

Effects of In-Fill Retail Center Development on Regional Travel Patterns

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Although the traditional centrifugal flow of metropolitan development continues, there is a countertrend both in the United States and abroad toward renewed real estate investment in the central business district (CBD) and in the older areas surrounding it. Construction in the non-CBD urban areas is called in-fill development. The goal of in-fill development is the rejuvenation of the urban environment through increasing densities, improving land use, and rationalizing transportation patterns. Regional transportation effects of the growing phenomenon of the in-fill mall are examined. Specifically, the focus is on changes in shopping area preference, travel mode choice, individual travel time, and vehicle hours traveled following the introduction of a new in-fill mall in the city of Haifa, Israel. Analysis is based on mall patrons' survey responses. These responses include information on shopping travel behavior before and after the opening of the retail center. Results show that the introduction of this in-fill mall appears to have resulted in a net improvement in the regional transportation system. Specific benefits include the reduction of individual travel times for preexisting shoppers by more than 17% and the reduction of highway network vehicle hours of travel by all patrons by more than 25%. On the basis of this research, it appears that in-fill locations of retail centers can be an effective way to rationalize development and maintain the strength and vitality of existing urban areas.

Traditionally, urban development has proceeded outward from the city center. Growth in the use of private transportation accelerated this trend and fostered the introduction of new patterns of consumption. Retail center complexes emerged in competition with the major stores in the central business district (CBD), and smaller shops scattered in clusters outside the CBD. The new retail centers combined a wide variety of stores and services in one location, often enclosed and climate controlled, and the centers were both easily accessed by the road network and capable of providing ample parking facilities. These shopping centers were built in fringe locations, typically in advance of residential development, where the sizable parcels necessary could be more economically acquired.

Although this traditional suburban flow of development continues, there is a countertrend toward renewed real estate investment in the CBD and in the older areas surrounding it. This paper refers to construction in the non-CBD urban areas as in-fill development.

In-fill development attempts to rejuvenate the urban environment by increasing densities, improving land use, and rationalizing transportation patterns. Typically, in-fill development occurs on undeveloped parcels or on parcels in which the original land use is no longer vibrant. In-fill locations, such as that of Boston's CambridgeSide

Galleria, can be particularly attractive for retail venues because often the sites are well connected to regional road and transit networks and are surrounded by existing residences of potential shoppers.

The question arises whether in-fill malls actually contribute to the rationalization of regional transportation patterns. Do these types of retail centers promote or hinder sustainable transportation for an urban region?

The purpose of this study is to examine the regional transportation effects of the growing phenomenon of the in-fill mall. Specifically, this study examines the changes in shopping area preference, travel mode choice, individual travel times, and vehicle hours traveled (VHT) following the introduction of a new in-fill mall in the city of Haifa, Israel.

This paper has three major sections. The first reviews the literature addressing the effects of new malls on regional travel behavior in general. This review also identifies traditional concepts of analyzing shopping trips. The second section introduces and considers the findings of a survey of visitors to a new in-fill mall. The third and final section concludes the paper and discusses avenues of future research.

LITERATURE REVIEW

A number of studies have been done on travel behavior to retail centers in general (1-11). Most of this research is aimed at refining the means of assessing effects of a new mall on the local road infrastructure, and does not directly address regional effects. Nonetheless, these studies do provide the tools and insights that help make a regional impact assessment possible.

Most research done to assess transportation effects at malls is performed using an approach that, first, considers the number of shopping trips likely to be generated at a retail center and, second, distributes those trips according to type. These trip types are meant to categorize shopping trips by the types of origins and destinations on either side of the shopping portion. The categories foster assessment of the total effects of a new in-fill mall.

Trip Generation

The traditional method for estimating the number of trips to a new mall is to use a formula based on the gross leasable area of a retail center. ITE planning guidelines provide an accepted formula (11), which has been confirmed largely by outside studies (7, 10). There is criticism that this method is too simplistic and does not sufficiently take into account variation of the actual retail center (7, 8). To improve this process, several researchers have tried to characterize the mall by more than ITE size factors alone (3, 4, 7, 8).

