Available online at www.sciencedirect.com

ScienceDirect

Transportation Research Procedia 00 (2018) 000–000

Transportation Research Procedia

www.elsevier.com/locate/procedia

World Conference on Transport Research - WCTR 2019 Mumbai 26-31 May 2019

Does Individual Capability Influence Travel Time Expenditure? Mediation and Moderation Modeling Approaches

Taiyo ISHIKAWA[a*], Makoto CHIKARAISHI[a] , Akimasa FUJIWARA[a] and Hong T.A. Nguyen[a]

[a]*Graduate School for International Development and Cooperation, Hiroshima University, Kagamiyama 1-5-1, Higashi-Hiroshima, 739-8529, Japan*

Abstract

Travel time savings has been thought of as the major benefit of transport investment in cost-benefit analysis in many developing cities. However, it has been criticized that the transport project evaluation based on travel time savings can lead to inequitable results. For example, a positive association between individual capability and travel time expenditure indicates that travel time savings might be beneficial mainly for those who are more capable. In this study, we empirically examine the association between individual capability and travel time expenditure in 17 developing cities by using person-trip survey data collected by JICA. We further explore the mechanism how the capability affects travel time expenditure with a particular focus on mediation and moderation effects of residential location choice on travel time. Mediation and moderation effects are modeled by using the person-trip survey data collected in Hanoi (Vietnam) in 2004. The results indicate that residential location choice influences the association between individual capability and travel time expenditure significantly.

Peer-review under responsibility of WORLD CONFERENCE ON TRANSPORT RESEARCH SOCIETY.

Keywords: capability, developing cities, SEM, mediation and moderation

1. Introduction

Cost-benefit analysis is widely used for evaluating infrastructure investments such as roads, railways, harbours, and so on. It is also widely known that the results of cost-benefit analysis highly depend on which benefits are taken into consideration. Recently, in developed countries, in addition to the existing basic benefits such as travel time savings, the social benefits such as improvement of education, health, and welfare have been discussed (Church et al., 2000; Lucas, 2006). However, such social benefits have been little discussed in developing countries. Given that

*Corresponding author. Tel.: +62-(0)82-424-6905
E-mail address: m185110@hiroshima-u.ac.jp

Peer-review under responsibility of WORLD CONFERENCE ON TRANSPORT RESEARCH SOCIETY

improvement of transportation infrastructure leads to better occupation and access to educational opportunities, it is desirable to evaluate social benefits in developing countries as well. One possible starting point is to consider the role of capability introduced by Sen (1987) in quantifying benefits from infrastructure investment. Capability approach, which is usually used to focus on living standards, is an attractive approach in terms of considering actual social welfare evaluation. Although the definition of the capability varies across applications (Lelli, 2008), it is simply defined as the set of opportunities the individual can undertake given economic, social, and mobility constraints (Chikaraishi *et al*, 2017). Chikaraishi *et al.* (2017) considered the influence of capability on travel time in the context of Mumbai, India, and showcased the problem of existing ex-ante assessment sorely focusing on travel time savings. In their study, the association was identified based on the viewpoint of the time allocation theory (Becker, 1965), where the nature of travel time is different depending on the capability. This indicates that the higher the capability is, the individual travel time expenditure, which is the total amount of time that people used in a day, tends to become larger. Meanwhile, those who are more capable, the greater benefit would be obtained from travel time savings. It is also pointed out that cost-benefit analysis focusing only on travel time savings makes it difficult to take enough benefits for low capability groups. For example, Karel *et al.* (2017) identified five equity effects (group size effect, trip rate effect, income effect, geometry effect, network effect) to analyse the fairness of the results of the cost-benefit analysis and each of them showed that transport projects serving the high capability people are highly likely to perform better in CBA than low capability people. In this regard, the analysis about the causal relationship between capability and travel time expenditure would play an important role for the discussion of the equality of transport infrastructure investment. However, Chikaraishi *et al.* (2017) only focuses on a limited residential characteristic where sufficient activity opportunities (jobs, educations, etc.) exist in surrounding areas in the slums of Mumbai. In addition, the mechanism of the association has not been well explored empirically. Therefore, the association between capability and travel time expenditure needs to be re-identified with a broader focus to obtain a more general conclusion.

Therefore, this study firstly builds a framework to conceptualize the impacts of capability on travel time expenditure with the consideartion of indirect effects (i.e., moderation and mediation effects), and then empirically confirm the association between capability and travel time expenditure in 17 developing cities by using person-trip survey data conducted by JICA in a more general setting. Then, the model considering indirect effects are developed to empirically explore the mechanism of the association.

