DOES THE CONCEPT OF 'NEARPORTING' PROVIDE A PATHWAY TO BETTER LOGISTICS SUSTAINABILITY?

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ABSTRACT

Firms are looking for innovative solutions to become greener regarding their end-to-end supply chain emissions without incurring additional costs. This paper discusses one such solution through a simple concept of 'nearporting', which is the explicit decision to use the nearest port of loading/discharging of cargo to reduce the overall amount of CO_2 and other emissions. This paper's empirical study has modeled data supplied by a major UK third-party logistics service provider comparing actual shipments to what could be achieved if a nearporting strategy was used. Actual shipment data using origin and destination postcodes were analysed to calculate the reduction in road freight mileage and related reduction in CO_2 emissions against additional nautical miles travelled which may temper some of the savings, but overall it was found that substantial savings would be achieved.

Keywords: *Nearporting, CO_2 emissions, Carbon footprint, Sustainability, Intermodal*

บทคัดย่อ

บริษัทต่างๆ พยายามหาวิธีที่สร้างสรรค์ที่เป็นมิตรกับสิ่งแวดล้อม ในการจัดการกับการปล่อยก๊าซคาร์บอนจากต้นสู่ปลายโซ่อุปทานโดยไม่ต้องเพิ่มต้นทุน งานวิจัยนี้อภิปรายวิธีจัดการผ่านหลักการที่เรียกว่า "การตั้งอยู่ใกล้ท่าเรือ" ซึ่งเป็นการตัดสินใจใช้ท่าเรือที่ใกล้ที่สุดในการขนถ่ายสินค้าเพื่อลดการปล่อยก๊าซคาร์บอนไดออกไซด์และก๊าซอื่นๆ งานวิจัยเชิงประจักษ์นี้เป็นการจำลองข้อมูลจากผู้ให้บริการลอจิสติกส์รายใหญ่ในสหราชอาณาจักร โดยเปรียบเทียบข้อมูลการจัดส่งจริงกับกรณีที่ใช้การขนถ่ายจากท่าเรือที่ใกล้ที่สุด ทั้งนี้ได้ทำการวิเคราะห์ข้อมูลการขนส่งจริงจากจุดเริ่มต้นไปถึงปลายทาง เพื่อคำนวณหาการลดลงของระยะทางการขนส่งทางบกและการลดการปล่อยก๊าซคาร์บอนไดออกไซด์ เทียบกับระยะทางที่เพิ่มขึ้นมาซึ่งอาจส่งผลต่อความประหยัด savings แต่โดยรวมแล้วพบว่าการใช้ท่าเรือที่ใกล้ที่สุดในการขนถ่ายสินค้าสามารถประหยัดค่าใช้จ่ายได้เป็นอย่างมาก

INTRODUCTION

There is evidence that firms are taking note of their end-to-end supply chain emissions and are looking for innovative solutions to become greener without incurring additional costs. This paper discusses one such solution through the concept of 'nearporting'. The concept is simple. In the days before containerisation, cargo tended to move to the nearest port. Even in the early days of containerisation, ships called at many ports along their route. However, as ship sizes increased, the tendency of shipping lines has been to reduce the number of port calls to key hub ports in order to increase ship efficiency. There is a trade-off that results. Cargo has to be carried further overland either by road or rail, with the associated increase in CO_2 and other emissions. Nearporting then is the explicit decision to use the nearest port of loading/discharging of cargo in order to reduce the overall amount of CO_2 and other emissions. This may involve trans-shipment onto feeder vessels. An example of a firm using a nearporting policy is the tea and coffee retailer Taylors of Harrogate, based in Yorkshire, UK (Yorkshire Post, 2009). Keith Writer, commodities director at Taylors, described nearporting as 'progress' and said it would dramatically reduce the company's carbon footprint by reducing the number of road miles travelled. Their products are now being imported through the Port of Teesport in the northeast of England, rather than through traditional southern UK ports such as Felixstowe or Southampton. Taylors imports over 1000 containers per year.

