Effect of Transportation on the Decline of City Commercial Center in Competition with Large Sub Urban Shopping Center

Kazuaki Nakai[1)] Kardi Teknomo [2)] and Kazunori Hokao[3)]

1) Department of Civil Engineering, Saga University
1 Honjo-machi, Saga-shi 840-8502, Japan
E-mail: 00t756@edu.cc.saga-u.ac.jp
2) Institute of Lowland Technology, Saga University
1 Honjo-machi, Saga-shi 840-8502, Japan
E-mail: kardi@cc.saga-u.ac.jp
3) Department of Civil Engineering, Saga University
1 Honjo-machi, Saga-shi 840-8502, Japan
E-mail: hokao@cc.saga-u.ac.jp

Abstract. The influence of large sub urban shopping center toward the decline of inner city commercial center has attracted many researchers. To prevent the decline of the city center due to urban sprawl, it is necessary to understand the influence of sub urban shopping mall development in competition with the city commercial center. This paper reports the investigation on the transportation effect on the decline of city commercial center in competition with large sub-urban shopping centers. A special case study was selected in Saga city in Japan where the city center has evident of declining. The data was gathered through an intensive questionnaires survey of the previous study. Statistical analysis of consumer behavior and a shopping location choice model were developed. It was found that one of the most important factors for shopping location choice is the availability of free parking lot in sub-urban shopping centers compare with the high paid parking in the city center.

INTRODUCTION

Recently, the influence of large sub urban shopping center toward the decline of inner city commercial center has attracted many researchers. The downtown shopping street is an important part of the city attractiveness. There is an apprehension that the decline of city center shopping center may leads to the decrease of the entire city appealing points. Moreover, the decline of the downtown shopping center creates many inconveniences for the transportation-disadvantaged people like the senior citizen and a handicapped person.

It is necessary, therefore, to clarify the factors that influence the city decline so that the continuation of downtown decline may be controlled and the effect could be minimized. To prevent the decline of the city center due to urban sprawl, it is necessary to understand the influence of sub urban shopping mall development in competition with the city commercial center. This paper reports the investigation on the transportation effect on the decline of city commercial center in competition with large sub-urban shopping centers.

Based on the previous study, it is understood that the rapid development of urban motorization is the reason of activation suburban development. The urban motorization may causes the shift of consumer shopping behaviors toward farther shopping destination as indicated by Yoshida et al (1999). This may lead to the increase of sub urban shopping centers users. In general, there is a strong competition between the downtown and sub urban shopping centers. We conjecture that suburban shopping center development is the main factor for the decline of the commercial establishment in the downtown area. However, the details of this conjecture have not been clarified enough at the present stage. We aim to examine the decline the commercial establishment of the downtown by focusing on the transportation point of view. In this research, we analyze the decline factors of downtown shopping street based on the change of the past and present transportation.

The significant of this research is due to the uniqueness of study area for research decline the commercial establishment of the downtown due to change of the transportation system factors. The research may demonstrate as real example of the investigation of transportation system factors (i.e. parking. public transportation facilities and motorization) on the decline of the city rather than on the city growth.

METHODOLOGY

Study Area

A special case study was selected in Saga city in Japan where the city center has evident of declining. For Saga city, the decline of the downtown becomes a main problem in for the city. The number of empty stores in downtown areas has remarkable increases recent years as a good sign of downtown decline. On average, the decline ratio of empty stores is 9.3% per year. The total ratio of the downtowns of empty stores is about 18% out of the total number of stores. When the number of shops in a shopping street declines with above 10% empty store ratio, many necessary business types of a shopping street will become incomplete and further advance the decline more rapidly. In 2004, about 40 percent of the shopping streets in Saga city have exceeded the 10% empty store ratio. While the city center is declining, a large number of shopping center developments are on the rise in sub urban area. This unique phenomenon has made Saga city as appropriate place to conduct this study.

The previous research in Saga city had been done by Umetani (2004) which analyze the change of consumer's shopping behavior due to the development of sub urban shopping center. The study pointed out that there is a simple relation of the transportation degeneration (in term of inconvenience) between sub urban development and downtown shopping center. The study however, failed to model this relationship and unable to indicate the factors of the decline.