This paper is organized as follows. Section 2 introduce a framework for exploring the causal relationship between capability and travel time expenditure considering the indirect effects of residential characteristics. Section 3 summarizes data collected in 17 cities and shows preliminary analysis of capability and travel time expenditure across these cities. Estimation results of moderation and mediation models are shown and discussed in Section 4. Finally, some research findings and future research issues are summarized in Section 5.

2. Framework

This section explores the framework of the causal relationship among capability, travel time expenditure, and residential characteristic. Following Chikaraishi *et al.* (2017), the association between capability and travel time expenditure is conceptualized based on the time allocation theory (Becker, 1965). We further explain the conceptual hypothesis on the association between capability and travel time expenditure with considering the indirect effects of residential characteristics.

2.1. Previous work on the association between capability and travel time expenditure

The fundamental concept of this study follows the concept introduced in Chikaraishi *et al.* (2017), which showed that travel time expenditure is positively linked with individual capability in a context of slums in Mumbai. The following is a summary of the concept. Firstly, the nature of time use depending on the capability level was expected through the concept of "full income" which has pointed out by Becker (1965). The concept indicates that there is no distinction between the time spent for leisure and the time to look for job opportunities, and it emphasizes that time and income should not be discussed separately. Based on the concept, it is expected that the time use of the low capability group would be restricted by income, and this explains the hypothesis that low capability people allocate

more time to productive activities than to nonproductive activities, and high capability people shift allocating time to nonproductive activities from productive activities.

In addition to the above nature of travel, they pointed out that wages for low capability group would not vary across the city because most of them may have low-skill jobs, and thus they may not travel longer to seek better job opportunities. Instead, finding a job physically close to home would be economically efficient because they could reduce travel time and cost (Anand and Tiwari, 2006; Mukhopadhyay and Dutt, 1993). In addition, because the study only focuses on a limited residential characteristic where sufficient activity opportunities exist surrounding the areas, they hypothesized the association that travel time expenditure is positively linked with individual capability and confirmed the association in a context of slums in Mumbai.

2.2. Indirect effects

Chikaraishi et al. (2017) simply look at the association between capability and travel time, while the association would be disrupted by other factors. Among others, residential condition would be one of the important factors worth exploring, since the empirical results provided by Chikaraishi et al. (2017) would be valid only to a limited residential condition where sufficient activity opportunities (jobs, educational institutions, etc.) exist in surrounding areas. This study deal with more general residential condition to obtain a more general conclusion.

Concretely, we develop a model with considering the residential characteristics as indirect effects. Firstly, a number of papers have examined the association between residential characteristic and travel time expenditure. Van der Hoorn (1979) examined travel time expenditures in rural areas, industrialized rural areas, small towns, commuter towns, middle-sized cities, large cities, and dense urban areas, and founded that travel time per person per week was the highest in dense urban areas for all trip purposes except for school. Landrock (1981) also found that people living in the London metropolitan area had significantly higher travel time expenditures than those living in other areas. Gordon et al. (1991) examined the commute times for the 20 largest metropolitan areas in the US and found that commute times were higher for large metropolitan areas. Supernak (1982) noted that in Baltimore, Maryland, urban travel times were higher than suburban travel times.

On the other hand, not all papers support the phenomenon that higher travel time expenditure for dense urban areas than for suburban and rural areas. Downes and Morrell (1981) examined travel time expenditures in the inner area, middle area, and outer area of Reading, Britain and found that these area types made little difference in daily travel time per person. Barnes and Davis (2001) showed that those who living in rural areas tend to spend less travel time expenditure than those who living in central urban area in Minnesota. Furthermore, many studies have stated the evidence that travel time expenditure is shorter at locations that are higher densities or mixed land use. (Cervero & Kockelman, 1997; Handy, 1993; Frank et al., 2000) The above papers indicate that there are some association between residential characteristics and travel time expenditures.