LITERATURE REVIEW

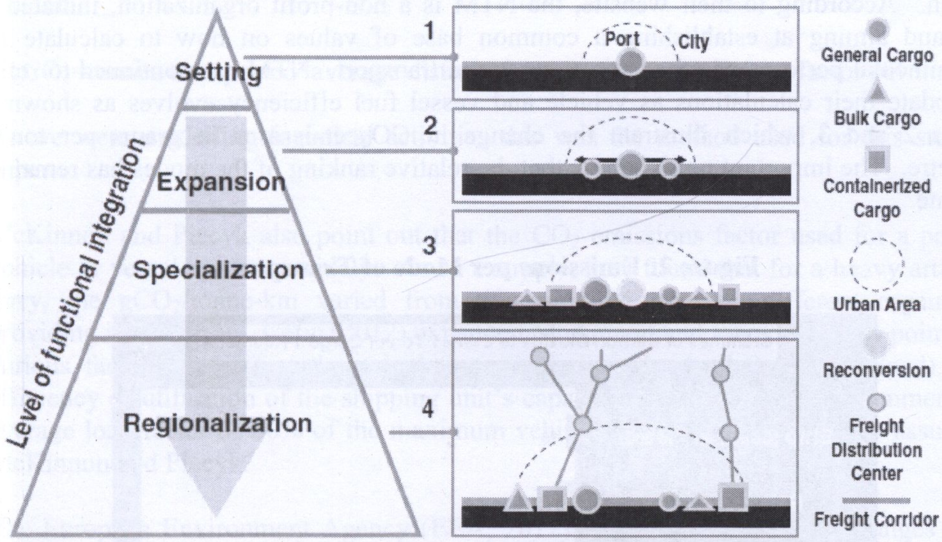
There is an abundance of literature relating to natural port hinterlands, port selection and choice, sustainable transport, and impact of transport on the environment. This research crosses the traditional boundaries of regional science, transport geography, business logistics, and supply chain management. The intent is to set the research undertaken in this paper to some of the key research in these fields.

Port Terminal Hinterlands

Starting with the natural hinterland of a port terminal, Rodrique (2013) refers to the entire area which is possible to service from the terminal. With current inland transport links, this could be so widely defined as to be meaningless in the context of this research. Rodrique goes further by defining both a *fundamental* hinterland, which refers to the market area for which a terminal is the closest, and the *competitive* hinterland which is used to describe the market areas over which the terminal has to compete with others for business. The research conducted in this paper will focus on the latter two definitions in terms of reducing CO_2 output.

Notteboom and Rodrique (2005) point out that there appears to be an evolution in port development towards regionalization. They point out that regionalization expands the hinterland reach of the port beyond the original natural hinterland through various developments. It also appears that they discuss this as a one-way evolution as shown in Figure 1. It may be that up to this point in time, it has been a one-way evolution, but as fuel becomes more expensive, and efforts to reduce the impact on the environment continue to expand, this may be more of a pendulum swinging back to the original natural hinterland.

Figure 1: Main Determinants in Port Selection



Source: Notteboom and Rodrique (2005)

In an OECD Discussion Paper, Notteboom (2008) summarizes some of the main determinants of port selection as shown in Table 1. This paper does not discount that many of these, and other factors, will affect the decision, but *ceteris paribus*, we are only looking at ways to reduce a shipper's carbon footprint by measuring a reduction in CO_2 due to a change to the nearest port.

Table 1: Main Determinants of Port Selection

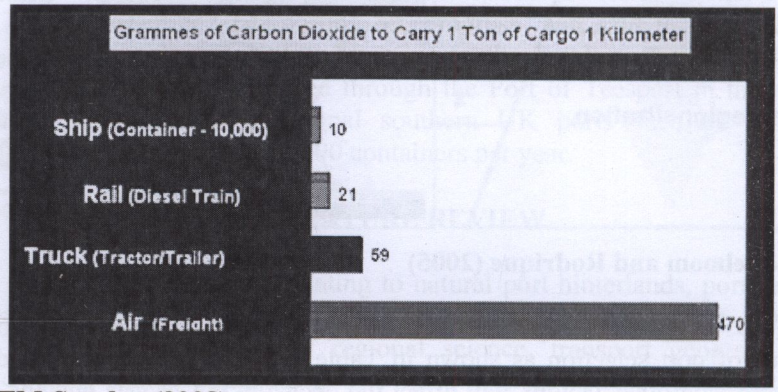
The physical and technical infrastructure
The geographical location
Port efficiency
Interconnectivity of the port
Quality and costs of auxiliary services such as pilotage, towage, customs, etc.
Efficiency and costs of port management and administration
Availability, quality and costs of logistic value-added activities
Availability, quality and costs of port community systems
Port security/safety and environmental profile of the port
Port Reputation
The reliability, frequency, capacity, and costs of inland transport services

