A STUDY ON TRAFFIC BEHAVIOR OF HIGH INCOME PEOPLE IN ASIAN DEVELOPING COUNTRIES

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Abstract: Disorderly urban sprawl in developed countries was aggravated by the progress of motorization. City planners in developing countries can avoid similar mistakes to be repeated. Since personal income level and car ownership seems to have a positive relationship, the objective of this study is to clarify the influence of rising income level on traffic behavior in developing countries. It was found that the car usage rate will rise with increasing income levels for cities with income levels above a certain value. One of the reasons is the relocation of high income people to the peripheral area of a city and this has been proven. Solutions to this imminent problem include development of a pleasant living environment in the city center so as to attract more people from high income level groups to reside in the city center area, and the compound use of city land in order to reduce trip length.

Key Words: developing countries, income, transport mode

1. INTRODUCTION

1.1 Background and Objective of the Study
Since the advent of the Industrial Revolution in old Europe, economic development in industrialized nations has been moving at a very rapid pace. Reflecting this phenomenon, city structure and urban planning have followed a completely different path from the conventional one. Concentration of jobs and services in city centers based on the concept of economy of scale around the world has compelled the decentralization of housing to the peripherals of the city where employees have to commute to work for long distances by rail. In addition, with the extensive progress of motorization, land utilization was not only limited to developments along major corridor of public transport, but also resulted in disorderly sprawls of housing all over the city area and suburbs. This in turn had led to economic burdens due to external diseconomy like traffic congestions and environmental pollutions. In order to improve the situation, the idea of compact city was explored to reduce the pressure on environment by restricting disorderly sprawls of housing in suburbs and restoring high density developments in city centers and local hubs. However, problems like dwelling rights and lifestyles of local citizens have been impeding the realization of the above concept into reality.

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In developing countries where the pace of economic development and population growth has been exponential, the respective governments have upped the tempo and embarked on ambitious infrastructure projects in order to meet the growing demand. However, these countries are rapidly following the same paths of preceding industrial countries and repeating their mistakes of not adopting measures to curb the increase of urban sprawls into suburban area. Many developed countries have been suffering from the severity of the problem of urban sprawls. City planners in developing countries can certainly avoid similar mistakes to ensure the continuation of orderly development in their countries. Therefore, it is imperative for cities to take preventive measures and avoid over-dependence on automobile.

This research has aimed to provide a preliminary study of developing countries with relatively low car usage rate as compared to developed countries and how these countries can maintain the current stage of economic development without significantly increasing the car usage rates. In view of the fact that personal income and car usage traditionally have a positive relationship, the objective of this study has been set on elucidating the influence of rising income level on the traffic behavior in developing countries.

It is inevitable to eliminate other situation such as cultural or historical difference among developing countries in order to conduct comparative analysis quantitatively. Therefore it should be noted that only the relationship between income level and car usage is focused in this study.

### 1.2 Review of Related Studies

Many studies for developing countries have been conducted based on societal and economic viewpoints such as social infrastructure assessment or land market mechanism (See David E. Dowall (1993)). However, there are some studies considering energy use and environment. Among the researches of comparative analysis of various cities, the relationship between population density and car energy use per capita is analyzed by Newman and Kenworthy (1989). Recently Morimoto et al. (2005) verified the relationship between land use and transportation energy use and the influences on environmental burden in developing countries. Then, Imai et al. (2000) clarified the basic knowledge for effective measures against air pollution in Southeast Asian developing countries. In their paper, they proposed effective examples of systematic measures about automobile-related taxes and restricting measures for sources of air pollution from automobiles. The transport issues in developing countries are paid attention as described previously, and it became apparent to consider car usage in particular. Zhang et al. (2005) compared transport accessibility in developing countries from the perspective of social inequality and suggested that accessibility aspect should be taken into account in the case of infrastructure improvement in developing countries.

Moreover, there are large differences between the rich and the poor in developing countries, and life style and transport behavior are different depending on income levels. In other words, transport behavior has much to do with income levels in developing countries. Doi et al. (2001) clarified that high automobile ownership in Manila metropolis is the result of suburbanization of middle and high income group or mixed land use. And they developed a model of relationship between urbanization and motorization by considering the mechanism between residential location and urban sprawl.

