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ABSTRACT

The five modes of freight transportation are normally characterized as motor carriers, railroads, airlines, water carriers, and pipelines. This paper will attempt to position the Internet as the sixth mode of transportation. This paper compares the strengths and weaknesses of the traditional five modes of transportation against the proposed 6th mode of the Internet. Without including the Internet as a mode of transportation, and tracking the economic value that it adds to the economy, the economic impact of the Internet as a mode is not considered. The recommendation of this study is that the Internet should be added to the list of modes of transportation of goods and therefore making the Internet the sixth mode of transportation.

INTRODUCTION

At the beginning of the 20th century, there were four modes of transportation. They were the railroads, water carriers, pipelines, and the horse. Today, transportation textbooks state that there are five modes of transportation for the movement of goods. The five modes of freight transportation are characterized as motor carriers, railroads, airlines, water carriers, and pipelines. Rodrigue, Comtois, and Slack (2006) stated that "Transport modes are the means by which people and freight achieve mobility." The currently accepted five modes of transportation obviously meet this definition, but the topic to be addressed in this paper is can the Internet be considered a mode of transportation. This paper is written in the form of an analytical essay and will attempt to make the case for the Internet as the sixth mode of transportation.

Background

Global electronic commerce (e-commerce) revenues are projected to be $963 billion by 2013 (Nguyen, DeCenzo, & Drucker, 2012), and as of 2012 e-commerce made up approximately 8% of U.S. retail sales (Bell, Choi, & Lodish, 2012). Electronic commerce ranges from retail shopping that must be delivered through the traditional transportation system to online downloadable media. Electronic commerce is expected to continue to grow well into the future and has become a part of daily life for many people. Shoppers that use e-commerce normally do not care how they receive a product as long as it is fast, and the faster the better. It is commonplace in today's e-commerce world to be able to instantaneously download music, computer software, and books, however most other physical products must still be delivered by one (or a combination) of the five traditional modes of transportation. With the continuing shift towards providing more products electronically and the advent of the three-dimensional (3-D) printer the Internet is being used more and more for the delivery of products.

Research Question

Using a qualitative analytical essay format the objective of this research is to explore the current status of e-commerce on the Internet and the transportability of products over the Internet. The research question explored in this paper is should the Internet be considered a mode of transportation? Thinking about the Internet as a mode of transportation raises interesting questions about the savings to shippers from reduced transportation costs. It also raises a number of questions about the societal benefits of using this mode in place of other modes. For instance, using the Internet in place of traditional transportation modes saves a great deal of fuel, reduces greenhouse gas emissions, and results in fewer truck/car accidents.

Significance of the Study

An extensive online search of the ProQuest, Transportation Research Board, and Northwestern University Transportation Library (Tran Web) databases revealed no academic literature that proposes that the internet should be considered as a mode of transportation. There is extensive literature that outlines the use of the Internet in supporting transportation and the global supply chain; however, the literature tends to focus on the movement of timely and accurate shipping information not physical products. This paper intends to justify the Internet as a standalone mode of transportation, not just to support the other modes. Since a literature search revealed no specific academic literature on the subject, this study will contribute to the body of knowledge on transportation research, and could affect the teaching and management of transportation.

DISCUSSION

Transportation adds value to a product by giving it time and place utility. Time utility is reflected in the concept that a product must be delivered to the market when it is needed (Coyle, Novack, Gibson, & Bardi, 2011). For example, snow blowers have little demand in the spring; however they have much more demand and therefore value in the fall or early winter. Place utility on the other hand is the concept that a product must be delivered to a geographical area where there is a demand for the product (Coyle et al., 2011). For example, snow blowers in Florida have very little demand, therefore little value, and no place utility.

According to Coyle, Novack, Gibson, and Bardi (2011) "the interrelationship between transportation and mass production points out the dependency of our global economy on transportation." Overall, transportation accounts for 10.5 percent of U.S. Gross Domestic Product (GDP), and freight transportation alone accounts for approximately nine percent of GDP according to Coyle et al. (2011). The availability of transportation is a major determining factor in the location of production facilities, and as changes in economic activity occur, so does the demand for transportation (Coyle et al., 2011).