For the association between capability and residential characteristics, a number of papers have been analyzed the impacts of income on residential location choice (e.g., Tran et al., 2016; Nguyen et al., 2017). Tran et al., (2016) examined the effects of land use attributes on residential location choice by using data collected in Hanoi, Vietnam, and it was found that high-income households groups tend to choose living in the area with high percentage of the commercial and business land. Furthermore, it was also showed that high-income households in the knowledge-intensive workers tend to inhabit in areas with more educational and cultural land, while labor-intensive workers are less likely to inhabit in such areas. This result indicates that the residential location choice can be decided by not only income but also other factors, which shows the importance of adapting capability approach. In addition, Nguyen et al., (2017) examined the mediation effects of income on travel mode choice with considering the indirect effect of residential location choice in Hanoi, and it is showed that income has statistically positive impact on residential location choice, which means high income households tend to choose the newly developed area where located outside of the city. In general, following the definition of the capability as the set of opportunities the individual can undertake given economic, social, and mobility constraints, it can be expected that those who have higher capability may tend to live in better residential locations, for example, areas proving a better transport service, compared to those who have lower capability. The above discussions indicate that individual capability is clearly related to residential characteristics.

2.3. Mediation and Moderation model

In this study, we hypothesize that the association between individual capability and travel time expenditure is affected by residential characteristics. To consider such indirect effects, mediation and moderation models (Amanda, et al., 2009) are used. Vincent (2005) states that the mediation model attempts to identify the intermediary process that leads from the manipulated independent variable (i.e., capability) to the outcome or dependent variable (i.e., travel time expenditure), and the moderation model attempts to identify individual difference or contextual variables that strengthen and/or change the direction of the relationship between the independent variable and the dependent variable. In the empirical analysis of this study, residential characteristics are treated as either moderators or mediators.

Even though there are some variables in terms of the residential characteristics, we use the population density of the residential area. Firstly, as the mediation model, we assume that the population density of residential location is a proxy variable of activity opportunities which exist in the surrounding area, i.e., the greater the population density of the residential location, the more various activity opportunities would be there. In other words, the area with various opportunities is attractive for many people, while the living cost may be higher than the other area in general, making the place mainly for the rich people. Thus, residential sorting would happen by the level of capability.

Also, since the population density is linked with various functions and activity opportunities in the surrounding area, the number of trips and travel distance would be affected by the population density. Sufficient activity opportunities around the residential area would shorten travel time from home to activity places, indicating that there would be the association between the population density and travel time expenditure. Such mediation effects need to be controlled when identifying the association between capability and travel time expenditure.

Another possible hypothesis on the role of population density is that the population density moderates the association between capability and travel time expenditure. With the moderation diagram, we assume that those who have less capability basically want to reduce travel time as much as possible to allocate more time to income-generating activities. This indicates that the number of activity opportunities in the surrounding area would be a crucial factor modifying travel time: they may be able to reduce travel time dramatically if they live in the urban core, while it would be very long if they live in the place with less job/education opportunities. On the other hand, since the rich may have more non-income-generating activities (e.g., leisure activities), their travel time may depend less on population density. Moreover, the spatial mismatch between residential location and activity opportunities would be related to the travel time expenditure. If low capable people live in a slum in a suburb area, they will spend more time on travel because of the spatial mismatch between residential location and activity opportunities such as job opportunity (Alberts et al., 2016) and the lack of affordable transport (Anand and Tiwari, 2006). On the other hand, if they live at the urban core, they will spend less travel time expenditure since more job opportunities are available near the residential area, and thus slum residents in an urban core would have fewer spatial mismatches between residential location and labor market opportunities. Based on these considerations, we also hypothesize that the association between capability and travel time expenditure is moderated by population density.

Note that the analysis we conduced does not intend to derive whether meditation or moderation modelling framework is appropriate to identify the association between capability and travel time, largely because assumptions on cause-and-effect relationships are distinct in concept rather than in the empirical results of model estimation (Wu and Zumbo, 2007).

3. Data summary and analysis

In order to confirm the association between capability and travel time expenditure in a general setting of residential characteristics, this section analyses the association in 17 developing cities by using person-trip survey data collected by JICA. We firstly summarize the data and then show the preliminary analysis on the association between capability and travel time expenditure across these cities.

3.1. Data summary and preliminary analysis

In this analysis, the person-trip (PT) survey data from 17 developing cities collected by JICA (Japan International Cooperation Agency) are used. The data can be categorized into household data, individual data, and trip data, but the

format and the type of data variable are not the same in all cities because surveys have been conducted by different consultants in different timelines. The basic information is shown in table 1.

