

The Impact of Retail E-Commerce on Transportation: A Conceptual Framework

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Abstract:

This paper presents a conceptual framework to understand the ways in which retail e-commerce activities can substitute for, and in certain cases stimulate, physical travel.

Introduction

Economic growth during the past several decades has caused traffic and pollution problems in many parts of the world. For example:

- Many low-population density areas in the New England region of USA have gone through a tremendous period of growth, resulting in problems of traffic congestion and environmental pollution that were unknown previously.
- China's rapidly developing economy is facing major problems of environmental air pollution (World Bank 1997, p.6). As the rising proportion of China's 1.2 billion people take to the road in their private cars, the problems of traffic congestion and pollution.
- Germany is more densely populated than the U.S., and has been confronted with traffic congestion and related pollution issues for decades. Political agencies have been more proactive than in the U.S. in terms of encouraging public transportation, controlling urban sprawl, raising gasoline taxes, creating pedestrian and bicycle zones and paths. Nevertheless, automobile use is at an all-time high, and still increasing. Individuals accept longer commutes,

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and with the spreading just-in-time supply chain management freight traffic is moving from rail to trucks.

While reengineering of traffic systems may address some the problems of traffic flow and environmental degradation, e-commerce has the potential to enhance quality of life in these regions through trip reduction as well as trip rationalisation behaviours. E-shopping could reduce trips and trip-miles expended in shopping and Internet-delivered information could encourage choice of alternate times, routes, and modes of transportation for shopping activities.

Telecommunications – including established broadcast media and the new Internet media – can substitute for physical transportation as well as stimulate it (Niles 1994, 1997, 1998). “Virtual” communication behaviours, facilitated by information technologies, could replace numerous activities that previously required physical travel. Of special significance are the technologies for teleworking, telecommuting (Garhammer and Mundorf 1997), distance learning, home shopping, information retrieval and home-based electronic entertainment. Travel reduction, however, is not the only possible consequence of telecommunications. Ubiquitous availability of information technology, especially mobile communications, can make people footloose and some travel may increase. Besides trip reduction and trip stimulation, another possible outcome is trip rationalisation. Information delivered in a timely, anticipatory manner using telecommunications may modify short-term transport behaviours such as route choice and timing of trips.

In this paper we focus on the impact of retail e-commerce on transportation. The paper is part of an ongoing, multiyear, multidisciplinary study of the relationships between transportation and telecommunications sponsored by the U. S. Department of Transportation and being conducted at a university in USA. This paper is the first attempt to formulate a conceptual framework that addresses the impact of retail e-commerce on people's transportation patterns.

Conceptual Framework

Forrester Research (1998) classified online shopping into three categories: (1) discretionary purchases of low-cost, convenience items (books, music, apparel and flowers); (2) replenishment

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goods with moderate cost and high frequency of purchases (groceries and personal care items); and (3) higher cost, information driven and planned purchases (airline tickets, computers, and automobiles). Drawing from and extending the Ghosh's (1990) work on retail store attributes, nine attributes appear relevant for characterising various online retailers: geography, accessibility, atmosphere, service/experiential convenience, speed of acquisition, price across brands, assortment, security, information availability, customisation/ personalisation. For the purpose of this paper, based on the established retailing concepts (Ghosh 1990) and the emerging e-tailing classifications (Forrester Research 1998), we deploy four factors to classify product categories: physical good or service, importance of physical contact, price of the offering, and shopping frequency. Table 1 presents detailed definitions and examples.

Table 1. Definitions of Product Categories

No.	Classifying factor:				Examples
	Physical Good or Service	Importance of Physical Contact	Price of the Offering	Shopping Frequency	
1	Good	High	High	Low	Automobile, Jewellery
2	Good	High	Low	High	Everyday clothing
3	Good	High	Low	Low	Contact lenses
4	Good	Low	High	Low	Computer, Printer
5	Good	Low	Low	High	Groceries
6	Good	Low	Low	Low	Hardware, Books
7	Service	High	High	Low	Tattoo, Spa massage
8	Service	High	Low	High	Haircut
9	Service	High	Low	Low	Ear piercing
10	Service	Low	High	High	Air ticket booking
11	Service	Low	High	Low	Cruise booking
12	Service	Low	Low	High	Movie
13	Service	Low	Low	Low	Museum visit

It should be noted that Table 1 is not exhaustive. Three possible categories, for example, are not mentioned: (1) Good, physical contact important, high cost, high frequency, (2) Good, physical contact not important, high cost, high frequency, and (3) service, personal contact important, high

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cost, high frequency. While these may be relevant to certain very affluent segments, average consumers rarely use these categories.