Source: Notteboom (2008)

CO_2 Emission Calculations

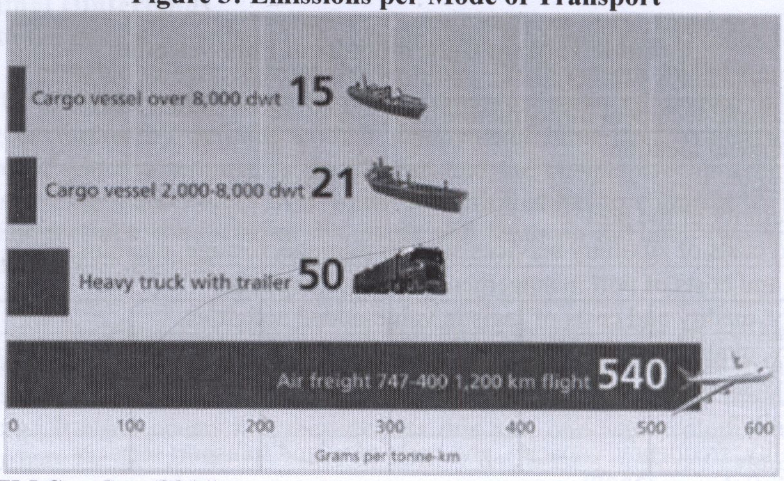
There is no shortage of websites offering to calculate a carbon footprint. A Google search for CO_2 Calculator returns 3,980,000 entries. However, most are focused on truck, automobile, and air passenger transport. There are several noteworthy sites that focus on comparing modes, with the Network for Transport and Environment (NTM) based in Sweden. According to their website, the NTM is a non-profit organization, initiated in 1993 and aiming at establishing a common base of values on how to calculate the environmental performance for various modes of transport. NTM has continued to refine and update their calculations as vehicle and vessel fuel efficiency evolves as shown in Figures 2 and 3, which illustrate the change in CO_2 emissions in grams per tonne-kilometre. The important point here is that the relative ranking of the modes has remained the same.

Figure 2: Emissions per Mode of Transport



Source: NTM-Sweden (2008)

Figure 3: Emissions per Mode of Transport



Source: NTM-Sweden (2011)

McKinnon and Piecyk (2011) discuss the two major methods to calculate CO_2 emissions. They are the Energy-based Approach and the Activity-based Approach. With the Energy-based approach, the amount of fuel consumed is used with standard emission factors (for the type of fuel) to convert energy values into CO_2. With the Activity-based Approach, an estimate of the carbon footprint of a transport operation is made by applying a simple formula:

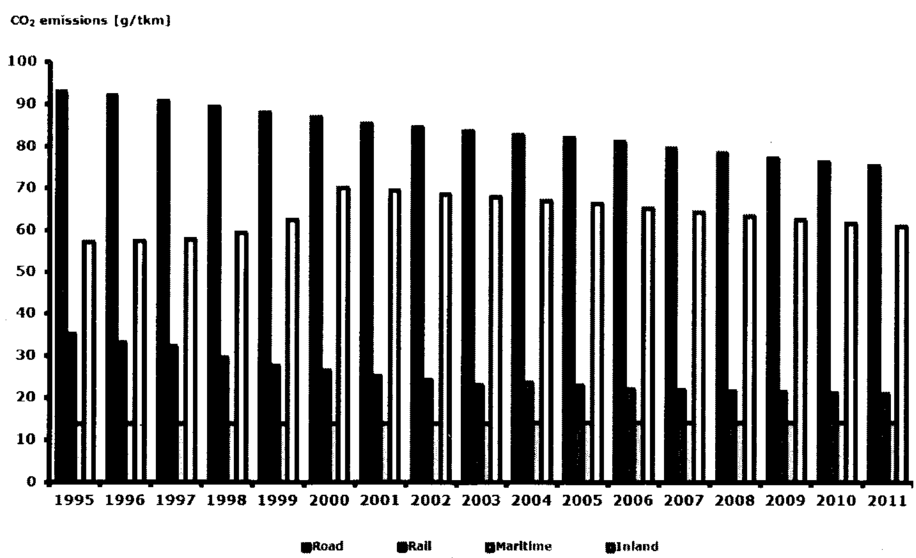
$$gCO_2 = \text{tonnes transported} * \text{average distance travelled} * CO_2 \text{ emissions factor per tonne-km}$$

