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Travel – Time to Jobs and Urban Growth in Hanoi City, Vietnam

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Abstract: The paper used an accessibility indicator, measured by average travel time to jobs, to investigate the urban growth in Ha Noi city of Vietnam in order to find the answers to some research questions: why Hanoians prefer using motorcycles, where urban likely to growth, to what extent of travel time people start to relocate their home, and in what conditions the conversion between residential density likely to happen.

Keywords: accessibility to jobs, average travel time to jobs, Ha Noi city, urban growth, population density, migration

1. INTRODUCTION

Hanoi - the capital city of Vietnam - is witnessing the rapid urbanization as the result of accelerated economic growth. It's population has increased from 5.3 million in 2002 to about 6.7 million in late 2010, and to 8.09 million in 2019 [5]. On average, Ha Noi city's population is increasing about 150 thousand people per year. It is expected to reach about 10.0 million by 2030. The urbanization level has increased from 33% in 2000 to 40% in 2009 [8] and 53% in 2019 [9].

However, it is observed that urban grows fast and dynamically in the urban fringe, while there is almost no urban development in the satellite cities and other small towns. Moreover, the statistical data (population per ward) reveals that population in some rural areas of Ha Noi city has decreased significantly. It implies that there is some portion of population in those areas has migrated to the main city and/or other areas to seek for jobs. There is no doubt that urbanization in Hanoi will increase drastically in near future. However, the major concern in urban planning is that where will be the places the urban likely to grow? Will the urbanization spark in satellite cities or continue to expand in the main city as in the current trend? Is there any relation between accessibility to jobs with urban growth? The answers to these questions can help to figure out the underneath reasons of urban development and travel behavior of people. This paper uses an accessibility indicator, the average travel time to jobs, to investigate the relation between travel behavior and urban growth in Ha Noi city of Vietnam.

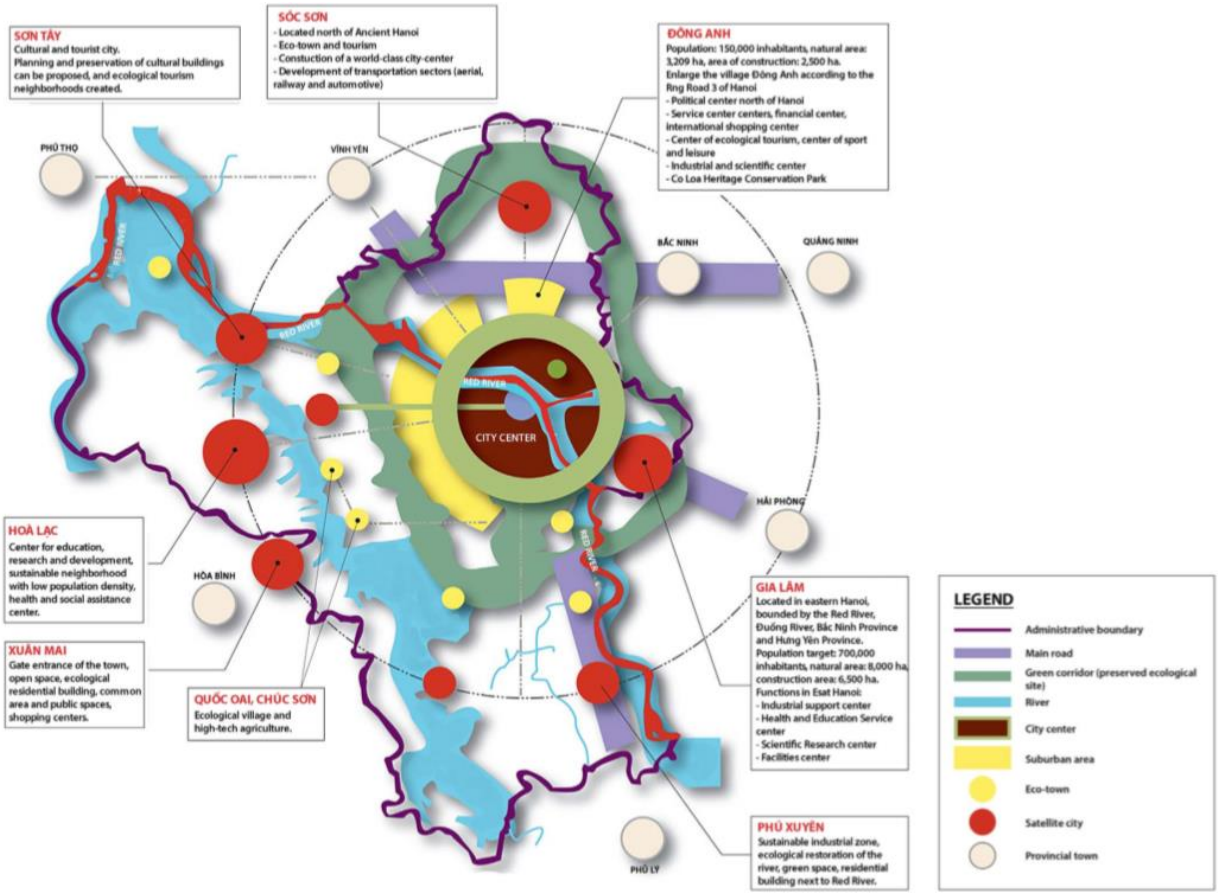


Fig 1. Functional areas of the Hanoi Capital Construction Master Plan to 2030 and Vision to 2050 [6]