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Peyrebrune (7) reanalyzed 345 studies of mall trip generation computed by the ITE system with a more nuanced classification system developed by the Urban Land Institute. This system, adopted by the International Council of Shopping Centers, characterizes malls on the basis of both their size and their tenants, as neighborhood, community, regional, and super regional centers. She found that other than for the category of neighborhood center—the smallest centers that provide simply “for the sale of convenience goods (foods, drugs, and sundries) and personal services (such as laundry and dry cleaning, barbering and shoe repairing)”—there was no significant difference from the ITE approach.

Some researchers have looked at households, instead of retail centers, as the generators of shopping trips. This research considers a fixed demand for shopping on the basis of demographic and socioeconomic characteristics of the surrounding population. This perspective suggests that a new mall will create few new trips and instead will redistribute trips from other retail locations (2, 3, 5, 6, 10). Kittelson and Lawton (10) are proponents of that approach. Their work has affirmed the idea that a new mall results in few new trips. In their study, 5% of trips were new. Similarly, Kamali and Crow (3) found that only 5.3% of total trips at a new mall in Hertfordshire, England, were new.

Trip Types

Most researchers of shopping travel behavior argue for the importance of accurately categorizing trips to and from the mall (1–3, 5–11). Attempts have been made to classify trips so as to take into account their effect on the surrounding and regional road system. Many systems are in use. This paper presents a two-tiered approach that tries to consolidate the different existing trip type taxonomies.

The first tier establishes the role of the shopping stop in the total travel tour. Primary trips are those in which the mall is the main purpose of the tour. In a primary trip, the shopper originates from and returns to the same place on either side of the retail center stop. Linked trips are those in which the mall is a stop on a larger tour. In a linked trip, the origin and destination on either side of the shopping stop are different. Linked trips include actions such as stopping off at the mall on the way home from work.

The second tier subdivides the trips within the categories of the first tier. Primary trips can be split into new and transferred trips. New trips are primary trips that are new to the network, such as those mentioned above. Transferred trips are primary trips that would previously have been made to another shopping venue. Linked trips can be split into undiverted and diverted linked trips. Undiverted trips are linked trips in which no route diversion is necessary to stop at the retail center. These are often called pass-by trips. Diverted trips are those linked trips that called a route diversion to accommodate the shopping portion.

Each trip type has a different effect on the transportation network. In theory, only new primary trips are “new” to the network, because both transferred and linked trips were preexisting (2, 3, 5, 6, 10, 11). Typically, undiverted trips are assumed to have no effect on the local or regional system, because the same route would be used regularly regardless of the introduction of the mall (2, 3, 6–11).

In reality, although new primary trips are most likely totally new to the network, the redistribution of transferred and linked trips may have substantial effects on the local and regional network. Furthermore, undiverted trips to a new mall may actually represent a change in travel patterns. For example, commuters who, before the new mall was introduced, regularly diverted their trips home to purchase groceries may find this previous diversion unnecessary with the introduction of the new mall. Therefore, their new, undiverted route will represent an increase in daily traffic volumes on the direct route to home.

Table 1 presents the results from several studies of retail centers in North America and Great Britain. These results show a remarkable consistency of trip type breakdowns for the afternoon peak period. This period is most often studied because it is the period in which the local effects of the mall are most predominant. According to these data, primary trips account for about one-third of traffic, and linked trips account for about two-thirds. New trips, when they are recorded, are not more than about 5% of all trips. Among linked trips, undiverted trips are always outnumbered by diverted trips but always account for at least one-fifth of total trips. These breakdowns vary slightly from the afternoon peak period rates presented in the ITE *Trip Generation* manual. There, primary trips account for 43% and linked trips account for 57% of afternoon shopping trips (11).

