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# THE VALUE OF DETAILED LOGISTICS INFORMATION IN CARBON FOOTPRINTS

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**ABSTRACT:** *This paper examines the value of detailed logistics information for calculating carbon footprints. The carbon footprint of transporting a product from a factory in Asia to a distribution center in the United States is calculated for five different products using two methods. The first method, a screening model, uses public information and readily available data to estimate the carbon emissions from warehousing, transportation, and port operations. These results are compared to those of Damco's SupplyChain CarbonCheck™ tool, which makes use of more detailed information. Results show the screening model can produce significantly higher or lower emissions estimates depending on product characteristics. Furthermore, the screening model is unable to capture efficiencies from improved routing and container utilization.*

One of the challenges faced by corporations when measuring the carbon footprint<sup>1</sup> of logistics operations is the lack of detailed information of outsourced activities. The most common approach to overcome this information gap is to use both a simplified representation of the logistics networks and average emission factors of outsourced operations to develop an initial baseline, or initial screening.

This document compares the carbon footprint of five different global logistics networks when using a carbon-screening methodology versus detailed operational data provided by a third-party logistics provider, Damco through its SupplyChain CarbonCheck service.

## Carbon Footprint Calculation of Global Logistics Networks

The analyzed global logistics network has four main sources of emissions:

- » *In-country transportation:* road transportation emissions (e.g., fuel) related to the movement of goods in the country of origin/destination between factories and the port of origin/destination
- » *International transportation:* emissions from oceangoing vessels (e.g., fuel) between the port of origin and destination
- » *Warehousing operations:* emissions from electricity use in maintaining warehouse operations, including equipment, refrigeration, and other support activities

- » *Port operations:* greenhouse emissions of all port activities, including electricity and fuel consumption by operator-controlled facilities and equipment

Data was collected for up to two years' worth of shipments from point of origin in Asia to destinations (warehouses and retail locations) in North America.

## Carbon Footprint Screening

For the initial screening, publicly available information was used when available:

- » Location information was provided for ports, warehouses, and distribution centers (DCs)
- » All domestic road distances between locations were computed using Google Maps' road distances
- » Ocean distances were calculated directly from port to port using dataloy.com
- » GHG Protocol-recommended emission factors were used for road and ocean transportation of 72g CO<sub>2</sub> per tonne-km and 10g of CO<sub>2</sub> per tonne-km
- » Port emissions were based on data reported by the Port of Seattle study of 2.56 g of CO<sub>2</sub> per kg, assuming a capacity of 10,000 kg per TEU<sup>2</sup>

For warehouse emissions, we used electricity and natural gas consumption at a major distribution facility along with the

<sup>1</sup>Through out this document the term *carbon footprint* represents the emissions of green house gases in CO<sub>2</sub>-equivalent factors.

<sup>2</sup>Twenty-foot Equivalent Unit container

average days spent in the facility for each product type to determine a factor that ranged from 126–250 g of CO<sub>2</sub> per cubic meter-day. (See Appendix 1 for the basic calculations used to estimate the carbon footprint for the screening model.)

## Damco Data

For the selected global networks, the 3PL provider had detailed information about container movements, including carrier information, ocean routes, ports of call, and truck road distances. In addition, for some ocean routes, the 3PL provider had detailed information on the fuel consumption of the ocean route including the vessel type. Information of port and warehousing emission factors were based on the historical data of their global operations. All the emission factor information was embedded in their proprietary tool, SupplyChain CarbonCheck™. The MIT CTL research team verified the validity and accuracy of emission calculations as well as the overall use of emission factors. No detailed audit was performed over individual emission factor derivation.

## Accuracy Analysis

The following charts show the difference on the carbon footprint calculations:

