Performance Indicator: Total Transportation Costs for Commercial Navigation

Technical Working Group: Commercial Navigation

Research:

Modeled by: Innovation Maritime, in collaboration with:
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Activity represented by this indicator: Total cost[1] of transportation linked with Commercial Navigation between Bécancour, QC, and Port Weller, ON, exclusive of port fees and port cargo handling.

Link to Water Levels: Water column availability in all the areas of concern are directly related to the quantity of cargo which may be loaded on ships after allowance for appropriate under-keel clearances when underway. If water levels are too low, carrying capacity is reduced, vessels may have to reduce speed, or stop, or light-load, all increasing overall transportation costs. If water levels are too high, vessel speed may be reduced to minimize shore erosion in critical areas.

Importance: This mode of transportation is important for the economies of 2 provinces and 8 Great-Lakes States, and also environmentally as studies have shown fewer particulate emissions per tonne-km when compared to other modes of transportation. Commercial shipping operates in an extremely competitive market. Small changes in shipping costs can affect the eventual mode commodities will be moved on (Rail versus water). Continued growth in the containership trade has the potential to reduce highway traffic congestion.

Performance Indicator Metrics: Total transportation costs in American dollars vs. water elevation, per geographic area (3), per quarter-month.

Temporal validity: Total transportation cost curves are derived for each quarter-month. Cost estimates were derived from 1995-99 commercial navigation traffic, and are deemed representative of commercial activities, cargo and vessel mix. The Seaway system in the study years (1995-99) was operating at approximately 45% of capacity in terms of transits.

Spatial validity: Valid for the lower St-Lawrence from Bécancour, QC to Port Weller, ON at the west end of Lake Ontario. Cost curves were derived for three geographical areas: Lake Ontario, the St. Lawrence River and Montreal.

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[1] In the context of these indicators, commercial shipping costs include : vessel capital and operating costs, fuel costs, seaway tolls, pilotage charges and Canadian Coast Guard fees (marine navigation service and maintenance dredging service fees) only.

Links with hydrology used to create the PI algorithm:

A total of 42 metrics were identified by the CNTWG. The majority of the metrics consist of alert and critical elevations at key gauges within each reach (low water elevations) which result in vessel speed reductions and ultimately draft reductions. Metrics corresponding to high level elevations at which ships must reduce speed to mitigate shore erosion were also identified at key locations. Other metrics defined maximum gradients between adjacent gauges as an indicator of excessive currents at which point navigation becomes unsafe and vessels in transit must stop. The Lake and River are treated as a continuum where favorable elevations and currents are required to avoid cost increases.

The Algorithm: Cost curves were developed for each of the three general geographical areas for a range of water level elevations:

- Lake Ontario (from Port Weller to Cape Vincent)
- The Seaway, (from Cape Vincent to the Seaway entrance)
- Montreal to Batiscan. (from the Seaway entrance to Batiscan)

The vessel transportation cost curves used in the Shared Vision Model were developed from transportation costs developed for individual ship movements that took place from 1995 to 1999 through the study area. Quarter monthly water levels were converted to daily water levels assuming linear interpolation between quarter-monthly data points. Vessel departure dates were used to identify the range of water levels that the vessel would encounter during its transit. These water levels governed the ships maximum load it could carry. The lowest water level encountered during the transit governed the ships carrying capability. These water levels were compared to the metrics developed for the geographical area the vessel would transit through. These metrics determined whether the vessel had to slow down or stop during its movement. A running summary of total transit time was computed for each vessel. These transit times were then converted to costs using daily vessel operating costs associated with various vessel types. Vessel operating costs were developed for 26 vessel types.

A number of simulation runs were made to isolate commercial navigation costs arising from three factors: costs due to ship transits based on tons carried according to available water levels, costs due to currents and costs due to high gradient delays.

Vessel transit costs due to ship loading according to available water levels were placed into three spreadsheet tables. Each table provides commercial vessel transit costs for a specific geographical area. Each spreadsheet table is arranged as follows:

- The first column of the table contains water level elevations appropriate to the sub-area. Hence, there are as many data rows as water levels. The water levels are in meters in descending order measured to the accuracy of a centimeter. The range of water levels varies by geographical area.
- The rest of the table consists of an additional 48 columns, one for each quarter month of the year.
- In each row and column cell for a particular elevation and quarter month, the total commercial vessel transit cost is presented.

Data was also provided that allowed transit costs associated with currents and gradients to be calculated for specific water levels. Currents encountered during a movement affected vessel speeds and thus total transit times. Gradients encountered during a vessel movement also impacted total transit times. If specific gradients were exceeded during a voyage, the vessel would stop until the gradient returned to a level below the target gradient.

Validation: Actual vessels moving cargos between various origin-destination pairs for the period 1995-1999 were used to develop total transportation costs versus water level elevation by geographic area, by quarter-month**.**

Documentation and References:

1. 2003. Planning Objectives and Performance Metrics for evaluating impacts of Lake Ontario Outflow Regulation Plans on Commercial Navigation. TWG Commercial Navigation.
2. July 2004. Impact Evaluation Model for Commercial Navigation on the St. Lawrence and Lake Ontario. Draft Final Report. Innovation Maritime.

Risk and Uncertainty Assessment: There are a number of caveats that need to be identified when using this Performance Indicator.

1. The vessel database used to develop this PI (1995-1999 vessel movements) is only representative of the fleet, traffic volumes, and commodity movement patterns within the system for the <u>near</u> future (Next 3 to 5 years).
2. The fleet mix using Montreal Harbor has already exhibited a shift to larger sized vessels.
3. Water level data was provided on a quarter monthly basis. However, impacts on vessel movements and loadings are associated with daily and even hourly water levels. The quarter monthly data tends to “average out” the impacts and leads to an underestimation of transportation costs.
4. The PI can be used to identify a good year of water levels from a bad year. However, usage to determine the ranking of plans is more problematic. Two plans may result in the same total transportation costs. However, the two plans may not be equal in ranking. A plan that provides a more consistent set of water levels would be preferred to a plan that has extreme fluctuations in water levels. Commodities moving by water require loading and schedule planning to assure that the vessels have adequate water depths to accommodate their passage throughout the entire length of their trip. A plan that provides a more consistent set of water levels, providing the levels are sufficient to maintain existing or deeper vessel drafts, would be preferred to a plan that has extreme fluctuations in water levels.
5. This PI is also sensitive to seasonality. A plan that provides more water than the current plan from say June through December would be preferred. This is the time of year water levels are typically decreasing and tonnage movements are highest.