2. OVERVIEW OF LAND USE, TRANSPORT SYSTEMS AND POPULATION DISTRIBUTION IN HA NOI CITY

2.1. Land Use Distribution in Ha Noi City

Ha Noi city includes a main city, five satellite cities and about ten small towns. The historical land use data has shown that there is almost no urban development at all the satellite cities and small towns while it has been developed rapidly and dynamically in the main city, especially in urban fringe, between the ring road No. 2 and No. 3.

2.2. Transport System in Hanoi City

Ha Noi city's transportation is remarked with the extremely high rate of motorcycles (MC). Motorcycle is predominant on streets. Most of people in working classes use motorcycles in their daily travel to work. Motorcycles account for about 80% of the total passenger daily trips while public transport, including conventional bus and one BRT line, just covers about 10% of the total travel demand. The rate of MC is absolutely high as compared with other cities in the region and the world [1] [10] [11].

The Ha Noi' bus service is not bad in term of network coverage and bus frequency. In the city center, the bus network is quite dense and the frequency is every 10-15 minutes, depending on the bus line. There are also buses to connect the main city with all satellite cities, small towns and neighborhood cities as well. The frequency of those buses is every 15-20 minutes. However, the main customer of the bus is students and retired people only. Very few people in working classes use buses for their daily travel.

