

As a key entry point to Quebec, Ontario, Western Canada and the U.S. Northeast and Midwest regions, the Port of Montreal needed to find a solution that enabled fast identification and prioritization of critical cargo and essential goods moving by container that both Canada and United States need.

The main business goals identified were:

- Accelerate the delivery of critical medical cargo to patients in need; in turn, enable Canadian and American populations' well-being and potentially save lives ("fast lane" creation)
- Rally the supply chain partners to ensure faster delivery of critical supplies to final destinations
- Reduce dwell time (unloading and distribution) of medical and other critical supplies at the Port
- Readjust priority level for critical cargo for strategic and operational planning
- Ensure supply chain continuity and resilience in scenarios of potential terminal operation closure due to labour infections

Objectives

Technical objectives

The main technical objective of the CargO2ai project was to be able to use available information within stakeholders to track incoming cargo that was deemed critical by the Canadian federal government during the peak of the COVID-19 crisis. By achieving this

objective, supply chain partners would have access to accurate real-time information on the status of every critical container at the port, from being still on a vessel in transit to unloaded and ready to be loaded on a truck or a railcar for delivery. CargO2ai still offers today a level of visibility that allows the prioritization and faster expedition of critical cargo handled at the Port of Montreal through a dashboard user interface fed with advance data, Natural Language Processing models (NLP) for extraction of key container-level data, and data engineering techniques to combine critical cargo information, physical location of vessels and terminal operations data for optimal unloading and distribution of goods.

Social objectives

To achieve acceleration of the delivery of critical units, the main objective was to be able to quickly label critical containers, follow them through their journey at the Port and reduce their dwell time as much as possible. Throughout the project, constant collaboration with terminal operators and key stakeholders allowed the implementation of an all-around communication system through multiple means: the creation of a dedicated CargO2ai interactive platform that: 1) uses algorithms that target goods based on official Canadian government critical goods lists; 2) communicates flagged critical units to the terminal's operating systems; 3) provides real-time status updates on the critical units found to operations teams at the Port; 4) communicates with the Port's rail operating system to automatically flag a railcar that is transporting critical cargo.

4. Methodology

Agile sprints

CargO2ai used an iterative and agile approach structured in short 2-week sprints, with continuous follow-up, validation and re-tuning was favored. This methodology was the best option to deliver value and to assure quick delivery of value in a COVID-19 pandemic context.

Main work packages

- Back-end (data pipelines, algorithms, analysis, and infrastructure)
- Front-end (dashboarding solution and reporting options for operational and strategic decision-making)

Detailed work packages

The CargO2ai project is divided in two phases. The first phase aimed at deploying a mature proof of concept as quickly as possible, so the solution has immediate impacts in critical times for the supply chain. The second phase aimed at improving the AI algorithm, streamline the user workflow, improve critical keywords management, and automate certain end user-related repetitive tasks. Overall planning for phase I and II is as followed:

Phase I - Back-end

- Consolidate historical data and analysis
- Select relevant HS codes based on [CBSA](#) list
- Create a library with keywords for positive matching with selected HS codes
- Connect to live data
- Use NLP for unknown HS codes

- Create a machine learning model that learns from the end user's decisions and iterates
- Connect databases to user interface
- Secure connections
- Automate pipelines
- Communicate outputs to key stakeholders through a secure network

Phase I - Front-end

- Conduct interviews with key stakeholders to customize to operations needs
- Create user interfaces
- Conduct User Acceptance Testing
- Assess quality assurance

Phase II - Back-end

- Facilitate vessels tracking and vessel manifest ingestion
- Build a dictionary to interpret destinations in EDI311s
- Improve the Machine Learning model to reduce flagged false positives within critical cargo

Phase II - Front-end

- Automate end-user workflow
- Display expected mode of transport (truck/rail) before vessel arrival
- Build User Interface to manage the critical-related keywords library
- Enable a massive keyword upload functionality

Data used to identify and track critical containers

- A source of HS codes and descriptions (both live and 5-year historical)
- Canada Customs Information (EDI311), which contains information needed to report information to Canada Customs
- Vessel AIS data, which indicates where the vessels are located
- Terminal Operations and Intermodal Ramp Activity data (EDI322), a source that provides upcoming and updated information at the container level on its status and movement in the Port
- Rail Advance Interchange Consist (EDI418), which transmits advance information related to equipment that is to be interchanged to a connecting rail carrier
- Other: Manual data, such as the list of keywords and priority HS Codes provided by external sources, e.g. the WHO, CBSA and the Quebec government

AI Models

The artificial intelligence component is the natural language processing (NLP) module which infers missing HS Codes. The artificial intelligence module will receive container content details. If the HS Code is present, it is presented directly. If it is absent, it is predicted using the NLP module. For the information retrieval approach, descriptions are broken down into tokens, which are then coded into a vector representation (bag of words [1] or bag of Ngrams [1]). The same procedure is applied to a reference description of the HS Code, built from the five-year historical data and from a reference description of HS Code. The descriptions are then compared to the reference descriptions. The solution is similar to a search engine where descriptions are queries, and the reference HS code descriptions are the documents. The solution has the feature that multiple HS Codes are presented to the user.

