EMPIRICAL ESTIMATION OF PRICE ELASTICITY OF DEMAND FOR TRANSPORTATION: THE CASE OF KLANG VALLEY (MALAYSIA)

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Abstract— Even though the investments in transportation are significantly increasing, the impact of public policies on public transportation is relatively unavailing. The city of Kuala Lumpur is still competing with high number of private vehicle users which result in every day car congestions and heavy air pollution. This article attempts to find possible strategies that can be adopted by local authorities in order to restrain the private vehicle users. Since the Malaysian government has recently taken certain steps which elicited overall transportation costs increases, our aim is to evaluate whether the extent of the policies would bring the desired outcomes in form of traffic reduction. Empirical analysis is based on price elasticity calculations capturing the reaction to a hypothetical percentage increase in maintenance, parking and toll costs. The survey also estimated a price elasticity of the public transportation customers and investigated the socio demographic characteristics of all transportation users in the Klang Valley area. With respect to the survey findings we proposed several policies which can reduce private vehicle utilization and lower the traffic congestion in the city.

Index Terms— Consumer survey, Ordered logit model, Price elasticity, Public transportation in Klang Valley.

I. INTRODUCTION

Malaysia is currently struggling with the same problems that were pointed out almost 10 years ago, including the traffic congestions in the city, insufficient public transportation (PT) and reluctance of local residents to use PT instead of cars/motorcycles. Malaysian government persist in regulating the transportation sector through number of policies. Unfortunately, some of the steps formerly adopted had negative effect on PT utilization, in particular high fuel subsidies, low road taxes and tolls, or lack in long-term sustainable development of PT planning and management (Gho Chee Yuan, 2013). Nevertheless, public authorities have recently changed their approach and within the Tenth Malaysian Plan and Subsidy Rationalization Program they embraced policies which incurred an increase in highway tolls, fuel prices, PT tickets and taxi fares. It is too early to analyze the full consequences of this overall transportation price change, but from our consumer survey results we can investigate whether the fuel and toll price increase will reflect in car reduction. The main objective of this article is to find out feasible ways of how to restrain number of private vehicles by using a consumer sensitivity analysis associated with hypothetical price changes in transportation sector. This objective is divided into three parts according to the authority responsible for price decision making. First we captured a reaction to the price increase of the maintenance cost, which generally depends on the particular user. Secondly, we focused on a reaction to the price increase in the overall costs connected with car/motorcycle use like increase in fuel price, parking costs or tolls. These factors can be influenced by the local government. The last part then captured a reaction to the price increase in the taxi fare which is influenced by SPAD agency (Land Public Transportation Commission). Since the consumer survey captures a reaction to a hypothetical price increase of PT tickets as well, we were able to study the price sensitivity of the PT users. This fact helped us to understand how this specific group perceive the PT costs and how this fact can be used by local authorities in price formation.
We consider the previous PT fares quite low, suggesting that the price increase would not discourage the current users from using public transportation. On the other hand, certain groups of respondents who are not price sensitive can react to higher cost for private vehicle utilization and switch to PT. Therefore, the conceivable steps for restraining car/motorcycle users are higher parking costs, increase in tolls for highways, reduction in the subsidy for fuel or implementing a so called carpooling policy which is successfully working in Singapore. The question is how significant must be the price increase in order to discourage the car/motorcycle drivers from using a private vehicle. The investigation of this critical amounts was part of the empirical analysis.

II. LITERATURE REVIEW

There is quite high number of publications specializing in high traffic congestion problem in Malaysia. The relevant studies predominantly investigated socio demographic characteristics of the transportation users through estimating the willingness to pay or willingness to accept certain policies which aim at strengthening the public transportation utilization. For instance Nurdden et al. (2007) discovered that among the factors that determine why car is a favored modal choice were the

travel time, travel costs and distance from home to the station. Kamba et al (2007) studied policies focusing on the increasing use of private transportation. Authors used a multinomial logit model developed for three transportation modes to identify factors that would influence car users to switch from car utilization to PT. Their results confirmed the importance of travel time and travel cost characteristics in the respondents' modal choice. Nevertheless, according to an article written by Irsyad (2015) most Malaysians are notably insensitive to higher costs or longer travel time. Irsyad is predicting that even a double increase of tolls would not make public transportation the first choice for millions of Malaysian commuters. An absence of PT users was highlighted in a World Bank report (2015) estimating that only 17% of commuters in Kuala Lumpur use public transport compared to 62% in Singapore and 89% in Hong Kong. Both mentioned sources see the main reason in inconsistent urban transportation planning and insufficient management. Current situation and delivery practices for urban transport are still not sufficiently robust to handle the underlying complexity of Malaysia's cities (ibid).