Interestingly, until recently, there are *only* two large urban developments in the sub urban area where become the particular locations of the study area. Figure 1 below show the map of Saga city with the train station as the city center and downtown shopping street in the south of the station. The two sub urban shopping centers are Mallage Saga Shopping complex in the east of the downtown and Eon Shopping Town Yamato in the north of the city. The details of the two sub urban shopping complex are given in Table 1.

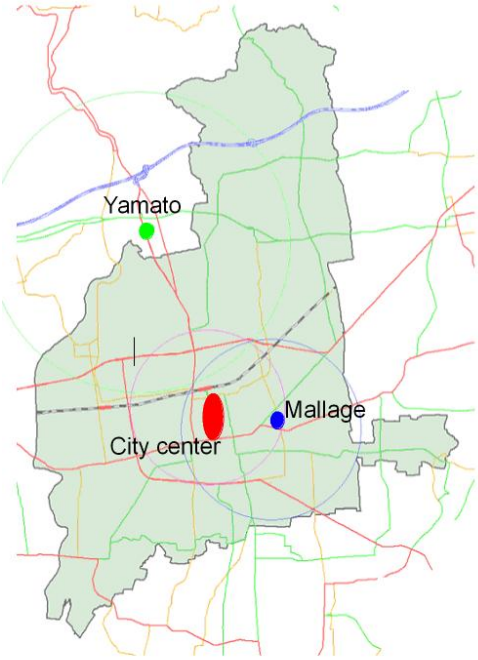

Figure 1 Study Area

Table-1 Outline of Sub Urban Large Scale shopping complex in Saga city

Shopping Complex	Yamato Shopping Town	Mallage Saga
Opening	9 September,2000	21 March,2003
Lot area	95,462m^2	108,000m^2
Area of store	36,620m^2	37,100m^2
Total parking lot	2084	3008
Sales expectancy	18,000 million Yen/year	15,000 million Yen/year
Visitor expectancy	3 million people per year	7 million people per year
Number of specialty stores	100	76

Data Collection

The data for this research was a secondary data from the questionnaires survey collected in the previous study. The data was gathered through an intensive questionnaires survey by Umetani (2004). The data comprises of more than 100 variables representing the individual shoppers' characteristics, shopping behavior and preferences, attractiveness toward itemize of shopping choices, and transportation means and its characteristics (such as travel time and cost, parking etc.). Total valid sample is about 500 individual data.

SURVEY RESULTS AND ANALYSIS

Our research focus is on the investigation on the transportation effect on the decline of city commercial center in competition with large sub-urban shopping centers. Statistical analyses of shopping location choice model and consumer behavior were developed and the results will be summarized in this section. Because of the discrete nature of the investigation, for both analyses, logistic regressions were used.

Before the modeling part, it is necessary to explain the transportation characteristics of the shoppers in Saga city. Firstly, we want to show the composition of the shoppers' based on their mode choices. Table 2 shows that majority of shoppers are car users while for downtown shopping mode the mode choices are more balance between public transport with car due to the high service of public transportation.

Table-2 Composition of transportation mode of shoppers

	Yamato	Mallage	City
Public transport and bicycle	7.2%	15.7%	41.0%
Car users	92.8%	84.3%	59.0%

Table-3 Travel time and travel distance of shoppers

	Travel time (minutes)			Travel Distance (km)		
	Yamato	Mallage	City	Yamato	Mallage	City
Average	20.82	15.89	14.60	7.662	6.208	4.520
Public transport and bicycle	30.18	15.83	13.70	4.750	2.900	2.323
Car user	20.22	15.90	15.36	7.744	6.883	5.730

Table 3 shows the travel time and travel distance of the shoppers separated by mode and on the average. Based on the travel distance separated by the transport mode we can draw the influence diagram of the three shopping centers as shown in Figure 2. Figure 2 indicate clearly the effect of the motorization since (a) represent non-cars travel distance while (b) represent cars users travel distance. Car users has ability to farther away for their shopping therefore make the sub-urban shopping centers become comparatively near.