Hardware/software used

The solution runs entirely on the Montreal Port Authority's servers. No additional hardware was necessary for the project besides dedicating parts of servers for development and production purposes. Due to the pandemic, all the work was done remotely on virtual machines. Software such as Jira and GitHub were used to manage the project and for coding the solution. The solution is a web-based interface that enables the MPA to manage critical cargo and generate files to be sent to terminal operators and shipping lines. The files generated by the solution are sent via an ftp server directly to the partners in a .csv format for them to integrate in their respective operating systems.

Project cost

The first phase was costed at CAD \$470,000 and the second phase is costed at CAD \$500,000, for a total of CAD \$970,000.

5. Outputs and results

Outputs

The CargO2ai initiative resulted in the production of two user interfaces. The first displays new proposed critical items by the algorithm once new EDI311s (vessel manifests in electronic format) are sent to the Port by the shipping lines. The trained end user refers to the CBSA's *COVID-19: Tariff Classification and Other Information to Import Medical Supplies* custom's notice and official government pharmaceutical lists to validate or discard the line items selected by the algorithm.



Critical cargo information

Identified containers		Create/Edit Priority		Vessel status		Keywords management		HS Codes management		Blacklist management		ETL logs !
▼Show Filter panel...												
	<input type="checkbox"/> Container ID	Voyage Number	Covid-19 flag ¹	Terminal	Vessel Name	Transport (truck/rail)	Final destination	Status	Identification reason	Description	EDI311 Transmission time	VSI Validation ²
+	<input type="checkbox"/> HLBU [REDACTED]	17W49	Identified	RACINE	OOCL ST. LAWRENCE		Montreal, QC (MONTREAL, QC)	On Vessel	Matched positive with keywords	MEDICAMENTS	Wed [REDACTED] 2021 07:28:35 GMT-0500 (heure normale de l'Est nord-américain)	<input type="checkbox"/>
+	<input type="checkbox"/> HLBU [REDACTED]	17W49	Identified	RACINE	OOCL ST. LAWRENCE		Montreal, QC (MONTREAL, QC)	On Vessel	User assigned HS Code	PDP-AMLODIPINE ORAL OF PDP-AMLODIPINE ORAL SOLUTION 5MG/5ML (NON HAZ PHARMACEUTICALS) ALL PACKED ONTO 5 PALLETS HS-CODE(S):30049000	Wed [REDACTED] 2021 07:28:35 GMT-0500 (heure normale de l'Est nord-américain)	<input type="checkbox"/>
+	<input type="checkbox"/> FCU [REDACTED]	17W49	Identified	RACINE	OOCL ST. LAWRENCE		Montreal, QC (MONTREAL, QC)	On Vessel	Positive keywords found by using the BM25 and regex module	CONTENTS: 1LITER SANITISER HANDGEL UN1170. ETHANOL SOLUTION (ETHYL ALCOHOL SOLUTION), PACKING GROUP II, LIMITED QUANTITY (BOXED IN 12 X 1 LITER) IMO-CLASS: 3 UN-NUMBER: 1170 PACKING GROUP: 2 PROPER SHIPPING NAME: 1170 - 3 - ETHANOL - II - 25 (FP -18 TO +22) OR 3 (FP = +23) EMERGENCY NAME ALEX MANN EMERGENCY PHONE: +44 2 380 62 65 23	Wed [REDACTED] 2021 07:28:35 GMT-0500 (heure normale de l'Est nord-	<input type="checkbox"/>