So far, there are few studies, particularly in comparative analysis, about car usage considering income level in developing countries. In this study we have tried to seek out the relationship between income level and car usage based on the person trip survey data in developing countries.
2. STUDY CITIES AND THEIR CURRENT TRAFFIC SITUATIONS

2.1 Cities Studied and Data Used
In this study, some cities in developing countries in Asia are chosen. They have historical background of former colonies and their bicycle transport growth seem to be similar. Their relationships between income level and car usage are compared among these cities. Person trip surveys were held in four cities, in which there are large differences about GDP, in order to analyze traffic characteristics from a viewpoint of high income groups who often tend to own and use automobiles. Japan International Cooperation Agency (JICA) conducted person-trip surveys in many developing countries. Among them are Kuala Lumpur in Malaysia (Pacific Consultants International, Suuri-Keikaku Co., Ltd, 1999), Chengdu in the People’s Republic of China (ALMEC Corporation, Chodai Co., Ltd, 2001), Manila in Philippines (ALMEC Corporation, Pacific Consultants International, Yachiyo Engineering Co., Ltd, 1999), and Phnom Penh in Cambodia (Katahira & Engineers International, 2001). As the consultancy companies in charge of the surveys differed from city to city, the person trip data collected and the format in which they were presented also varied. However, the person trip data constitutes primarily three different types: Household data (profiles of the households and the number of cars or motorcycles owned), individual data (individual profiles including sex, age and driving license) and trip data (OD where one trip is counted as one record and other information such as departure time and arrival time, trip mode and departing and arriving facilities). Therefore, following the consolidated format of “one trip = one record” based on the trip data, individual and household data were added to the records. The summary of these four cities (Akira Nakamura et al., 2004) is shown in Table 1. Here, these data are somewhat older and some indicators such as socioeconomic data or transportation systems in study cities might be different from present situations. However, in this study, it is important to consider the relationship between income level and automobile usage for developing countries at that time.

Table 1 Outline of person trip survey data

<table>
<thead>
<tr>
<th>City</th>
<th>City sphere population</th>
<th>Investigation years</th>
<th>Number of household</th>
<th>Number of individual</th>
<th>Number of trip samples</th>
<th>Modal share of transport mode</th>
<th>Investigation name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phnom Penh</td>
<td>1,152,000</td>
<td>2000-5-8</td>
<td>6,446</td>
<td>18664</td>
<td>40,369</td>
<td>Motorcycle(41.6%),Walking(31.9%),Motorcycle(12.8%),Motorcycle(5.6%)</td>
<td>The Study on The Transport Master Plan of The Phnom Penh Metropolitan Area in the Kingdom of Cambodia</td>
</tr>
<tr>
<td>Manila</td>
<td>9,454,000</td>
<td>1996-8-12</td>
<td>60,752</td>
<td>231889</td>
<td>471,035</td>
<td>Jeppney(34.6%),Walking(24.8%),Tricycle(13.9%),Car/Jeep(8.2%),Standard</td>
<td>Metro Manila Urban Transportation Integration Study</td>
</tr>
<tr>
<td>Chengdu</td>
<td>3,090,000</td>
<td>2000-6-7</td>
<td>14,537</td>
<td>31188</td>
<td>70,199</td>
<td>Bicycle(43.2%),Walking(35.1%),Motorcycle(4.1%),Car(3.9%)</td>
<td>Study For Public Transportation Improvement in Chengdu City in The People's Republic of China</td>
</tr>
<tr>
<td>KL</td>
<td>1,390,800</td>
<td>1997</td>
<td>27,331</td>
<td>80560</td>
<td>218,460</td>
<td>Car(33.3%),Walking(20.2%),Motorcycle(19.5%),School Bus(8.9%),Bicycle(3.3%)</td>
<td>A Study on Integrated Urban Transportation Strategies for Environmental Improvement in Kuala</td>
</tr>
</tbody>
</table>