To our knowledge, there exists a lack of empirical studies investigating an exact travel costs increase which would encourage the car/motorcycle users to shift to PT. One relevant study written by Alsemati et al. (2015) examined the passengers' willingness to pay (WTP) and willingness to accept (WTA) improved PT ridership in Malaysia. Their results showed that the best reduction rate for both travel time and travel costs was 45% and the best parking cost increment reached US$0.68. With respect to this study, our objective was to suggest an exact percentage increase of the travel costs like parking, tolls and maintenance that would reduce the car/motorcycle ridership.

III. METHODOLOGY

Pricing studies can be conducted by using a variety of methodological approaches, including direct pricing measures, Van Westendorp models and regression estimation. With respect to our objectives, we decided to adopt direct pricing measurement testing the predictive validity of willingness to accept (WTA) a hypothetical price increase for a given transportation service. Consumer willingness to accept a wide range of different hypothetical price increments can be elicited directly through a self-designed questionnaire survey. Unfortunately, consumer surveys of this sort have many well-known limitations. Frequently, the answers provided to a hypothetical questions are not very accurate, especially when enumerators use open-ended questions. To make this approach more subtle, the survey included closed-ended questions supplemented by answers regarding the perceived quality and travel time reduction. However, these additional results are beyond the scope of this article and were examined elsewhere.

A. Price elasticity

The effects that transportation system changes have on customers' mobility are generally referred to a 'sensibility' to a specific factor and are measured with elasticities (Litman, 2013). In our analysis we calculated price elasticity for the various transportation modal splits as a reaction to a hypothetical increase of PT ticket, taxi fares, and private vehicle operating costs. Elasticity indicates the percentage change in transportation ridership resulting from a percentage change in price, expressed as:

$$E = \frac{percentage\ change\ in\ volume\ of\ travel}{percentage\ change\ in\ price} = \frac{\%\,\Delta Q}{\%\,\Delta P}$$

Price elasticity is ordinarily negative because, under the law of demand, price and quantity move in opposite directions. If the relationship is in compliance with law of demand, it is common to omit the negative sign of the elasticity coefficient (Lee, 2002). The elasticity value is then comparable using an absolute magnitudes (i.e. elasticity -1 is higher than elasticity -0.2). Equation (1) for price elasticity at the certain point can be expressed in mathematical terms as:

$$E = \frac{\frac{Q_1 - Q_0}{Q_0} * 100}{\frac{P_1 - P_0}{P_0} * 100} = \frac{P_0}{Q_0} * \frac{\Delta Q}{\Delta P}$$

Concerning the interpretation of the elasticity value, if the absolute value of the resulted elasticity is smaller than 1, we classify its magnitude as inelastic meaning that the price change cause less than proportional consumption change. In case of a value larger than 1, the magnitude of a demand is elastic (prices change cause more than proportional consumption change) and the declining quantity outweighs the increasing price in proportionate terms. Price increase will than cause a decline in total revenues. The concept of unitary demand elasticity then reflects a fact that price change exactly correspond to demand reaction, while total revenues are being maximized.

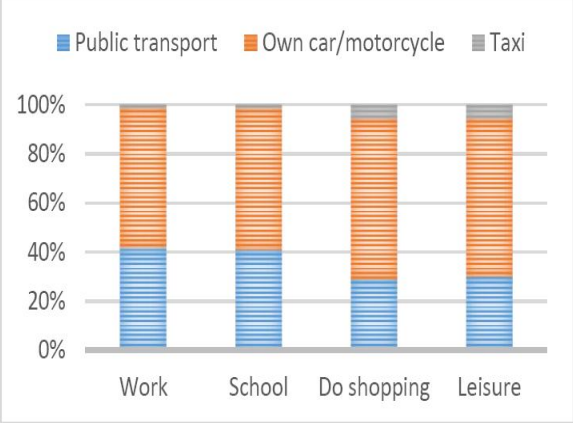
IV. CONSUMER SURVEY AND DATA CHARACTERISTICS

In order to obtain socio demographic characteristics and transportation users' reactions to certain price increases, we conducted a consumer survey which covered the whole examined area of Klang Valley. This area consists of ten separate districts (KL center, Klang, Putrajaya etc.) where all of these regions are served by the public transportation including KTM trains, LRT trains, buses and monorail. Taxis are generally classified as a special type of public