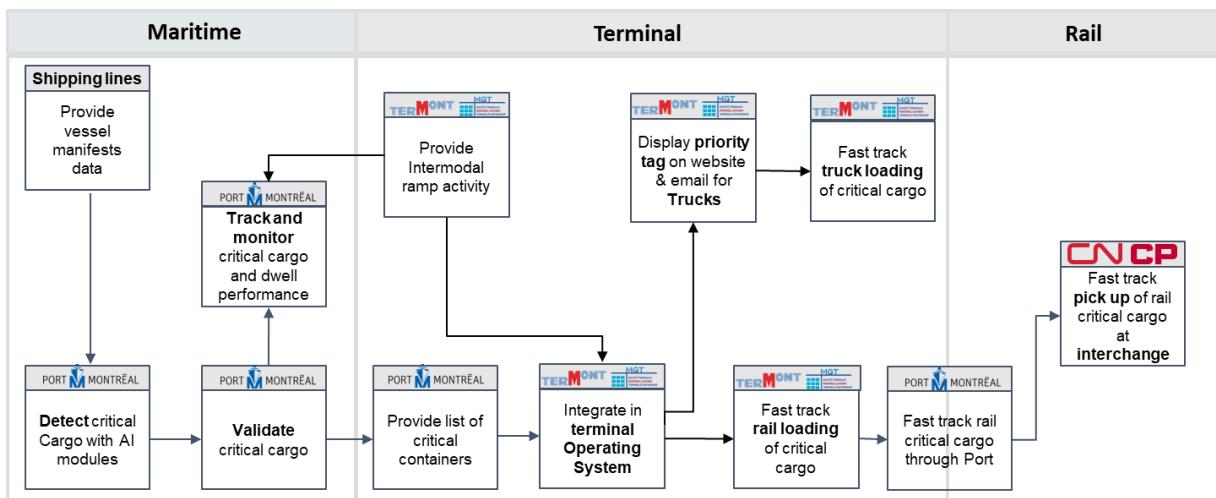
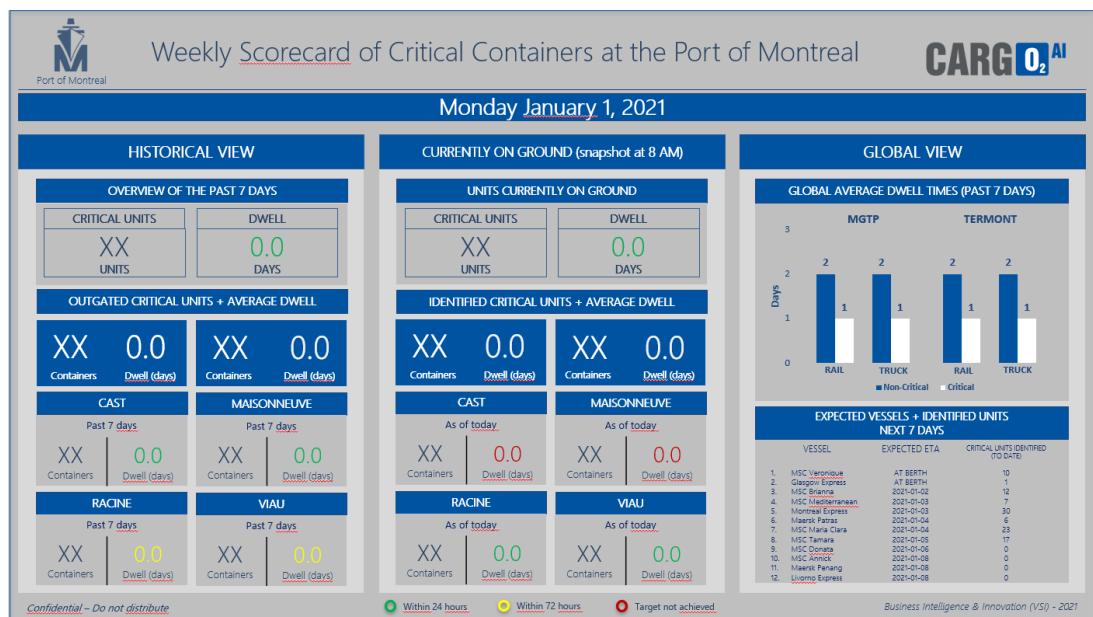
The second user interface allows an end-to-end tracking of containers labeled by the Port as critical in the fighting of COVID-19. It is possible to track every container within the port, intra terminal or even on a railcar, ready to depart for hinterland destinations. The interface displays information at the container level for the following data:



Validated Containers												ETL Logs
	Container ID	Voyage Number	Covid-19 flag ¹	Terminal	Vessel Name	Railcar ID	RM Railcar Flag	Transport (truck/rail)	Final destination	Status	Dwell Time (hours)	Timestamp (322)
+	MSMI [REDACTED]	29W47	Validated	RACINE	OTTAWA EXPRESS	DTTX [REDACTED]	✓	Rail	TORONTO, ON	Loaded on rail	[REDACTED]	Tue [REDACTED] 2021 19:39:00 GMT-0500 (heure normale de l'Est nord-américain)
+	HLBI [REDACTED]	39W48	Validated	CAST	TORONTO EXPRESS	N/A	-	Truck	MONTREAL, QC	Unloaded from vessel	[REDACTED]	Tue [REDACTED] 2021 10:00:00 GMT-0500 (heure normale de l'Est nord-américain)
+	HLBI [REDACTED]	39W48	Validated	CAST	TORONTO EXPRESS	N/A	-	Truck	MONTREAL, QC	Unloaded from vessel	[REDACTED]	Tue [REDACTED] 2021 09:37:00 GMT-0500 (heure normale de l'Est nord-américain)
+	GESL [REDACTED]	39W48	Validated	CAST	TORONTO EXPRESS	N/A	-	Truck	MONTREAL, QC	Unloaded from vessel	[REDACTED]	Tue [REDACTED] 2021 09:05:00 GMT-0500 (heure normale de l'Est nord-américain)