As a preliminary analysis, we compare the average travel time expenditure between wealthy and poor people in order to simply confirm the difference of the travel time expenditure between them. Firstly, wealthy people and poor people are defined by the seven indicators (car ownership, motorcycle ownership, household income, education standards, occupation, housing possession and license hold). Specifically the following indicators are used to identify the living standard, (1) Possession/non-possession of private car, (2) Possession/non-possession of motorcycles, (3) Top 25%/bottom 25% of household income, (4) Graduated university/graduated high school or less, (5) Skilled/unskilled worker, (6) Ownership/non-ownership of house, (7) Possession/non-possession of car driving license. Table 2 compares the average value of travel time expenditure between wealthy and poor people. Upward arrow indicates that the travel time expenditure of the wealthy people is more than that of the poor at the 5 percent significant level, and bold-type arrow indicates the difference of travel time expenditure is 10 minutes or more. Because the investigator and the background of the person-trip survey are different in each city, not all indicators are covered in seven cities. As the result of the analysis, significant differences in travel time expenditure between poor people and wealthy people are confirmed in most of the cities through almost of all indicators, and wealthy people tend to travel more compared to poor people.

Table 1. Basic information of data

City	Year	Samples	Trips	Population	Car	Motorbike	Income	Education	Occupation	Home	License
Tripoli	2000	3,608	7,615	330,900	○	○			○		○
Phnom Penh	2000	18,664	40,369	1,152,000	○	○	○				
Damascus	1998	38,490	81,698	3,078,190	○	○	○		○		○
Manila	1996	231,889	471,035	9,454,000	○	○	○		○	○	
Chengdu	2000	31,188	70,199	3,090,000	○	○	○		○		○
Managua	1998	24,854	54,138	1,200,000	○		○				
Belem	2000	24,043	59,529	1,782,394	○	○	○	○	○	○	
Bucharest	1998	87,792	169,069	2,150,000	○	○		○			
Cairo	2000	136,070	268,360	14,400,000	○	○	○		○	○	○
Jakarta	2000	423,237	1,083,280	20,964,000	○	○	○		○		
Kuala Lumpur	1997	80,560	218,460	1,390,800	○	○	○		○	○	○
Ho Chi Minh	2002	27,412	71,890	7,785,000	○	○	○	○	○	○	○
Hanoi	2004	63,716	188,949	2,355,000	○	○	○	○	○	○	○
Lima	2004	115,728	270,384	7,995,000	○	○	○	○	○	○	○
Dar es Salaam	2008	11,200	22,950	2,487,000	○	○	○		○		○
Da Nang	2010	18,171	52,694	890,000	○	○	○	○	○	○	○
Ulan Bator	2009	16,196	40,995	885,000	○	○	○		○	○	

Table 2. Difference of travel time expenditure

	Car	Motorbike	Income	Education	Occupation	Home	Driving License
Tripoli	→	→					↑
Phnom Penh	→	→	→				
Damascus	↑	→	→		→		→
Manila	↑	→	↑		↑	↑	
Chengdu	↑	↑	→		→		↑
Managua	→		↑				
Belen	→	→	↑	↑		→	
Bucharest		↑	↑		↑		
Cairo	→	↓	↑		↑	→	↑
Jakarta	↑	→	↑		→		
Kuala Lumpur	↑	↓	↑		↑	↑	↑
Ho Chi Minh	→	↑	↓	↑	↑	↑	↑
Hanoi	→	↑	↑	↑	↑	→	↑
Rima	↓	→	↑	↑	↑	↑	↑
Dar es Salam	→	→	→		↑		↑
Da Nang	↑	↑	↑	↑	↑	→	↑
Ulan Bator	→	→	↑		→	→	