transportation since they are available for public use and may have a role complementary to other buses and trains (Balcombe et al., 2004). However, the survey's main objective is to find policies which would reduce the number of cars and incurred pollution. Therefore we will not include taxi service in public transport but consider it as a separate category. Self-designed questionnaires were spread among the representative sample of the residents living in the considered urban districts chosen according to the population density. With respect to the research objectives the sample of respondents covered both PT and car users, as well as taxi users. Because we were interested solely in a shift between private vehicle (taxi) and PT as a whole, we did not interview a proportional number of respondents from all PT means. Moreover, we assumed that most of the respondents use both private and public vehicles depending on a purpose and distance travelled.

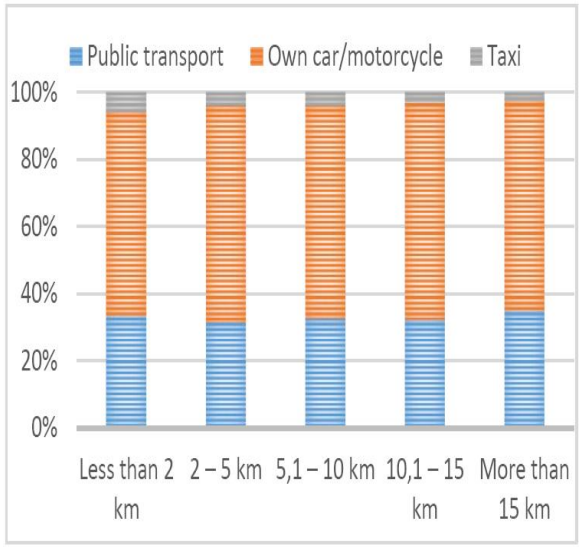
Every interviewed respondent carried an important information which helped us to describe the passengers' decision making process and found factors which would help local authorities in pricing formation. Together was interviewed 532 respondents which highly exceeds the minimum limit of 383 answers. This boundary was calculated with the help of Cochran's formula used for categorical data and ensures a good relevance of the survey (Cochran, 1977 and Barlett et al., 2001). First part of the questionnaire dealt with an identification of the respondents by using a simple questions about age, gender, monthly income and highest level of completed education. Beside the social demographic characteristics we also included general questions estimating the frequency of PT use, monthly spending on PT and access to a private vehicle. An overview of all mentioned characteristics with a data distribution is presented in Appendix 1. Concerning the transportation utilization, respondents were asked to choose their common type of transportation related to the purpose and distance travelled. The mentioned phenomenons are captures in Graphs 1 and 2, respectively.

Graph 1: Type of chosen transportation according to the purpose



Graph 1 captures a perceptual distribution of the transportation type with respect to the given purpose. From all respondents going to work and school 40% chose PT and almost 60% are regularly traveling by car or motorcycle. Last two categories have very similar data distribution. Almost 30% of the respondents chose PT as a mean of transport for leisure and shopping activities, approximately 65% then prefer car or motorcycle. Taxi, in general, is used rather occasionally, reaching maximum value of 5% in case of leisure and shopping activities. Data distributions related to a distance travelled are almost same across all five categories. This fact can implicate that people usually adhere to the same type of transportation whether they travel over a short distance or not. 30% of the respondents travel commonly by public transportation, 65% of them then use private car or motorcycle. The remaining 5% represents the travelers going by taxi.

Graph 2: Type of chosen transportation according to the travelled distances



Nonetheless, the most important questions in our consumer survey were the reactions to hypothetical price increases of the PT ticket, taxi fare, maintenance costs and cost of fuel, parking and tolls. Respondents were asked how they would react to five possible percentage increases starting from 10% to 100%. The results were used to calculate the average acceptable price increase and price elasticities.

V. RESULTS

A. Price elasticities

First of all we concentrated on an average price acceptance calculated from consumer survey results. Beside this statistic, Table 1 shows also number of respondents regarding the (no) acceptance of given price increase. The sum of responses differ across the segments since not every respondent is using all types of transportation means.

