Article

Urban Form and Accessibility to Jobs

A Comparison of Hanoi and Randstad Metropolitan Areas

Environment and Urbanization ASIA
2(2) 265–285

SAGE Publications
Los Angeles, London,
New Delhi, Singapore,
Washington DC
DOI: 10.1177/097542531100200209
http://eua.sagepub.com
SAGE

Pham Thi Hong Ha, Frans van den Bosch, Nguyen Ngoc Quang and Mark Zuidgeest

Abstract

Accessibility is a comprehensive performance measure for the integration between land use and transport systems. In this research, two accessibility measures were applied to evaluate the integration between transport and land use in Hanoi metropolitan area: Vietnam, which has a typical monocentric urban form in the current situation, and Randstad metropolitan area, the Netherlands, which has a typical polycentric urban form. Job accessibility by private and public transport was calculated using the traditional potential accessibility measure corrected for competition of jobs. The results show there is a potential improvement of levels of accessibility in Hanoi through its planned transition into a polycentric urban form. The results illustrate the complex relationship between urban and regional planning and transport, and how spatial knowledge and geographic information system (GIS) tools can be used to provide urban planners, transport planners and engineers in Hanoi with valuable information related to its present plans of decentralization, and bring them together.

Keywords

Urban form, job accessibility, transport, Hanoi, Randstad, GIS

Introduction

Starting from the renovation period in the late 1980s, Hanoi metropolitan area in Vietnam is rapidly changing with high levels of urbanization (van Horen, 2005). These rapid developments have urged the (re)development of several master plans with the two most recent ones being (i) the Master Plan 2020 developed by Japan International Cooperation Agency (JICA) in 2007, and (ii) the Hanoi Master Plan 2030 and the Vision 2050 as proposed by Perkins Eastman United States (US), POSCO E&C and JINA, Korea (PPJ) in 2010 (ALMEC Corporation, 2007; PPJ, 2010). In these plans, Hanoi is proposed to be further decentralized, changing its urban form from a typical monocentric to a polycentric urban one, including five satellite towns and three ecological townships. To guide the development in a proper and sustainable way, spatial knowledge and tools used to model and map urban development and transport can bridge the gap between urban planners, transport planners and engineers.

With such rapid urbanization and together with the large influx of migrants from the rural areas and other nearby cities, several urban problems have come up: such as the rise of informal settlements, urban sprawl, congestion and accidents, amongst others, challenging the development of transport infrastructure (Cusset and Hai, 2001; Nguyen, 2007). Besides, the master plans mainly point out the orientation for urban development of Hanoi metropolitan area, while the more detailed land use and development plans are investigated and implemented by public or private developers and then submitted to relevant authorities for approval (Mizuno et al., 2000). In practice, lack of coordination between the authorities constrains the integration between transport and land use in Hanoi's planning, causing more urban problems. The problems that Hanoi is facing in terms of urbanization and decentralization are common in other large Southeast Asian cities, except for Singapore and Hong Kong. Dealing with these facts, experiences from developed countries in integrated land use and transport development can be studied and lessons be learned.

The Randstad metropolitan area in the Netherlands is a good example. Presently, the Randstad region comprises several large cities such as Amsterdam, Rotterdam, Utrecht, the Hague, Amersfoort, Leiden, Dordrecht, Haarlem, Hilversum and Gouda. With its high numbers of population and jobs, new settlements have been planned at about 10–15 km from the main cities in the area (Hilbers and Wilmink, 2002). In the Randstad area, transport is facilitated by a complete infrastructure network of motorways and for various kinds of public transport, such as railways, subways, tramways and buses in and between the cities. However, over the past decades, travel in the Netherlands, and particularly in the Randstad, has increased significantly (Hilbers and Wilmink, 2002; van der Werff et al., 2005), causing more and more congestion and its impacts, such as traffic-related emissions.

Accessibility is seen as an important indicator for the integration of land use and transport. It is defined as the ease to reach goods, services, activities and destinations, which are altogether called opportunities (Geurs, 2006; Litman, 2010). It is a performance indicator for sustainable development and a key criterion to assess transport policies, as well as density and spatial distribution of people and activities in cities or countries.

Even though the newly planned urban form of Hanoi is now oriented towards that of the Randstad, there are still controversial issues on the advantages as well as disadvantages of these plans. Therefore, the effects of these urban forms on accessibility for both Hanoi and the Randstad metropolitan areas should be studied. Comparison and understanding of accessibility can be the key element for Hanoi's planning in particular, and for Southeast Asian cities in general. This article will compare levels of accessibility to jobs for Hanoi and Randstad, through a comparative geographic information system (GIS)-based accessibility analysis in order to draw urban and transport planning lessons for Hanoi metropolitan area and beyond.

Urban Form versus Travel

Different urban forms, whether polycentric or monocentric, have different characteristics in terms of density, geometric shape, land use and infrastructure. Impacts of urban form on transport or travel behaviour is based on the notion that travel is a derived demand (Schepel and Zuidgeest, 2009). These impacts have been studied at the level of individuals, and also for cities or regions. However, they have also been under controversy (Alberti, 2008; Grazi et al., 2008; Schwanen et al., 2001). Generally, urban form is seen to have an impact on travel behaviour through its spatial distribution of important activities such as residences, jobs and shops. One has to be cautious since changes in urban form take place gradually over time, while other changes such as in the economy or transport happen much faster. This makes it more difficult to study the impact of urban form on transport.

Several researchers have studied the influence of urban form on travel behaviour (Boarnet and Crane, 2001; Cera, 2003; Handy and Niemeier, 1997; Kitamura et al., 1997). In general, three main factors of influence are listed, which are density of development, mix of land use and local accessibility to public transport (Cervero, 1996; Schepel and Zuidgeest, 2009).

The density of development factor deals with travel distance. Higher density of development, which often appears in more compact urban form, can reduce the travel distance and the number of trips made by individuals to home, work and service areas. In more compact urban forms or monocentric form, people are likely to live near their downtown jobs (Grazi et al., 2008; Organization for Economic Cooperation and Development [OECD] and European Conference of Ministers of Transport [ECMT], 2007; Williams, 2003). More compact cities also provide a population density high enough to build public transport system, such as Bus Rapid Transit. It is also expected that people residing in a more compact urban form tend to use the private car less, and use public transport, walking and cycling more. In addition, people have more opportunities they can reach within the same distance. This obviously increases the potential accessibility.

Mix of land use impacts on the spatial distribution of activities, travel distance and travel modes and thus, accessibility (Cervero, 1996). For example, the presence and absence of neighbourhood shops and commercial land uses can partially predict the use of transport modes and physical separation of activities such as going to work/home, shopping and entertainment.

A spatial factor to affect the choice of transport mode is the proximity to public transport (Kitamura, 1997). Increasing distance to the nearest railway station, for example, can reduce the choice of using train as a transport mode. Increasing distance to bus stop can increase the number of car journeys. The geographical locations of workplace also have impacts on the choice of transport modes and accessibility (Manaugh et al., 2010; Susilo and Maat, 2007).

There is a clear link between urban form and travel. More compact cities seem to generate less travel distances, more use of public transport, and hence provide more sustainable transport options. To understand more about the impacts of urban forms on sustainable transport or accessibility, this research will evaluate the results of accessibility for different urban forms present in two distinctly different areas through a comparative GIS-based accessibility analysis.

The Metropolitan Areas of Randstad and Hanoi

The urban structures of Randstad and Hanoi will be identified in this section. To do this the Randstad is divided into 799 zones, for ease of understanding called Traffic Analysis Zones (TAZ), available in a geo-database. These TAZs together form 147 cities in this region. In Hanoi, there are 29 districts which have been further divided into 574 communes. The communes are modelled as TAZ. Demographic data of these areas for the year 2009 are used to identify their urban form characteristics. First, the urban form of Randstad as a polycentric area and Hanoi as a monocentric area will be analyzed.

From literature, an urban centre has a close relationship with employment, employment density, population and population density. However, employment is the key in forming urban centres. A centre is best identified by a clearly higher employment density than the surrounding areas (Giuliano and Small, 1991; McDonald, 1987). More complex ways to identify a centre may be based on both land use mix and commuter flows (Giuliano and Small, 1991). Different approaches for centre identification have also been proposed. Giuliano and Small (1991) identified centres by cut-off values of employment data and the notion of proximity. McDonald and his colleagues used regression analysis to determine centre areas (McDonald, 1987). McMillen used locally weighted regression to illustrate the locally employment density function (McMillen, 2001).

