In mitigating urban transportation problems and providing a sustainable transit system, rail-based systems have become popular. While rail-based systems are welcome in many developed countries, it is impractical for cities in developing countries due to the high cost of system building and operation. Thus, a staged or incremental adjustment towards fixed guide way transit implementation of greater interest to many agencies today, and these days it has started developing in terms of Bus Rapid Transit (BRT). As it is very new to developing cities, it is a challenge to get the users to understand the system and to grasp their attitude. Besides, there are many other general issues like literacy, lack of a sample frame etc. Survey design needs to be tuned carefully for these cities to obtain a resonant output. Concerning all these problems, a hypothetical questionnaire survey such as Stated Preference (SP) has become popular. This study conducted a survey on BRT implementation with SP as a hypothetical tool at a selected corridor in Colombo, the capital of Sri Lanka. The main objectives were to identify questionnaire design(media) effects, literacy of users, segmental variation, and the important variable(s). In this survey design, system explanation has been set in two slightly different ways (media: TEXT ~ IMAGE) for comparison and it was found that even a slight difference on design affected the users' response considerably. Income level could not be predicted directly, but car ownership was found to be a good predictor, it was found to be an important variable and it showed a correlation with literacy.

Key Words: Travel behavior, Developing countries, Survey design, Stated Preference, Bus Rapid Transit

1. INTRODUCTION

Urban transportation problems have become alarming problems these days in developing countries and planners are looking for different policy instruments to mitigate the dramatic rise in traffic congestion, air pollution, etc. Improved public transportation implementation and screening vehicles from mixed traffic may be a viable solution for mitigation. Sustainable public transport development is an immediate need with the following attractiveness; raised quality of life integrating transport and land-use planning, low emission vehicle usage, reliable and relieved congestion through high-capacity services, esthetic and secure station/stops availability, etc. Though rail-based systems are quite common in developed cities, it is impractical for cities in developing countries due to high establishment and operating costs. Something similar to exclusive or semi exclusive lines such as Light Rail Transit (LRT), or Bus Rapid Transit (BRT) are two of the feasible alternative options.

After having knowledge of its success throughout the world, along with the low cost and staged development possibilities, BRT is recently becoming more popular in developing countries. Because of various kinds of challenges in developing countries, such as illiteracy, lack of a sample framework, respondent selection, social, religious and cultural norms, suspicion of the purpose of a survey among users, response reliability, achieving users understanding without interviewer bias, etc, implementing new transit system (NTS) suffers from two main challenges; (1) a NTS must focus on all social groups of people in terms of age and income, etc., and (2) a NTS might be very new to citizens thus explaining the system itself becomes an additional problem.

Therefore, questionnaire design becomes very important in survey design to manage the aforementioned
challenges and target-area awareness is essential. Concerning all these problems, as well as time consumption for detailed surveying, hypothetical type questionnaire surveying has become more popular in travel behavior research nowadays.

NTS demands hypothetical type question setting in questionnaires as it makes NTS explanation easier. Though hypothetical type questions are comparably flexible, it has more risks in developing countries. Hence, survey design needs to be tuned carefully for these cities to obtain a useful outcome. Literature reviews also indicate that, so far, more attempts are made for better modeling than on data. Richardson1 describes that “to date, data collection process is not commensurate to fit to those well sophisticated models developed so far”.

Traditionally, analysis of preference and behavior were based on the Revealed Preference (RP) method, in which the observation was made on the existing transportation system (actual market). When a new or alternate transport system (commodity) is planned, the project evaluation demands for a trial observation before the system comes into operation. To handle such hypothetical – not yet existing – situation, the Stated Preference (SP) method was developed first in marketing research in the 1970s and then the concept has been brought to the transportation field. A SP survey presents hypothetical scenarios (attributes and levels) to a respondent and asks him/her to identify the preferred alternative2.