Coyle, Novack, Gibson, and Bardi (2011, p. 11) stated that "the demand for freight transportation is usually dependent upon demand for a product in another location." The primary definition of a mode of transportation is the ability to move products from one location to another. Transportation bridges the supply demand gap and adds value to a product by giving it place utility, in other words transporting the good to a location where the product can be used. The traditional five modes of transportation satisfy this requirement to bridge the supply demand gap, but transportation over the Internet also achieves the objective of time and place utility. Not only can the Internet move a digital product, but with the advent of the 3-D printer can now be used to locally produce tangible goods.

Three-dimensional (3-D) printing has been around for over 20 years however it has only recently been refined to the point where detailed objects can be produced at home or at a business point of use (Holland Herald, 2012). 3-D printing is the process of making objects by gradually laying down successive layers of material in an additive fabrication process. 3-D printing is fast leaving the realm of the hobbyist; and is being integrated into more mainstream commercial applications every day. In short, the science fiction *replicator* as used on the Star Trek Enterprise is becoming a reality. Theoretically almost anything can be printed, including cups, car parts, furniture, jawbones, cloths; and research is being conducted on printing of food and human organs (Holland Herald, 2012).

Products can now be designed and the print files transmitted over the Internet for printing locally (Maxwell, 2012). In the future, instead of going to the store to go shopping a customer will be able to simply go into a 3-D print shop and request a product be made while they wait or even better print out the product at home.

Likewise, slow moving products, such as replacement parts for older cars, can be printed at the dealership where the car is awaiting repair. Other applications in industry are emerging daily.

Through the use of 3-D printing, and the digital movements (downloads) of goods across the Internet, inventory holding cost and product obsolescence are virtually eliminated. A true just-in-time manufacturing process can be used for the production of goods. Manufacturing will become decentralized and large-scale production operations, which in the past have provided *economies of scale*, will be rendered unnecessary. In addition, *geographic specialization*, the idea that each geographic area specializes in the production of products for which they have the greatest advantage will be rendered pointless. This creates its own transportation economics issues, however this is beyond the scope of this paper.

Shopping and Transporting Goods on the Internet

The shopping, purchasing, and immediate downloading of music, books, computer software, and other digital content is an everyday occurrence on the Internet. In fact, Amazon (2011) now sells more electronic books than printed books. In addition to the commonly downloaded music, books, and computer software, many services are increasingly being purchased and transmitted via the Internet. For example, this paper can be transmitted over the Internet to an editor, editing services paid for electronically, and the final edited paper returned to the author via the Internet. In the past, this paper would have to be printed and mailed to the editor who would then edit the paper, and mail the final edited product back to the author. The mailing of these items would have been accomplished using the traditional transportation system. Likewise, commercial services can be transported from suppliers directly to offices or service locations. Blueprints would be one example, digital movies another.

Environmental and Social Impact

Transportation has a significant negative environmental and social impact. Most modes of transportation rely on the use of internal combustion engines so are a contributor to air pollution and related effects such as acid rain, CO2 emissions, and ozone reduction. Transportation can also have a negative effect on water quality through oil spills, garbage dumped from ships, and hazardous material losses (Coyle, Novack, Gibson, & Bardi, 2011). In addition, transportation is a contributor to noise pollution, with noise emissions from aircraft, trucks, and rail operations. Noise can decrease property value near transportation facilities and routes, and increase congestion, both of which can have a negative economic impact (Button, 2010). And last, is the environmental issue of *land take*, in which large expanses of land are needed for roads, ports, airports, and railroads and pipeline right of ways (Rodrigue, Comtois, & Slack, 2006).

By eliminating the need for the movement of goods through the traditional transportation system, the Internet in combination with 3-D printing could eliminate transportation cost and the associated fuel emissions, and therefore provide a benefit to the environment (Maxwell, 2012). At the same time, this 6th mode can and has had a dramatic impact in reducing fuel consumption, and reducing costs for shippers and ultimately consumers. Lastly, transporting goods through the Internet has the added benefits of the zero generation of waste packaging.