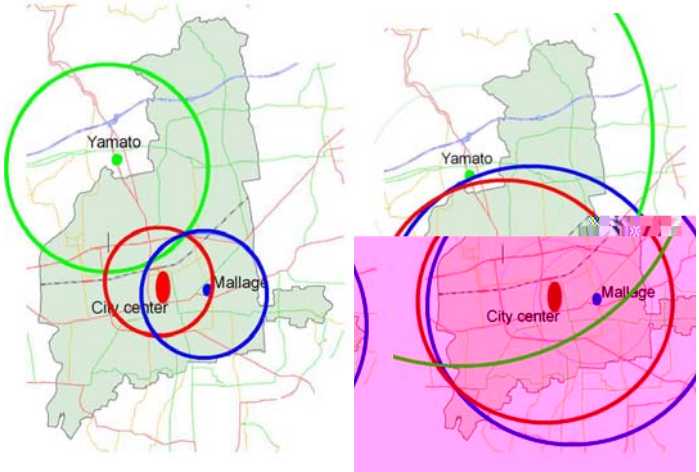

Figure 2 Influence diagram based on travel distances for the three main shopping mall for (left) public transport and bicycle users, and for (right) car users

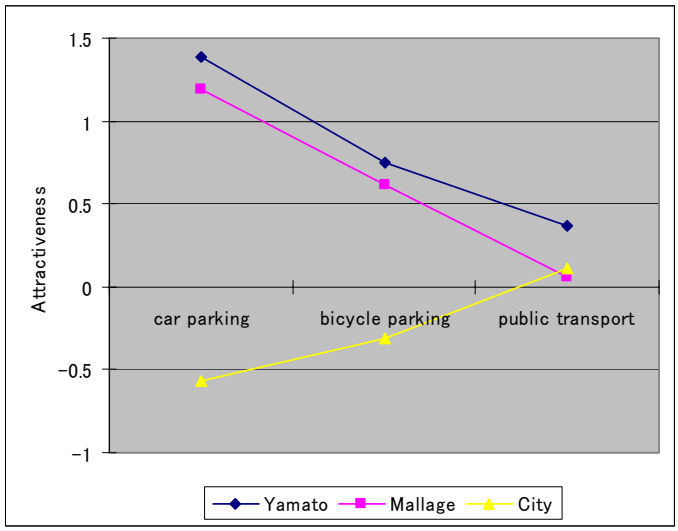

Figure 3 Cross tabulation of shopping center attractiveness by the transportation facilities

Figure 3 shows the overall attractiveness index based on the questionnaires survey cross tabulation with the transportation facilities and the three shopping centers in the study area. The figure clearly indicates that car parking facility is very unattractive in the city center compare with the two sub urban sopping centers. The public transportation facilities, however, indicates that the three main shopping centers has the same attractiveness level. This result will be strengthening further by the shopping location choice models below.

Shopping Location Choice Models

The purpose of the modeling process is to select the main factors that customers select a particular shopping location. At first, the three major locations of downtown shopping street, Mallage and Yamato were investigated with extensive combinations of factors. Multivariate logistic regressions were used for these modeling; it varies from linear combination to several non-linear combinations. The investigations, however, did not produce any significant model that statistically can explain the why the shoppers choose a particular shopping location.

Table 4 Main Independent variables

X_1	Travel time (minutes)
X_2	Distance from trip origin (km)
X_3	Stay time in the shopping center (minutes)
X_4	Transportation Mode (Car = 1, bicycle and public transportation = 0)
X_5	Attractiveness due to availability of free parking
X_6	Attractiveness due to availability of bicycle-parking space
X_7	Attractiveness due to enhancement of public transportation facility
X_8	Use day (Weekday/Holiday)
X_9	Gender
X_{10}	Age group (Young, middle age and old)
X_{11}	Shopping frequency (number of visit / month)

Further analyses therefore, were performed with the combination of the dependent variables. Instead of three shopping location choices, the two sub urban shopping centers were combined as sub urban shopping centers against downtown shopping streets. The model becomes binary logistic. The dependent variable is set to 1 for the people who select downtown shopping streets and 0 for the customers of sub

urban shopping complex. Among more than 100 variables, we have carefully chosen 11 main independent variables based on the statistical significant contribution of these variables toward the dependent variables. These 11 variables are shown in Table 4. Variables X_1, X_2, X_3 and X_{11} are ratio scale. Variables X_5, X_6 and X_7 are ordinal scale with 5 distinct values. They measure the people perception and preference but not behavior. The other remaining variables are nominal scale.

Let p be the probability of selecting sub-urban shopping centers and $1-p$ is the probability to select the city center shopping street, the shopping location choice model is given by Equation (1) as logarithmic of the odd ratio between the two selections.

$$\log\frac{p}{1-p} = b + \sum_i a_i x_i \qquad (1)$$

A noted must be given here that though the equation (1) has form of linear combination of the independent factors, the real model are not necessarily linear. In fact, the analysis from the survey result for linear combinations did not produce any significant result for the model. Thus, we explore model into non-linear one that give quite satisfactory results as will be shown below.