In this research, to simplify the identity of urban structures, an easy and commonly used method to identify urban centres using GIS was applied based on the work of Giuliano and Small (1991). In this study, a centre is defined as a continuous set of zones which have a density (in terms of employment) above a preset cut-off value $\bar{D}$, and altogether have at least $\bar{E}$ total employment. In addition, all the immediately adjacent zones must have a job density smaller than $\bar{D}$. This definition helps identify all high-density zones to be part of an urban centre unless they are too small to form a total employment above $\bar{E}$. Cut-off values for each study area depend on the minimum total employment and maximum area.

For the Randstad, the cut-off values with different number of centres are presented in Table 1.

Table 1. Cut-off Values and Equivalent Number of Centres for Randstad

Employment Cut-off	No. of Centres	Area (km^2)	Cumulative Area (%)	Employment Density Cut-off	No. of Centres	Area (km^2)	Cumulative Area (%)
400,000	1	196.4	3.15	2,500	1	84.2	1.35
300,000	2	467.0	7.48	2,000	5	417.5	6.69
200,000	4	650.2	10.4	1,500	10	520.2	8.33
100,000	10	1136.5	18.21	1,000	18	979.0	15.69

Source: Authors.

With these cut-off values, four large centres emerge in the Randstad with a total employment of more than 200,000 and an employment density higher than 1,000 jobs per kilometres square (km^2), which are the known large cities in the area: Amsterdam, Rotterdam, Utrecht and Den Haag.

These four cities are spread over the Randstad area, which justifies naming this a polycentric urban form. This is further illustrated in the maps in Figure 1.

Similar to the analysis for the Randstad area, the process to identify cut-off values for the Hanoi metropolitan area was done and this is presented in Table 2. However, because the Hanoi districts vary in size a lot, ranging from 5 km^2 to more than 400 km^2, the identification of urban centres for Hanoi was done on the basis of the employment density figures, rather than the absolute employment figure. Centres in Hanoi have an employment density higher than 400 jobs per km^2, and a total employment larger than 15,000 jobs.

Centres identified in Hanoi lie next to the core of the area. Employment density decreases from Hanoi centres to suburban areas. Hanoi city clearly appears as a monocentric area. This is further illustrated in the maps of Figure 2.

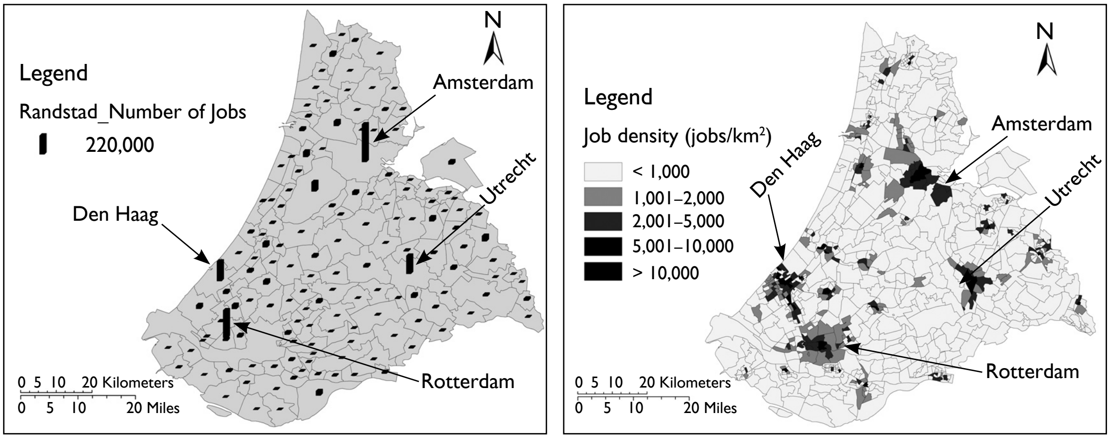

Figure 1. Job Distribution and Job Densities in Randstad Metropolitan Area

Source: Authors.

Table 2. Cut-off Values and Equivalent Number of Centres for Hanoi

Employment Density Cut-off	No. of Centres	Area (km^2)	Cumulative Area (%)
5,000	1	5.2	0.15
3,000	2	15.0	0.45
2,000	4	34.4	1.02
1,000	6	56.0	1.67
400	10	214.1	6.4

Source: Authors.

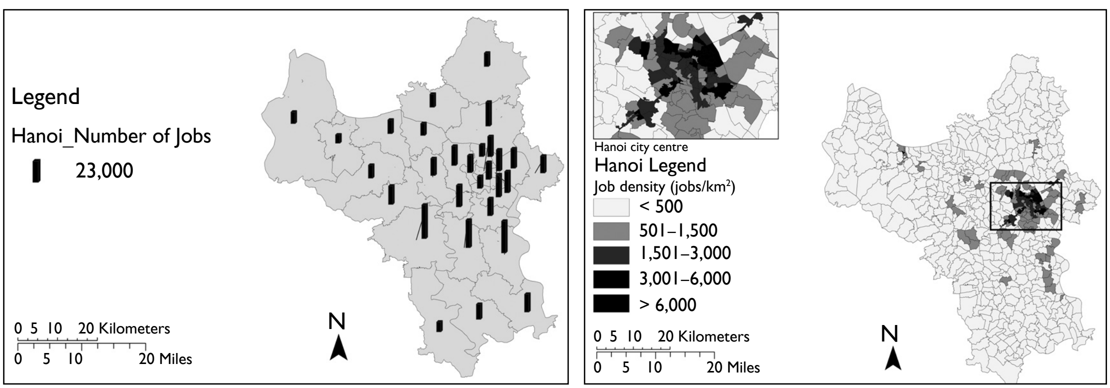

Figure 2. Job Distribution and Job Densities in Hanoi Metropolitan Area

Source: Authors.

In general, with their existing urban forms, Randstad and Hanoi are ideal cases representing polycentric and monocentric structures. Each urban form will have its own advantages as well as disadvantages. For example, a polycentric urban form may provide options for spatially distributing mobility better at the cost of longer travel distances and higher car dependency. In addition, a polycentric urban form makes the designing and implementation of a public transport network more difficult. Monocentric urban form, on the other hand, can provide planners with easier function of public transport by designing radial network. Nonetheless, monocentric urban form can result in high congestion levels, and higher levels of local air pollution.

Accessibility versus Urban Form

The definition of accessibility is often linked to a listing of accessibility measures and indicators (van Wee et al., 2001). There is a wide variety of accessibility measures which have been developed since the 1950s. Three main types of measures can be distinguished as (El-Geneidy and Levinson, 2006; Geurs and Ritsema van Eck, 2001; Geurs and Wee, 2004; Handy and Niemeier, 1997): (i) infrastructure-based measures; (ii) activities-based measures (which is subdivided into location-based and person-based measures); and (iii) utility-based measures.

Infrastructure-based measures, such as congestion levels (Cerda and El-Geneidy, 2010; El-Geneidy and Levinson, 2006; Geurs and Wee, 2004; Wachs and Kumagai, 1973), only depend on transport infrastructure characteristics. They do not provide insight and understanding to how accessibility levels vary with different groups and land use patterns (Handy and Niemeier, 1997), thus urban form. Person-based and utility-based measures, on the contrary (Geurs and Ritsema van Eck, 2001; Kwan et al., 2003; Miller, 2007), can analyze accessibility at an individual's level, such as counting the number of activities in which an individual can participate at a given time, but require an intensive data supply, which is very difficult to obtain in reality. Among the stated measures, location-based measures are preferable and are used most in literature for its balance between required data and quality of results (Cerda and El-Geneidy, 2010; El-Geneidy and Levinson, 2006; Geurs and Ritsema van Eck, 2001; Shen, 1998; van Wee et al., 2001; Vickerman, 1974). This type of measure analyzes the accessibility of locations and evaluates the spatial distribution of services or activities. To enhance the results, competition for activities in locations is sometimes included using competition factors (Shen, 1998; van Wee et al., 2001; Vickerman, 1974), or using balancing factors and place rank measures (El-Geneidy and Levinson, 2006; Geurs and Ritsema van Eck, 2001). Details for such location-based measures are provided in the next section.