SP technique has become an increasingly common practice in handling these hypothetical situations3 and among many recent SP studies, e.g. the one conducted in Yangon, Myanmar by Zhang4,5 with few added techniques and assured the capability of SP.

This study has been designed with the objectives to identify questionnaire design (media) effects, literacy of users, segmental variation, and important variables by collecting users’ preferences on their trips to the Central Business District (CBD) area with an additional alternative mode of BRT as a public transportation improvement policy and also with a SP type question in addition to a general RP question.

This study mainly concentrates on the effect of an NTS demonstration method (media) upon users’ preferences. Therefore, instead of a general SP design – where NTS is produced with only an attribute value level change – in this study NTS, here BRT, was defined and demonstrated prior to the SP questionnaire using two different media: TEXT (written expression of some BRT elements) or IMAGE (written plus graphic expression of those elements) in the questionnaire. Other than this BRT demonstration page, all of the respondents received exactly the same questions. This is in contradiction to the general SP question distribution method and such a method was chosen for comparing effects arising purely from the media.

In addition to the SP set of questions, a few RP set was also added for completeness and cross-checking. Drop-off and pick-up method was used to avoid any verbal influence on BRT demonstration from the interviewer. Respondents were given about two weeks to complete the survey. As a case study area, a potential corridor (Gale road) in Colombo, the capital of Sri Lanka, was selected and the study was conducted in September, 2005.

2. IMPROVED PUBLIC TRANSPORT: NEEDS OF A DEVELOPING CITY

Buses are the predominant mode of public transportation in many developing countries which are suffering from the worst traffic congestion in urban cities. This congestion needs urgent transit policy implementation. Rail-based systems are superior in relieving congestion, but need a dedicated right-of-way and have very high construction costs. Many agencies are thinking that LRT is capable of carrying more passengers and possess an appealing modern image but there is no big difference between LRT and bus service with few improvements on the number of passengers carried, in a single corridor6,7. Many other studies, especially, ITDP8, Hook and Ernst9, Leal and Bertini10 have compared many BRT cases around the world including the popular model of Curitiba, Brazil. These are leading cities to consider BRT, while reviews reveal that area(city)-specific-issues and users’ attitudes on such new systems need to be studied, especially in developing countries.

Firstly, what needs to be considered for BRT. Different organizations define the BRT system in different ways. Diaz and Schneck11 defined BRT as “distinct from conventional bus transit in a way it combines technology, the operational plan, and the customer interface to create a higher quality of service”. Transit Cooperative Research Program (TCRP)12 defined it as a “rubber-tired light rail transit (LRT) but with greater operating flexibility and potentially lower capital and operating costs”. It also summarizes the whole picture of BRT elements and examples. Most of the definitions are very broad and are related to the cases or projects concerned.

Therefore, in this study, BRT, the selected transit improvement policy, has been defined and categorized prior to questionnaire design as in Table 1. Because of the
greater flexibility available in BRT system element combination, users can become perplexed with its elements when just the name BRT is stated. To reduce this complexity in definition, the authors categorized BRT into three hierarchical orders according to developing country’s respondents’ needs and stage of deployable elements as shown in Table 1. While Walter and Matthew\textsuperscript{13} mentioned about four stages of BRT deployment, which is based on developed countries’ examples and infrastructures. Though the table does not say, it is more realistic to say that a selected type may possess more or all attributes of lower type(s) in addition to its own. In this research, BRT was defined to respondents as using the Type 1 category.

### 3. EXPERIMENTAL DESIGN AND DATA COLLECTION

#### 3.1 Study area

A pilot survey was conducted in Colombo, the capital of Sri Lanka, along the potential corridor of Gale road, which connects the CBD area and south suburban area (Panadura) as depicted in Figure 1. The Colombo metropolitan region consists of 5.4 million population (30% of the country’s population) and 3,593sq.km land area. This corridor is the only major line from Panadura to the CBD, and becomes crucially congested during morning and evening peak time, and consists of commercial and residential mixed land use. The survey was conducted in September, 2005.

