Carbon Footprints of 3PLs

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Introduction

Third Party Logistics (3PL) companies have an important role to play in reducing carbon emissions from transportation, but quantifying this role can be difficult. Current methods involve calculating the emissions from shipments managed by the 3PLs for their customers, but this approach neglects the important role 3PLs can play in reducing emissions. 3PLs often provide key management services, such as load matching, which can help to reduce overall emissions by reducing empty miles. This presents challenges in developing methods that accurately account for the impact of shippers, carriers, and 3PLs on reducing emissions. Four methods are presented below to illustrate how differences in assumptions regarding empty miles can impact the estimated carbon emissions.

Method 1: Basic Distance Calculation

Figure 1: No Empty Miles

Emissions = Distance x Emissions Factor (g CO2/mile)

The simplest method of estimating the emissions from a truckload shipment is to simply calculate the distance between the origin and destination, then multiply the distance by an emissions factor expressed as an amount of CO_2 per mile traveled. An emissions factor can be calculated from a given miles per gallon rating by using a standard value of the CO_2 in a gallon of fuel. While this method is simple and easy to calculate it neglects a significant source of emissions, those that come from the empty running of the truck. This distinction is important, especially when comparing emissions to those of a private fleet. Most emissions reporting programs, including Smartway and the GHG Protocol, require the owner of a fleet to report their emissions based on the total fuel consumed. This figure will obviously include emissions from the empty running of trucks, and therefore emissions calculated using a basic distance method would underestimate emissions in comparison to actual emissions reported by the owner.

Method 2: Empty Return Trip

Figure 2: Empty Return Trip

Emissions = Distance x 2 x Emissions Factor

One method to include emissions from empty running is to assume the truck returns to the origin after making the delivery. This may often be the case for a private fleet where the vehicle must return to a DC or depot after delivering a shipment.

Emissions are calculated in the same manner as the basic distance calculation, but distance is calculated based on the total round trip distance. However, in reality most trucks do not simply return to the origin empty after a shipment, instead they either move to a new origin to pick up a backhaul shipment back to the origin or simply move on to a new shipment without a return to the origin. Therefore assuming an empty return trip is an upper bound on the emissions from a given shipment.

Method 3: Average Empty Miles

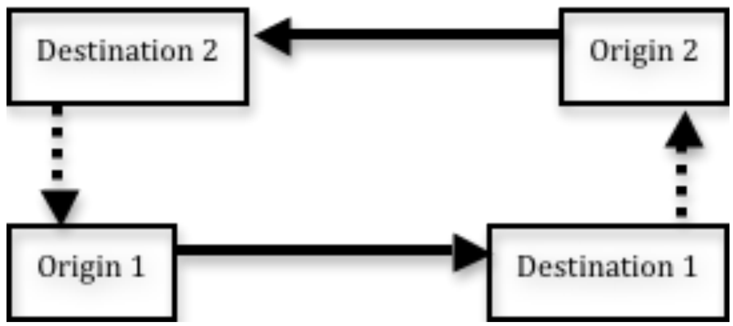

Figure 3: Average Percentage Empty Miles

Emissions = (Distance + Distance x Avg. Empty Miles) x Emissions Factor

Rather than assume the truck returns empty to it's origin we can instead assume it travels some distance from the end of one shipment to the beginning of the next. This could involve traveling empty to obtain a backhaul load to the origin or simply traveling to pick up the next shipment destined for a different location. These empty miles are typically tracked by carriers and reported as a percentage of total miles traveled. Using this average value for each shipment is a more accurate method in estimating the overall miles traveled, and therefore the total carbon emissions, than either assuming no empty miles or assuming a round trip. Though this method is more accurate than the other simplistic methods of accounting for empty miles it does not accurately represent the impact the shipper's decisions can have.