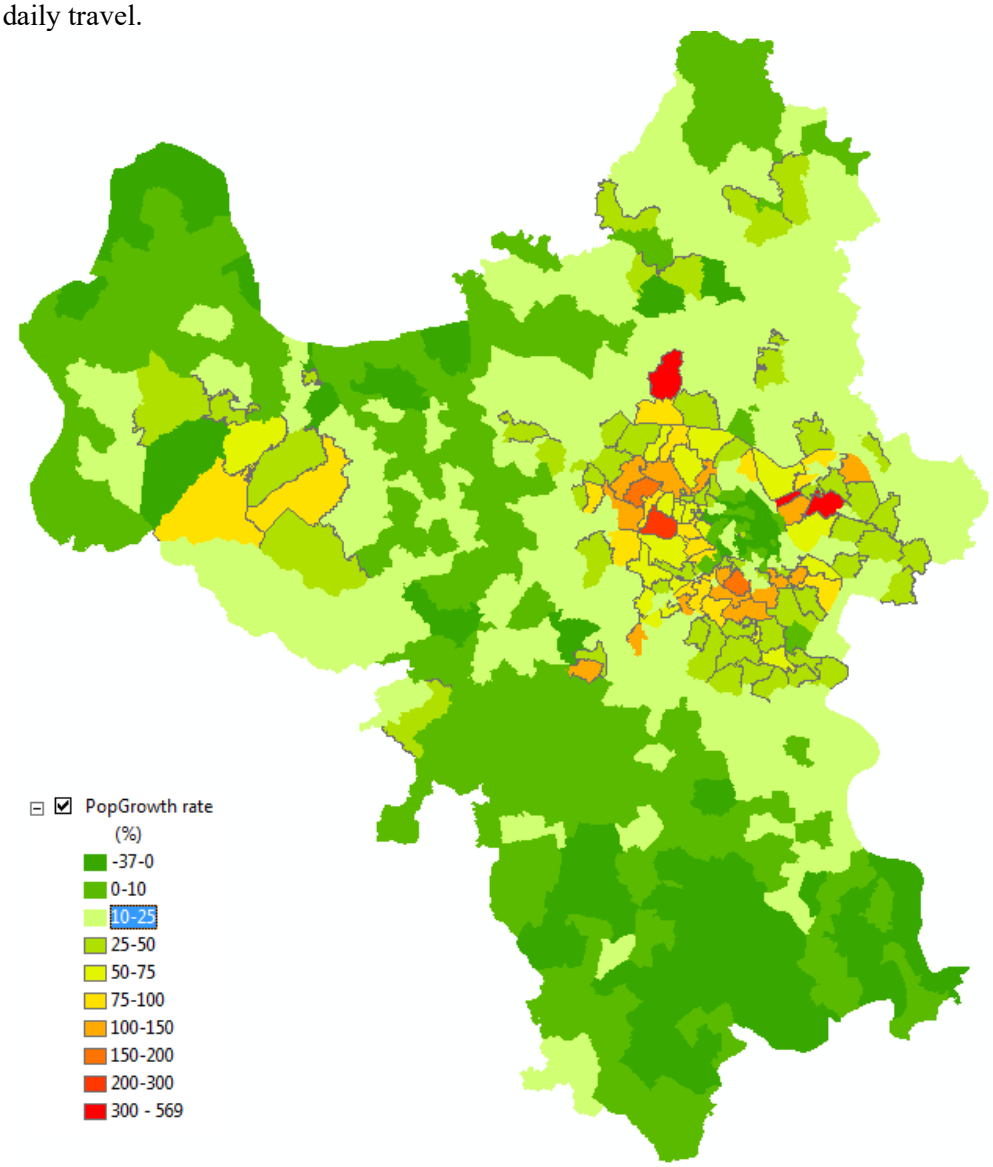


Fig. 2. Population changes in Ha Noi city during 2002 and 2010

2.3. Distribution of Resident in Ha Noi City

According to statistics data, the average population growth in Ha Noi city between the two national population surveys 1999 and 2009 is 2.2% per year in which the natural growth rate is 1.35% per year. It means during the period of 8 years, from 2002 to 2010, on average the growth rate of population in a

ward should be from 10-18%. It will be abnormal if the growth rate is lower than 10% or higher than 18%.

The statistical data of population (population per ward) during the period from 2002 to 2010 collected by the first author from Ha Noi Statistics Office shows that population growth during the period 2002-2010 varies largely in the whole region, from -37% to 570%. It is observed that population grew fast in urban fringe, especially around My Dinh (North-West) and Dinh Cong-Linh Dam (South), and Long Bien (East). The three highest growths are wards around the two large industrial zones: Kim Chung which is near Noi Bai industrial park (population growth rate of 305%), Phuc Dong which is near Sai Dong-Daewoo industrial park (population growth rate of 570%), and My Dinh which is new urban area (population growth rate of 209%). There is a belt of normal population growth around the main city. There are two areas that have population decreased significantly: the urban core and the wards which are a bit further from the city center, especially in the South of Ha Noi city. The decrease in population in the urban core can be the result of reloading population to newly urban zones developed in this period [6, 7] while the decrease in population of wards which are further away from the city center can be the result of migration process from rural areas to the main city.

3. RESEARCH METHODOLOGY

3.1. Accessibility Indicator-Travel time to Jobs

The travel time to jobs is an important factor that involves in the decision of the places to live and work, therefore, in this paper we use the average travel time to jobs as accessibility indicator to investigate the relation with urban growth in Hanoi. Average travel time to jobs/ opportunities of a zone i (Ti) was proposed and used by Geertman & Van Eck [2], Guttiérrez [3] and Gutiérrez et al. [4]. This indicator is easily interpreted for urban planners and policy makers. It is calculated as follows.

$$T_i = \frac{\sum_{j=1}^{n}(A_{ij} * t_{ij})}{\sum_{j=1}^{n} A_{ij}} = \frac{\sum_{j=1}^{n}(t_{ij} * O_j * f(t_{ij}))}{\sum_{j=1}^{n}(O_j * f(t_{ij}))}, \quad (1)$$

in which:

Ti: average travel time to jobs of people living in zone i, using transport mode m.

Oj: number of jobs or opportunities available in zone j.

$f(t_{ij})$: Distance decay function. In this case study, we applied $f(t_{ij})$=1 as suggested by Guttiérrez [3] to make the same base for comparison.

t_{ij}: travel time from zone i to zone j, using transport mode m.

3.2. GIS Model

To calculate average travel to jobs for Ha Noi case study a GIS model was built using network analysis extension of ArcGIS software of ESRI. A net of hexagon of 1.500m was created with assumption that people will travel from centroids of hexagons. The average travel time to jobs (Ti) were calculated for different available transport modes: MC, car, bus (PT+walk), using Origin-Destination (OD) cost matrices in which the hexagon's centroids were considered as origins or destinations. Based on the historical land use data and statistical data, the number of jobs per land use categories was calculated and transferred to the hexagon net. Speeds of transport modes used in the model are listed in the Table 1 and Table 2 below.

4. RESULTS AND DISCUSSIONS

4.1. Average Travel Time by Transport Modes

Fig. 3 shows that the accessibility, measured by average travel time to jobs, by public transport (buses) is completely poor compared to motorcycles and cars. In the urban core, on average it just takes about 30 minutes by MC to access to jobs while it takes about 40-60 minutes by PT. In urban fringe, it takes less than 40 minutes on average to go to work by MC or car while it takes about 60-90 minutes on average to go to work by PT. Therefore, it is not surprised that very few people in working classes use bus in their daily travel to jobs in the current situation. All satellite cities and towns have absolutely poor accessibility to jobs in term of travel time with all transport modes. It shows clearly that satellite

cities and towns have very poor connection with the main city, therefore, those areas have almost no chance for urban development by 2020. The urban residential land use layer was overlaid. It shows that the most dynamic urban area is in areas where travel time to job is within about 40 minutes by MC or car.

The results suggest the answer to the questions why people don't like to use public transport in their daily travel and why motorcycle is predominant in Ha Noi. Besides, they help to understand why by 2020 satellite cities and towns have almost no developments while the most dynamic urban development is only in the main city where people have high accessibility to jobs and average travel time to jobs by MC is within acceptable ranges.