Comparisons of the Modes of Transportation

There are five traditional modes of transportation plus the new mode of the Internet for which this paper argues, available for use in the movement of goods. Each mode has its strengths and weaknesses, which must be considered when making a modal selection. Table 1 provides a comparison of strengths and limitations for the six modes of transportation. The Internet as a mode of transportation has strengths such as accessibility, speed, low cost, and international capabilities; however, for the

moment has limited flexibility in regards to the types of products that it can transport at this point in time.

When purchasing transportation a firm must take into consideration the different modal capabilities to determine which mode is best suited for their needs. Often time's shipment will occur on more than one mode of transportation (intermodal) which takes advantage of each modes strengths and minimize their limitations. One of the negative aspects of the Internet as a mode of transportation is the inability to integrate the Internet into intermodal transportation operations.

Another form of comparison which is typically used in transportation textbooks and within the transportation industry is the consideration of the operating characteristics of each mode of transportation. Table 2 compares the operating characteristics for each mode of transportation. Speed indicates the total movement time, availability is the characteristic that a mode can service any location, dependability refers to deviations from the expected delivery schedule, capability refers to the ability to handle any transportation requirement, and frequency is the number of schedule movements. Using this criterion, the Internet is the most capable mode of transportation; however the Internet has the major drawback of limited capability and currently can only move digital products. As discussed above, with the future development of 3-D printing the Internet will be able to transmit the plans and drawings needed for local production of almost any product. Currently, the type of product to be transported, and the geographic location of the production facility and the end-user must be taken into

TABLE 1
COMPARISON OF MODAL CAPABILITIES

Mode	Strengths	Limitations
Motor carrier	Accessibility	Limited capacity
	Fast and versatile	High cost
	Customer service	-
Railroads	High-capacity	Accessibility
	Low-cost	Inconsistent service damage rates
Airlines	Speed	Accessibility
	Freight protection	High cost
	Flexibility	low capacity
Water carriers	High-capacity	Slow
	Low-cost	Accessibility
	International capabilities	-
Pipeline	In transit storage	Slow
	Efficiency	Limited network
	Low-cost	-
Internet	Accessibility	Limited products
	Fast	-
	Low-cost	-
	International capabilities	-

Note: Adapted from "Transportation: A Supply Chain Perspective" by Coyle, Novack, Gibson, & Bardi, 2011, Table 10-4.

consideration when determining the overall best mode of transportation.

If the internet argument is accepted then many of the transportation economic models will need to be reconsidered. For example, the classic transportation economic model of the influence of distance on cost will have to be reconstructed (see Figure 1). Unlike other modes of transportation, distance does not influence cost so the cost for transportation over the internet is essentially a flat line on the zero cost line.

CONCLUSIONS, RECOMMENDATIONS AND FUTURE RESEARCH

This study has attempted to justify adding the Internet as a mode of transportation of goods. Transportation of goods is essential to the world economy. So important that governments and academia track the quantity and value of goods being moved by each mode of transportation. Governments regulate the transportation system and provide funding for the expansion and maintenance of transportation infrastructure. Without including the Internet as a mode of transportation, and tracking the economic value that it adds to the economy, the economic impact of the Internet as a mode is not considered. By not considering the Internet as a mode of transportation, and the added economic value that it brings, government regulation and financial support cannot be properly allocated to support its growth for the future transportation of products. Until the use of 3-D printers becomes more affordable and widespread the Internet will be mostly relegated to moving of digital products. However as the 3-D printing industry expands, decentralization of production will occur and the need to move a physical product will decrease. Of course, the movement of goods by the other modes of transportation will never be completely eliminated. At a minimum, they will be needed to transport the printing material for 3-D printers.