TABLE 1 Retail Shopping Trip Distribution (P.M. Peak Period)

Year Published	Researchers	Location	Number of Retail Centers Surveyed	Primary			Linked		
				Total	New	Transferred	Total	Undiverted	Diverted
1981	Slade and Gorove	Washington, D.C.	1	35%	NA	NA	65%	25%	40%
1987	Kittelson and Lawton	Portland, OR	NA	35%	5%	30%	65%	NA	NA
1989	Hazel	Edinburgh	1	35.9%	1.8%	34.1%	63.8%	30.7%	33.1%
1990	Toth et al.	Calgary	7	38.7%	NA	NA	61.3%	20.5%	40.8%
1991	Moussavi and Gorman	Omaha, NE	5	26.8%	NA	NA	73.2%	22.4%	50.8%
Average			NA	34.3%	NA	NA	65.7%	24.7%	41.2%
<i>Trip Generation (11)</i>			NA	43%	NA	NA	57%	24%	33%

Although these researchers made very comprehensive surveys of mall use, few of them compared the current situation with previous patterns in terms of regional effects. Notable exceptions are Kittelson and Lawton (10), who argue that an additional shopping center may reduce total traffic on the regional network and Kamali (2), who argues that retail centers located between residences and town centers or residences and other malls may lead to a net reduction of total regional traffic. Kamali's description of such a mall location characterizes the settings of in-fill malls, in general. Such conditions are true for the Grand Canyon, the new in-fill mall in Haifa, which is the focus of this study.

HAIFA SURVEY

The 2000 opening of the Grand Canyon provided an excellent opportunity to study in-fill mall effects on the regional transportation network.

City of Haifa

The city of Haifa is built on Carmel Mountain, rising up from a bay on the Mediterranean Sea. Because of the topography of this mountain, the roads and public transit routes are quite circuitous. The city has developed two distinct CBDs and a third smaller center at three different levels of the mountain. The two CBDs include the Lower City, at the foothills of Carmel Mountain, and Hadar, located halfway up the mountain. At the top of the mountain is the Carmel Center, which, although smaller than Hadar and the Lower City, boasts an array of tourist and cultural activities. The only straight-line connection between these three centers is a six-stop, underground funicular called the Carmelit. All these centers are composed of small shops and have been losing their attractiveness as shopping destinations over the years in part because of their continuing parking shortage.

The Haifa metropolitan area is divided into two main sections, each with its own residential and business areas. One section is the city of Haifa itself and the other is an amalgam of smaller cities, called the Keryot, located to the north of the city of Haifa. "Keryot" literally means "cities" in Hebrew and together these smaller municipalities make up a second major residential and employment center.

The Grand Canyon

The Grand Canyon has the characteristics of a typical in-fill mall development. It has a central location between the CBD and the edge of the city. It lies at the junction of several major roads. It is well serviced by the region's predominant mode of public transit, in this case, buses. And, it is close to several residential neighborhoods. Unlike some in-fill malls, the Grand Canyon also provides an ample amount of free parking.

The Grand Canyon was built on land taken from green space in the city of Haifa. It is currently the biggest retail center in the metropolitan area. The mall is well named, not only for its great size, but because it is located in a natural valley and the word in Hebrew for mall is "kanyon."

Before the Grand Canyon, there were no malls in the city of Haifa. Haifa residents who wanted to shop in a regional mall had the option of traveling to the Haifa Mall, located at the southern entrance to the city, or to a few malls located in the Keryot, north

of the city. These malls are all traditional city edge or fringe malls. The other shopping locations in the region would be classified as community centers.

Survey Methodology and Questionnaire

To study changes in travel patterns after the introduction of a new in-fill mall, a survey of 240 visitors to the Grand Canyon was conducted in April 2000, mostly during the afternoon peak period. The mall had been open for roughly 4 months. It was thought that at that point the initial wave of "curiosity" visitors had given way to regular shoppers, and that these shoppers would still be likely to accurately recall their previous patterns. Such patrons were randomly sampled at several main locations in the mall to avoid bias in the data.

Visitors were asked a series of detailed questions, which can be broken down into two categories: demographics and travel behavior. The demographic data requested included gender, automobile availability, age, household size, income, and number of children over/under age 8. Travel behavior information requested included pre- and postshopping origin and destination (by both purpose and location), purpose of the mall visit itself, mode of travel to the mall, number of people traveling together, number of visits in the previous month, duration of mall visit, former shopping location, and mode of travel to the former shopping location.