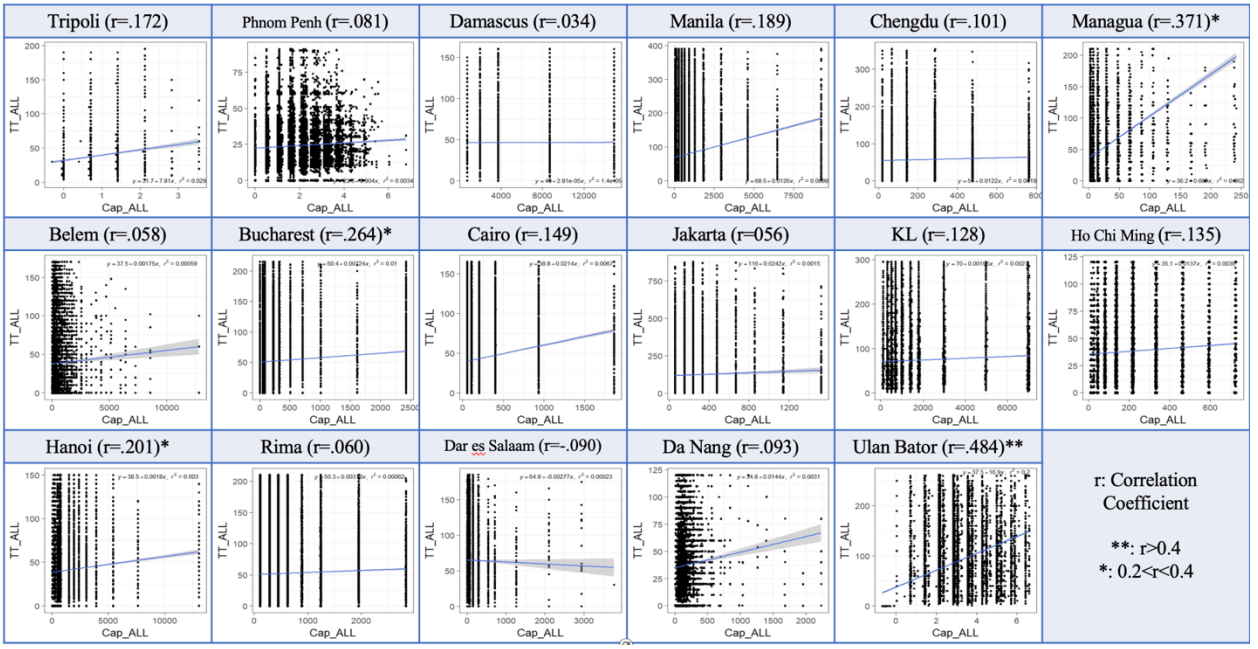
Note: ↑ : Wealthy > Poor (Significant)
↓ : Wealthy < Poor (Significant)
→ : No significant difference

3.2. Relationship between capability and travel time expenditure

In order to analyse the relationship between capability and travel time expenditure in 17 developing cities, the capability index is constructed through principal component analysis (PCA) of seven indicators used in preliminary analysis with reference to the concept of capability indicated by Sen (1987) as an index for living standards. Since the existing index data are different across cities, we formulate the capability by performing PCA for each city separately.

Table 3 shows the analysis result on the relationship between capability and travel time expenditure in 17 cities. The horizontal axis is capability and the vertical axis is travel time expenditure, and the correlation between these two indices is expressed using correlation coefficients (** $r > 0.4$, * $0.2 < r < 0.4$). As the result, it is found that significant correlations between the two indicators are confirmed only in 4 cities (Managua, Bucharest, Hanoi and Ulan Bator) and there is no significant correlations in 13 cities. This result indicates that, in most of the developing cities, the association between capability and travel time expenditure cannot be visible partially because the situation of residential characteristics is mixed. This also implies that further clarification on the mechanism of the association between capability and travel time expenditure is required to obtain more general conclusion on the association between them.

Table 3. Difference of travel time expenditure



4. Estimation results of mediation and moderation models

In order to take account the mechanism how the capability influences the travel time expenditure, we employ path diagrams by considering indirect effects and confirm the performance of each model by using a structural equation model. Mediation and moderation models are developed by using the PT survey data as shown in section 2. Because of the availability of population density data, we only focus on Hanoi in the analysis. Population density in Hanoi is calculated by using the area with 301 zones and population data in 2004.

Based on the framework described in section 2, it is hypothesized that the capability does not only have a direct effect on travel time expenditure but also have an indirect effect through the population density of residential location. The hypothesis of path diagram among capability, density and travel time is as shown in Fig. 2 and Fig. 3.