A core premise of our conceptual framework is that the substitution of physical shopping by electronic shopping will depend on the relative hedonic values of these shopping activities. To compare physical and electronic shopping in terms of their hedonic values for different categories of consumer goods and services, we focused on five effort-intensive characteristics of these shopping trips: price comparison, time needed for shopping (including research), product information other than price, interpersonal interaction, and access to the store. For convenience, we use the term p-shopping for physical shopping and e-shopping for electronic shopping. We rated these five characteristics of shopping for each category of consumer products in the p-shopping as well as e-shopping modes. Since the rating is subjective and heuristic, we employed a simple rating method in which -1 represents a negative hedonic value, 1 represents a positive value, and 0 represents a neutral state.

We made several assumptions to rate these product categories. For example, we assumed that consumers would have a hard time comparing prices in p-shopping. Price paid for a product detracts from its hedonic value. Hence, for high-priced products the score of -1 is assigned and for low-priced products the score of 0 is assigned. Going to p-shopping takes time; thus all categories of products are assigned -1 in terms of "time needed for shopping". For services, consumers must eventually go to the shop or service centre to receive services; thus all types of services are assigned 0. In p-shopping, consumers can get detailed information about the brands carried by the store. In addition, we assume consumers have enough about the information regarding frequently purchased products; thus, frequently purchased products are assigned 0 and less frequently purchased products are assigned 1. Some products need interactions with sales people and commodities (e.g., trying on a garment) or services people (receiving a massage). These products that need physical contacts are assigned 1 and other products are assigned 0. We assume consumers have better access to stores that offer frequently purchased products (assigned 0) and less access to stores that offer less frequently purchased products (assigned -1).

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Table 2. Hedonic Assessment of Physical Shopping Trips

Type of Shopping Trip*	Characteristics of the Trip (Trip Rating: -1=Negative, 0=Neutral, 1=Positive)					Hedonic Index of Trip
	Price Comparison	Time Needed	Information Needed	Interpersonal Interaction	Access to store	
1	-1	-1	1	1	-1	-1
2	0	-1	0	1	0	0
3	0	-1	1	1	-1	0
4	-1	-1	1	0	-1	-2
5	0	-1	0	0	0	-1
6	0	-1	1	0	-1	-1
7	-1	0	1	1	-1	0
8	0	0	0	1	0	1
9	0	0	1	1	-1	1
10	-1	0	0	0	0	-1
11	-1	0	1	0	-1	-1
12	0	0	0	0	0	0
13	0	0	1	0	-1	0

*Note: Trip type codes refer to the trip profiles in Table 1.

Using these assumptions, the hedonic indices of trips were calculated (Table 2). Table 3 rearranged shopping trips for different categories of products according their hedonic index scores.

Table 3. Hedonic Classification of Physical Shopping Trips

Physical Shopping Activities Classified by Hedonic Scores					
Low Hedonic Score		Medium Hedonic Score		High Hedonic Score	
Trip Type*	Score	Trip Type*	Score	Trip Type*	Score
4	-2	2	0	8	1
1	-1	3	0	9	1
5	-1	7	0		
6	-1	12	0		
10	-1	13	0		
11	-1				

*Note: Trip type codes refer to the trip profiles in Table 1.

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In the same manner, we assigned ratings for e-shopping activities. The results are shown in Table

4. For price comparison, we assigned 0 to frequently purchased products and 1 to less frequently purchased products. For time used for shopping, we assigned 1 for goods and 0 for all services.

For product information, we assigned 0 to frequently purchased products and -1 to less frequently purchased products. For interpersonal interaction, we assigned -1 to products that physical contacts are important and 0 to other products. For accessibility, we assigned 1 to all commodities and -1 to all services. Table 5 rearranges e-shopping activities based on their hedonic index scores.

Table 4. Hedonic Assessment of Electronic Shopping Trips

Type of Shopping Trip	Characteristics of the Trip (Trip Rating: -1=Negative, 0=Neutral, 1=Positive)					Hedonic Index of Trip
	Price Comparison	Time Needed	Information Needed	Interpersonal Interaction	Access to store	
1	1	1	-1	-1	1	1
2	0	1	0	-1	1	1
3	0	1	-1	-1	1	0
4	1	1	-1	0	1	2
5	0	1	0	0	1	2
6	0	1	-1	0	1	1
7	1	0	-1	-1	-1	-2
8	0	0	0	-1	-1	-2
9	0	0	-1	-1	-1	-3
10	1	0	0	0	-1	0
11	1	0	-1	0	-1	-1
12	0	0	0	0	-1	-1
13	0	0	-1	0	-1	-2

*Note: Trip type codes refer to the trip profiles in Table 1.