The locations of origin and destination sites on either side of the shopping trip were converted into the metropolitan transportation analysis zone system. The Haifa transportation model was then used to determine automobile, bus, and walk travel times between the stated preshopping origin and postshopping destination for both the Grand Canyon and the previously used shopping venue.

SURVEY DATA ANALYSIS

The collected data were entered into a spreadsheet and analyzed in several ways. The first analysis assesses trip types for comparison with the studies presented in the literature review. The second analysis examines the data in terms of the previous shopping venue. The purpose of this analysis is twofold: first, to see whether the in-fill mall draws its clientele from peripheral malls or from the CBD and, second, to compare general changes in mode and travel times that result from the change in shopping area choice. The third and final analysis focuses exclusively on changes in mode choice to examine effects on vehicle hours traveled.

Because the sample size is limited as a result of budget constraints, effort was made to emphasize only findings for which there was a relatively high response. In several cases findings based on a few responses are noted as well. These data are included either to denote a relationship to trends found elsewhere or to provide a baseline measure for comparison with future research efforts.

Analysis 1: Trip Type Distribution

Respondents were asked to categorize their trip origins and postshopping destinations as home, work, errands, or other. Table 2 presents this information in a matrix. These data are used to examine trip types for comparison with the data from the studies shown in Table 1. Shopping tours for which the origin and destination are the same and are either a home or a work location are considered to be primary trips. All other tours are considered linked trips.

TABLE 2 Shopping Tour Origins and Destinations

Origin	Destination				Total
	Work	Work	Errands	Other	
Home	153	8	7	5	173
<i>Car</i>	106	2	5	4	117
<i>Bus</i>	36	6	2	0	44
<i>Walk</i>	16	0	0	1	12
Work	38	9	2	0	49
<i>Car</i>	33	7	2	0	42
<i>Bus</i>	5	2	0	0	7
<i>Walk</i>	0	0	0	0	0
Errands	8	3	0	0	11
<i>Car</i>	4	0	0	0	4
<i>Bus</i>	4	3	0	0	7
<i>Walk</i>	0	0	0	0	0
Other	7	0	0	0	7
<i>Car</i>	6	0	0	0	6
<i>Bus</i>	1	0	0	0	1
<i>Walk</i>	0	0	0	0	0
Total	206	20	9	5	240

The matrix provides insight into travel behaviors to the mall. There is a very high proportion of primary trips that begin and end at a residence. Almost two-thirds of all respondents reported such home-home primary trips. This figure suggests that mall proximity to home is a major factor affecting shopping behavior. This idea is affirmed by the 31% of such shoppers who came by bus or pedestrian modes. These mode selections seem likely only if the time costs are reasonable.

Figure 1 presents the breakdown of trip types from the Grand Canyon survey. There are a number of interesting findings. One is the 2.9% of "new" trips on the network that could be discerned from survey responses. This low rate is in accord with rates reported in the literature review. It should be noted, however, that half of these new trips are by people who came to work in the mall. Therefore, in addition to new shopping opportunities, the mall provides new employment opportunities. Another finding is that the percentages of primary and linked trips at the Grand Canyon are rough inverses of the results from elsewhere.

This distinction may be the result of several possible and interacting factors. First, these results may be a unique feature of in-fill

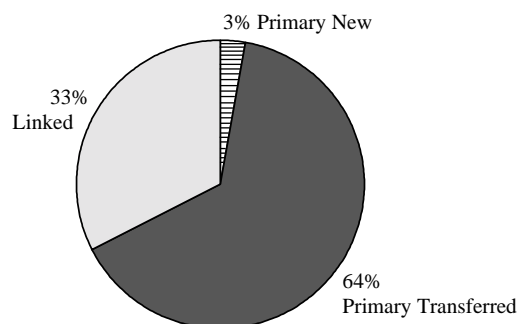


FIGURE 1 Trip type breakdown at the Grand Canyon.

malls. That is, that there is a consumer preference to stop at home before shopping, and in-fill mall proximity to residential areas makes it possible for such a stop to be made. Second, the relatively dense urban form of Haifa may also facilitate stopping at home first. Finally, because of the relatively early dismissal times of Israeli schools, parents need to go home earlier to tend to their children. Therefore, afternoon shopping trips may originate disproportionately from home rather than from work locations.