2.2 Annual Income Level and Modal Share of Transport
In the process of advancing the research to develop concrete coordination measures, the relationships between urban form and transportation energy consumption per person analyzed by Newman and Kenworthy (1989, 1999) were referred again. Here, in order to grasp the trend of economic circumstances versus car ownership, the relationship between per capita GDP and car ownership rate of both developed and developing countries is shown in Figure 1. Per capita GDP and car ownership rate are calculated according to official data sources (JETRO 2003, CIA 2003). From this graph, it is evident that the four study cities, with GDPs that are about one-tenth of that of developed countries, have car ownerships that are very much lower than that found in developed countries. Also, it can be deduced from the graph that, in general, the higher per capita GDP is the higher car ownership will be.
Next, Figure 2 shows the relationship between income level and population percentage, whereas the relationship between income level and car usage rate can be seen in Figure 3. As shown in Figure 2, the income level distribution for Chengdu and Manila are similar, the income gap for Phnom Penh and Kuala Lumpur can be considered to be substantial. Here, it must be emphasized in the subsequent analysis car usage rate is used, not car ownership rate. This is because the car usage data is obtained from person trip surveys. It is reasonable to assume that those who own cars are likely to use them.

In addition, as shown in Figure 3, out of the four study cities, income level and car usage rate do not show any correlation in the city of Phnom Penh. Conversely, in the cities of Manila, Kuala Lumpur and Chengdu, they exemplify similar relationships between income level and car usage. The greater the rise in income level, the higher the car usage rate will be. Moreover, although per capita GDP in these three cities varies, all three cities have shown that car usage rate exceeds 50% when monthly income is over 200 US dollars. Also, from Figure 2 and 3, it can be seen that the percentage of people in the income level with car usage is evidently low. Consequently, with the current rapid rate of economic development in developing countries, it can be deduced that future car usage rate will rise together with increasing annual income in these cities.
3. CAR USAGE RATE AT HIGH INCOME LEVEL

3.1 Definition of High Income Level
The previous chapter proved that rises in annual income tend to have a positive effect on car usage rate. A simple explanation for this is that in developing countries where the income gap can be huge, car usage has conventionally been limited to the group of people with high income levels. Therefore, for this research to accurately predict future trends of traffic behaviors as the percentage of people with high income increases, it is important to first examine present traffic behaviors of people with high income levels. This research has focused its attention on this percentage of people and their choice of transport, in comparison with that of other people from varying income levels. However, as the standard of living is different for each city, the car usage trends of high income level groups will also vary according to the city if a certain value or percentage were to be used to determine the high level income groups. Here, high income level has been defined as the income level where car usage rate exceed 50%. Therefore, from the graphs earlier, the percentage of people with high income level is 49% in Kuala Lumpur, 7% in Manila and 3% in Chengdu.

3.2 Effects of Income on Modal Share of Transport
In order to examine ways to prevent escalation of car usage rate with increasing income levels, this research has compared the car usage rate between high income levels with total income levels in the three study cities. Looking at Figure 4, it becomes evident that while the average car usage rate is 43% in Kuala Lumpur, 27% in Manila and 18% in Chengdu, the car usage rate for high income level groups in the three cities are almost the same at approximately 70%. In spite of the varying economic circumstances in these three countries, the fact that car usage rate in the high income level are high showed that there is a strong relationship between income level and car usage rate. Thus it can be deducted that a high income level has promoted the use of cars. To decipher the reasons behind this trend, (1) significant difference in car usage arising from increased income levels, and (2) trip length becoming longer, the above two varying patterns that could increase the necessity of car usage have been included for the purpose of this research.
3.2.1 Dependency Rate of Car Usage
As the use of cars increases our mobility from place to place, the number of people in developed countries that are excessively dependent on cars increases greatly. For example, even at times where it may be faster to walk, say, to a nearby convenience store, people tend to choose to drive; or to places where traffic is typically heavy and roads are very congested such as at famous tourist spots, people again tend to rely on their cars and refused to take a train even though it would be a faster option. Consequently, car usage rate is increasing dramatically. If such a phenomenon frequently found in developed countries is to happen to the high income level groups in developing countries, there is a strong possibility of increasing dependency on car usage even for short distances. Here, distance traveled can be computed by looking at car usage time. From the Figure 5 shown below, the distribution of distance traveled by car in all three cities did not present any significant difference between high income level groups and the rest. In other words, the distance traveled by car does not differ between high income level groups and the rest, meaning which the trend of high income people using their cars to get to nearby places accessible by foot could not be observed.