As we were modelling logistical activities this was the method used for this study and paper.

McKinnon and Piecyk also point out that the CO_2 emissions factor used for a particular vehicle or vessel can vary widely. As an example, they found that for a heavy articulated lorry, the gCO_2/tonne-km varied from 59g to 109g between different organisations providing information. Cefic (2012) expanded McKinnon and Piecyk's work, pointing out various factors that affect the calculations, including the load factor (payload), or the efficiency of utilisation of the shipping unit's capacity. This value they recommend is an average load factor of 80% of the maximum vehicle payload which was also assumed by McKinnon and Piecyk.

The European Environment Agency (EEA, 2012) has been tracking the changes in CO_2 emissions by mode since 1995. The trend has shown that all modes are becoming more efficient, but the relative relationship has remained the same as shown in Figure 4.

Figure 4: Changes in CO_2 Emissions since 1995



Source: EEA (2012)

METHODOLOGY

In order to develop the nearporting concept beyond the conceptual stage we undertook an exploratory empirical study. Rather than take a few theoretical shipments and calculate the change in CO_2 output, actual shipment data was considered to better demonstrate the concept. In this vein, the cooperation of a major third-party logistics (3PL) service provider in the UK was obtained. They provided the data for all of their international container shipments for the year 2009 but requested anonymity as regards the data source. The majority of shipments were transported by road, and the number of containers moved by 'rail and road' was negligible. Therefore the study focuses on the road as the major alternative method to move containers inland from the ports.

The research was conducted in two phases. First the distances were calculated, and once the savings in road miles were known, the CO_2 emissions factor was applied and the estimated CO_2 savings was calculated.

Distance Calculations

Road Mileage Calculations

The research was set up as follows. The shipments were analysed to determine the total amount of road miles travelled using origin and destination postcode information calculated using Microsoft MapPoint Europe 2013 software. This would set the benchmark and then each shipment would be further analysed to determine if the shipment was actually using the nearest port, and if not, how many road miles could have been saved if the nearest port was used.

The number of containers moved, both import and export, totalled 280,550 for the year. This was immediately reduced to 139,278 by excluding those that did not have full postcode data. Due to the heavy computational nature of using MapPoint, the number of the sample size was further reduced to use import containers into the UK in January 2009. This resulted in a sample size of 2453 shipments. The shipments were spread across nine UK ports (see Table 2). As expected, the majority of the containers came through the major container hub port of Felixstowe on the Suffolk coast in eastern England (60.6%).

Table 2: Number and Location of Import Containers – January 2009

Port of Discharge	Number of Containers	Percent of Total
Bristol (Avonmouth)	7	0.3%
Felixstowe	1487	60.6%
Hull	445	18.1%
Immingham	8	0.3%
Liverpool	35	1.4%
Southampton	232	9.5%
Teesport	20	0.8%
Tilbury	202	8.2%
Tyneside	17	0.7%
Total	2453	100.0%

A Visual Basic macro was developed to import data from Microsoft MapPoint into an Excel spreadsheet. Data was calculated using the origin postcode (port of entry) and the inland destination. This set the current base mileage for the project. It should be noted that there were various postcodes that were no longer in use and some updates to the dataset needed to occur. Each time the Visual Basic encountered an invalid postcode, the processing would stop. We would then search for the new postcode based on the actual address information. This occurred in approximately 5% of the entries.

