Travel needs in school trips in Tanzania and Namibia: analyzing relationship between use of in-vehicle travel time and willingness to avoid crowding

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Abstract

In this paper, we study travel needs in school trips and we present the results of the survey conducted in Tanzania and Namibia. We analyze relationship between use of in-vehicle travel time and willingness to avoid crowding. In the light of the empirical results, we discuss how travel needs and preferences related to the use of in-vehicle time and crowding should be taken into account in designing and providing new public transportation services for students and commuters.

Keywords: use of in-vehicle travel time, crowding, survey, public transport, school trip, minibus

1. Intoroduction

Crowding in public transport is observed influencing on value of travel time in several studies during the last two decades. Li and Hensher (2011) provide review on empirical studies estimating willingness to pay for crowding reduction. Moreover, analytical models have been developed to consider crowding in optimal pricing and scheduling of public transport (de Palma, Kilani, and Proost, 2015; de Palma, Lindsey and Monchambert, 2015). The perceived discomfort due to crowding in public transport varies between individuals and in different travel contexts. For instance, the costs of crowding are different for seated and unseated passengers (Veitch et al., 2013), and for different lines and income classes (Lapparent and Koning, 2016).

One advantage of public transport over private car is that it enables to use in-vehicle travel time for other tasks than driving (at least before the self-driving cars are commonly available). Therefore, decent possibilities to use in-vehicle travel time effectively, e.g., for work or study, would decrease the value of travel time, i.e., willingness to pay for travel time savings. Thus, improving possibilities to use travel time effectively in public transport by design of vehicles and seats, better ICT infrastructure and related digital services would increase attractiveness of public transport and simultaneously even improve productivity of commuters and travelling students.

In this article, we present our survey results focusing on travel needs of students and use of in-vehicle travel time during the school trips in several cities and villages in Namibia and Tanzania. The research has two objectives. Firstly, we analyze dependence between use of in-vehicle travel time (both actual and potential use) and various trip and passenger characteristics. Secondly, we analyze dependence between use of in-vehicle travel time and WTP for reducing crowding.

The survey consists of two parts. The first part includes a set of questions related to demographics and current school trips. The second part includes a stated preference experiment where students are asked to make choices between the current trip and minibus trips with alternative travel times and levels of crowding. The focus of the experiment is on the choices between seated but crowded trips and non-crowded trips with longer travel times. Similar passengers' trade-off between travel time and crowding was studied previously by Lapparent and Koning (2016), but the new aspect in this study is the impact of the desired use of in-vehicle time on this trade-off. Moreover, the context of this study is different.

The rest of the article is presented as follows. In Section 2, we present the model and related assumptions describing decisions of travelers. In Section 3, we describe the survey and data collection. In Section 4, we present modelling of choices and the results. In Section 5, we discuss about designing, provisioning and pricing new public transportation services in the light of the survey results. Finally, the conclusions are drawn in Section 6.

2. Model

Our aim is to model students' willingness to increase travel time for reducing crowding and its dependence on individual characteristics and use of in-vehicle travel time. In our stated choice experiments we assume that alternative trips from school to home are free (of charge) allowing us to exclude monetary costs from the analysis of the tradeoff between in-vehicle travel time and crowding. Lapparent and Koning (2016) considered 5 alternative formulations of the generalized cost functions for the analysis of travel discomfort-time tradeoffs, and we adopt their fifth formulation as it is adequate for our modeling purposes. Thus, we assume that a student i associates a real-valued generalized cost function of travel time (t) and crowd density (d) to a trip alternative m:

$$C_{i,m} = \gamma_i t_m + \delta_i d_m. \qquad (1)$$

We assume that the function strictly increase with travel time and crowd density, i.e., $\gamma_i > 0$ and $\delta_i > 0$. Moreover, we assume that travelers aim to minimize the generalized costs of the trips. Together with this assumption, discrete choice modelling with the function 1 enables us to estimate the marginal rate of substitution between travel time and crowd density as a ratio of coefficients, $\frac{\delta}{\gamma}$, which can be interpreted as a willingness to increase travel time to reduce crowding in the bus, and which defines the dependent variable in our modelling. We study how use of in-vehicle travel time explains willingness to increase travel time for reducing crowding. Therefore, we asked respondents opinion on statements describing different aspects of use of in-vehicle travel time.