Table 1

Assumed speeds of transport modes

No	Road type	Car Speed (km/h)		MC Speed (km/h)		Bicycle Speed		Walk Speed (km/h)	Note
		City center	Out of city center	City center	Out of city center	City center	Out of city center		
1	Expresssway		70		45				Bicycle and walk are not allowed to enter expressways
2	National road		50		40		15	5	
3	Province road		45		35		15	5	
4	District road		35		25		15	5	
5	Primary road	25 (15)	40 (20)	25 (15)	30 (20)	12	15	5	
6	Secondary road	22 (15)	35 (20)	22 (15)	25 (20)	12	15	5	
7	Local main street	18 (15)	30 (20)	18 (15)	22 (20)	10	12	5	
8	Small road	5	5	15	20	8	10	5	Car cannot enter small roads but drivers can walk

Table 2

Assumed speeds of bus

No	Transport mode	Average Speed (km/h)	Frequency (minute)	Access time (minute)	Egress time (second)	Note
1	Bus	22 (15)	5-15	Frequency/2	15-20	in the city center (within the ring road no.2);
		28 (15)	5-15	Frequency/2	15-20	Urban fringe (between ring road no. 2 and ring no. 3
		35	10-20	Frequency/2	15-20	Out of the city center

Note:

- *Car cannot access small roads and bicycle is not allowed to enter expressway.*
- *In the city center, car and MC have the same speed since in Ha Noi car and MC run on the same lane then it is the speed of traffic flow.*
- *Since MC and car have to stop in front of red light at intersections therefore speeds of MC and car were set lower in the city center than in the outside the city center.*

The numbers in brackets are speeds in peak hours or in traffic congestion situation in which 15km/h is applied for area inside the city center and 20km/h for urban fringe.

4.2. Travel Time to Jobs and Migration in Hanoi City

In Vietnam, car is still quite expensive as compared to income for most of people in Hanoi therefore car is not a choice in their daily travel. As shown in the previous section, people have no better choice than using a motorcycle in their daily journey to work. The question is to what extent of travel time

people will start to find other solutions, for example changing job or relocating home? Is there any relation between travel time to jobs and migration in reality?

A comparison between the population growth during the period of 2002 and 2010 and average travel time to jobs by MC in 2010 was made. The result is shown in the Fig. 4. It is noted that the rate of 1.35%-2.2% per year is the natural population growth according to the statistical data of Ha Noi region between the two national surveys in 1999 and 2009. The areas with serious migration are the areas that have population decreased during period 2002-2010. The areas that have population growth smaller than the rate above may have a portion of population migrated to the city center or somewhere else. The histogram of average travel time to jobs for population category is shown in the Fig. 5.