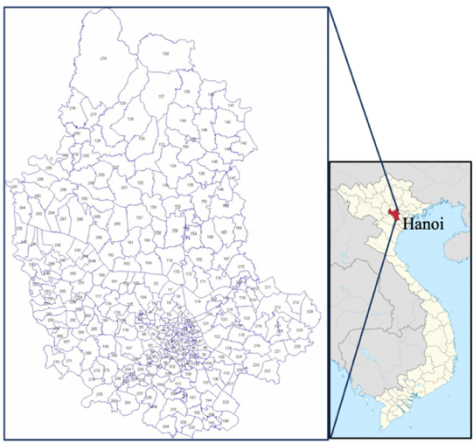


Fig.1 Zone units of data in Hanoi city

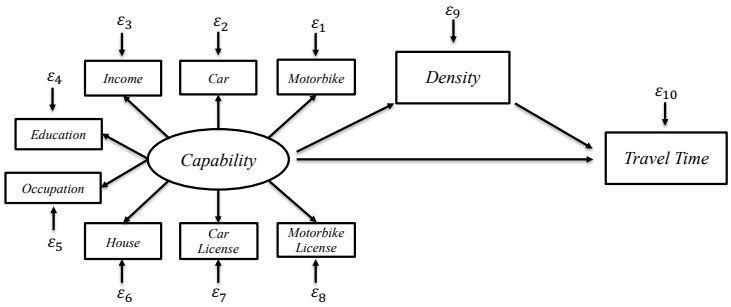


Fig. 2. Path diagram of the mediation model

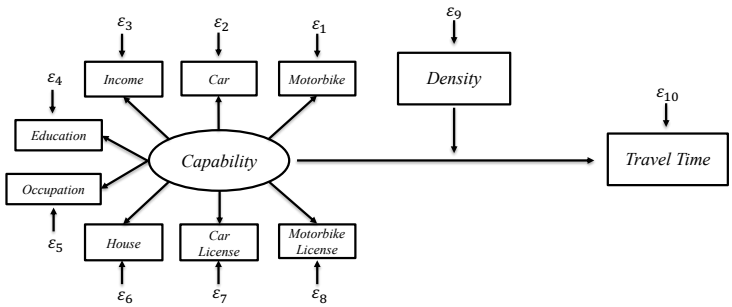


Fig. 3. Path diagram of the moderation model

Structural equation modeling (SEM) is used to confirm the relationship of the assumed two path diagrams. In this analysis, we explain capability as the latent variable by factor analysis using observed variables as shown in table 4. For the model estimation, statistical analysis software M-plus is used with maximum likelihood estimation method.

Table 4. Description of the observation variables

Variables	Description	Mean	S.D.
Number of Car	Number of owned cars in household [units]	0. 015	0. 15
Number of Motorcycle	Number of owned motorcycles in household [units]	1. 47	0. 98
Income	Household income in US dollar for one month [$\times 10^3$ USD]	0. 38	0. 35
Education Level	Number of years of receiving school education [year]	10. 62	2. 91
Occupation	Job category (1: Skilled Job; 0: Unskilled Job)	0. 087	0. 28
Ownership of House	Ownership of house (1: Own; 0: Not own)	0. 92	0. 26
Car License	Ownership of car license (1: Own; 0; Not own)	0. 026	0. 16
Motorcycle License	Ownership of motorcycle license (1: Own; 0: Not own)	0. 41	0. 49

Firstly, Table 5 and Fig. 4 shows the estimation result of the mediation model. As shown, all parameters constructing capability show positive value except the parameters of ownership of house. The main finding is that the influence of the population density of residential location on the travel time expenditure is negative, while the influence of

capability on the population density is positive. Hence, it can be said that capability would indirectly influence travel time expenditure through the mediator - the population density of residential location.

Secondly, Table 6 and Fig. 5 shows the estimation results of moderation model. As shown, the influence of the population density on the travel time expenditure is negative, and the influence of the confounding factor which multiplies the capability and the population density on the travel time expenditure is positive. It means there are the positive moderation effects of population density toward the travel time expenditure.

The above results indicate that population density play a significant role, affecting the association between capability and travel time either as a mediator or as a moderator. Although both mediator and moderator assumptions are plausible as discussed in the previous section, it is known that these two would produce quite different results particularly when using the model for prediction (Hong et al., 2017). Further theoretical and conceptual discussions on the causal relationship remain as a future task.

Table 5. Result of SEM (Mediation model)

	Capability		
Explanatory Variables	Parameter	S.E.	p
Number of Motorbike	0.563	0.004	**
Number of Car	0.126	0.005	**
Income	0.496	0.004	**
Education Level	0.657	0.004	**
Occupation	0.457	0.004	**
Ownership of House	-0.091	0.005	**
Car License	0.174	0.005	**
Motorbike License	0.574	0.004	**

Path	Parameter	S.E.	p
Capability → Density	0.310	0.005	**
Capability → Travel Time	0.206	0.005	**
Density → Travel Time	-0.056	0.004	**
Sample Size n = 59674			
Initial Log likelihood = -1,612,674.18			
AIC = 3,225,410.35			