3. Survey and Data Collection

The survey was designed so that firstly basic demographic questions were asked. Then respondents were asked to describe their daily school trips, which provided information on the travel times and transport modes. Moreover, this part prepared respondents mentally to focus on

their travel needs and behavior. Next, the respondents were asked their opinion on several sentences with the scale from 1 to 5, where number 1 means totally disagree and number 5 means totally agree. The sentences considered use of public transportation and especially use of in-vehicle travel time for studying, working or relaxing, i.e., opinion on 6 sentences were asked:

1. It's important that I can use travel time effectively to work or study in public transportation.
2. I'm satisfied with the possibilities to use travel time effectively (e.g. to work or study) in public transportation.
3. It's important that I can use travel time for relaxing in public transportation.
4. I'm satisfied with the possibilities to relax in public transportation.
5. It's important for me that I can use my mobile devices in public transportation.
6. Travelling in public transportation is safe for me.

After that the stated choice questions were asked. In the stated choice questions the respondents were asked to "imagine that you have a minibus ride from your school to home for free", and then four choice questions were asked:

1. Select the best minibus ride for you (A or B):

A: Travel time is the same as you have now, and you have a seat, but the minibus is very crowded (full of people)

B: Travel time is a 1 minute longer, but you have a seat with free space around (half empty minibus)

2. Select the best minibus ride for you (A or B):

A: Travel time is the same as you have now, and you have a seat, but the minibus is very crowded (full of people)

B: Travel time is 6 minutes longer, but you have a seat with free space around (half empty minibus)

3. Select the best minibus ride for you (A or B):

A: Travel time is the same as you have now, and you have a seat, but the minibus is very crowded (full of people)

B: Travel time is 12 minutes longer, but you have a seat with free space around (half empty minibus)

4. Select the best minibus ride for you (A or B):

A: Travel time is the same as you have now, and you have a seat, but the minibus is very crowded (full of people)

B: Travel time is 20 minutes longer, but you have a seat with free space around (half empty minibus)

In the presented four choice questions above the longer travel time in B-alternatives increased gradually, i.e., 1, 6, 12 and 20 minutes. The increasing travel times were varied in two other versions, i.e., in the first version as 3, 8, 16 and 30 minutes, and in the second version as 5, 10, 20 and 40 minutes respectively. Thus, we had three versions of the selection questions in the questionnaires, which were mixed and distributed for respondents randomly in order to obtain more comprehensive data on preferences.

The stated preference questions were designed so that there is a variation between alternatives only in the in-vehicle travel time and crowding level, which can be interpreted so that less crowded buses drives longer routes and/or with more frequent stops. Moreover, the variation in crowd density was limited to two levels, i.e., (1.) the bus is full of passengers but seats are still available for every passenger (d=1.0) and (2.) the bus is half empty so that there is free space around the seat (d=0.5). Thus, this stated preference experiment has natural and easily understandable interpretation and it allows us to focus on in-vehicle travel times (and to exclude other travel cost components from the analysis).

The survey was conducted in two cities (Dar as Salaam and Iringa) in Tanzania during 5 days in March and April 2017, and in four cities (Rundu, Mariental, Otjiwarango and Walvis Bay) in Namibia during four days in April and May 2017. The questionnaires were given for the students participating in the CodeBus Africa workshops, which were one-day workshops where basics of making music by coding were taught for the students of the local schools. The workshops were organized by Aalto University and Ministry of Foreign Affairs of Finland as a part of the official Finland 100 program celebrating 100-year-old Finland.

Before the questionnaires were given, a short motivational introduction and explanation of the questions were given. Moreover, the survey was voluntary for the students and there was a small reward for answering the survey. Table 1 presents the descriptive sample statistics. The questionnaire was given for 360 students and 339 questionnaires were returned. Part of the

respondents answered only for the background questions and some respondents clearly misunderstood the choice questions or gave inconsistent answers for other reasons. After cleaning the data, the sample size was 240, where 125 observations were collected from Namibia and 115 from Tanzania. Approximately 61% of respondents were females. The average age was 17 years and most of the students were studying in secondary schools or high schools. The mean travel time from school to home was 57 minutes. In Tanzania travel times were somewhat longer as the mean was 73 minutes whereas in Namibia it was 39 minutes respectively. The most common used transport modes were walking and bus in the both countries.