For the purpose of customer behavioral choices, we examine the shopping location choice model by gender and age group representing the customers' behavior. Similar separation for other type of study has been done by Hanaoka et al (1999) which suggested separation of travel time of shoppers by gender and age group. General model without category, or other categories had been tried in this research without satisfactory results.

Separation of customer choices by gender produces high classification rate with satisfactory coefficient of determination as shown in Table 5. The best-fitted models are given by equation (2) for man and equation (3) for woman.

$$\log\frac{p}{1-p} = 2.043x_5 - 52.972x_3^{-1} + 1.157 \qquad (2)$$

$$\log\frac{p}{1-p} = 1.700x_4 + 1.555x_5 + 0.002x_1^{2} + 1.289\ln x_3 - 7.503 \qquad (3)$$

Table-5 Significance Level for Shopping Location Choice Model separated by Gender

	Nagelkerke R^2	Percentage Correct
Equation (2) – Man	0.747	90.3
Equation (3) - Woman	0.638	86.6

Table-6 Odds Ratio for Shopping Location Choice Model separated by Gender

Man	x5	x3	Constant		
Odds ratio	7.713	0.000	3.180		
Woman	x4(1)	x5	x1	X3	Constant
Odds ratio	5.472	4.737	1.002	3.630	0.001

For both models, staying time in the shopping mall (x_3) and the availability of free parking space (x_5) are the significant factors. For woman, additional car as transportation mode (x_4) and travel time (x_1) also affect their choices.

For both man and woman, they wish to stay longer time in the shopping center produce more choices to the downtown shopping center. Noted must be given that though the coefficient of x_3 in equation (2) is negative, the factor is in the inverse form. Longer staying time produces higher odd ratio.

Interestingly, the shopping location choices also yield significant results for separation by the age group. The age groups were categorized into three classes of young (<39 years old), middle age (40-59 years old) and elderly (>60 years old) with high classification rate with satisfactory coefficient of determination as shown in Table 7. The best-fitted models are given by equation (4) for young, equation (5) for middle age and equation (6) for elderly people.

$$\log\frac{p}{1-p} = 2.665x_5 - 3.994x_2^{-1} + 1.571\ln x_3 - 5.503 \quad (4)$$

$$\log\frac{p}{1-p} = 1.942x_5 - 0.780x_7 + 1.660x_{11}^{-1} - 1.222 \quad (5)$$

$$\log\frac{p}{1-p} = 2.299x_4 + 1.191x_5 + 2.135x_{11}^{-2} + 0.002x_1^{2} - 3.409 \quad (6)$$

Table-7 Significance Level for Shopping Location Choice Model separated by Age Group

	Nagelkerke R^2	Percentage Correct
Equation (4) – young	0.833	95.9
Equation (5) – middle age	0.583	83.1
Equation (6) - elderly	0.620	84.6

Table-8 Odds Ratio for Shopping Location Choice Model separated by Age Group

Young	x_5	x_2	x_3	Constant	
Odds ratio	14.366	0.018	4.810	0.004	
Middle Age	x_5	x_7	x_{11}	Constant	
Odds ratio	6.972	0.458	5.260	0.295	
Elderly	x_4	x_5	x_{11}	x_1	Constant
Odds ratio	9.965	3.292	8.454	1.002	0.033

For young shoppers, the main factor for shopping location choice are staying time in the shopping mall (x_3) and the availability of free parking space (x_5) and distance of the shopping mall from their house (x_2). Interestingly, for middle age people, the main factors of the shopping choice are the availability of free parking space (x_5), availability of public transportation facility (x_7) and shopping frequency (x_{11}). For elderly people, the shopping choice location is depending on the car usage (x_4) and availability of free parking space (x_5), shopping frequency (x_{11}) and travel time (x_1).

It is interesting to see that the availability of the free parking space remain for the three models indicate this factor is dominant. Shopping frequency factor only appears in middle age and elderly model in an inverse form indicate that these age group has more concern about shopping habits (compare to the young shoppers) and people who has less frequent to shop will go to downtown shopping street rather than to the sub urban shopping mall. Elderly has more concern about transportation mode since they are more concern to car as transportation mode rather than to public transport.