Defining and Operationalizing Potential Accessibility

The traditional potential accessibility measure is a location-based measure that discounts opportunities such as jobs over space. The accessibility level is assessed for a single travel mode. Attractiveness of opportunities decreases with longer distance or higher travel costs by applying a distance decay function. This function will vary according to economy, travel habit and perception of the opportunity values in each region. The following equation gives the accessibility level of an area (or zone) i (A_i):

$$A_i = \sum_{j=1}^{n} \frac{O_j}{T_{ij}^{\alpha}} \tag{1}$$

where, A_i: potential accessibility level of zone *i*;
O_j: the number of (job) opportunities in zone *j*;
$1/T_{ij}^{\alpha}$: distance decay function for travel from *i* to *j*;
T_{ij}: travel time from *i* to *j* (minutes); and
α: parameter for the distance decay function.

Although the potential accessibility measure can reflect the supply of opportunities such as jobs over space, it does not account for competition of available opportunities. It assumes that competition will not affect the level of attractiveness or accessibility level. This disadvantage can be tolerated in some opportunities, but not with jobs.

A competition factor should be added to the equation to limit the opportunities that one can reach. This factor depends on the education background, characteristics of the available jobs or spatial distribution of people versus opportunities. One reasonable measure including competition factor is the adapted potential measure (Shen, 1998). In this method, the effect of competition in the destinations is expressed by dividing the available number of opportunities in a zone to the demands reaching that zone. Van Wee et al. (2001) enhanced this measure by distinguishing a volume component of job opportunities ($Jobs_j$) and a competition component in Equation (1) as follows:

A_i = Volume component × competition factor

$$A_i(T < T_{\max}) = \sum_{j=1}^{n} \left(\frac{\text{Jobs}_j}{T_{ij}} \times \frac{\sum_{k=1}^{n} \left(\dfrac{\dfrac{\text{Jobs}_k}{Lf_k^{\alpha}} \times Lf_k}{T_{jk}^{\alpha}} \right)}{\sum_{k=1}^{n} \left(\dfrac{Lf_k}{T_{jk}^{\alpha}} \right)} \right) \tag{2}$$

where, A_i: potential accessibility to job *s* within a certain time T_{max} from zone *i*;
$j = 1 \ldots n$: all zones within certain time T_{max} from zone *i*;
$k = 1 \ldots n$: all zones within certain time T_{max} from zone *j*;
$Jobs_j$: number of jobs in zones *j*;
Lf_k: the size of employment market in zone *k* (active population);
T_{ij}: travel time from zone *i* to zone *j* (minutes); and
α: parameter for the distance decay function.

With their method, van Wee et al. (2001) enhanced the existing adapted potential measure by taking into account the impacts of other jobs in other zones related to the original zone *i*, as depicted in Figure 3.

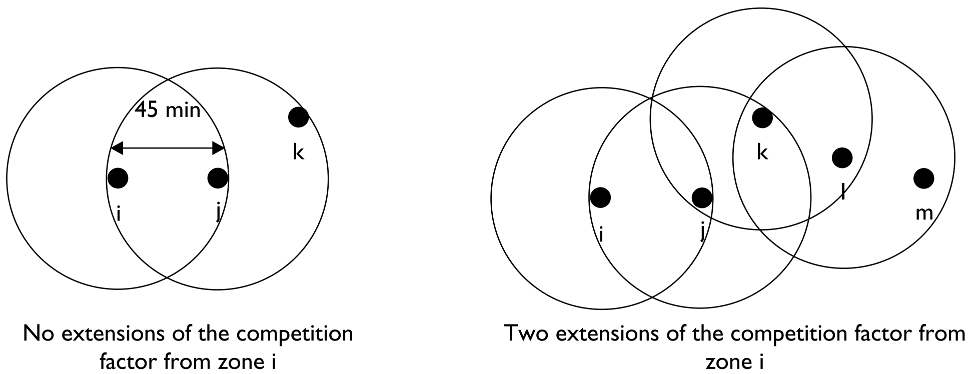

Figure 3. Visualization of Accessibility with Competition of Zone *i*

Source: van Wee et al. (2001).

The accessibility of zone *i* is not only affected by number of jobs and population in zone *j* (which is next to *i*) but also affected by number of jobs and population in zones *k*, *l*, *m*, etc. As long as zones *k*, *l, m* and other zones lie within the maximum travel cost from zone *i* (in this case, travel time, or T_{max}), they will have impacts on the accessibility of zone *i*. Travel cost from each of these zones to *i* will also be important factor, which decides the influence of these zones on zone *i*. In each zone, within the travel time limit, the number of jobs per working person, labour market and travel cost from zone *i* are determinants of competition for zone *i*. This accessibility measure with competition by van Wee et al. (2001) is implemented in this study.

GIS-based Data and Modelling

Two accessibility measures for the year 2009, that is, the potential accessibility measure and the potential accessibility measure corrected for job competition, were implemented in a GIS software environment and applied to Hanoi and Randstad metropolitan areas in their current situation. The objective is twofold. First, potential accessibility measures will be tested for two transport modes: car and public transport for the Randstad; and motorcycle and bus transport for Hanoi, allowing for a comparison between the different modes. Second, the impacts of decentralization or a comparison of the effects of different urban forms represented by the Randstad and Hanoi areas can be performed.

In the case of Hanoi, the level of accessibility at the commune level was calculated using origin–destination (OD) cost matrices in the ArcGIS modelling environment. Some basic data used are: (*i*) administrative boundaries in Hanoi; (*ii*) employment and demographic data (number of jobs in each commune, obtained from Hanoi Statistical Office and Vietnamese Ministry of Natural Resources and Environment); and (*iii*) a road network that was partly digitized manually from the Hanoi Map 2010 (VietNam Publishing House of Natural Resources, Environment and Cartography [NARENCA], 2010), and using previous digitization work of Nguyen (2007). Travel times were calculated in ArcGIS software based on the length and assumed average travel speeds on each street segment for a single travel mode, either by motorbikes or buses in combination with walking access to the bus stop. The speeds of the motorcycle were classified into four categories depending on the road category (the highest speed for motorbikes is 40 km per hour and the lowest speed is 8 km per hour), which were obtained from Nguyen (1999) and Chu Cong et al. (2005). Bus average speed was obtained from Nobuyuki et al. (2005), which is assumed at 22 km per hour. Speeds of motorcycles or buses were assumed to be average speeds during the day. Transit travel time includes the walking time to the transit stop, in-vehicle time, transfer time and walking time to the destinations. To implement the accessibility measures, OD matrices of transit time were generated with assumption that people travel from centroids to centroids of 574 zones in Hanoi.

In the case of Randstad metropolitan area, travel time matrices for the year 2004 were obtained from Goudappel Coffeng and Transumo (2010), and were considered representative for the year 2009, while the other data were actually from 2009. These matrices were generated using the travel demand modelling software OmniTRANS. Two matrices were available for use, one on the travel time by public transport, another one on the travel time by car, which accounts for congestion in non-peak hours. The matrices, however, have travel time data from several locations within some TAZs (for example: central, north or south of a district or from a port within that district). Thus, when calculating the accessibility level for that district, it was assumed that people will choose the shortest route to leave the TAZ. Illustration of this process is shown in Figure 4.

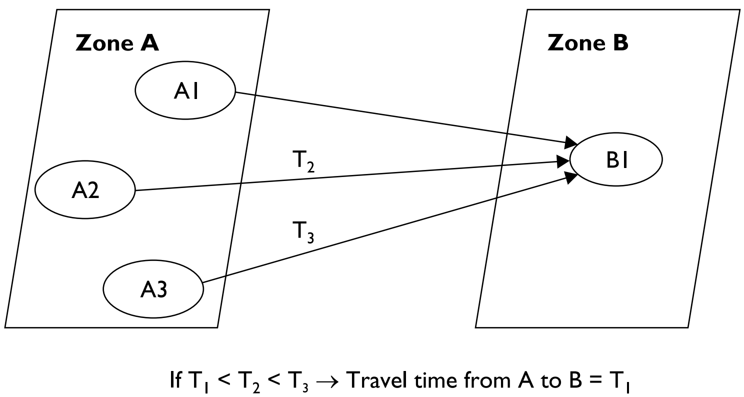

Figure 4. Method for Travel Time Calculation of Randstad

Source: Authors.

The other 2009 data on (*i*) administrative boundaries; (*ii*) jobs and population data obtained from Statistics Netherlands (CBS), 2010. The two accessibility measures were accordingly calculated for 799 TAZs.