Table 1

Descriptive sample statistics

Variables	Frequency	Freq. Namibia	Freq. Tanzania
Total sample size	339	146	193
Cleaned sample	240	125	115
Male	94	64	30
Female	146	61	85
	Mean	Namibia	Tanzania
Age	17.2	16.6	17.6
Travel time from school to home (minutes)	57	39	73

4. Modelling and Results

The choices of the respondent for the presented four stated choice experiments reveal the interval value for the marginal rate of substitution between travel time and crowd density. For example, if all four choices are A, then willingness to increase/pay travel time for reducing crowding (from d=1 to 0.5, i.e., 50%) in the bus is less than 1 minute (and less than 3 or 5 minutes in the two alternative choice experiments), i.e., $\frac{\delta}{\gamma} < \frac{1}{0.5}$, which can be deduced from the equation (1) as in this example the selection with the cost minimization assumption implicate that $\gamma_i t_m + \delta_i d_m < \gamma_i (t_m + 1) + \delta_i (d_m - 0.5)$. Respectively, if the first choice is B and the last three choices are A, then willingness to increase travel time is between 1 and 6 minutes, i.e., $\frac{1}{0.5} < \frac{\delta}{\gamma} < \frac{6}{0.5}$. Table 2 summarizes relationships between the choices and interpretation for interval values.

Table 2

Interpretation of the choice experiments

	1. Choice (A/B)	2. Choice (A/B)	3. Choice (A/B)	4. Choice (A/B)
1. CE, proposed increase in travel time in B (min.)	1	6	12	20
2. CE, proposed increase in travel time in B (min.)	3	8	16	30
3. CE, proposed increase in travel time in B (min.)	5	10	20	40
Choices	A,A,A.A	B,A,A,A	B,B,AA	B,B,B,A
WTP, 1. CE, min	< 1	1< WTP < 6	6< WTP <12	12< WTP <20
$\frac{\delta}{\gamma}$	$<\frac{1}{0.5}$	$\frac{1}{0.5} < \frac{\delta}{\gamma} < \frac{6}{0.5}$	$\frac{6}{0.5} < \frac{\delta}{\gamma} < \frac{12}{0.5}$	$\frac{12}{0.5} < \frac{\delta}{\gamma} < \frac{20}{0.5}$

Table 3 summarizes the choices of the respondents. As expected, the total acceptance rate decreases gradually from the first choice to the later choices where travel times in alternatives B were gradually increased. The results indicate that in addition to the travel time increase the order of the choice has also impact on the acceptance of alternative B. This can be seen by comparing acceptance rates of the first choice in the third CE (91%) and the second choice in the first CE (61%) where the decrease in the acceptance rate is clearly lover even though the travel time increase is only 1 minute higher. It seems that respondents are more critical when answering for the later choices. Most clearly, this can be seen in the comparison between the third choice of the third CE (44%) and the fourth choice of the first CE (32%) where the travel time increases are equal (20 minutes).

Table 3

Acceptance of increased travel times in the choice experiments

	1. Choice (A/B)	2. Choice (A/B)	3. Choice (A/B)	4. Choice (A/B)
1. CE, (minutes in the parenthesis)	85% (1)	61% (6)	43% (12)	32% (20)
2. CE	92% (3)	67% (8)	47% (16)	35% (30)
3. CE	91% (5)	58% (10)	44% (20)	22% (40)
Total	**89.6%**	**60.7%**	**44.8%**	**29.4%**

The acceptance rates presented in Table 3 are, in general, as expected and in line with the theoretical assumptions, but the observed impact of the order of choices on acceptance must be taken into account in the analysis and interpretation of choices. Therefore, we first modeled the

four choices separately with logit model to get deeper insight on each choice question. After that, we modeled choices together interpreted as interval values as presented in Table 2.

Thus, we adopted bivariate logit model for analyzing the choices and impact of opinions on the four sentences describing use of in-vehicle travel time (1. It's important that I can use travel time effectively to work or study in public transportation, 2. I'm satisfied with the possibilities to use travel time effectively in public transportation, 3. It's important that I can use travel time for relaxing in public transportation, 4. I'm satisfied with the possibilities to relax in public transportation) as independent variables of the model, which had statistically significant impact on choices only in the model of the first choice. Estimation results of this model are presented in Table 4.