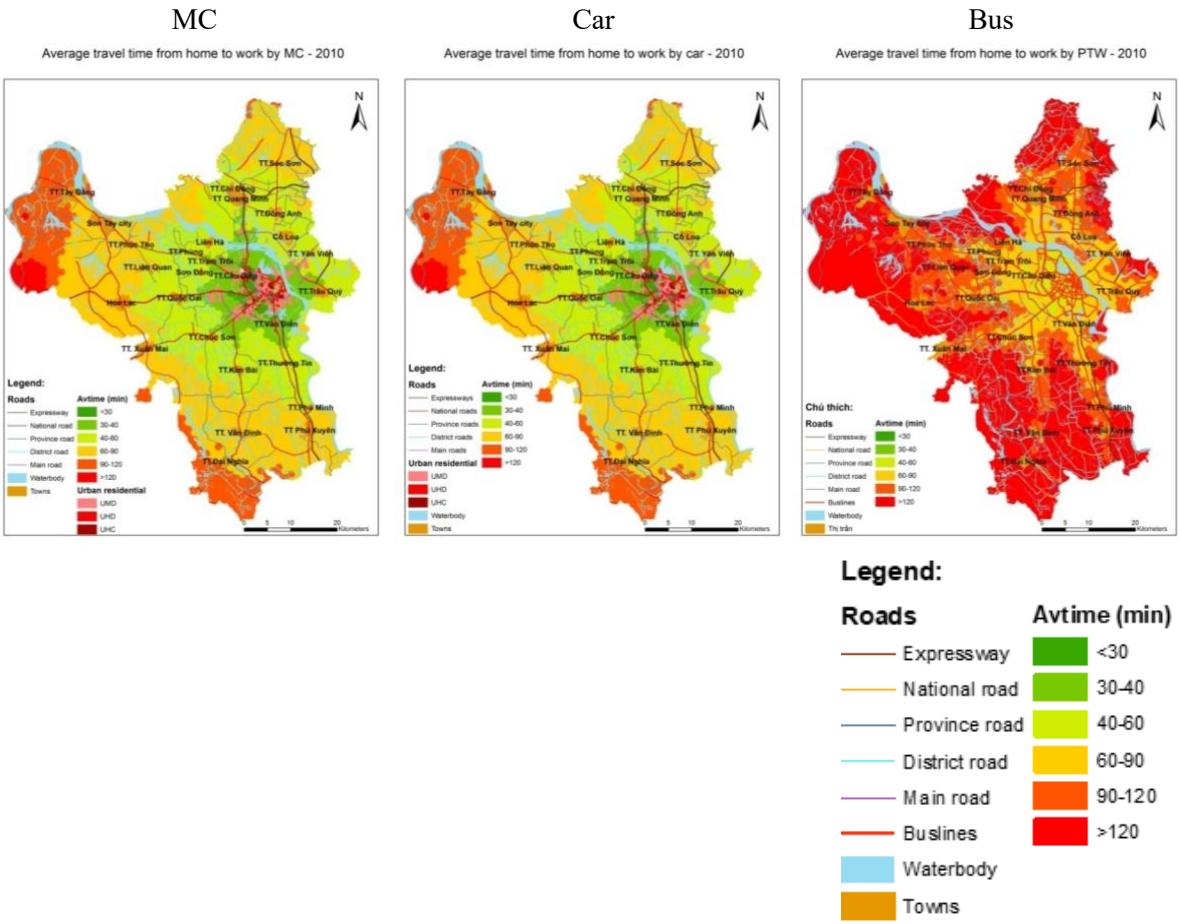


Fig 3. Average travel time to jobs by transport modes

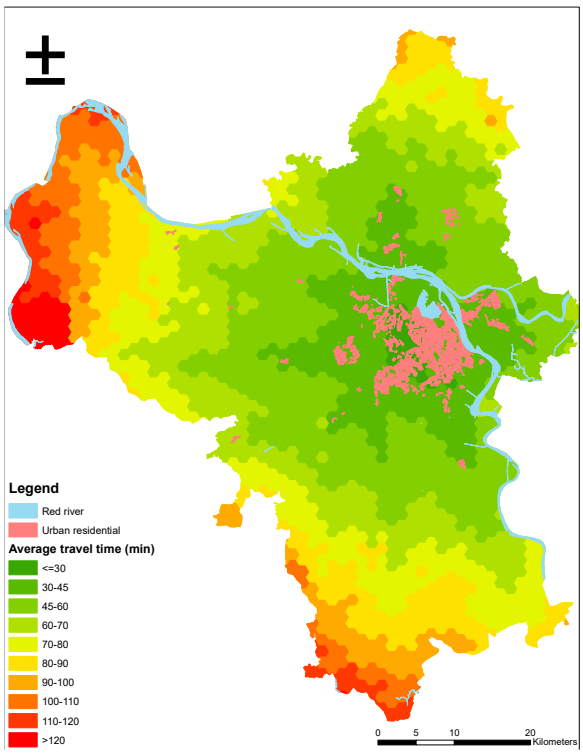
The Figs. 4 and 5 show that Ha Noi city has very clear structure of a mono-centric city with an urban core that has very high accessibility in term of average travel time to jobs. It is observed that residents living in the main city have high accessibility to jobs with average travel time to jobs by MC less than 40 minutes. The areas surround the urban core where average travel time to jobs is between 40-60 minutes by MC have normal population growth. The migration starts when average travel time to jobs is more than 40 minutes by MC. The migration is more serious in areas that have quite poor accessibility to jobs with average travel time to jobs is more than 60 minutes, especially more than 70 minutes. People living in areas that have average travel time in the range of 50-70 minutes will trade-off between migrating to the city center and accepting longer travel time.

4.3. Travel Time to Jobs and Distribution of Residential Density in Ha Noi city

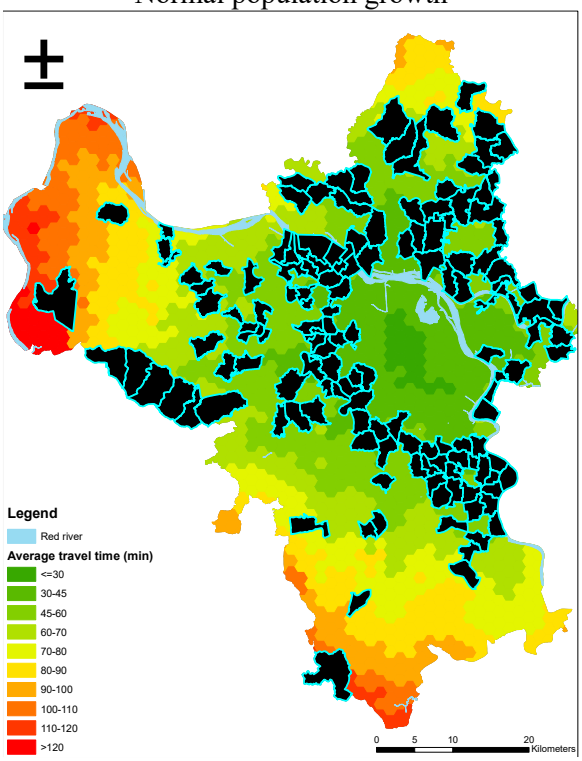
What is the relation between residential densities with average travel time to jobs? To answer this question, population density is classified into 6 groups in Table 3, in which urban has three groups and rural has three groups.