Impedance Function

One of the main problems dealing with potential accessibility measures is identifying the distance decay or impedance function. The impedance function $f(c_{ij})$ represents the degree to which zone i is attracted by other zones based on travel time or travel costs. In the equation, the impedance function of travel time depends on the actual modes, trip purposes and household characteristics, such as gender, age, income and educational level (Geurs, 2001). Because of its complex nature, the choice and identification of travel time impedance in these equations is not straightforward. The form of impedance function can vary from a simple inversely linear regression to more complicated negative exponential function or logistic function (El-Geneidy and Levinson, 2006; Geurs and Wee, 2004; van Wee, 2001). Some researchers have tested accessibility level using different impedance functions for their study areas (El-Geneidy and Levinson, 2006; Geurs, 2006).

For the chosen impedance function, estimating the α is rather complicated and requires several trials. The α value represents the degree to which people in one zone prefer to work near their home. Two extreme cases of α value are zero and infinity. If α equals zero, people can work everywhere. In contrast, if α reaches infinity, people in zone *i* will only accept to work in their zone. Because people in Randstad have 39 minutes as mean travel time to work (Statistics Netherlands [CBS], 2010) and people in Hanoi travel to work with 19 minutes as average (ALMEC Corporation, 2007), the travel time decay curve is assumed steeper for Hanoi. Assumptions on α values are 0.5 for Hanoi and 0.4 for Randstad to represent the average travel time correctly. See Figure 5.

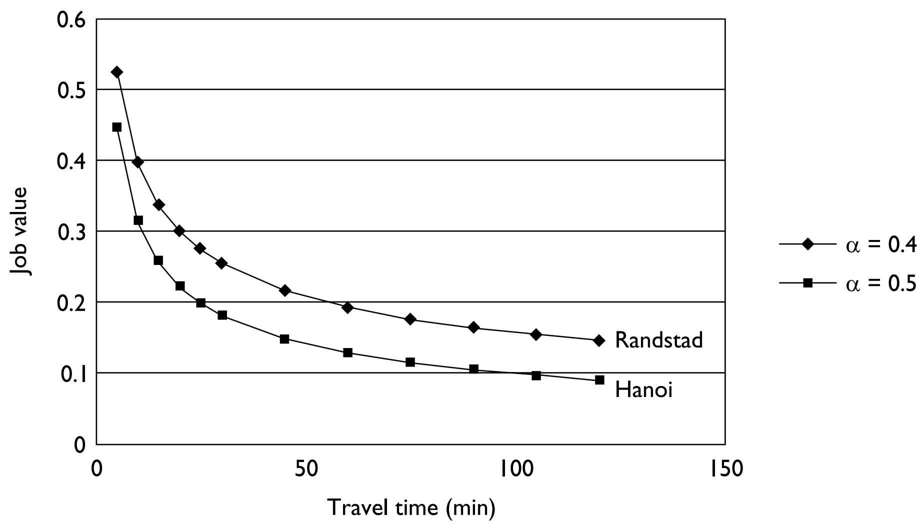

Figure 5. Impedance Function 1/Tα Used in this Study (for all Modes and Trip Purposes together)
Source: Authors.

It should be noted that comparison of accessibility, which is the main goal of this research, should be done in a relative manner and not to compare the numbers directly. Thus, in this research, to easily identify how the competition factor alters the results, the shape of the impedance function is kept the same for the two measures. This power function has been used in other studies as well (El-Geneidy and Levinson, 2006; Geurs, 2001). Although this function is crude and simplified, it can include the impacts of travel time or cost on the employment market and it is suitable for the goal of this research: to compare accessibility levels by different transport modes and affected by different urban forms.

Spatial Analysis

The integration of land use and transport is investigated through accessibility by both private and public transport modes. Since more than 80 per cent of transport in Randstad is by cars or public transport (Statistics Netherlands [CBS], 2010), these modes will be representative for the quality of private and public transport respectively. For Hanoi area, according to HAIDEP (JICA, 2007) (ALMEC Corporation, 2007), buses account for just about 10 per cent while motorcycles and cars account for more than 70 per cent of transport in Hanoi. Thus, the quality of private and public transport will be assessed through motorcycle and bus networks. Potential accessibility to jobs corrected for competition was calculated using the travel time decay curves with ArcGIS and its Network Analyst extension.

The potential accessibility measure relates to the potential number of jobs that people from each zone can reach discounted for impedance (Figure 5), and is shown in Figure 6 for private transport, and in Figure 7 for public transport in Randstad and Hanoi. For ease of comparison, the two areas are visible at the same scale.

In order to include the competition for jobs at the destinations, the potential accessibility measure is corrected using the competition factor in Equation (2). The travel time limit was set for both Randstad and Hanoi using the study of Egeter et al. (2000; cited in Geurs, 2001) and ALMEC Corporation (2007). The travel time threshold is set as 90 minutes for every zone in both study areas. The results of accessibility corrected for competition are shown in Figure 8 for private transport and Figure 9 for public transport.

In both Hanoi and the Randstad, the impact of urban form, in terms of job concentrations and available infrastructure, is clearly visible in these results. Either using private or public transport, centres in these areas always have the highest accessibility levels.

For the Randstad, the accessibility with competition level shows the polycentric structure with the four large cities as polycentres: Amsterdam, Rotterdam, the Hague and Utrecht. The so-called Green Heart area, which lies strategically between these four cities, also has a higher accessibility than the outskirts of the Randstad area. Only one area to the right of Rotterdam, which is the west part of the Green Heart from Nederlek to Zederik, shows a low accessibility level even though it is located near to the large cities. A combination of lack of infrastructure-based accessibility and lack of nearby jobs within a travel time threshold seems to cause this.

The result of job accessibility in the Randstad is comparable to similar research reported by Geurs (2001). In the measure corrected with competition factor, the results show a high accessible number of jobs within the four largest cities and in the Green Heart area despite the large labour market. These results reflect that number of jobs exceeds the labour force in these cities. This fits to the expectations and the results from van Wee (2001). Even though we used a simpler different impedance function than the function used by van Wee et al. (2001), the correlation of accessibility levels of different zones is quite similar to their research.

Applying these measures to Hanoi shows a typical monocentric result. Higher levels of accessibility to jobs quickly reduce away from the city centre, either with or without competition, to the suburban areas, regardless of transport modes. This result comes from the fact that city centre is well located regarding accessibility to job opportunities. Although the city centre has a high population and worker population, it also has a good transport system. In Hanoi area, there are some TAZs outside the city centre that show high accessibility because these are the locations of big industrial parks or locations near main highways and bus routes.