- Container Identification number
- Voyage Number associated to the container
- Container terminal where the container will be / is / was
- Name of the vessel that carried the container
- Railcar identification number, if the container is loaded on a railcar
- Confirmation that an automatic association was made in the rail operating system
- Mode of transport for the container
- Real-time status on the container (On Vessel / Unloaded from vessel / Loaded on rail or Truck / Rail or Truck Departure from terminal / Rail Departure from port)
- Amount of time the container has dwelled at the port
- Timestamp associated to the last status update

In addition to the user interfaces, an efficient communication system was built to provide 1) a real-time update on the status of the critical containers; 2) a mean for the terminal operators to ingest the critical cargo-related information automatically within their terminal operating systems; 3) a monitoring system that measures key indicators to provide weekly feedbacks on the performance of the initiative; 4) a display of a priority tag of every critical container on the two terminal operator's websites, that alerts the trucking companies on the criticality of the cargo that they need to pick up at the port.



Results

Impact

To date, as of the time this entry is being submitted, more than 6,400 container units (12,100 TEUs) have been identified by CargO2ai and expedited to consumers. The impact is clear for the Port of Montreal, its terminal operators and other stakeholders. The solution supports planning and coordination of operations at the strategic and tactical levels alike. Decision making on critical cargo is based on data and quantitative information to accelerate operations and reduce dwell time for imported goods. Dwell time for critical containers can be cut by up to 50% between their unloading and their departure from the terminal compared to the average dwell times for all containers.

A key benefit of this solution is that it enables additional MPA capabilities to manage the COVID-19 crisis and any future crises because it improves the understanding of crisis management needs, it ensures business continuity, and it avoids the disruption of essential port activities.

Furthermore, the CargO2ai solution enables better understanding of the data flowing through the Port, introduces AI-driven innovative solutions into processes that are traditionally conservative, and creates a tool that acts as a single source of truth (SSOT) for the entire supply chain linked to the Port of Montreal, increasing the technical level of maturity of all organizations involved.

A humanitarian project

The benefits of the CargO2ai project are humanitarian in nature. Thanks to the collaboration of all the partners in the supply chain, the Port of Montreal is playing its role as a public utility service at the service of society, with the well-being and health of the population at heart. Through this project, we are returning to the core mission of a port infrastructure, which is all the more important in a crisis context: to deliver and distribute the goods that people need in the most efficient way possible.

A revolutionary tool

The CargO2ai tool represents a major innovation from a logistics solutions perspective. First, AI processes are not common within enterprises, and even less across the supply chain. The solution provides a single source of truth for the shipping lines, the terminal operators, the railway carriers and the trucking companies, allowing them to rally and fight the pandemic. Second, the solution is a perfect example of the augmented human concept, which aims to assist the worker in improving decision-making processes and accelerate the understanding of the massive flow of data that a port receives on a daily basis. The solution is truly hybrid, allowing partial automation by machine learning and incrementation. Last, the solution leverages already existing data and IT infrastructure to create a powerful visibility and decision-making tool for the stakeholders of the supply chain. The solution is very cost-effective and independent from external applications or software, which gives flexibility in developing for future purposes.

Immediate results

The results of the CargO₂ai tool are being felt throughout the supply chain. Launched on a large scale in the port territory as of September 2020, the outputs of the solution are used by most of the stakeholders of the Greater Montreal port community. The outputs of the solution are discussed on the daily operational calls between rail carriers CN and CP, terminal operators MGTP and Termont, and the MPA to ensure coordination and prioritization, especially on the rail side. On the trucking side, CargoM, a cluster that brings together all Greater Montreal freight transport and logistics stakeholders, promotes the initiative and provides incentives to trucking companies that accelerate their last mile delivery processes when handling cargo flagged as critical by the solution.

Transferability to the port industry

The solution was also developed for re-use as a business tool in a post-pandemic context. The solution will allow uploading of every possible HS Code or keyword, enabling the user to customize a business or customer need.

Beyond the context in which it was born, the CargO₂ai system could see its use extended to other regions and other types of products. Based on the same artificial intelligence and natural language processing system, CargO₂ai can be used to quickly identify other types of cargo based on current priorities, such as in-demand agri-foods, specialized components and hazardous materials.

It can be adapted to the reality of any port in the world to improve the efficiency and management of freight transport and help various supply chains serve people and businesses in a smart and visionary way.



www.port-montreal.com/cargo2ai

Canada 