Note: *p<0. 05, **p<0. 01

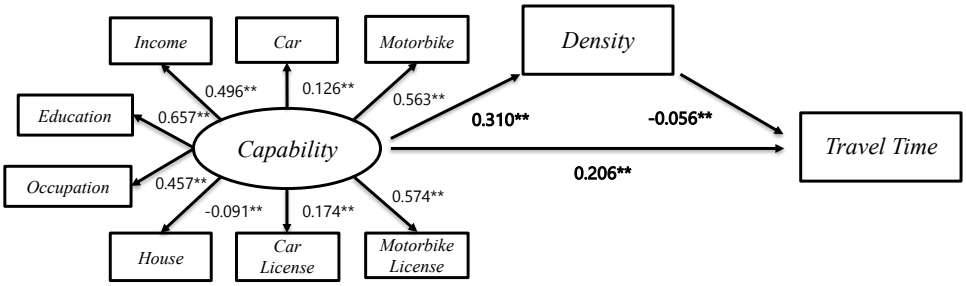


Fig. 4. Result of Path diagram (Mediation model)

Table 6. Result of SEM (Moderation model)

	Capability		
Explanatory Variables	Parameter	S.E.	p
Number of Motorbike	1. 000	0. 000	**
Number of Car	0. 035	0. 001	**
Income	0. 307	0. 004	**
Education Level	3. 567	0. 044	**
Occupation	0. 243	0. 004	**
Ownership of House	-0. 029	0. 002	**
Car License	0. 035	0. 002	**
Motorbike License	0. 537	0. 006	**

Path	Parameter	S.E.	p
Capability → Travel Time	0. 186	0. 007	**
Density → Travel Time	-0. 921	0. 097	**
Capability × Density → Travel Time	0. 186	0. 210	*
Sample Size n = 59674			
Initial Log likelihood = -268,083.70			
AIC = 536,225.40			

Note: *p<0. 05, **p<0. 01

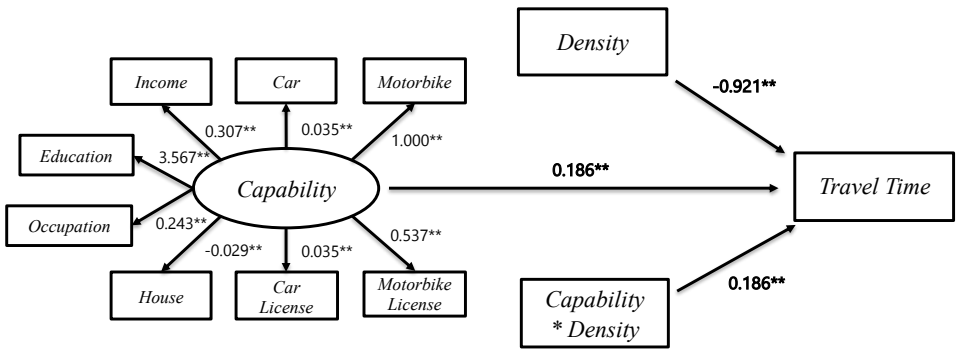


Fig. 5. Result of Path diagram (Moderation model)

5. Conclusions

In this research, we first empirically analysed the relationship between capability and travel time expenditure in 17 developing cities by using JICA person trip survey data. We found that, although capability tends to be positively associated with travel time expenditure, the degree of association varies across cities, implying that the importance of taking into account other factors influencing the association. We then explored mediation and moderation effects of population density on the association between capability on travel time expenditure. Concretely, we develop mediation and moderation models by using a person trip survey data collected in Hanoi in 2004. The mediation model basically assumes sequential causal relationship between factors, i.e., capability influences population density, which will then influence travel time expenditure, while the moderation model assumes population density will adjust the impacts of capability on travel time expenditure. The model estimation results show that population density plays a significant role either in the mediation modelling framework or in the moderation modelling framework. These results indicate that the importance of controlling other factors affecting the association. We believe that such a deeper understanding

of indirect effects would be a fundamental basis for taking into account the wider impacts of transport investment such as equity aspects.

There are a number of limitations that could not be addressed in this study. First, the validity of the capability index could not be examined. Although it would not be possible to have a ground-truth data of capability, we could confirm the stability of the results with different definitions of capability. Second, we conducted empirical analysis only in Hanoi city due to the data availability issue, while more empirical evidences are needed to give a more general conclusion. Third, our initial motivation is to add the social aspects (particularly equity aspects) into the cost-benefit analysis, but we have not shown how we could concretely embed the social benefits into the cost-benefit analysis. Currently, a number of studies have been exploring social benefits of transportation, but little has been reflected in practice in developing cities.