Method 4: Adjusted Empty Miles by Cost

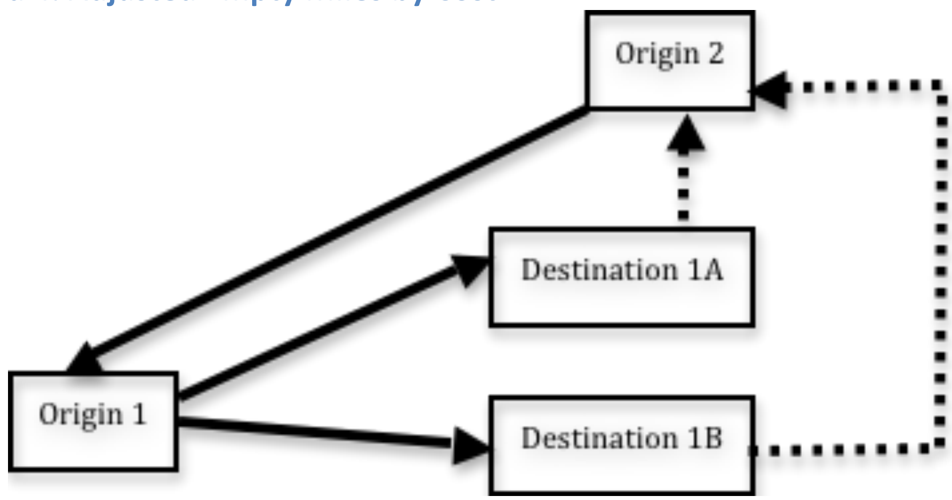

Figure 4: Adjusted Empty Miles by Cost

Emissions = (Distance + Distance x Avg. Empty Miles x Adjustment Factor) x Emissions Factor

Using an average empty miles percentage for every shipment is more accurate than other simple assumptions, but ignores the fact that empty miles are affected by decisions the shipper makes. Shipments in and out of certain regions can have an impact on the number of empty miles a carrier must travel. This is due to the imbalance of flow on lanes throughout the network, and is often reflected in the prices charged by carriers to the shippers when traveling in and out of certain regions. When carriers know it will be difficult to find the next load and they will have higher empty miles they charge a premium to the shipper. Thus a carrier may report higher empty miles simply due to the regions they serve rather than any lack of performance on their part.

Unfortunately understanding the true flow of goods in a complex network is an extremely difficult task requiring enormous amounts of data that are simply not available. Instead we can make use of price information, which often is more readily available, to estimate this flow. If the price per mile into a given region is higher than other regions we can assume it is more difficult to easily find then next load, and therefore there will be more empty miles. Likewise if it is cheaper we assume empty miles will be less. If we begin with some baseline amount of empty miles set to equal the average amount we can adjust the expected empty miles for a given shipment up or down from this value based on price. In essence we are taking the total amount of empty miles, based on the average value, and allocating more empty miles to high priced shipments and less to the lower priced ones.

The decision of how to determine the adjustment factor is an open question. Our proposed method is to compare the price of the shipment to the price of the backhaul leg from the original destination back to the origin. In essence looking at the round trip journey calculates the cost needed to return the system back to its state before the shipment. If the original shipment leg is more expensive than the backhaul we should allocate more empty miles to the original leg, since the pricing indicates there will be a greater imbalance at the end of the shipment than at the beginning. Similarly if the backhaul is the more expensive leg then it indicates the truck is better positioned at the end of the shipment than at the beginning, and therefore we allocate less empty miles. This method is consistent with the idea of allocating total emissions between the high and low priced lanes. More detail on the method used is shown in Appendix A.

Comparison of Methods

Using these four methods and applying them to a sample of approximately 66,000 shipments managed by CH Robinson for PepsiCo we get a range of possible values for the total emissions and the amount of empty miles. The comparison is shown in Table 1 below.