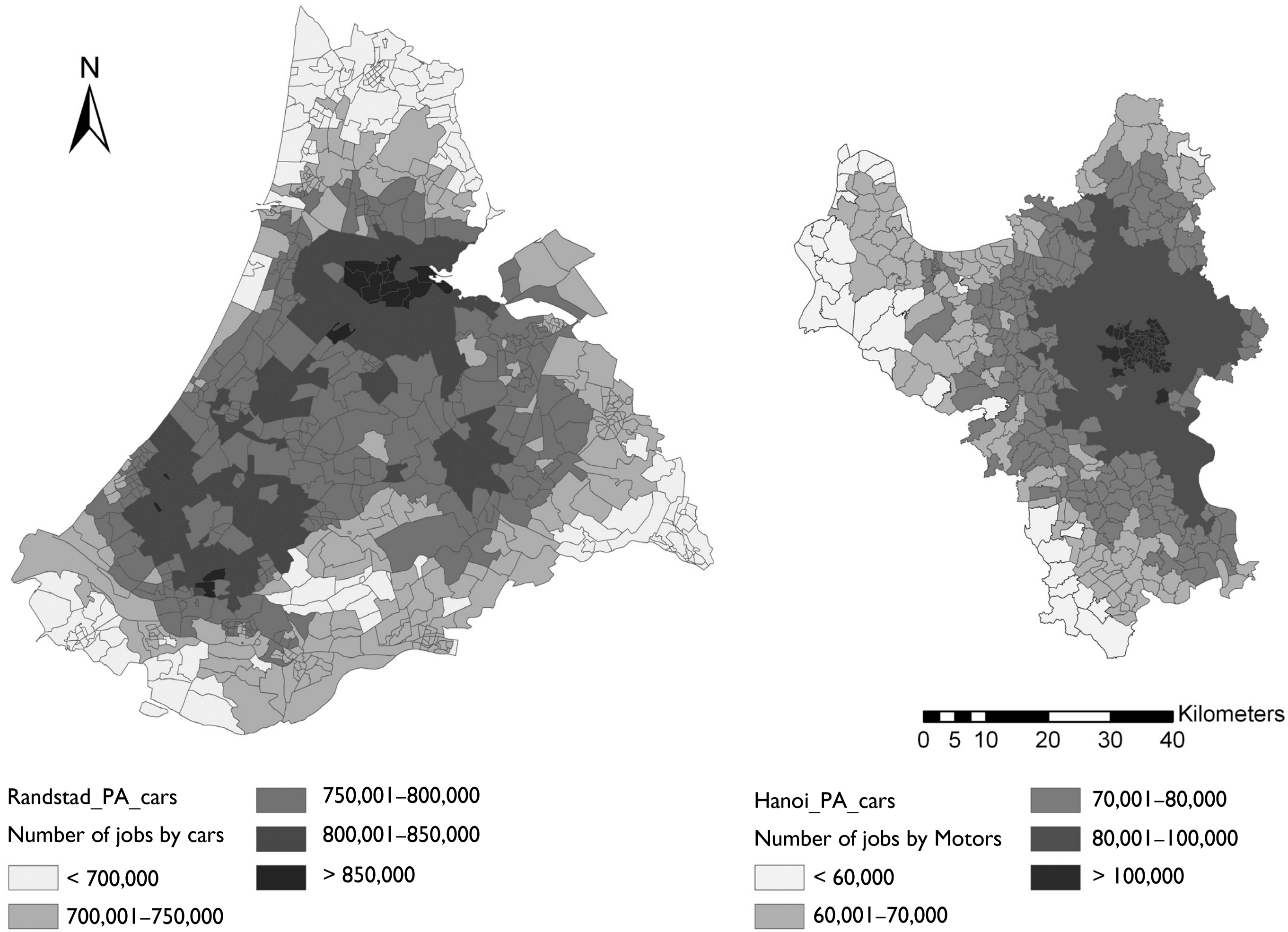

Figure 6. Potential Accessibility to Jobs by Private Transport in Randstad and Hanoi

Source: Authors.

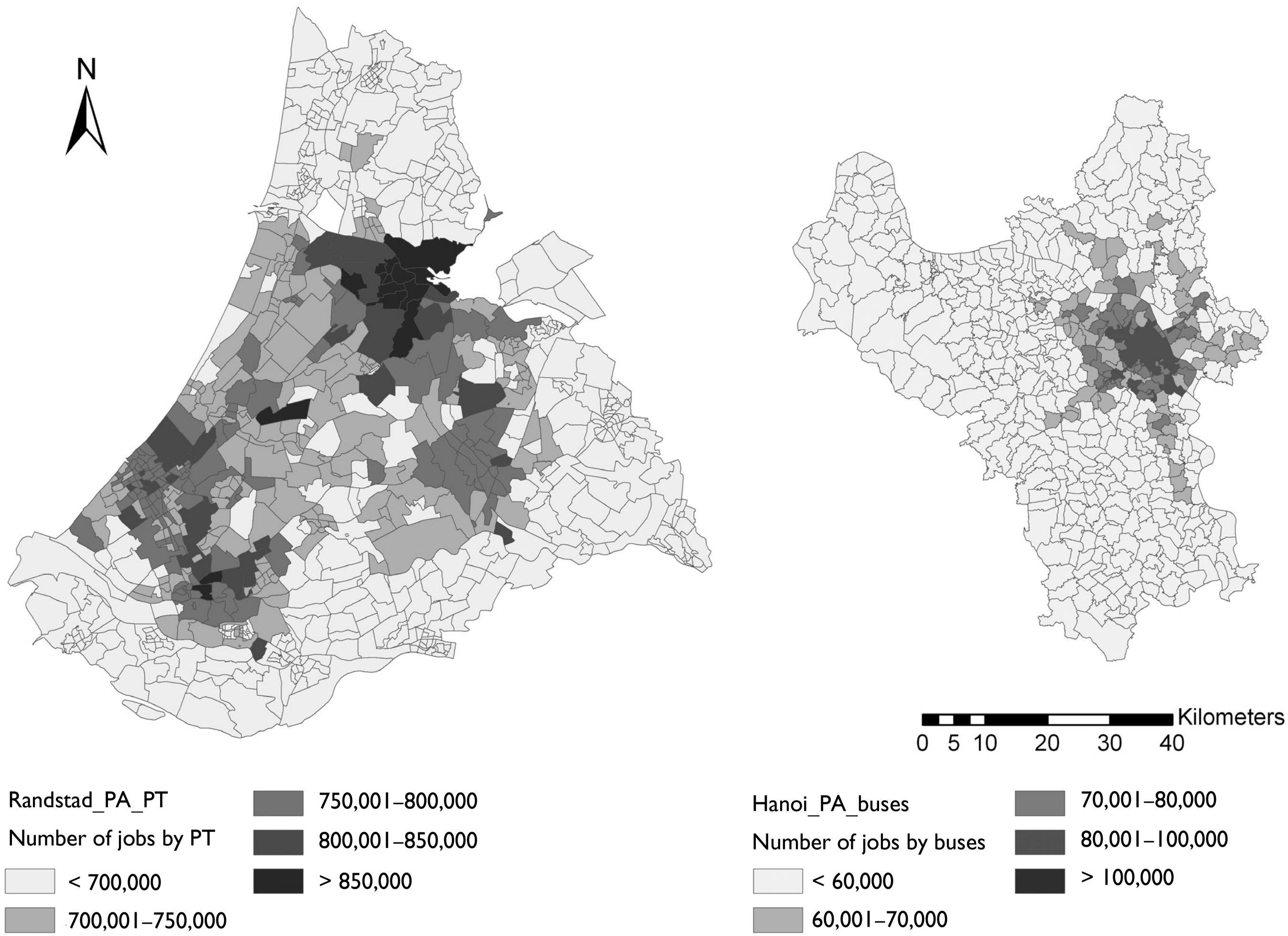

Figure 7. Potential Accessibility to Jobs by Public Transport in Randstad and Hanoi

Source: Authors.