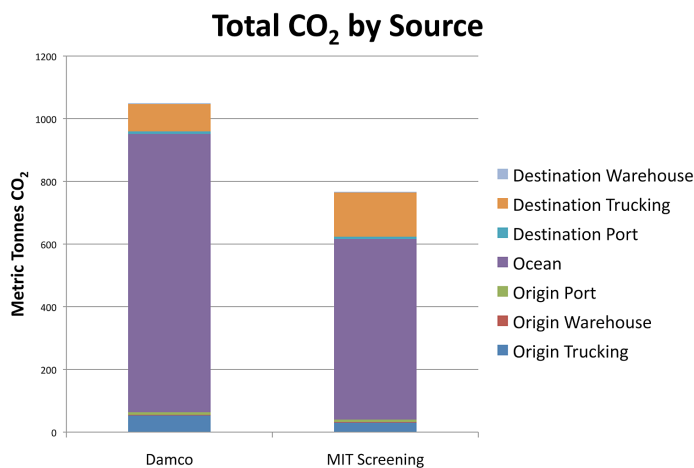


FIGURE 1 – SCREENING VS. DETAILED EMISSIONS BY SOURCE

We can see the significant difference between the total emission calculations: the screening total emissions were 27 percent lower than the calculations with the 3PL higher resolution information. Individual products varied greatly, with the screening model numbers ranging from 57 percent lower to 58 percent higher than the 3PL model. There were three main sources for this difference:

» *Ocean route distance* – Due to stops at intermediate ports between the origin and destination, ocean distances are on average 10 percent higher than direct port-to-port distance,

and on some strings may be as much as 21 percent higher

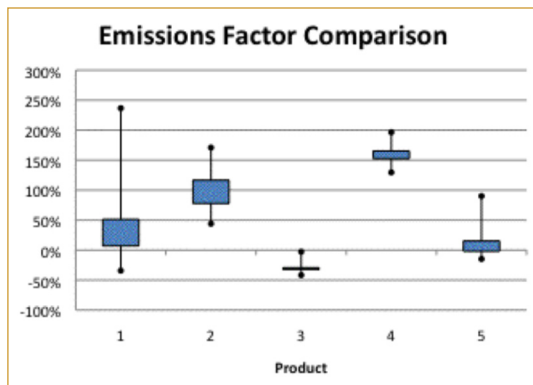
- » *Vessel-specific emissions* – The public factor for ocean shipping assumes a single emissions factor, but different vessels and voyage strings may have different emissions characteristics. These differences may vary by more than 30 percent from average.
- » *Emission business drivers* – In the maritime industry, operational decisions are based on TEUs, a volumetric measure. The screening level uses weight as the main driver.

There were also differences in the truck and warehousing emission estimations; but, for the selected scope of the logistics network, they were not significant for the carbon footprint differences.

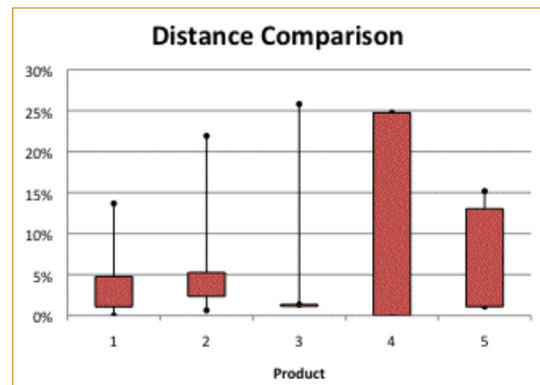
Figure 2 compares the drivers of the differences in ocean emission for multiple shipments of two of the selected logistics networks. The distance and per km emissions factor for each shipment using the SupplyChain CarbonCheck™ methodology are compared to the screening model, and the range of these differences are shown in the charts as a percentage of the screening model value.

For each product shipment, we compare the calculations from the more detailed emissions factors with those of the screening model in three categories: (a) the emissions factor in terms of kg CO<sub>2</sub> per product-km; (b) the distance of the shipment in km; and (c) the total CO<sub>2</sub> of the shipment in kg. Using the screening model emissions factor, each product shows a constant amount of emissions per kilometer, while the more detailed factor accounts for differences in emissions among different carriers, routes, and utilization of the TEU. Furthermore, the public factor uses direct port-to-port distances, while the detailed calculation uses the actual port routings, which vary depending on which ocean service and carrier handled the shipment. The variations in these factors combine to produce variation in the calculated CO<sub>2</sub> for the product shipment. In Figure 1, the bars show the range of the minimum and maximum across all shipments of the product, and the boxes show the range from the 25th to 75th percentile.