The Fig. 6 shows the relation between the average travel time to jobs and residential density land uses in 2010. It can be seen that all urban residential classes (UMD, UHD, and UHC) locate in areas that have average travel time is less than 40 minutes by a motorcycle. The villages with high residential density (RHD) locate in areas that have quite high accessibility to jobs, in the range from 30-60 minutes by a motorcycle. Villages with medium residential density (RMD) locate in areas that have average travel time to jobs by a motorcycle from 40 to 60 minutes. The villages with low density (RLD) locate in areas that have average travel time to jobs is longer than 50 minutes by a motorcycle. It is not acceptable for daily travel.

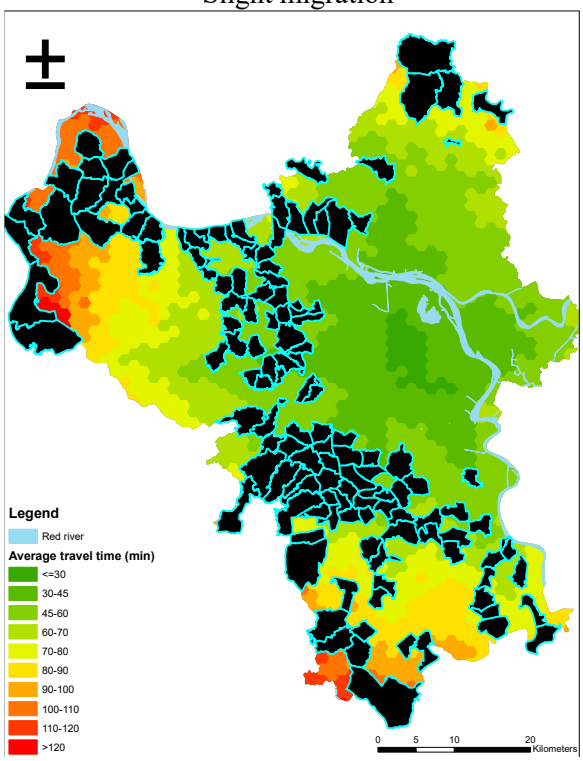
Urban area



Normal population growth



Slight migration



Serious migration

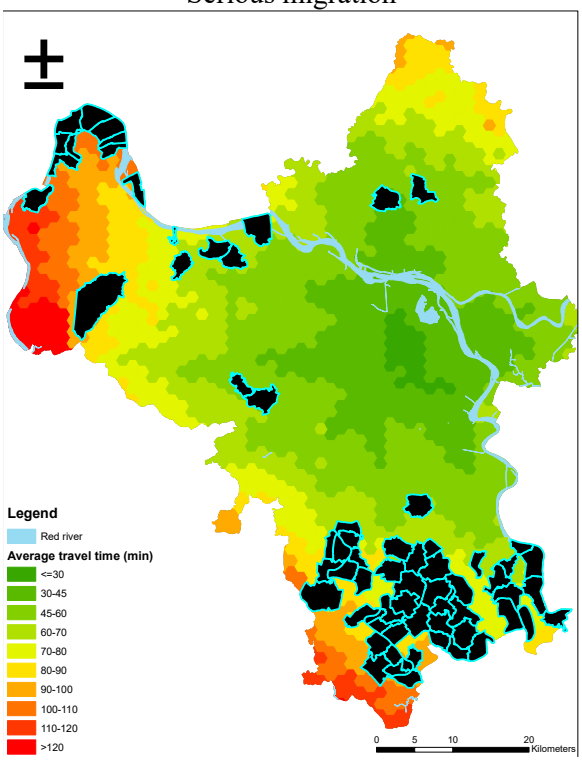


Fig. 4. Comparison between average travel time to jobs and population growth in Ha Noi city, period 2002-2010 (Source: authors)