3.2.2 Necessity of Car Usage with Trip Length
Next, considering that traveling range is usually wider for high income level groups than total income level groups, the necessity of car usage is possibly higher, too. In order to study the difference in trip length between high income level groups and total income level groups in the three study cities, we compared the average trip length for all types of transportation modes as shown in Figure 6. From the graph, the average trip length for high income level groups is higher by 2.7 km in Kuala Lumpur, 4 km in Manila and 9 km in Chengdu. In particular, the difference in trip length is huge in Chengdu. From the above results, it can be
observed that trip length to one’s destination is generally longer for high income level groups as compared to total income level groups. This in turn increased the necessity for car usage which resulted in greater car usage rate for high income groups. Figure 6 also shows the difference of trip length compared among three cities. This is due to the differences in land use in their cities. For instance, most population is less than 5 km from Central Business District (CBD) in Chengdu (ALMEC Corporation, Chodai Co., 2001). On the other hand, business and commercial land uses are actually laid in CBD, however, residential land use is out of CBD in Kuala Lumpur (Pacific Consultants International, Suuri-Keikaku Co., Ltd, 1999). Moreover people in Manila tend to live suburban area and low-income people are particularly out of metropolitan area. Therefore not only high-income people but also low-income people have high trip length (City Planning Institute of Japan, 1999).

By the way, average trip length of high income group shows higher value than average trip length of the entire population in Chengdu compared with Kuala Lumpur and Manila. In fact average trip length of high income group in Chengdu is 14.2 km which is almost 3 times longer than average of all population (5 km). Therefore the relationship between residential location of high income group in Chengdu and traffic behavior is analyzed by using zone map in following section in order to further examine above phenomenon.

Figure 6 Change in trip length

4. RESIDENCES OF DIFFERENT INCOME LEVEL GROUPS AND THEIR TRANSPORT CHARACTERISTICS IN CHENGDU

In this chapter, we will focus on Chengdu where the difference in trip length for high income level groups is greatest among three study cities and the reasons why this is so. In other words, while we have shown that trip length become longer in high income level groups than total income level groups, the reason for this still remains unclear. Therefore, for the purpose of this research, the hypothesis that residences of high income level groups have increasingly become decentralized and away from city centers which is the reason why trip lengths have become longer, has been adopted.

4.1 Understanding the Distribution by Land Use in Chengdu

Before we can grasp the residential trends of high income level groups and prove the validity of the hypothesis, it is necessary to understand the distribution of land use in the city of Chengdu first. However, due to the difficulties in obtaining land use data from the nation’s
statistical board, we have conducted the research based on the following improvised method (ALMEC Corporation, Chodai Co, 2001).
(a) To grasp the distribution of land use for residential purposes from the population density within the city.
(b) To estimate the distribution from person trip data of accumulative trips. In other words, from person trip data analysis based on varying destinations, we have tried to approximate the distribution of land use in the city by examining the accumulative trips to buildings used for different purposes.

Figure 7 Distribution of population density in Chengdu

Figure 8 Distribution of trip attraction by trip purpose
The results of the distribution based on (a) and (b) are shown in Figure 7 and 8. From Figure 7, areas with population density of 52.4 persons/ha, similar to that of Tokyo’s, and concentrated within 4 km from the center of the city can be generally considered to be residential areas of high densities. And from Figure 8, it is evident that the above estimated distribution of trip attraction by trip purpose is all concentrated in the city center where the population density is high. In other words, not only residential land use but also business, commercial and school land uses are in the city center. Moreover, bus is the only public transport that can be found in Chengdu and most of the bus routes operate within 4 km of the city center. Bus routes that extend to the suburb of the city make up only one-quarter of the total route (ALMEC Corporation, Chodai Co, 2001).

4.2 Distribution of Residences of High Income Level Groups

Next, for us to understand the difference between distribution of residences of high income level groups and total income level groups, we have examined the ratio of high income level groups in various zones within the city as shown in Figure 9. Based on the results of Figure 9 plus that of Figure 7, it can be established that areas with greater distribution of high income level groups are more likely to be found in the peripherals of the city where population densities are much lower than that of the city center. Therefore, the high income level groups living in these areas where public transport facilities are usually inadequate are more likely to rely on car usage.