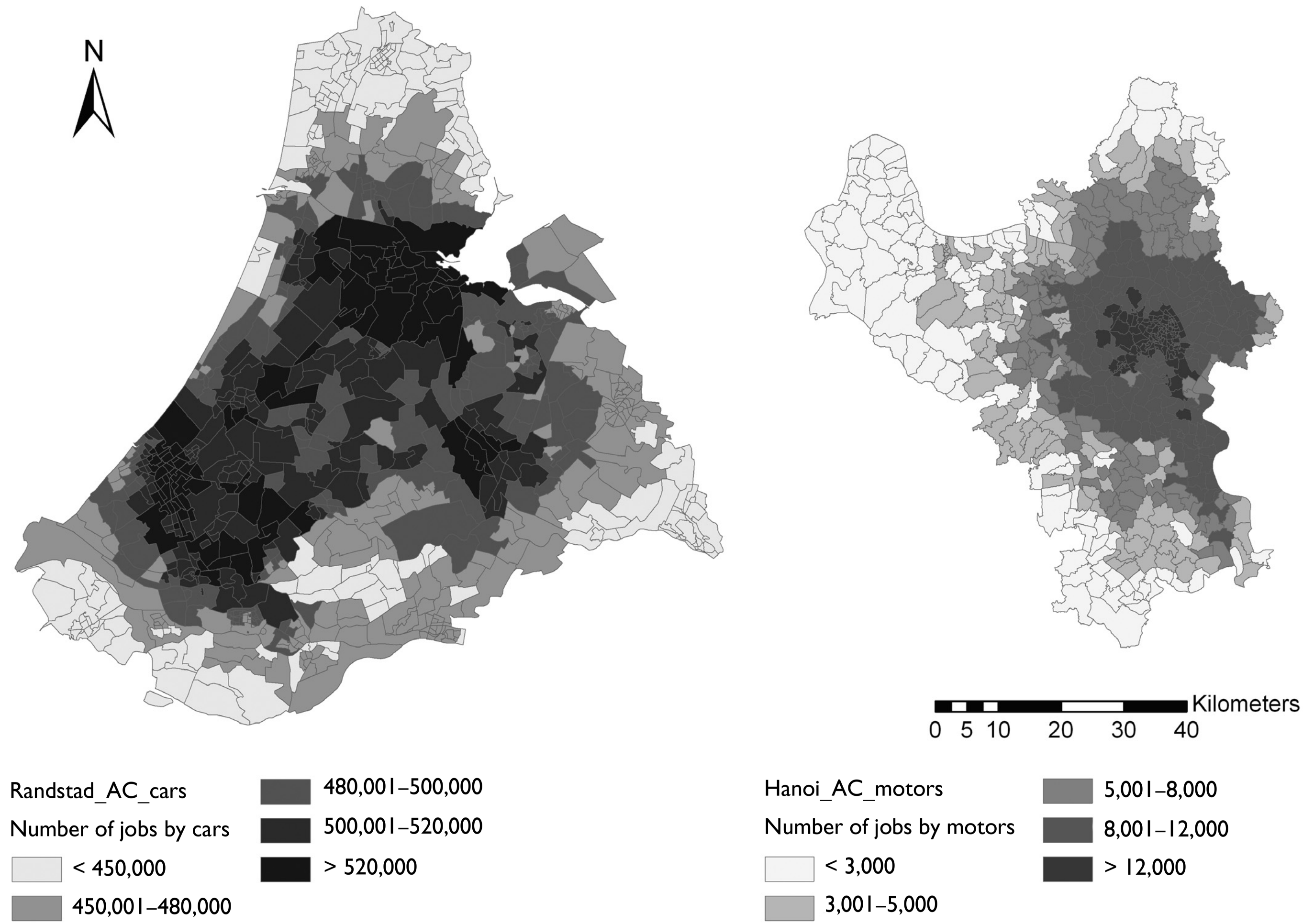

Figure 8. Potential Accessibility with Competition to Jobs by Private Transport in Randstad and Hanoi

Source: Authors.

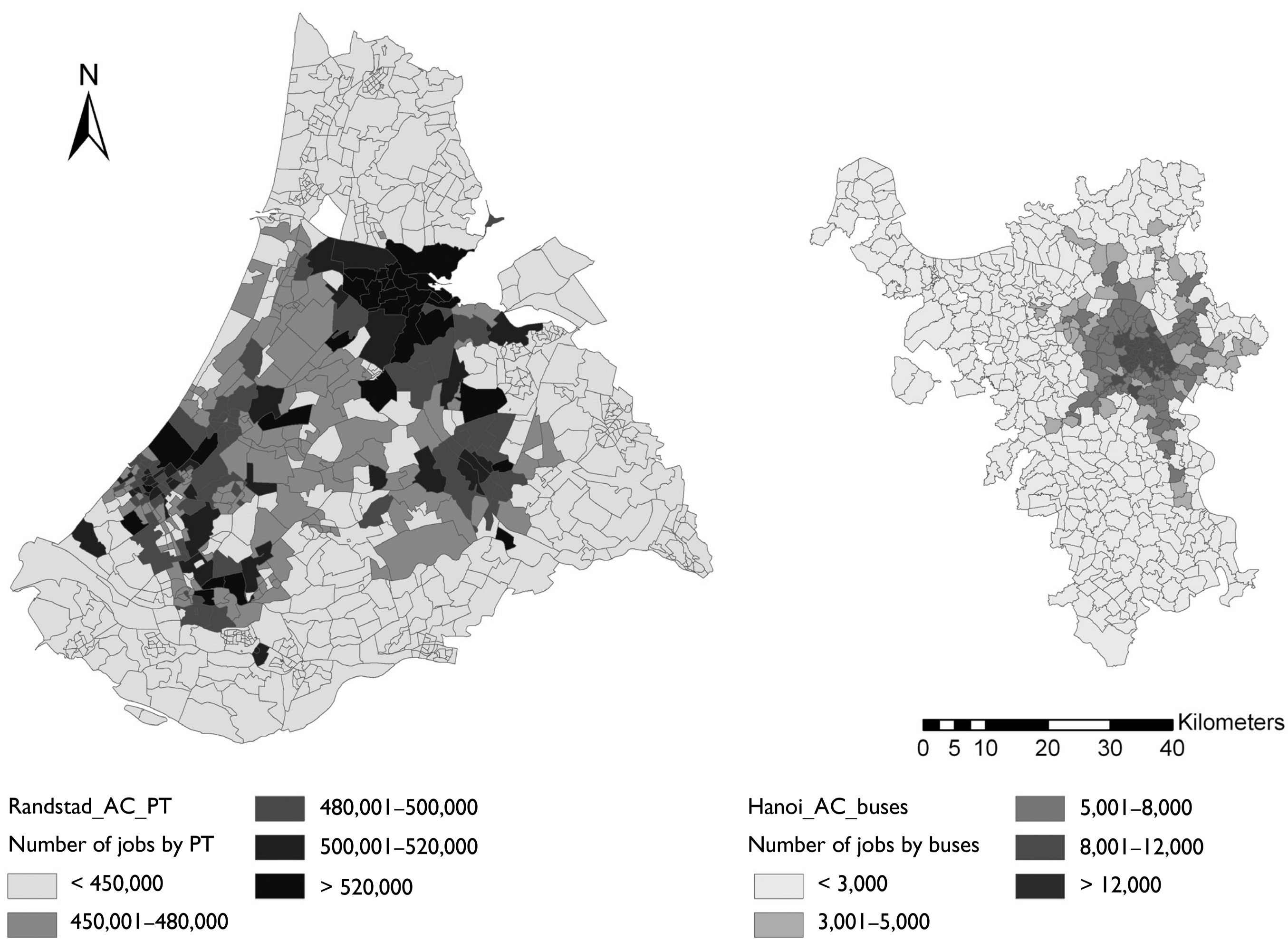

Figure 9. Potential Accessibility with Competition to Jobs by Public Transport in Randstad and Hanoi

Source: Authors.

In addition, the clear impacts of urban characteristics, the infrastructure of transport, including availability of transport modes and speed or travel time, also has an impact on the accessibility of TAZs and is further investigated in this study.

In Hanoi, the higher availability of motorways rather than public transport (bus) routes gives motorcycles better accessibility in every region. The bus network in Hanoi is only available in the city centre. There are several bus routes connecting the city centre with some suburbs in the south and west of the city. However, these connecting bus routes are quite short, limited in frequency and capacity, and cannot cover the demand of the very large rural and suburban outside.

To compare the difference between use of motorcycles and buses, the ratio of accessibility of these two modes can be calculated and is shown in Figure 10. The ratio of motorcycles to buses ranges from 1.1 to 2.4 using potential accessibility measure and from 1.5 to 800(!) when the measure is corrected for job competition. The ratio of accessibility by motorcycles to buses in Hanoi shows a somewhat high imbalance between private and public transport in Hanoi, especially in the rural and suburban areas. Due to a lack of good bus network in the Hanoi rural and suburban areas, the accessibility to jobs by public transport in these areas can hardly be compared with accessibility by private transport. Although job accessibility by public transport in Hanoi centre appears to be less than that by private transport, other factors such as mode availability due to the high cost of private modes, parking costs, etc., are known to make public transport still surpass private transport use in Hanoi city centre. However, this research does not deal with these factors. Thus, the unfavourable result of public transport mode over private transport mode is only partially evaluated here.

Due to the variety of public transport infrastructure in Randstad, which includes buses and train, the difference in job accessibility of cars and public transport in Randstad is much less than in Hanoi. Some zones even have higher job accessibility by public transport than by cars, such as in Amsterdam, Den Haag and Rotterdam. Figure 11 shows this difference between potential accessibility with and without competition for car and public transport in the Randstad.

Using the potential accessibility measure to calculate job accessibility, the number of jobs that can be reached by car is 0.86 to 1.4 times the number of jobs that can be reached by public transport, while this

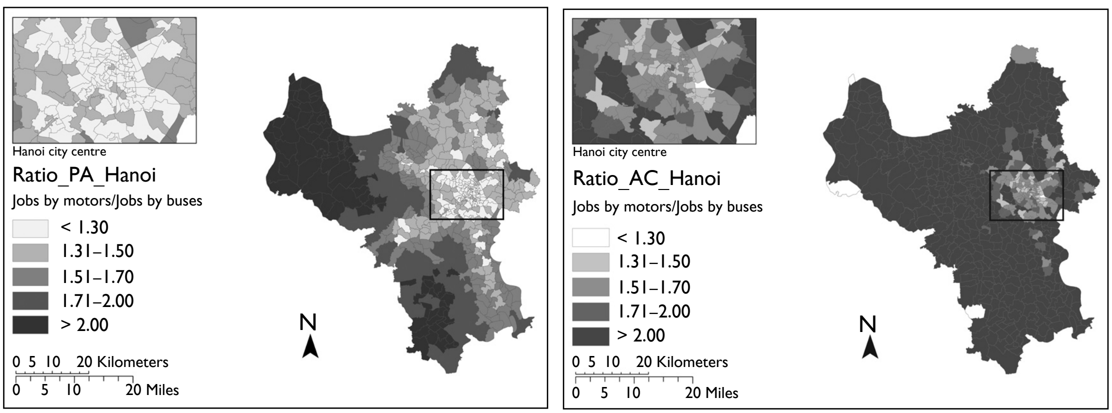

Figure 10. Ratio of Potential Accessibility to Jobs by Private and Public Transport in Hanoi (wihtout and with competition; PA and AC)

Source: Authors.