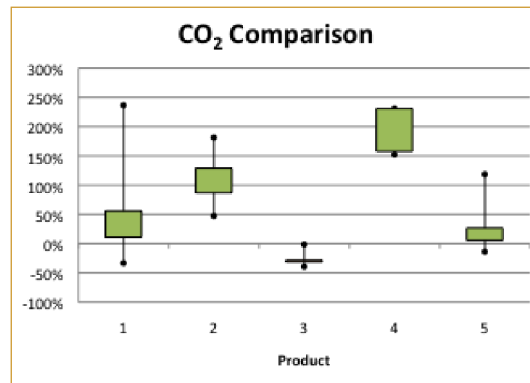
We can see no consistent pattern: For product 3, the detailed emission calculations are lower than the screening model; while for product 4, the detailed calculations are almost twice as much as the screening calculations. This has important implications when using screening data for redesigning global logistics networks: Unless operational data is included in carbon calculations, the level of uncertainty of CO<sub>2</sub> reductions will remain high.



(A)



(B)



(C)

FIGURE 2 – DIFFERENCE IN SCREENING VS. DETAILED CALCULATIONS

### Emission Business Drivers

At the screening level, transportation emissions are calculated by combining the total weight and the distance traveled with average CO<sub>2</sub> emissions per ton-mile. The emission factor embeds and implied efficiency, load utilization, and asset utilization (e.g., empty miles) of the transportation mode. As presented before, 3PL data allows for the refining of these elements. However, an additional value of using 3PL data is worth highlighting. In ocean transportation, weight is not the major driver of emissions or business decisions: the utilization

of ocean vessels is driven by TEU, a volumetric unit. Converting total weight shipment data into TEU provides better allocation of emissions. This information is usually visible only to the 3PL unless full containers are moved throughout the network. In addition, some operational decisions, such as consolidating ocean shipments, may not translate into carbon footprint reductions unless expressed into TEUs. For ground transportation, both weight and volume play an important role, but weight usually balances better emissions and operational decisions, if combined with rough volumetric drivers (e.g., full truckload).

### NEXT STEPS

For further information, contact Dr. Edgar Blanco, director of the MIT CTL Carbon Efficient Supply Chains project, at: eblanco@mit.edu, or tel: +1 617 253 3630

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### Reference

GHG Protocol, 2001.

## Conclusions

Our goal was to compare two different approaches for carbon footprint calculations: (1) a screening level using standard corporate data and public information and detailed and (2) detailed 3PL data, specifically Damco SupplyChain CarbonCheck™ methodology. The analysis shows significant differences in total emission calculations when using 3PL detailed data. The extra level of information provides more detail and better reflects the business drivers (e.g., TEU calculations). While the level calculation was able to identify the major emission sources, it significantly underestimated logistics emissions. Thus, we believe that there is significant value in using validated carbon calculations from logistics partners to drive operational decisions.

We learned other important lessons about working with a 3PL on this process. In the case of Damco, an accurate calculation

methodology was automated through a standardized tool. Not all 3PLs may have this technology available, however. It requires the construction of screening models to use as a reference in understanding the differences.

Moreover, 3PLs do not always provide higher visibility to all logistic functions. do not always have higher visibility to all logistics functions. In the case of Damco, warehousing and port operational data was biased toward the company's own operations and was not necessarily providing higher resolution data, but just a different set of assumptions. For the selected international supply chains, this uncertainty did not significantly affect the final calculations, but it could be more important in other logistics networks. In those cases, selectively engaging with other parties in the calculation process is important. ■

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## APPENDIX 1 – CARBON FOOTPRINT CALCULATIONS

### Screening Transportation Emission Calculations

Shipment Distance \* Shipment Weight \* GHG Protocol Mode Emission Factor

### Screening Warehouse Emissions Factor

The emissions factor for warehouse operations was estimated based on the total electricity and natural gas consumption in the partner company's distribution center for a one-year period. We allocated this to the specific product by estimating the total percentage of warehouse space dedicated to the SKU. Then we divided the percentage of the total emissions by quantity of the SKU handled by the facility during the year to determine the approximate energy consumption required per unit of SKU at the facility. Next, this value was turned into an equivalent emissions factor by dividing the total emissions for one unit by the volume of the unit in cubic meters and the average number of days a unit spent in the facility. This produced an emissions factor for each SKU in terms of CO<sub>2</sub> per cubic meter-day.

### Damco Emission Factors

Damco emission factors were derived from operational data, including fuel and oil consumption records from Maersk Line shipping routes, electricity consumption from APM terminals, and Damco facilities around the world.