	Method 1	Method 2	Method 3	Method 4
Loaded Miles	42,618,254	42,618,254	42,618,254	42,618,254
Empty Miles	0	42,618,254	7,671,286	7,854,369
% Empty Miles	0.00%	100.00%	18.00%	18.43%
CO2 (tonnes)	61,796	123,593	72,920	73,185
Cost ($20/tonne CO2)	$1,235,929	$2,471,859	$1,458,397	$1,463,706

Table 1: Comparison of Results

Methods 1 and 2 provide the range of possible values from minimum to maximum. All other methods of calculating empty miles should fall within this range. The difference between these values is quite significant, resulting in almost 62,000 tonnes of CO2 more if an empty return trip is added to a shipment. At a price of $20 per tonne of CO2 emitted this would result in an extra $1.2 million in CO2 costs alone.

When compared to the average empty miles value used in Method 3 the adjusted empty miles used in Method 4 provides similar overall results. This is not surprising, as it used the same average empty miles value as a base. However, when viewed on a shipment-by-shipment basis the results can vary greatly. Figure 5 below shows the distribution of the empty miles on an individual shipment basis. While most shipments fall into the range ±6% from the average 18% value some are below 3% or above 27%. Over a large number of shipments distributed between high and low priced lanes the values may be close to the average, but for a smaller number of shipments or on a distribution that is skewed towards high or low priced lanes the differences could be more significant.

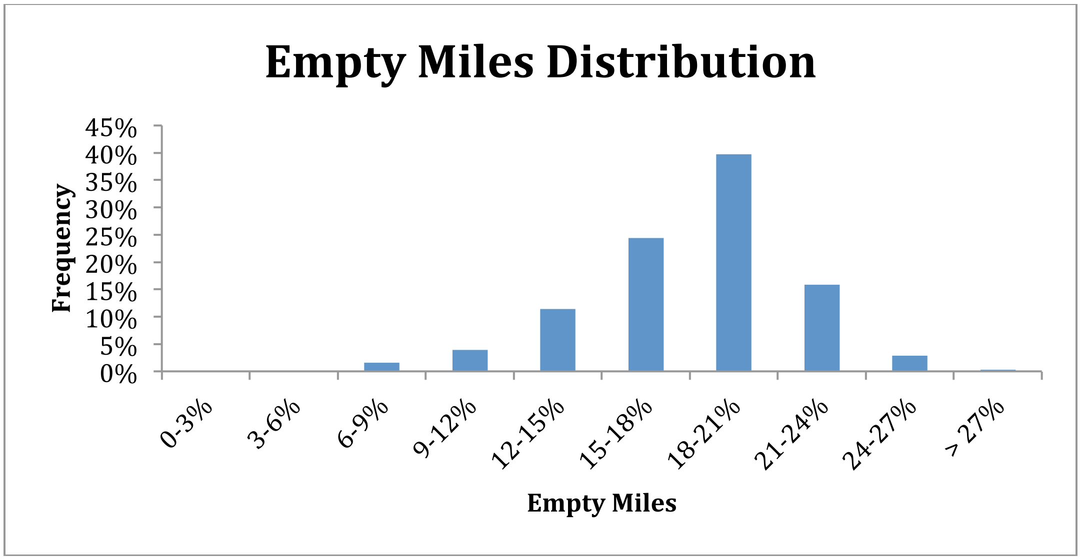

Figure 5: Distribution of Adjusted Empty Miles

Quantifying the Role of a 3PL

While the methods discussed above provide insight on ways to measure the carbon footprint of shipments without knowing actual fuel consumption they do not necessarily provide insight on the role a 3PL can play in reducing emissions. In one sense the need for empty miles are created by the shippers whose demand for transportation creates the imbalances in the flow of goods. Carriers also affect the empty miles, as their requirements and ability to manage their trucks can help reduce the amount of empty miles traveled. Since 3PLs neither create the demand for shipments nor control the trucks their ability to reduce empty miles rests on their management skills. By better matching carriers with shipments 3PLs have the opportunity to improve system wide performance by reducing empty miles. Quantifying how well they do this is a challenge.