Consumer Behavior Indicator

By converting the odd ratio into probability, as shown in equation (7), the effect of each variable to the consumer choice to select the shopping center can be simulated.

$$p = \frac{e^{b+\sum_i a_i x_i}}{1+e^{b+\sum_i a_i x_i}} \quad (7)$$

Since the number of population in the town is relatively stable in a short time period, we can easily assume that the number of shoppers is constant. The probability p represents the number of people to shop in sub-urban shopping centers and we model the competition between downtown and sub-urban shopping centers; therefore, the value of probability itself can be used as an index of consumer behavior. Higher the value of probability p, more shoppers will select sub urban shopping centers and reduce the number of shoppers in the downtown shopping street. Conversely, high probability value p corresponds to the city center decline and growth of sub urban shopping centers. In other word, the probability value p is the consumer behavior indicator of the decline of downtown shopping street.

Based on the models describe in the previous sub sections, sensitivity analysis and simulation of the

included variables has been performed. Figure 4 shows the sensitivity of attractiveness due to the availability of free parking for car users (left figure) and shopping frequency (right). The vertical lines characterize the current conditions. For the attractiveness of free parking in downtown, the value of current condition is 0.67 while the current average of shopping frequency is 4.3 number of visit per months. The value of indicator p in general are higher for car users rather than for the bicycle and public transportation users. This happens because the number of shoppers using car is much greater than the shoppers that use other transport mode. The simulation results yield that greater the number of free parking may attract consumer to sub-urban shopping center non-linearly. Providing more free parking in both sub-urban shopping centers and downtown shopping street will only affect to the decline of the downtown. It may be suggested to put some parking charge to sub-urban shopping center, which will reduce the attractiveness of sub-urban shopping mall due to parking facilities. This suggestion, based on Figure 4 left, may improve the decline of downtown.

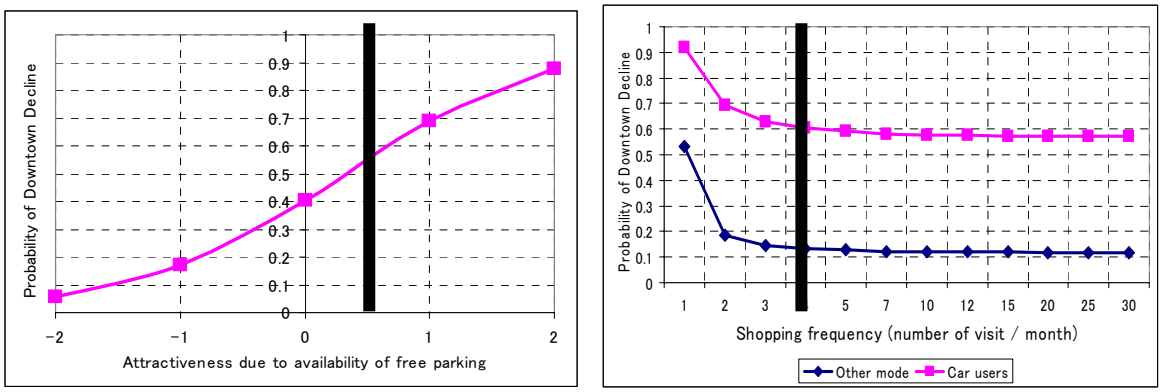

Figure 4 Sensitivity of Parking availability (left) and shopping frequency (right) by mode of shoppers

Other results suggest that for people who come to shop more often than the current average conditions, the choice between city center and sub-urban shopping mall will yield to a constant value. This can be seen from the asymptotic values of indicator p that is going to flat as the shopping frequency increases. For the people who shop with frequency less than once a week, the sub-urban shopping center is a better choice than the sub urban shopping mall, regardless whatever the transportation mode they use. This behavior may come from the travel distance or travel time to downtown that is less than sub-urban shopping mall. Furthermore, the right graph of Figure 4 indicates that for people who shop more often, they may prefer downtown shopping street to sub urban shopping centers. This result is potentially interesting as a new way to improve the decline of the city center by suggesting downtown shopping street to provide market that sell daily products (such as food or raw cooking materials) and supermarket in order to differentiate the market from sub-urban shopping centers.

Further analysis of the travel time to go to the shopping center, as shown in Figure 5 specify that nearer the consumer house from the shopping market, downtown shopping street would be more attracted than the sub-urban shopping mall. Car users may be more attracted to sub-urban shopping center than the public transportation and bicycle users.