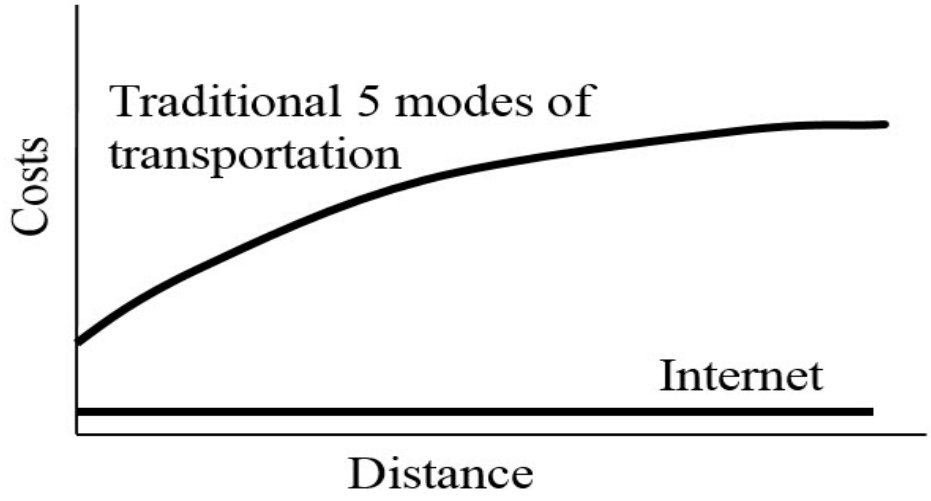
The recommendation of this study is that the Internet should be added to the list of modes of transportation of goods and therefore making the Internet the sixth mode of transportation. Additional justification and research will be needed to determine how best to compare the digital transportation of goods with the five traditional modes of transportation.

TABLE 2
RELATIVE OPERATING CHARACTERISTICS BY MODE

Mode	Motor Carrier	Railroads	Airlines	Water carriers	Pipeline	Internet
Speed	3	4	2	5	6	1
Availability	2	3	4	5	6	1
Dependability	3	4	6	5	2	1
Capability	3	2	4	1	5	6
Frequency	3	5	4	6	2	1
Composite Score*	14	18	20	22	21	10

Note: *lowest rank is best. Adapted from "Supply Chain Logistics Management" By Bowersox, Closs, and Cooper, 2010, Table 8.5.

FIGURE 1
GENERALIZED RELATIONSHIP BETWEEN DISTANCE AND TRANSPORTATION COST



Adapted from *Supply Chain Logistics Management* by Bowersox, Closs, and Cooper, 2010, Figure 9.1

Nevertheless, like a number of the futuristic gadgets used on Star Trek that have now come into reality, the *replicator* is just around the corner.

Future research on this topic should attempt to quantify the benefits to shippers and society form use of this 6th mode of transportation. For industry the benefits that should be estimated relate to reduced transportation costs. For society, the analysis should consider the savings in fuel costs, greenhouse gas emissions, and the reduction in car/truck accidents that result from having less trucks on the road.

These savings from use of this 6th mode could be calculated by estimating the total ton-miles of freight that no longer has to be shipped using the traditional modes. The approach would involve enumerating a list of some of the most important products that are now being 3D printed or transported digitally. For each product category the mix of modes could be estimated, and then for each mode, the volume that might have moved over that mode could be estimated. Likewise typical distances could be estimated using federal statistics. Based on an estimate of total ton-miles of freight that has been eliminated from a particular mode, an estimate of fuel savings, emissions reductions, and reduced accidents could be calculated. Freight cost savings could also be calculated. These estimates could then be summed across modes for each commodity, and then summing all commodities. Another approach would be to estimate the total dollar value of 3-D printing based on various articles that have been written with such estimates. Then an average weight and distance could be estimated for each dollar of product that is 3-D printed. This would allow for a ton-miles estimate and rather straightforward calculations of the reduced negative impacts of less truck, air, or rail ton-miles.

Estimation of these benefits would be very useful to those advocating for increased use of this 6th mode. The estimates would also allow corporations to calculate the reductions in greenhouse gases they are achieving through use of digital transmissions and 3-D printing, information they could report in their annual sustainability reports. Federal policymakers

could also use this information in planning federal policy and promotion programs that would support increased use of this 6th mode.

It would also be useful for future research to estimate the rate at which the 6th mode will grow and the impact that such use would have on the need for additional transportation infrastructure. For instance how many fewer highway lane miles of roadway might need to be added in the future? What might the impact be on the need for additional air freight capacity? Such information could also be useful for companies that build aircraft and trucks.

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