Table 4

Estimation of the logit model for the first choice

	B	S.E.	Sig.
1. It's important that I can use travel time effectively to work or study in public transportation	**-0.352**	0.182	**0.05**
2. I'm satisfied with the possibilities to use travel time effectively in public transportation	-0.031	0.175	0.86
3. It's important that I can use travel time for relaxing in public transportation	0.257	0.183	0.16
4. I'm satisfied with the possibilities to relax in public transportation	**0.477**	0.191	**0.01**
Constant	2.945	0.974	0.003

As Table 4 presents, only the first and fourth independent variables are statistically significant in addition to the constant. The interpretation of the fourth variable and the coefficient value 0.477 is rather straightforward, i.e., satisfaction on possibilities to relax in public transportation increase willingness to increase travel time for reducing crowding. In other words, this means that persons who are already satisfied for possibilities to relax during the trips are more likely willing to accept an increase in travel time for increasing travel comfort even more. The negative coefficient value (-0.352) of the first variable is somewhat complicated to interpret, because persons willing to work or study during the bus trip certainly would like to reduce crowding. Our interpretation is that those persons surely want to reduce crowding, but as they obviously are work/study oriented they still prefer to minimize travel time even more, which explains the negative coefficient.

For modelling the four choices together interpreted as interval values (see Table 2) we adopted an ordered probit model with known thresholds (see, for example, (Train, 2009)), where WTP is assumed to follow normal distribution with mean W and variance σ^2 which was estimated by maximum likelihood method to obtain parameter values W = 18.54 and σ = 16.49, which were statistically significant based on the likelihood ratio test. We also modeled the impact of the opinions on the four sentences (as in the logit model above) with the ordered probit model and the results indicated similar impacts than in the logit model, but the coefficients were not statistically significant, which was expected based on the previous estimation results of the logit models and due to larger variance when the all four choice question were modeled together. Understanding this variance of WTP is important and we will adopt more detailed models with additional explanatory variables obtained from this survey in the near future.

5. Implications on Service Provision and Pricing

Our motivation for studying relationship between use of in-vehicle travel time and crowding is based on our goal to find new ways to improve attractiveness of public transportation by means of service design, intelligent transport technologies and related digital services. From the viewpoint of solving urban transportation challenges the commuters are obviously the most important passenger group, but students are interesting research object especially when the goal is to understand needs and preferences of the future commuters and to develop new transportation services based on that understanding.

If crowding costs are clearly higher for the passengers willing to work or study during the trip, then they would be willing to pay for less crowded service classes and lines or new public transport modes designed for working travelers such as train cabins designed for working and studying or automated demand responsive transportation services (Jokinen, 2016) enabling door-to-door shared rides with sufficient working conditions, which can be ensured by limiting the occupancy rate of the vehicles. Moreover, travel information services proposing less crowded lines and departure times would be beneficial for these passenger groups.

Approximately 41% of respondents answered that it is important that they can work or study when traveling in public transportation. As can be concluded from the logit model estimation in Table 4 these respondents still prefer more travel time savings than decreasing crowding. However, faster travel times and decreased crowding are both desired improvements, which can

be achieved simultaneously by increasing service provision of public transportation. The results just indicate that faster travel time seems to be more desired currently on the school trips in Tanzania and Namibia. If the willingness to work during trips remains later when the students graduate and start to earn salary, they could be willing to pay more for less crowded transport services. This should be taken into account when designing new public transportation services or extensions of the current services. Thus, less crowded service classes or lines with higher prices should be considered. Moreover, need for higher service classes could provide possibilities also for commercial commuting services possibly subsidized or fully paid by the employers.

6. Conclusion

In this paper, we have presented the survey results considering travel needs in school trips in Tanzania and Namibia. The results showed that the use of in-vehicle travel time has impact on the tradeoff between travel time and crowding. We also discussed how the use of in-vehicle travel time should be taken into account in designing and provisioning of new transportation services. The data was collected just recently during the spring 2017 and in the near future we will put effort for more detailed modeling of willingness to pay for reducing crowding, which is possible due to several alternative explanatory variables measured in the survey.

In the stated choice experiments of the survey the trip alternatives were provided by minibus, which is common transport mode in African countries. Minibuses have most likely important role also in the future of the African transportation systems even though large-scale mass transportation services have been developed during recent years in many countries like BRT services in Dar es Salaam, regular bus services in Windhoek and train services in South-Africa. We see that understanding the needs and preferences related to the use of in-vehicle travel time also in the other transportation modes and in the multimodal transportation chains is important issue for the future research aiming to provide new knowledge for the development of more attractive public transportation services.

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