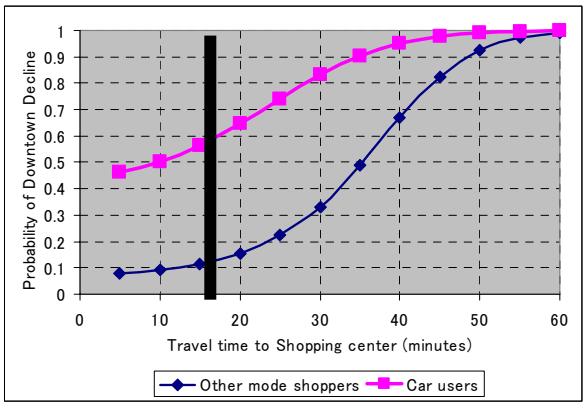

Figure 5 Sensitivity of travel time to shopping center

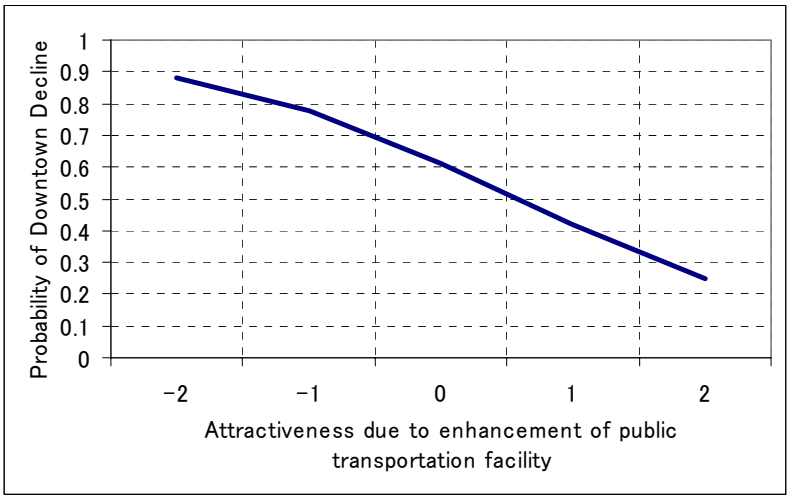

Figure 6 Sensitivity of public transportation facility

Figure 6 shows that the slope is negative as the public facility increases. It means that if public transportation facilities could be improved, the declining situation of the downtown shopping center may be also affected positively. In other word, we can revitalize the downtown shopping center by improvement of public transportation facilities.

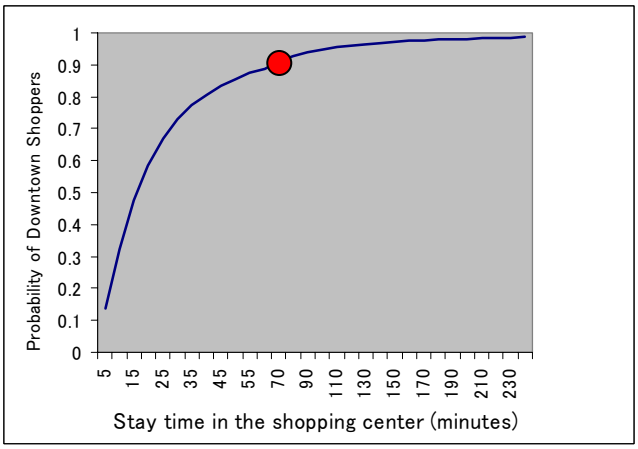

Figure 7 Simulation of staying time in the shopping center

It is also interesting to show that the simulation of staying time in the shopping center, as shown in Figure 7, produces result that if the shoppers need to stay longer in the shopping center, they will select sub-urban shopping mall rather than downtown shopping street. This result is also appealing way to improve the decline of the city center by faster services rather than providing activities that attracting people to stay longer in downtown.

CONCLUSIONS & RECOMMENDATIONS

This research has investigated the effect of transpo

paid parking in the city center. It was also found that for the people who shop with frequency less than once a week, the sub-urban shopping center is a better choice than the downtown shopping street, regardless whatever the transportation mode they use. The study suggests that downtown decline may be improve potentially by put some parking charge to sub-urban shopping center, improvement of public transportation facilities, providing downtown market which sell daily products and supermarket to differentiate the market from sub-urban shopping centers and providing faster services.

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