Analysis 2: Previous Shopping Venue Comparison

The survey addressed the change in shopping behaviors by asking shoppers where they would have gone for the same purposes before the opening of the Grand Canyon. Figure 2 presents the breakdown of responses.

These data are extremely important for assessing the relative effect of the Grand Canyon on both CBD and city edge shopping venues. Notably, 69% of in-fill mall visitors would previously have used one of the other three regional malls, and only 12% would have used the two CBDs or the Carmel Center. This finding could be interpreted to suggest that the Grand Canyon is more successful at luring shoppers from peripheral malls than from CBD shopping areas. However, it is more likely that the peripheral malls have already taken a large share of downtown shoppers.

It is also interesting to note the high percentage of shoppers at the Grand Canyon who previously visited the Haifa Mall and Lev HaMifratz. These two malls on the edge of the city of Haifa were the previous retail venue of choice for roughly one-third and one-quarter, respectively, of Grand Canyon shoppers. This finding affirms the importance of proximity in enticing consumer trips and demonstrates the draw of an in-fill mall.

These data of previous shopping venue choice also confirm the idea that the introduction of a new mall does not create many new trips, but rather redistributes the existing demand for shopping. More than 95% of trips to the Grand Canyon would have previously been made to other retail venues, with less than 5% of all shopping trips being induced by the new mall opportunity.

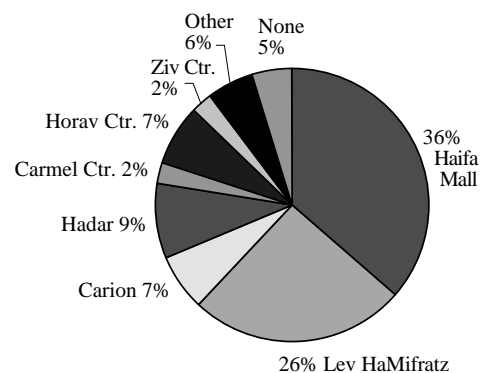


FIGURE 2 Previous retail venue split. (The "other" category = locations with three or fewer responses, including distant shopping areas such as Tel Aviv and the Lower City. Therefore, 11.7% of Grand Canyon shoppers surveyed previously shopped at the CBDs.)

TABLE 4 Travel Times by Previous Retail Venue

Retail Center Used Previous to Grand Canyon	Average Travel Times for Grand Canyon (min.)			Average Time Savings per Trip (min.)			Percent Difference
	To Mall	From Mall	Total	To Mall	From Mall	Total	
Haifa Mall	21.2	26	47.2	5.7	5.1	10.8	18.6
Lev HaMifratz	19.4	21.8	41.2	6.7	-0.2	6.5	13.6
Carion	30.1	39.9	70	-0.4	-5.1	-5.5	-8.5
Hadar	20.5	16.7	37.2	13.7	13.6	27.3	42.3
Carmel Center	16.5	20.4	36.9	-1.5	-1.2	-2.7	-7.9
Horav Center	9.8	12.6	22.4	10.5	8.7	19.2	46.2
Ziv Center	10.6	12.6	23.2	2.8	3.4	6.2	21.1
Other	22.5	24.6	47.1	-1	-5.8	-6.8	-16.9
None (New Trip)	39.2	25.7	64.9	NA	NA	NA	NA
All Respondents Previous	20.4	24.1	44.5	4.5	1.3	5.8	11.5

to the Grand Canyon, roughly 14% changed their mode. The remaining 5% of patrons were not previous shoppers. This finding affirms that the introduction of a new retail center can affect mode choice. In this case, as noted above in the second analysis, the net effect of that choice slightly favors more sustainable modes.