Once the base mileage was computed, a new macro was run for each of the ports of Immingham, Felixstowe, Tilbury, Liverpool, Southampton, and Teesport for all 2453 shipments. For time saving reasons, due to the intense computational requirements of MapPoint, the ports of Bristol (Avonmouth), Hull and Tyneside were not considered for this phase of the research due the fact that Bristol is a not a major port for container shipping, Hull is very close to Immingham and results would be similar to Immingham, and likewise, Tyneside is very close to Teesport. To put the computational time in perspective, each run of the macro would take between 3 and 5 hours to calculate the road mileage from each port to the inland destination of the shipment. On one occasion, the calculation time took 6 ½ hours.

Once the database was complete, it became a simple matter to choose the minimum inland road distance to the inland destination from either the original port or any of the other ports that could be used as options (see Equation 1).

Equation 1

$$D = \sum_{n=1}^{n} Min\ d_{pi}$$

Where d is the minimum distance from any port p to the inland destination i.

Nautical Mileage Calculations

In the instance that the original port of entry was not calculated to be the nearport option, the additional seagoing mileage would have to be calculated. A distance matrix using information from Searoutefinder.com (2016) was used and the results are shown in table 3. These calculations are in nautical miles and reflect the need for a circuitous route that needs to be taken.

By way of example, a container that was unloaded on the 2nd of January, 2009 at the Port of Felixstowe with a destination in Manchester was transported 263 miles over the road. The calculations show that had the container been discharged at the Port of Liverpool, the over the road distance would have only been 38 miles, potentially saving approximately 225 road miles. However, the additional sea miles would require an additional 647 nautical miles of transport. The next section will address how the CO_2 emissions calculations were measured.

Table 3: Distance between Ports in Nautical Miles

	Imming-ham	Hull	Felixst-owe	Bristol	Liver-pool	Tyneside	Tilbury	Southam-pton	Tee-sport
Immingham	0								
Hull	6	0							
Felixstowe	232	228	0						
Bristol	731	727	536	0					
Liverpool	842	838	647	290	0				
Tyneside	117	114	284	783	894	0			
Tilbury	260	257	58	549	660	312	0		
Southampton	382	379	188	415	525	435	201	0	
Teesport	137	134	304	803	914	25	332	455	0

Source: Searoutefinder.com (2016)

CO_2 Emissions Calculations

The only reasonable way to calculate the CO_2 emissions for an individual container is the activity-based method. This is due to the shared nature of carrying multiple containers on a container vessel and the loading and discharging of containers at every port in a ship's rotation (see Equation 2).

Equation 2

$$gCO_2 = tonnes\ transported\ x\ average\ distance\ travelled\ x\ CO_2\ emissions\ factor\ per\ tonne - km$$

It was decided to use the CO_2 emissions factors provided by the European Environment Agency (2012) summarised in Table 4. The two factors used were the Maritime and Road figures.

Table 4: gCO_2 per tonne-km by mode

Freight	Inland	Maritime	Rail	Road
2011	60.97	14.02	20.97	75.33

Source: EEA, 2012 – TREMOVE V3.3.1

Additionally, we needed to calculate the weight of the shipping container. Using standard information provided by ForwarderWebsites (2016), a standard 40 foot container weighs approximately 3,700kg, and the maximum cargo weight it can hold is 21,000kg. Using the 80% load factor recommended by McKinnon and Piecyk (2011) and Cefic (2012) results in an average cargo weight of 16,800kg. Adding in the weight of the container gives a total weight of 20,500kg (20.5 tonnes). The formula used is noted in Equation 3.