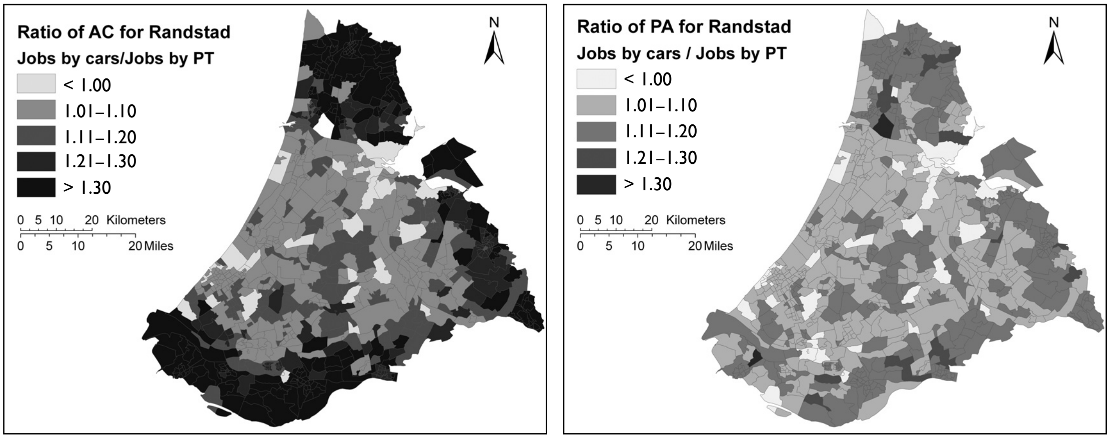

Figure 11. Ratio of Potential Accessibility (Without and with Competition, PA and AC) to Jobs by Private and Public Transport in Randstad

Source: Authors.

ratio can reach three times using the accessibility corrected with competition. The differences between car and public transport are quite evenly distributed. Four big centres, Amsterdam, Rotterdam, Den Haag and Utrecht, together with some surrounding cities, form an area with the least difference between cars and public transport. In these areas, public transport may even have higher accessibility than cars. The border areas of Randstad generally have more differences between private and public transport. Although Randstad is equipped with a good public transport infrastructure, cars seem to be more prominent than public transport using both measures. For example, the number of journeys to work by public transport account for 25 per cent, while the number of journeys to work by cars accounts for about 40 per cent in Amsterdam according to European statistics 2009 (European Commission, 2009). This may be a result from the polycentric urban form characteristics, which have large space within area and require longer travel distance or time.

Discussion

In general, the Randstad and Hanoi metropolitan areas have job accessibility levels for the different transport options varying relatively with their urban form structure: polycentric in Randstad and monocentric in Hanoi. Four big cities (Amsterdam, Rotterdam, Den Haag and Utrecht) in Randstad and the city centre in Hanoi show the highest level of job accessibility. The border areas often have the lowest accessibility to jobs. Explanations for these results are the high concentration of jobs as well as the better transport infrastructure in the centres. High job density in one zone obviously brings higher accessibility of jobs in the nearby areas. In addition, the accessibility to transport network also affects the accessibility to jobs, reflected through the result using public transport in the rural areas of Hanoi.

Randstad, in this case, is a good example for successful allocation of jobs as well as good transport infrastructure between the different large cities. Considering the supply of private and public transport infrastructure, the accessibility by different modes in Randstad is more balanced. Considering the job distribution among regions, Randstad has a more even distribution than Hanoi. Thus, in the future development of the city, Hanoi should learn to deal with both transport infrastructure development and land use management.

Conclusion and Recommendation

The main goal of this study is to evaluate the integration of transport and land use through accessibility levels and to evaluate the impact of different urban forms on accessibility. Two accessibility measures have been described and implemented. The potential accessibility is found to be more suitable for public and decision makers because it has less data requirements and is easier to understand as well as to interpret. However, accessibility with competition is preferred to the traditional measure, especially in Hanoi where the job market is small, thus increasing the importance of including the competition effect. Two study areas with suitable urban forms are chosen: Randstad with polycentric urban form in the Netherlands; and Hanoi with monocentric urban form in Vietnam.

To obtain the results, most of the spatial data in this research are obtained from different sources and are secondary data. The main result in this study relates to job accessibility of two study areas using different transport modes and calculated with the two measures.

From the results, urban form clearly shapes the accessibility level, which can have impacts on transport in general. Polycentric urban form shows a lesser difference in accessibility level of zones within regions. In other words, polycentric urban form brings more balanced results in accessibility to jobs. Monocentric urban forms make these differences bigger. However, polycentric urban form also favours private transport use due to its larger distances. In a more compact urban form, travel time to work is often shorter. People living in centres can reach more jobs within the same travel time when they live in a monocentric urban form. In addition, a monocentric urban form may take less time, money and efforts to build an efficient public transport network in theory. Scattered centres require building more links to obtain the same level of accessibility in total. Although polycentric urban form seems to be unfavourable in terms of travel time to work and car dependency, it can however prevent major congestion and overcrowding of areas, further causing air pollution, noise and affecting the quality of life, as is now the case in Hanoi.

Although there is still controversy on whether monocentric or polycentric urban forms are better, the results of this research show that the shape of the urban region, in combination with its transport infrastructure, influences job accessibility levels to a great extent.

Another noted conclusion is that competition for jobs really alters the results. Within a travel time limit and a specific α value, competition among zones makes the job accessibility more theoretically sound. When the set travel time limits increase, more zones will be included in the competition for jobs. When the travel time limits reach the longest travel time in the area, all zones within that area will be included in the calculation of job accessibility with competition for each zone. However, the competition factor highly depends on employment size as well. Due to a much smaller employment market in Hanoi, the results for job accessibility with competition in Hanoi show much more change when including the competition factor rather than in Randstad.

By further simulating the configuration of both different urban form and transport conditions, it will become clearer how the decentralization policy that Hanoi has embarked on will impact accessibility, and how accessibility can be improved and present congestion problems be solved. However, the risk of stimulating further rise in private transport is also high in this case. To prevent becoming a car or motor bike-dependent city instead of a transit city, Hanoi should plan and build a good public transport system as soon as possible; taking Randstad as an example, where even with a very good public transportation network, private transport accessibility in the Randstad still surpasses public transport in almost every area. The further design of public transport system in Hanoi, thus, needs to have urgent priority and be developed strategically.

On the whole, the analysis in this study showed that urban forms greatly impact on transport accessibility. The types of accessibility indicators selected and the use of GIS tools to operationalize and present them make it relatively easy to understand the complex relation between land use and transport, and to communicate this to the community at large.

Further work should be done to include other sustainable transport options, such as cycling and walking. In addition, the research presented here is based on limited data and makes some assumptions to achieve the given results. These include assumptions related to travel time, impedance function and exclusion of impacts from external areas of Randstad and Hanoi. Other limitations include the lack of network data and different size of TAZs.

Acknowledgement

The authors wish to acknowledge Goudappel Coffeng consultancy for providing the travel time matrices for the Randstad used in this study.

References

Alberti, M. (2008). Ecological signatures: The science of sustainable urban forms. *Research and Debate*, 19(3), 56–60.

ALMEC Corporation, Nippon Koei Co., & YACHIYO Engineering Co. (2007). *The comprehensive urban development programme in Hanoi capital city of the Socialist Republic of Vietnam (HAIDEP)*. Hanoi: Japan International Cooperation Agency, Vietnamese Ministry of Transport, Ho Chi Minh City People's Committee.

Boarnet, M., & Crane, R. (2001). The influence of land use on travel behavior: Specification and estimation strategies. *Transportation Research Part A: Policy and Practice*, 35(9), 823–45.

Cera, M. (2003). Land use, transport and environmental sustainability in cities. In Department of Highway and Transportation Bari, Italy: Polytechnique of Bari.

Cerda, A., & El-Geneidy, A.M. (2010). Understanding the relationships between regional accessibility travel behaviour and home values. Transportation Research Board 89th Annual meeting, Washington DC, January 10–14, 2010.