Vehicle Hours Traveled

From a transportation system perspective, a critical gauge of the regional effects of a new mall is that center's effect on VHT and vehicle miles of travel (VMT). Although these two measures are highly correlated, VHT is analyzed here and can serve as a proxy for VMT as well. By examining the travel time changes for each of the 12 combinations of mode choice, it is possible to calculate changes

in private vehicle travel times. Only private vehicles are considered because bus vehicle trips are assumed to be fixed and pedestrian trips are not counted in an analysis of VHT. In comparing private vehicle travel times of shoppers before and after the introduction of the Grand Canyon, a 26% reduction in VHT is found. This reduction is noteworthy and is a testament to the positive transportation effects of this in-fill mall.

CONCLUSIONS

The goal of this paper is to assess the effect of a new in-fill mall on regional travel patterns. The data collected in this study suggest that the addition of an in-fill mall can reduce individual travel times for

TABLE 5 Changes in Mode and VHT

Previous	Mode			Total Travel Time		Time Savings		VHT		
	Current	Number	Percentage	Previous	Current	Net	Percentage	Previous	Current	Savings
Car	Car	153	63.8	5742.0	4325.9	1416.1	24.7	5742.0	4325.9	1416.1
	Bus	13	5.4	540.2	1618.1	-1077.9	-199.6	540.2	0	540.2
	Walk	5	2.1	187.0	245.6	-58.6	-31.3	187.0	0	187.0
Bus	Car	5	2.1	449.0	149.0	300.0	66.8	0	149.0	-149.0
	Bus	41	17.1	3985.2	2973.6	1011.6	25.4	0	0	0
	Walk	4	1.7	641.8	306.4	335.4	52.3	0	0	0
Walk	Car	5	2.1	333.1	69.2	263.9	79.2	0	69.2	-69.2
	Bus	2	0.8	118.1	167.3	-49.2	-41.6	0	0	0
	Walk	1	0.4	10.0	115.2	-105.2	-10.52	0	0	0
No Trip	Car	6	2.5	0.0	266.2	-266.2	NA	0	266.2	-266.2
	Bus	3	1.3	0.0	388.3	-388.3	NA	0	0	0
	Walk	2	0.8	0.0	60.0	-60.0	NA	0	0	0
Totals		240	100.0	12006.3	10684.8	1321.5	11.5	6469.2	4810.3	1658.9

preexisting shoppers by more than 17% and the highway network VHT by all patrons by more than 25%. Such a mall reduces total vehicle trips only slightly because the benefits of those preexisting shoppers who switch to more sustainable transportation modes are counterbalanced by the trips of new shoppers and employees induced by the new mall.

The majority of the shoppers attracted to the new in-fill mall previously frequented peripheral malls. These shoppers shifted to more sustainable transport modes in the highest numbers. Only a small percentage of Grand Canyon patrons previously shopped in the CBD.

In short, the introduction of this in-fill mall appears to have had a net benefit on the regional transportation system. Although this study took place in a specific location with a relatively small sample size, results suggest that such in-filling can be an effective way to rationalize development to maintain the strength and vitality of existing urban areas. Further research should be undertaken to study these phenomena in other cities.

FURTHER RESEARCH

This paper is aimed at studying the regional transportation effects of a new in-fill mall. Currently, there has been little research conducted on regional transportation effects of any types of malls—CBD, in-fill, or city edge. It is hoped that this work will encourage a greater exploration of the macroscale effects of all types of malls. Such research should emphasize changes in consumer behavior after the addition of a new shopping opportunity and the regional effects of those changes. More research will make it possible to increase the ability to generalize results across countries and communities.

This paper emphasizes the unique situation of in-fill malls in affecting regional travel patterns. Because a greater planning emphasis is currently being placed on in-fill development (often under the guise of urban renewal, land use densification, and transit-oriented development), more research needs to be undertaken to properly assess the regional effects of in-filling.

This paper presents a tripartite taxonomy of retail center location: CBD, in-fill, and city edge. This breakdown is seen as a useful means to categorize malls by their place in a community. Future work could add significantly to our understanding of the differing effects of these

different types of malls and to the conceptual usefulness of these categories.

Finally, improved survey methods such as trip diaries and stated preference studies regarding shopping habits could advance this work further. Analysis based on activity-based models would also be quite useful.

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