Does Individual Capability Influence Travel Time Expenditure?
A Mediation Modeling Approach

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1. Introduction

Cost-benefit analysis is widely used before implementing infrastructure development such as roads, railways, harbors, and so on. It is widely known that the results of cost-benefit analysis are highly depends on which benefits are taken into consideration. Recently, in developed countries, in addition to the existing basic benefits such as travel time saving, the social benefits such as improvement of education, health, and welfare have been discussed. On the other hand, such social benefits have been little discussed in developing countries. Given that improvement of transportation infrastructure leads to better occupation and access to educational opportunities, it is desirable for developing countries to evaluate social benefits as well. One possible starting point is to consider the role of capability in quantifying benefits from infrastructure investment. In this regard, Chikraishi et al. (2017) confirm that there is a positive correlation between individual capability and travel time expenditure, but the mechanism how the capability affects travel time expenditure is not clear. Therefore, in this research, we explore the mechanism how the capability affects travel time expenditure with a particular focus on a mediation modeling approach.

2. Existing research and position of this research

Chikaraishi et al. (2017) [1] considered the influence of capabilities on traffic behavior theoretically and empirically in Mumbai, India, and pointed out the problem of existing ex

ante assessment which focuses on travel time saving from the viewpoint of fairness through showing the evidence that there is a positive correlation between capability and travel time expenditure. Here, the capability is an evaluation index focusing on the standard of living introduced by Sen (1987) [2], which is a useful approach to considering the evaluation of social welfare. However, this analysis only focuses on a limited situation where sufficient activity opportunities (jobs, educational institutions, etc.) exist in surrounding areas in the slums of Mumbai. In addition, only the correlation between capabilities and travel time expenditure is analyzed, and the mechanism of the correlation is not considered. Therefore, in this study, we firstly analyze the association between capabilities and travel time expenditure in 17 cities of developing cities using the data of person trip survey which are conducted by JICA. Then, we analyze the mechanisms how capabilities affect travel time expenditure with considering indirect (moderation) effects with the aim at providing information for a better transport project evaluation in developing cities.

3. Data overview and preliminary analysis

In this analysis, we used person trip survey data in 17 developing cities, collected by JICA (Japan International Cooperation Agency). For a preliminary analysis, we defined poor people and wealthy people from the seven indicators (car ownership, motorcycle ownership, household income, education standards, occupation, housing possession and license hold) used in defining capability, and we conducted comparison analysis of travel time expenditure. The analysis results are shown in Table 1. When it is statistically significant that the travel time expenditure of the wealthy people is more than that of the poor, they are indicated by downward arrows, and when the difference is 10 minutes or more, they are

expressed in bold-type. Based on the results, significant differences of travel time expenditure between poor people and wealthy people are verified in most of the cities and most indicators, and it is shown wealthy people tend to have much more travel time expenditure compared to poor people.

Table 1. Difference in travel time expenditure between poor and wealthy people

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

4．Analysis of relationship between capability and travel time expenditure

In order to analyze the relationship between capabilities and travel time expenditure in 17 developing cities, we firstly construct the capability index through principal component analysis of seven indicators used in preliminary analysis with reference to the concept of capabilities indicated by Sen (1987) [2] as an index which shows living standards. Significant correlations between the developed capability index and travel time were confirmed only for four cities, including Managua, Bucharest, Hanoi and Ulan Bator. The result points out it is difficult to say the association between capabilities and travel time expenditure in the case of Mumbai is applicable in other developing cities. However, there is a problem when we compare the association in Mumbai and the 17 developing cities, which is the mechanism how capabilities affect travel time expenditure. The mechanism is not clear in the research, then we analyze the mechanisms how capabilities affect travel time expenditure with considering the indirect effects

5. Structural Equation Modeling Considering Indirect Effect

In order to analyze the mechanism how the capability influences the travel time expenditure, we assumed the path diagrams considering the mediation effect and the moderation effect as the indirect effect and verified the validity of each model using the structural equation model. These models are developed by using the person trip survey data collected in Hanoi in 2004. As a hypothesis of the mediation model, we assumed the mechanism which considers not only the direct effect from capability to travel time expenditure, but also the indirect effect which capability affect travel time expenditure through mediated by the population density of the residential location. As a result of the analysis, as shown in Fig. 1, the model using the population density of the residential location instead of the residential location choice indicated that all passes are significant. On the other hand, when the population density of the residential area was used as the moderator, it was not possible to show significant values in all the paths, so it was verified that the hypothesis of the mediation model is valid.
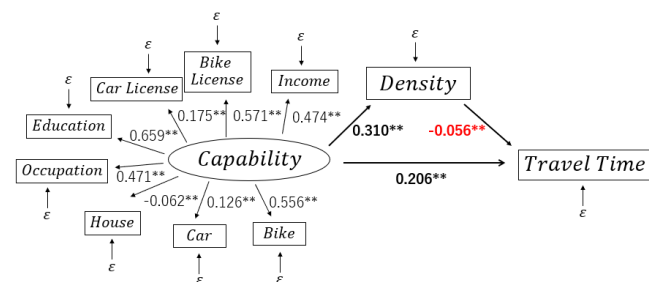
Fig. 1 Causal relationship when considering mediation effect

Table 2. The result of SEM

	Capability		
Explanatory Variables	Parameter	z-Value	p
Number of Car	0.126	25.910	**
Number of Motorbike	0.556	130.227	**
Income	0.474	105.954	**
Education Level	0.659	169.999	**
Occupation	0.471	109.864	**
Ownership of House	-0.062	-12.708	**
Car License	0.175	36.668	**
Motorbike License	0.574	151.549	**
Path	Parameter	z-Value	p
Capability → Density	0.310	68.125	**
Capability → Travel Time	0.206	40.439	**
Density → Travel Time	-0.056	-12.810	**

6. Conclusion

In this research, we introduced the concept of capability as an indicator of living standards and analyzed the relationship

between capabilities and travel time expenditure in developing cities. Although the relationship indicated in the Mumbai region was not found generally in 17 developing cities as a result of the analysis, it was clear that there is a problem when we compare the association in Mumbai and the 17 developing cities, which is the mechanism how capabilities affect travel time expenditure. Then we explored the mechanism how the capability affects travel time expenditure with a particular focus on a mediation effect through residential location choice, and for whom the causal relationship between capability and travel time expenditure is modified by emphasizing on a moderation effect - the residential location choice. As an initial step to understand the mechanism, mediation and moderation models are developed by using the person trip survey data collected in Hanoi in 2004. The results indicate that controlling residential location choice in identifying the association between individual capability and travel time expenditure is crucial.

References

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