Cervero, R. (1996). Mixed land-uses and commuting: Evidence from the American Housing Survey. *Transportation Research Part A: Policy and Practice*, 30(5), 361–77.

Chu Cong, M., Kazushi, S., & Soji, M. (2005). The speed, flow and headway analysis of motorcycle traffic. *Journal of Eastern Asia Society for Transportation Studies*, 6, 1496–1508. Online ISSN: 1881–1124.

Cusset, J.M., & Hai, L.D. (2001). Transport and environment in Hanoi: Attitudes and opinion towards environmental policy measures. *Journal of the Eastern Asia Society for Transportation Studies*, 4(5), 71–88.

Egeter, B., Verroen, E., Blom, U., Puylaert, H. & Schrijver, J. (2000). Mogelijkheden voor een extra kwaliteitsimpuls voor het openbaar vervoer tussen de stadsgewesten in de Deltametropool. (Ed Inro - V&V/2000-13). Delft/Den Haag.

El-Geneidy, A.M., & Levinson, D.L. (2006). *Access to destinations: Development of accessibility measures*. Minneapolis, Minnesota, US: Centre for Transportation Research, University of Minnesota.

European Commission. (2009). *Eurostat statistical yearbook—Panorama of transport*. Luxembourg: Eurostat.

Geurs, K. (2001). *Accessibility measures, review and applications*. Bilthoven: Rijksinstituut voor Volksgezondheid en Milieu (RIVM).

———. (2006). *Accessibility, land use and transport. Accessibility evaluation of land-use and transport developments and policy strategies*. Delft, Netherlands: Eburon.

Geurs, K., & Ritsema van Eck, J. (2001). *Accessibility measures: Review and applications. Evaluation of accessibility impacts of land-use transportation scenarios, and related social and economic impact*. Bilthoven: National Institute of Public Health and the Environment.

Geurs, K., & Wee, B.V. (2004). Accessibility evaluation of land-use and transport strategies: Review and research directions. *Journal of Transport Geography*, 12(2), 127–40.

Giuliano, G., & Small, K.A. (1991). Subcenters in the Los Angeles region. *Regional Science and Urban Economics*, 21(2), 163–82.

Goudappel Coffeng & Transumo. (2010). Nationale Bereikbaarheidskaart (The Netherlands Accessibility Map). Goudappel Coffeng, Deventer. Retrieved from http://www.bereikbaarheidskaart.nl on 1 February 2010.

Grazi, F., van den Bergh, J.C.J.M., & van Ommeren, J.N. (2008). An empirical analysis of urban form, transport, and global warming. *The Energy Journal*, 29(4), 97–107.

Handy, S.L., & Niemeier, D.A. (1997). Measuring accessibility: An exploration of issues and alternatives. *Environment and Planning A*, 29(7), 1175–94.

Hilbers, H.D., & Wilmink, I.R. (2002). The supply, use and quality of Randstad Holland's transportation networks in comparative perspective. *Tijdschrif voor Economische en Sociale Geografie*, 93(4), 464–71.

Kitamura, R., Mokhtarian, P., & Laidet, L. (1997). A micro-analysis of land use and travel in five neighborhoods in the San Francisco Bay Area. *Transportation*, 24(2), 125–58.

Kwan, M.-P., Murray, A.T., O'Kelly, M.E., & Tiefelsdorf, M. (2003). Recent advances in accessibility research: Representation, methodology and applications. *Journal of Geographical Systems*, 5(1), 129–38.

Litman, T. (2010). Land use impacts on Transport—How land use factors affect travel behaviour. In *250-360-1560*: Victoria Transport Policy Institute.

Manaugh, K., Miranda-Moreno, L., & El-Geneidy, A. (2010). The effect of neighbourhood characteristics, accessibility, home–work location, and demographics on commuting distances. *Transportation*, 37(4), 627–46.

McDonald, J.F. (1987). The identification of urban employment subcenters. *Journal of Urban Economics*, 21(2), 242–58.

McMillen, D.P. (2001). Nonparametric employment subcenter identification. *Journal of Urban Economics*, 50(3), 448–73.

Miller, H. (2007). Place-based versus people-based geographic information science. *Geography Compass*, 1(3), 503–35.

Mizuno, K., Ishigami, K., & Kidokoro, T. (2000). Urban development and housing sector in Vietnam. In N. Kitano (Ed.), *JBIC Review— Recent studies on urban sector issues in Vietnam— Urban development and housing and urban public transportation* (pp. 130–35). Tokyo: Japan Bank for International Cooperation.

Nguyen, H.T. (2007). The pressures of urbanization process in Vietnam (translated from Suc ep cua qua trinh do thi hoa o Viet Nam). Retrieved from http://www.tapchicongsan.org.vn/Home/Nghiencuu_Traodoi/2007/74/Suc-ep-cua-quantrinh-do-thi-hoa-o-Viet-Nam.aspx

Nguyen, K. (1999). *Road and urban transportation*. Hanoi: Transport Publishing House.

Nobuyuki, M., Tetsuro, H., & Yoji, T. (2005). Imaged processing analysis of motorcycle oriented mixed traffic flow in Vietnam. Proceedings of the Eastern Asia Society of Transportation Studies, Bangkok.

OECD & ECMT. (2007). *Report of the 137th round table on transport economics: Transport, urban form and economic growth*. Paris, France: OECD.

PPJ (Perkins Eastman US, POSCO E&C and JINA, Korea) (2010). Hanoi master plan to 2030 and vision to 2050 In The evaluation of "Hanoi master plan to 2030 and vision to 2050". Hanoi: Vietnam Urban Planning and Development Association.

Schepel, S., & Zuidgeest, M.H.P. (2009). Ideas that shape urban form: And how urban form shapes us. In C.P.T. Godefrooij and L. Sagaris (Eds), *Cycling—Inclusive policy development: A handbook* (pp. 32–46). Utrecht: Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), Interface for Cycling Expertise.

Schwanen, T., Dieleman, F.M., & Dijst, M. (2001). Travel behaviour in Dutch monocentric and policentric urban systems. *Journal of Transport Geography*, 9(3), 173–86.

Shen, Q. (1998). Location characteristics of inner-city neighborhoods and employment accessibility of low-wage workers. *Environment and Planning B: Planning and Design*, 25(3), 345–65.

Statistics Netherlands (CBS). (2010). *Wijk en buurtkaart 2009*. Retrieved from http://www.cbs.nl/nl-NL/menu/themas/dossiers/nederland-regionaal/publicaties/geografische-data/archief/2010/2010-wijk-en-buurtkaart-2009.htm on 1 February 2011.

Susilo, Y., & Maat, K. (2007). The influence of built environment to the trends in commuting journeys in the Netherlands. *Transportation*, 34(5), 589–609.

van der Werff, M., Lambregts, B., Kapoen, L., & Kloosterman, R. (2005). *Polynet Action 1.1—Commuting and the definitions of functional urban regions—The Randstad*. Institute of Community studies/The Young Foundation and Polynet Partners.

van Horen, B. (2005). Hanoi. *Cities*, 22(2), 161–73.

van Wee, B., Hagoort, M., & Annema, J.A. (2001). Accessibility measures with competition. *Journal of Transport Geography*, 9(3), 199–208.

Vickerman, R.W. (1974). Accessibility, attraction, and potential: A review of some concepts and their use in determining mobility. *Environment and Planning A*, 6(6), 675–91.

VietNam Publishing House of Natural Resources, Environment and Cartography (NARENCA) (2010). Hanoi Map.

Wachs, M., & Kumagai, T.G. (1973). Physical accessibility as a social indicator. Socio-Economic Planning Science, 7(5[October]), 437–56.

Williams, K. (2003). *Spatial planning, urban form and sustainable transport: An introduction*. UK: Ashgay Publishing.

Pham Thi Hong Ha is a graduate from the Erasmus Mundus MSc programme in Geo-information Science and Earth Observation for Environmental Modelling and Management at the University of Twente, Enschede, the Netherlands. E-mail: ph.ha910@gmail.com

Frans van den Bosch is a Lecturer, Geo-Information Science, University of Twente, Enschede, the Netherlands. E-mail: bosch@itc.nl

Nguyen Ngoc Quang is a PhD student at the University of Twente, Enschede, the Netherlands. E-mail: nguyen12887@itc.nl

Mark Zuidgeest (corresponding author) is Assistant Professor, Urban Transport, University of Twente, Enschede, the Netherlands. E-mail: zuidgeest@itc.nl