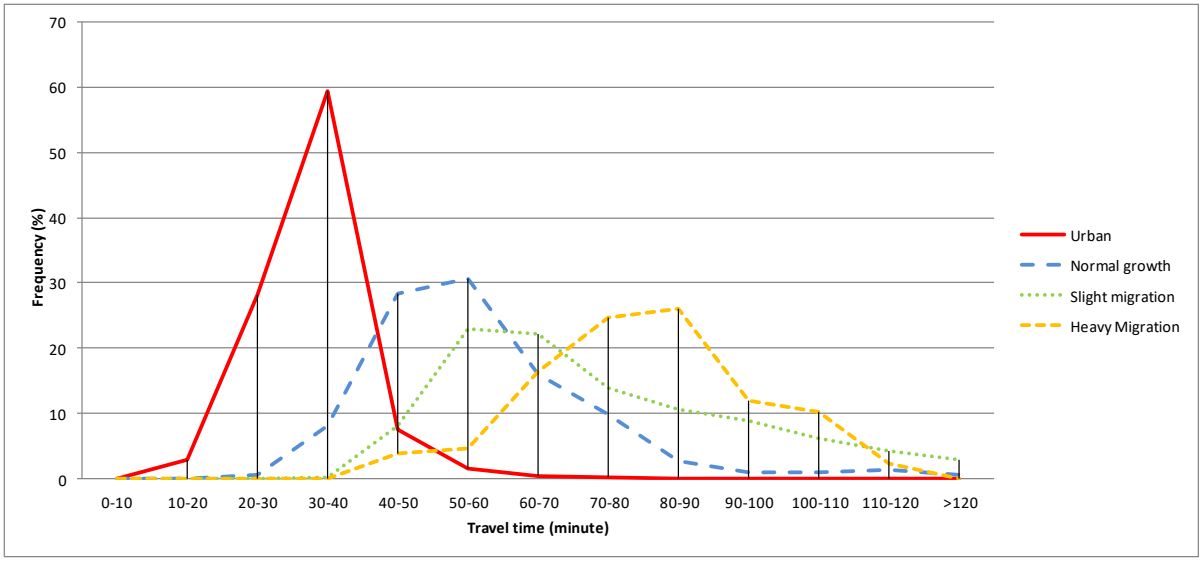
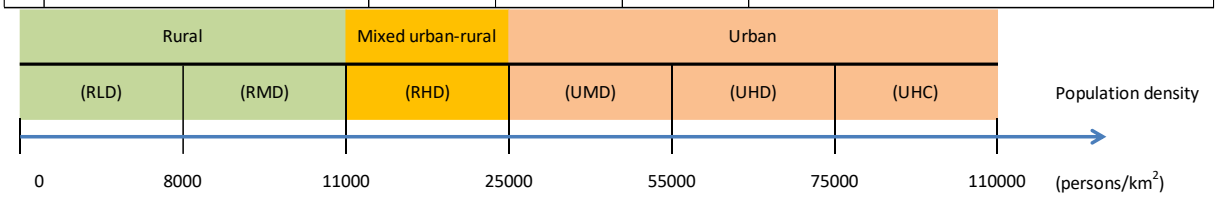


Fig. 5. Histogram of average travel time to jobs for each region (source: authors)

Table 3

Population density classes

No	Residential classes	Population density (persons/km^2)	Required area for a person (m^2/person)	Required area for a house hold (m^2/HH)	Note
1	Urban residential-High compact (UHC)	>=75.000	9.0-13.0	34-50 m^2/HH	This area is very typical total land for an household in the city center in Ha Noi (within the ring road no. 2).
2	Urban residential-High density (UHD)	55.000-75.000	13.0-18.0	50-70 m^2/ HH	This area is very typical total land for an household in the urban fringe in Ha Noi (from the ring no. 2 to ring road no. 3).
3	Urban residential-Medium density (UMD)	25.000-55.000	18.0-40.0	70-150 m^2/HH	This is standard area for an household in apartments (high rise buildings) in Ha Noi.
4	Rural residential-High density (RHD)	11.000-25.000	40.0-90.0	150-350 m^2/HH	This is also typical for rural areas that is near city.
5	Rural residential-Medium density (RMD)	8.000-11.000	90.0-125.0	350-500 m^2/HH	This is typical total land for an household in rural area that is further away from the city centre.
6	Rural residential-Low density (RLD)	<=8.000	>=125.0	>=500 m^2/HH	



The Fig. 7 shows the relationship between average travel time to jobs and the conversion between residential density land uses. In this figure the conversion between urban residential density land uses is not shown because they are located in the same range of travel time. It can be seen clearly that the conversion from RHD to UMD is likely to happen with travel time from 25 to 40 minutes by a motorcycle. It means the villages in reachable by a motorcycle is likely to change to urban medium density. The conversion from RMD to RHD is in the range from 30 to 60 minutes by a motorcycle but the strongest conversion happens with about 30-40 minutes by a motorcycle. The conversion from RLD to RMD is in the same range with the conversion from RMD to RHD but more likely to happen with travel time to jobs is from 40 to 50 minutes by a motorcycle

5. CONCLUSIONS AND RECOMMENDATIONS

In this study, the average travel time to jobs was applied to understand the population growth and residential distribution in Ha Noi. It can be useful for decision and policy makers in the sense that they can play as the ground for discussions and testing policies in order to have better integration of land use and transport in the future. Moreover, the average travel time to jobs (Ti) can give suggestions on

places where people likely to live and what transport mode people likely to use with assumption that people likely to live in areas that have high accessibility to jobs and travel time to jobs by a common transport mode is within acceptable range. In other words, they can suggest the places where urban is likely to growth in the future.