Table 1: Average price acceptance (APA) and number of respondents accepting given price increase

	PT	Maintenance	Fuel/parking/toll	Taxi
APA	40.7	56.0	43.5	8.3
Accept	294	404	394	84
0	33	27	3	41
10	63	38	39	20
25	94	122	146	39
50	54	107	80	15
75	25	34	36	8
100	58	111	104	3
Sum	327	439	439	126

The average acceptable price increase of PT fares reaches approximately 40%. The statistic for maintenance costs is slightly higher – almost 44%. Average acceptable price increase for fuel, parking and toll costs is significantly higher attaining 56%. Conversely, taxi users were not willing to accept almost any price increase. In order to get the price elasticities we had to calculate first the percentage change in demand. The demand volume of travel is already captured in Table 1. For instance, in case of 10% price increase of PT fares, 33 respondents would not accept the given price change and switch to another option like taxi or private vehicle. This fact result in almost unify response i.e. 10% price increase incur almost 10% reduction in consumption. For illustration, we exemplify the calculation of percentage demand change for 25% price increase:

$$\frac{231-327}{327} * 100 = -\frac{96}{327} * 100 = -29.36\%$$

In sum 96 respondents would not accept the given price change, resulting in almost 30% demand change. Using formula (2) mentioned in methodology part, we calculated a demand changes and resulted price elasticities for all transportation means. The results are captured in Table 2.

Table 2: Percentage demand changes and demand elasticities

Change in demand				
	PT	Maint.	F/P/T	Taxi
10%	-10%	-6%	-8%	-33%
25%	-29%	-15%	-17%	-48%
50%	-58%	-43%	-50%	-79%
75%	-75%	-67%	-68%	-91%
100%	-82%	-75%	-76%	-98%
Elasticity				
	PT	Maint.	F/P/T	Taxi
10 %	-1.01	-0.62	-0.77	-3.25
25 %	-1.17	-0.59	-0.67	-1.94
50 %	-1.16	-0.85	-1.00	-1.59
75 %	-0.99	-0.89	-0.91	-1.22
100 %	-0.82	-0.75	-0.76	-0.98

Price elasticities for PT are circulating around value 1, indicating a unitary elastic demand. Percentage change in quantity demanded is very similar to the percentage change in price. This result demonstrate an optimal pricing policy for public transportation which is maximizing the total revenues. This is valid for most given changes, apart from the last one – 100% which result in only 82% less consumption. Elasticities for car/motorcycle users who faced the increase in maintenance, fuel, parking and toll costs are lower than 1 and therefore inelastic. On the other hand, taxi users appeared to be very price sensitive with almost all elasticities highly exceeding value of 1, in case of 10% increase even reaching 3.25.

B. Interpretation of the results

Beginning with 2nd December all residents of Klang Valley area experienced a general price increase in PT fares based on a new distance structure. According to the comparison report made by Muzakir Xynll (2015) the average price across all routes reached approximately 30% (from the previous average ticket price of RM2.64 to RM3.43). This number is lower by 10% than the average acceptable price increase calculated from our data set. The unitary price elasticity for public transportation confirms that a 10% price increase would cause an exact 10% decline in service demanded. Total revenues would be maximized simultaneously with this particular price change, making the decision about the new pricing policy justifiable and in compliance with the economic theory. However, the price increase should have been much smaller reaching optimally only 10%. On the other hand, taxi users deem to be very price sensitive with average elasticity 1.79 and average acceptable price increase reaching only 8.3%. Under new rates announced by the Land Public Transport Commission (SPAD) in May 2015, fares for budget taxis in the Klang Valley increased from 10 sen/115m to 25 sen/200m (i.e. 14.38 sen/115m). In percentage expression attains this increase almost 44%. With reaction to this pricing policy regular taxi users are currently not willing to accept any more price increases. 53% of the respondents stated that in case of a price increase they would substitute taxi for private vehicle, 44% would then switch to public transportation.

Concerning the private vehicle costs, in December 2014 were proportionally reduced fuel subsidies and was implemented a managed float pricing system based on average monthly prices of crude oil. Since 2009 the prices for RON95 increased from RM 1.75 per liter to RM 2.26. At the end of 2015 was this policy supplemented by a highway toll rate increase announced by twelve major highways concessionaires in Klang Valley. The new rates did not increase proportionally but they represent a hike of between 18% and 100%. Looking at the data