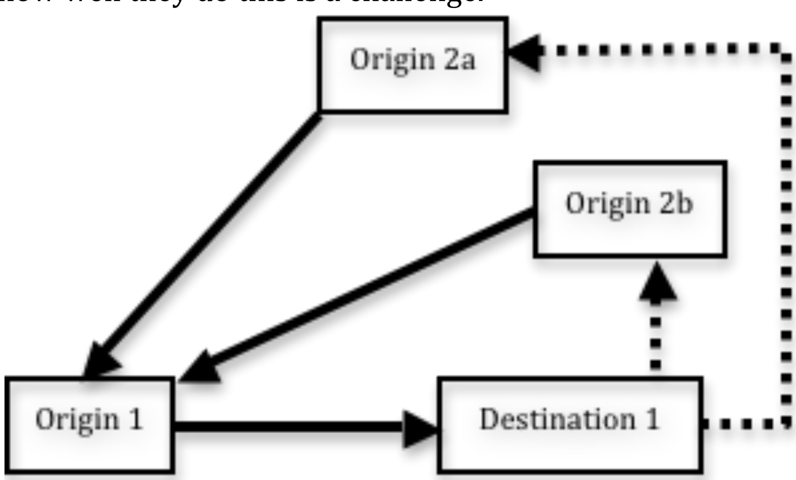

Figure 6: Reducing Empty Miles Through Load Matching

Figure 6 illustrates the role intelligent load matching can have on reducing empty miles and CO_2 emissions. After dropping off a shipment at Destination 1 a truck then proceeds to Origin 2a to pick up a backhaul load. If, however, the truck had proceeded to Origin 2b to pick up a different backhaul load the number of empty miles would have been reduced. This difference in miles driven represents the possible savings from better matching loads. Properly quantifying this benefit is difficult, because it is not enough to know what was actually done. Rather, the current process must be compared against what would have been done otherwise in order to measure the improvement. In order to properly understand the role of 3PLs in reducing emissions it is necessary to develop new methods that go beyond simply measuring the emissions from services they provide to customers.

Appendix A

Calculation Approach for Method 4

For this method the adjusted amount of empty miles is based on seven factors:

- The system wide average empty miles (Avg Empty Miles)
- The distance of the shipment (Distance)
- The average price per mile (Price per Mile)
- The regional price adjustment OUT of the ORIGIN region (Origin Outbound Price)
- The regional price adjustment IN to the DESTINATION region (Destination Inbound Price)
- The regional price adjustment OUT of the DESTINATION region (Destination Outbound Price)
- The regional price adjustment IN to the ORIGIN region (Origin Inbound Price)

The empty miles for a shipment are then calculated in this manner:

Shipment Cost = (Distance) x (Price per Mile) + (Origin Outbound Price) + (Destination Inbound Price)

Backhaul Cost = (Distance) x (Price per Miles) + (Destination Outbound Price) + (Origin Inbound Price)

Adjusted Empty Miles = (Shipment Cost) / [(Shipment Cost) + (Backhaul Cost)] x (Distance x 2) x (Avg. Empty Miles)

The distance is multiplied by 2 in this case to represent the total miles traveled to make the shipment and then return to the origin. The expected average empty miles for a shipment of this length is calculated and then this number is adjusted up or down based on the allocation of costs between the shipment and its backhaul.

Example:

Avg. Empty Miles = 15%
Distance = 1000 miles
Price per Mile = $1
Origin Outbound = $50
Destination Inbound = $100
Destination Outbound = $20

Origin Inbound = - $20
Shipment Cost = 1000 x 1 + 50 + 100 = $1150
Backhaul Cost = 1000 x 1 + 20 + -20 = $1000
Adjusted Empty Miles = 1150/(1000+1150) x (1000 x 2) x .15 = .535 x 300 = 160.5

Empty Mile % = 16.05%
Increase in Empty Miles = 7%