References

Alberts, A., Pfeffer, K., Baud, I., Rebuilding women's livelihoods strategies at the city fringe: agency, spatial practices, and access to transportation from Semmencherry, Chennai. J. Transp. Geogr. 55, 142–151 (2016)

Amanda, J., and David, P., A general model for testing mediation and moderation effects, Prevention Science 10(2):87-99, (2008)

Anand, A., Tiwari, G., A gendered perspective of the shelter–transport–livelihood link: the case of poor women in Delhi. Transp. Rev. 26, 63–80. (2006)

Barnes, Gary and Davis, Gary, Land Use and Travel Choices in the Twin Cities, 1958- 1990. Report No. 6 in the Series: Transportation and Regional Growth Study. Center for Trans- portation Studies, University of Minnesota. (2001)

Becker, G.S., A theory of the allocation of time. Econ. J. 75, 493–517., (1965)

Cervero, R., and Kockelman, K. Travel Demand and the 3Ds: Density, Diversity, and Design. Transportation Research D, 2: 199–219. (1997)

Chikaraishi, M., Arnab, J., Ronita, B., Varun, V., Fujiwara, A.: A framework to analyze capability and travel in formal and informal urban settings: A case from Mumbai, Journal of Transport Geography 65 (2017)

Church, A., Frost, M., Sullivan, K., Transport and social exclusion in London. Transport 7. (2000)

De Vos, J., Witlox, F., Do people live in urban neighbourhoods because they do not like to travel? Analysing an alternative residential self-selection hypothesis, Travel Behaviour and Society 4 29–39, (2016)

Downes, J. D. and Morrell, D., Variation of Travel Budgets and Trip Rates in Reading. Transportation Research 15A, 47-53. (1981)

Frank, L. D., Stones, B., and Bachman, W. Linking Land Use with Household Vehicle Emissions in the Central Puget Sound: Methodological Framework and Findings. Transportation Research D. 5(3): 173–196 (2000)

Gordon, Peter; Richardson, Harry W.; and Jun, Myung-Jin, The Commuting Paradox – Evidence from the Top Twenty. Journal of the American Planning Association 57(4), 416-420. (1991)

Handy, S. Regional versus Local Accessibility: Implications for Non-work Travel. Transportation Research Record, 1400: 58–66. (1993)

Karel, M., and Florida, D.C.: Travel time savings, accessibility gains and equity effects in cost-benefit analysis, Transport Reviews, 37:2, 152-169, (2017)

Landrock, J. N., Spatial Stability of Average Daily Travel Times and Trip Rates within Great Britain. Transportation Research 15A, 55-62. (1981)

Lelli, S. Operationalising Sen's capability approach: the influence of the selected technique, Cambridge University Press, Cambridge, pp.310–361, (2008)

Lucas, K., Providing transport for social inclusion within a framework for environmental justice in the UK. Transp. Res. A Policy Pract. 40, 801–809. (2006)

Mukhopadhyay, A., Dutt, A.K., Slum dweller's daily movement pattern in a Calcutta slum. GeoJournal 29, 181–186. (1993)

Nguyen, T.A.H., Chikaraishi, M., Fujiwara, A., Zhang, J., Mediation effects of income on travel mode choice: Analysis of short-distance trips based on path analysis with multiple discrete outcomes, Transportation Research Record, 2664, pp. 23-30. (2017)

Schirmer, P., Eggermond., ,,,, The role of location in residential location choice models A review of literature

Sen, A., Commodities and Capabilities, Oxford India Paperbacks, (1987)

Supernak, Janusz, Travel-Time Budgets: A Critique. Transportation Research Record 879, 15-25. (1982)

Tran, T.M., Zhang, J., Chikaraishi, M., Fujiwara, A., A joint analysis of residential location, work location and commuting mode choices in Hanoi, Vietnam, Journal of Transport Geography, Vol. 54, 181-193 (2016)

Van A. T., Travel Behavior and the Total Activity Pattern. Transportation 8, 309-328. (1979)

Vincent, Y., When Moderation Is Mediated and Mediation Is Moderated, Journal of Personality and Social Psychology, Vol. 89, No. 6, 852– 863, (2005)

Wu, A. D. and B. D. Zumbo, Understanding and Using Mediators and Moderators, Social indicators Research, 87 (3), 367–392. (2007)