presented in Tables 1 and 2, car/motorcycle users appear to be rather price insensitive in terms of rising cost connected with private vehicle utilization. However, the higher price increases exceeding 50% have significantly stronger impact on this particular segment of respondents. For instance a 50% and 75% price increase would cause a decline in car/motorcycle demand by 50% and 68%, respectively. Therefore, the overall conclusion of our survey is not in compliance with the articles mentioned in the literature review predicting that even a double increase of tolls would not make public transportation the first choice for millions of Malaysian commuters. According to Table 2, in case of 100% price increase in tolls more than 76% of the respondents would switch to another transportation mean (95% would change over to PT, 5% would then use taxi service). According to the World Bank (2015) estimation, public transportation share in 2014 was only 17%; other sources predict only 10 - 12% (Malaysian government, 2010). On the other hand, local public transportation features high occupancy and congestion especially during peak periods. The main rail lines suffer from excessive crowding with 140% capacity on KTM train and 180% on the Kelana Jaya LRT services (ibid.). Similarly, bus services on popular routes suffer from packed conditions during peak hours, where at least 23 of 166 routes are over capacity. Thus, we cannot support the idea that the source of peoples' reluctance to use PT is solely their negative unsubstantiated attitude. Conversely, there is an excessive demand for PT which translates into a highly uncomfortable journeys with overcrowded vehicles. We support the frequently mentioned idea that the traffic congestions and high private vehicle utilization originate from the unsatisfactory PT planning and management. But we cannot confirm that people are reluctant to PT use; on the contrary, public transportation is in its present state not sufficient to meet the service demand.

CONCLUSION

The objective of our survey was to examine the Klang Valley commuters' reactions to hypothetical transportation costs increases and provide recommendation to local authorities aiming to reduce private vehicle utilization. Our working hypothesis was that people's reluctance to use PT streams from the insufficient quality of the public transportation and giving priority to the comfort of their own car/motorcycle. In order to express the responsiveness to the price changes we calculated an average acceptable price increase and price elasticities using the direct pricing measures in form of a self-designed consumer survey. Since the survey was conducted before the implementation of the PT fare increase, the outcomes can be interpreted in terms of new pricing policy rationalizations and sustainability. Klang Valley residents also had to face a fuel subsidy reduction which was adopted within the Tenth Malaysia program and caused sequential grow of fuel prices since year 2009. Beside the increasing fares of public transportation and costs of private vehicles, residents also experienced an increase in taxi fares and highway tolls in May 2015.
According to our results and its interpretation, we conclude that there is most importantly an insufficient extent of provided service which in addition does not adhere to timetables, lacks of clear connectivity and suffers from poor quality and frequent system failures. Therefore, we do not recommend any further price increases in transportation field, neither in PT fares nor in fuel/toll costs because public transportation in Klang Valley is not ready to serve higher amount of customers. Malaysian local authorities have already started to act according to this statement and have taken certain measures to rise attractiveness of the PT, for instance by investing in new MRT lines, buying new vehicles etc. This step is definitely in a right direction which is necessary for further development of the Klang Valley area.

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APPENDIX

Appendix 1: Socio demographic characteristics of the respondents

VARIABLE	COUNT	%
Age		
25 or under - 1	296	56%
26-40 - 2	161	30%
41-55 - 3	54	10%
56 and older - 4	21	4%
Gender		
Male - 0	247	46%
Female - 1	285	54%
Income		
Less than RM 3.000 - 1	263	49%
RM 3.000 – RM 4.500 - 2	147	28%
RM 4.501 – RM 6.000 - 3	65	12%
RM 6.001 – RM 7.500 - 4	23	4%
More than RM 7.500 - 5	34	6%
Education		
Grammar school - 1	3	1%
High school or equivalent -2	102	19%
Some college, no degree - 3	162	30%
Bachelor's degree - 4	202	38%
Master's degree - 5	46	9%
Doctoral degree - 6	11	2%
Professional degree -7	6	1%
Work sector		
Public sector - 1	105	20%
Private sector - 2	169	32%
Self-employed - 3	64	12%
Other (please specify) - 4	24	5%
Student - 5	170	32%

Car access		
Yes - 1	360	68%
No - 0	172	32%
Loyalty card		
Yes - 1	197	37%
No - 0	335	63%
Transportation spending		
Less than 1% -1	196	37%
1 -5% -2	184	35%
5,1 - 10% -3	97	18%
More than 10% - 4	55	10%
Freq. of PT use		
Less than 6 months - 1	169	32%
Once in 6 months - 2	82	15%
Once a month - 3	37	7%
Once in 2 weeks - 4	41	8%
Once a week - 5	55	10%
Couple times a week - 6	49	9%
Every day - 7	99	19%

★★★