Several research limitations are as lacking of empirical studies to improve the argument's foundation. Although the paper's theoretical and conceptual contributions are significant, its relevance and applicability in real-world situations may be limited by its lack of empirical backing. In this case, it might be necessary to define "the strategy." What is this strategy's conceptual underpinning? How does it address the particular issues outlined in the context, and why is it necessary? Giving the reader this explanation would improve comprehension and bolster the reasoning behind the suggested argument. All of these research limitations will be considered for the authors' future studies.

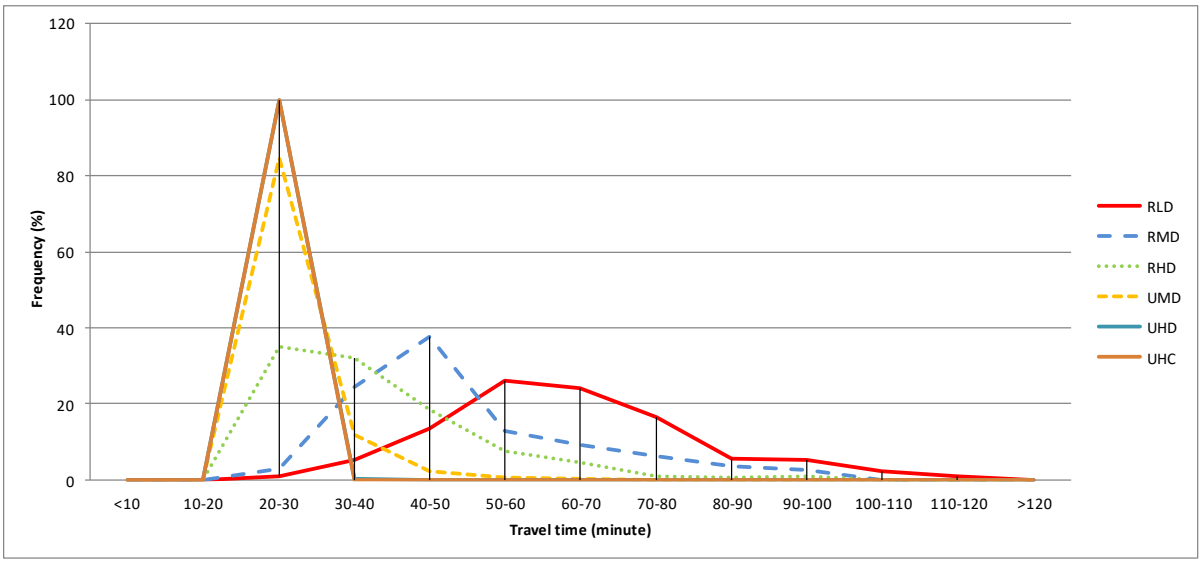


Fig. 6. Relation between average travel time to jobs with residential density in 2010 (source: authors)

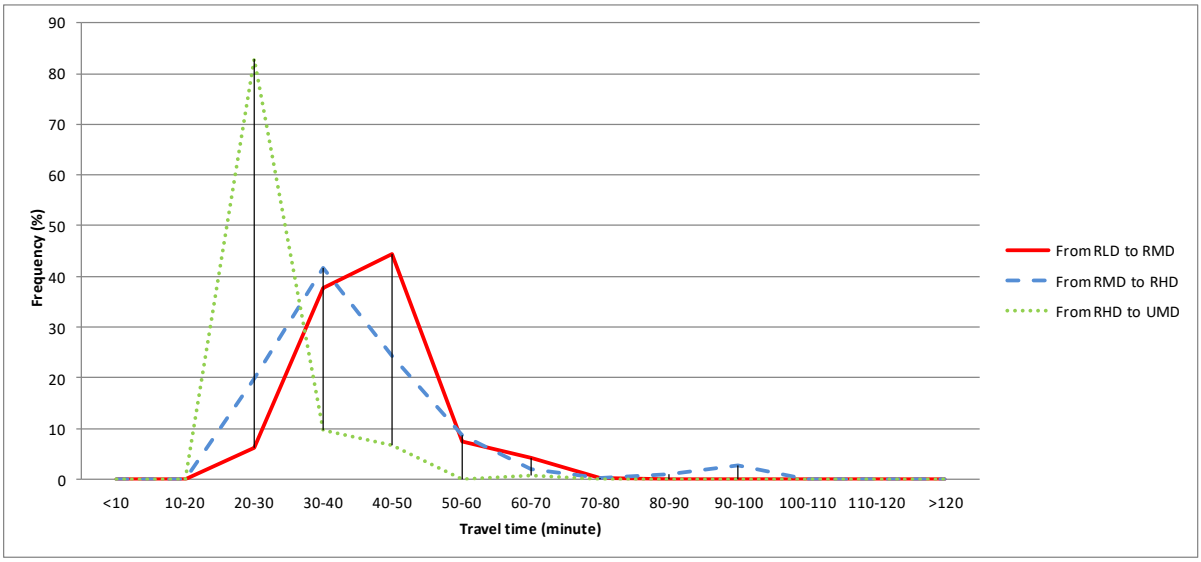


Fig. 7. Relation between average travel time to jobs and the conversion between residential density land uses (source: authors)

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