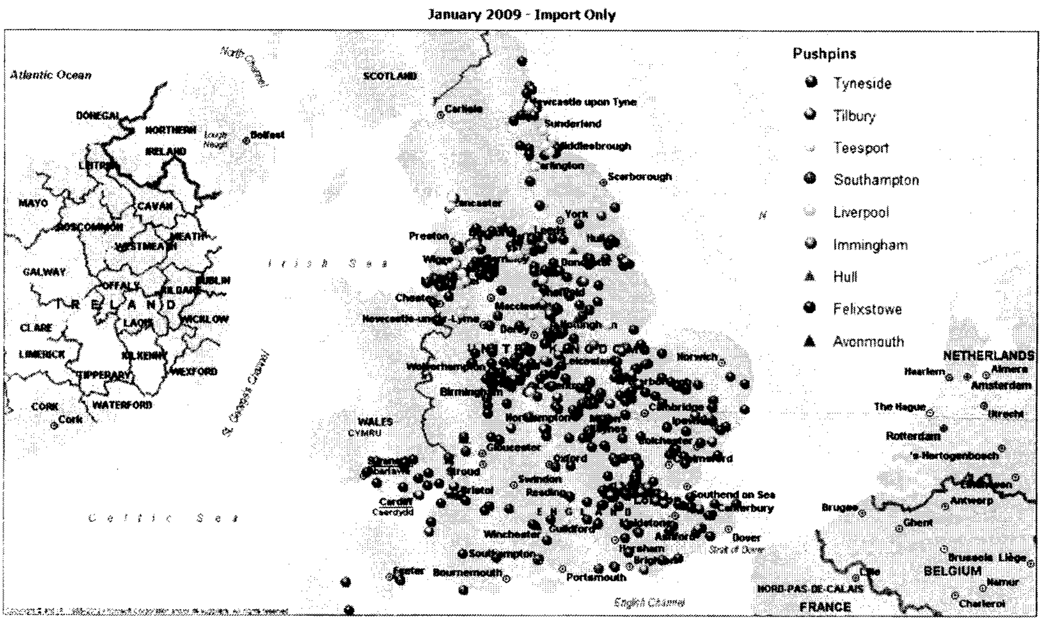
Equation 3 – Total gCO_2 saved by nearporting

$$Total\ gCO_2 saved = gCO_2 saved\ via\ reduction\ in\ road\ miles - additional\ gCO_2 incurred\ via\ additional\ sea\ miles$$

RESULTS AND ANALYSIS

Initial results indicate that nearporting is a viable method to reduce CO_2 emissions. Figure 5 shows the inland destinations by port of discharge.

Figure 5: Inland Destinations Shown by Port of Discharge



Of the original 2453 import shipments, only 456 were already at their 'nearport' port. However, by employing a nearporting solution a total reduction in road miles for the month of January 2009 for import shipments only from one 3PL would have been 169,964 miles. The net result in terms of CO_2 emissions reduction for the month was 37.4 tonnes. This reflected a reduction of 422.6 tonnes from reduced road miles, but an additional 385.2 tonnes emitted because of the additional sea miles travelled.

An initial look at the results clearly shows that the two major UK container ports of Felixstowe and Southampton have the most to lose by shippers moving to a nearporting policy. Due to the physical location of Felixstowe on the Suffolk coast away from the industrial and population centres, it could be the most hurt by this approach. Basically, nearly all of the shipments were moved to a different port resulting in a savings of road miles and reduction in CO2 output.

On the other hand, the ports most likely to gain from a nearporting strategy are Liverpool, Tilbury and Immingham. The new terminal at London Gateway was not included in the analysis, but it too would appear to benefit. These ports are closer to the industrial base and major population centres.

IMPLICATIONS AND LIMITATIONS

It is clear that nearporting has a future role in determining the port terminal to be used. Taylors of Harrogate has consciously made this choice, and with environmental sustainability issues likely to grow, it is expected that more firms will also make this choice. However, not every shipment that can save road miles will result in a net CO_2 reduction. There were some shipments that actually resulted in a net increase because the additional sea miles needed to carry the cargo outweighed the truck emissions savings.

Calculations used straightforward road and sea miles, and it is likely that some of the shipments would require feeder services from other ports (most likely ports like Rotterdam and Antwerp) which would incur additional time, and potentially cost due to transloading. Rail services were also not considered in this analysis as the 3PL that supplied the data insisted that almost none of the containers in the analysis were moved by rail.

There was no attempt to measure whether or not each port could actually handle the extra traffic generated from a nearporting strategy, but this could easily be compared to the current port capacity constraints. Further analysis will look at each individual port and the effect a nearporting policy may have on it.

As the dataset is so large, there is scope to expand the analysis using more shipments and also look at the profile of export containers. Although the dataset provided is from 2009, there is no reason to believe it is not representative of other 3PLs services, especially as there was no known nearporting strategy being employed at the time. Finally, if available data were available, it would be good to expand the study to other countries to see if a nearporting strategy would work elsewhere.

However, the overall conclusion is that nearporting will be added to the list of reasons why a specific port terminal is chosen.

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