Table 5. Hedonic Classification of Electronic Shopping Trips

Electronic Shopping Activities Classified by Hedonic Scores					
Low Hedonic Score		Medium Hedonic Score		High Hedonic Score	
Trip Type*	Score	Trip Type*	Score	Trip Type*	Score
9	-3	11	-1	4	2

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7	-2	12	-1	5	2
8	-2	3	0	6	2
13	-2	10	0	1	1
				2	1

**Note:* Trip type codes refer to the trip profiles in Table 1.

E-Commerce and Transport Interactions

Tables 3 and 5 classified p-shopping and e-shopping activities into categories with low, medium, and high hedonic scores. Table 6 combines the results of Table 3 and 5.

Table 6. E-Shopping and P-Shopping Trips : Hypothesized Interactions

		<i>Hedonic score of e-shopping experience is</i>		
		LOW	MEDIUM	HIGH
<i>Hedonic score of p-shopping experience is</i>	LOW		10, 11	1, 4, 5, 6
	MEDIUM	7, 13	3, 12	2
	HIGH	8, 9		

**Note:* Trip type codes refer to the trip profiles in Table 1.

Substitution Effects

According to Table 6, we believe that products that have high or medium e-shopping and low p-shopping hedonic values could reduce consumer travelling to the store. These are trips to purchase product categories 1, 2, 4, 5, and 6. Examples include automobile, clothing, computer, groceries, and books. If the substitution effect happens, consumers would reduce their travel for shopping substantially. For products that have low e-shopping and high p-shopping hedonic values, however, e-commerce would have little substitution effects for travel. These are product categories 8 and 9 and examples include getting a haircut or getting one's ears pierced.

Rationalisation Effects

Rationalisation refers to the situation in which consumers modify their shopping trips with assistance of Internet and e-shopping. The modification could be changing the length of a trip,

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frequency of trips, timing of a trip, route of a trip, and mode of a trip (driving or riding bus) (Niles, 1997). Rationalisation could reduce total travel. Consumers could do online research for high cost products for price comparison and other information before the purchase. For products where physical contact is important, consumers could do online information and price research first, then go to desirable shops to test and buy the product. E-shopping has limitations in delivering services to consumers; especially services that occur in different locations and need intensive interpersonal interactions. Consumers could use two-step shopping for services. First they can do online research to compare services and even electronically purchase the package judged the best. Then they can go to the service centre or location to receive the service. E-shopping for products with medium e-shopping and medium p-shopping hedonic values (m-m profile) or other similar combinations, such as m-l, and l-m, should have rationalisation effects. According to Table 6, these products include categories 3, 7, 10, 11, 12, 13. Examples could be contact lens, tattoo, air ticket, cruise, movies, and museum. Thus, the rationalisation effect may reduce the total trips for shopping because it could reduce the trips for information search and ticket purchase.

Stimulation Effects

In most instances, transportation planners are not interested in stimulating user behaviour that leads to additional trips and could cause traffic problems. Usage of the new Internet and wireless media (and e-commerce activities using such media), however, could *sometimes* have the intended or unintended consequence of stimulating greater numbers of trips. If products have high hedonic values in both p-shopping and e-shopping, e-shopping may stimulate p-shopping and result in travel. While no product in Table 6 fell in this category, it is only a matter of time before multimedia e-commerce technologies would evolve in ways that could induce more travel.

Macro-systemic Effects

So far, we have only looked at the potential impact of retail e-commerce on physical travel by the shoppers. E-commerce, however, also affects the logistics of the retail supply chain. Instead of big shopping centers, e-commerce encourages the location of supply centers in low-rent areas with good shipping access. Also, instead of individual consumers making trips to the stores, there are trips made by delivery vans to the neighbourhood. Thus, the total trip reduction would be the difference between the reduced consumer trips and increased delivery trips caused by e-commerce in a certain area. E-shopping has advantages in busy holiday seasons in terms of time saving and

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accessibility. Thus, the availability of e-commerce in holiday seasons might mitigate traffic jams caused by holiday shoppers in commercial zones.

Individual Differences

Individual consumer characteristics could also affect the choice of p-shopping and e-shopping.

Early profiles indicate that men are more likely to go e-shopping and women to go p-shopping.

Computer literate people might like e-shopping. Outgoing people might like p-shopping and

introverts may like e-shopping. Consumers who lack computer and Internet access are unlikely to do

e-shopping unless kiosks are provided. Consumers who perceive using credit card online is

insecure are less likely to use e-shopping. Thus, demographics of a population might affect the

extent of the impact of e-commerce on people's travel patterns.

Summary and Conclusions

In those regions of the world where there is old, established and often congested road

infrastructure, any e-commerce-based methods that could lead to trip reduction and/or trip

rationalisation can contribute to an improvement in the quality of life. In those regions of the world

where new road infrastructure is being built, or could potentially be built, it is important for

transportation planners and new media and e-commerce planners to develop mutually supportive

systems that avoid the problems of congestion and pollution. While preliminary, this conceptual

framework helps in understanding the relationships between e-commerce activities and physical

travel.

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