![Figure 9 Residential distribution of high income level groups](image)

4.3 Comparison of Trip Length in Various Zones

While we have shown that the most of activities concentrate in the city center and the proportion of high income level groups living in the peripherals of the city is exceptionally high, it still remains unclear whether this group of people in reality commutes to the city center or not. Therefore, in order to find out the trip length of this group of people as compared to that of total income level groups, we have drawn the average trip length of various income level groups in distribution maps as shown in Figure 10 and 11. From Figure 10, it becomes obvious that trip length is reasonably short across all income level groups regardless of its starting point. In addition, Figure 11 has further shown that the trip length of people from high income level groups living in the city’s peripherals is relatively longer. Conversely, trip length of the same income level groups of people living in the city center is comparatively shorter.
Comparison of Car Usage Rate in Various Zones

In Section 3, we have hypothesized that the great value of car usage rate for high income level groups is due to the longer trip length. Here, for us to examine the relationship between car usage rate and trip length in various zones, we have tried to estimate the car usage rate from traveling trips based on various zones. From Figure 12, it is clear that car usage rate of high income level groups are greater for trips that originated from the city’s peripherals than from the city center. This result, together with that obtained from the trip length distribution map shown in Figure 11, has demonstrated that areas with high car usage rate coincide with areas where trip length is high. Therefore, it can be concluded that the reason why trip length of high income level groups is increasing is due to the decentralization of their residential homes from the city center.

This research has aimed to elucidate the relationship between income level and traffic behavior, especially for high income level groups by examining car usage rate, average trip lengths and distribution of residences.

First, with rising income level, car usage rate in general will also increase. And there is correlation between car usage rate increase and increase in average trip length. Also, the increase in trip length can be attributed to the decentralization of residential homes of people in high income level groups as far as the City of Chengdu is concerned.
5. COMPARISON BETWEEN CITIES

In addition to the city of Chengdu, the other cities examined in this research have also exemplified that car usage rate rises with increasing income level. In order to verify that the underlying reason lies in the peripherals of the cities as per the city of Chengdu, population density and residential distribution of high income level groups were represented in Figure 13 as shown below and compared. Although the population density of Kuala Lumpur (Pacific Consultants International, Suuri-Keikaku Co., Ltd, 1999) is different from that of Chengdu and is not overly concentrated in any particular zone, it can be observed that the proportion of high income level groups residing in areas of low population density is comparatively high. In Manila (ALMEC Corporation, Pacific Consultants International, Yachiyo Engineering Co., Ltd, 1999) where the population density is similar to Chengdu and is heavily concentrated, high income level groups can be seen to reside in the peripherals of the city where population density is low. Consequently, in all the three cities examined for the purpose of this research, it can be concluded that the majority of high income level groups resides in zones of low population density, and as long as public transport in these areas remains undeveloped, car usage by the high income level groups will continue to rise. Therefore, there exists the danger where sprawls of housings around the city center will develop unhindered, as what industrialized countries have experienced.
6. CONCLUSION

This research has examined the relationship between income level and traffic behavior in four cities from major Asian developing countries. The resultant findings can be summarized as follows.

1) While changes in car usage rate could not be detected in cities where income levels are very low such as in Phnom Penh, it has been proven that car usage rate will rise with increasing income levels for cities with income levels above a certain value.

2) By comparing the trip length distribution of high income level groups with that of total income level groups, it has been established that average trip length for high income level groups tends to be longer and this could be attributed to the increase in car usage.

3) In the City of Chengdu, one of the reasons why trip length for high-income group becomes longer would be attributed to the suburbanization of residential land use.

From the above findings, it can be predicted that developing countries with exhilarating pace of economic development are going to face the same problems as their industrialized counterparts, where the development of sprawls of housings around the city center due to rising income levels is likely to accelerate the usage of cars.

Cities in developing countries are rapidly following the same paths of developed countries and repeating their mistakes of not adopting measures to curb the urban sprawls into suburban areas, which many developed countries have been suffering from the severity of the problems.
City planners in developing countries can certainly avoid similar mistakes to ensure the continuation of orderly development in their countries. Therefore, it is imperative for cities to take preventive measures and avoid over-dependence on automobile and subsequent urban sprawl.

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