#### 3.2 Survey details

As mentioned above and shown in Figure 1, the residential area, mid-way along the corridor, was selected as the target population area and their preferences on trips to the CBD have been studied by using household based surveys. In order to cover more respondents, who use this corridor to the CBD, office-based (destination based) surveys were also carried out. The questionnaire was structured in the following order: personal details, BRT system demonstration (media consisting of TEXT or IMAGE) compared to existing buses (EBus), SP type questions, presented mode usage details, and rate of satisfaction on EBus, etc. Both the household and office-based surveys were conducted by a drop-off and pick-up method by giving about two weeks for completion. Selected residential areas were divided into four subdivisions to assure that people from all social groups were included.

#### 3.3 SP survey

To gain preference among hypothetical situations from users, trade-off type questions are popular in this form of SP\textsuperscript{14}. Manuel used the SP technique to compare heavy rail(HR) and BRT in developing countries with a case study area of Lima\textsuperscript{15}. SP type surveys can also predict relative preference among attributes and can easily estimate level of desire for any attribute among users.

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**Table 1 BRT types according to its elements**

<table>
<thead>
<tr>
<th>Type 1</th>
<th>Type 2</th>
<th>Type 3</th>
</tr>
</thead>
</table>
| ➢ Some means of separation from mixed traffic  
  • All along or partially  
  • Bus lane, by road marking/ slightly raised median | ➢ Additional priority measures  
  • At at-grade intersection  
  • Passenger information at station and onboard  
  • Modal coordination (Operation & payment)  
  ➢ Feeder system, Park & Ride | ➢ Sophisticated ITS  
  • Signal priority  
  • Vehicle tracking  
  • Real time passenger information  
  • Enables pre-planned trips (web based) |

---

**Fig. 1 Map of selected corridor (in Colombo)**
Generally SP techniques are performed by producing a set of scenarios (in this research the word “case” is used) in a systematic manner with a certain number of alternatives for each case, carefully selected attributes for each alternative, and different levels of attribute values. Therefore the complexity of SP depends on the size and should be minimized, however, at the same time keeping it meaningful.

As mentioned before, one of the main objectives of this study was to evaluate the media effect of BRT demonstration on users. The questionnaire was set so that the BRT demonstration appears prior to the SP question, similar to a general SP questionnaire, which is specially designed for NTS implementation studies. Here, BRT elements were demonstrated to the user comparing it with existing buses in either one media of which the study mainly considered and designed; one is written expression of some elements (TEXT) and the other one is written plus graphic expression of those elements (IMAGE).

Figure 2 shows an example of BRT attractiveness of a level-floor-boarding possibility with a low-floor-bus for IMAGE where the left side for EBus and right side for BRT. For breaking the language barrier, the questionnaire was set in all the three official languages of Sri Lanka. Nearly equal numbers of questionnaires for both TEXT and IMAGE were distributed among respondents. So, every respondent received either one of the two media. Other than the media differentiation, there was no difference in information.

Considering the existing condition of the study area, the following attributes were considered important and used in SP questions; travel time (TT), travel time variance (TTV), fare (F), and comfort. Comfort was presented in terms of mode; EBus and BRT. Following BRT demonstration, in this study, the SP questionnaire was given with six cases, each case having four alternatives. Each alternative with four attributes and the attribute levels were set to a maximum of three. Selected attributes and their level values are as follows; TT = {15, 20, 30} min, TTV = {0, 5, 10} min, F = {10, 20, 30} Rs, comfort = {EBus, BRT}. Each respondent received 6 cases × 4 alternative question sets. Table 2 shows an example of the SP questionnaire given. It shows only first two cases out of the six. Only these two cases will be used for further illustration later in the paper to make the discussion brief.

### 4. RESULTS AND DISCUSSION

Overall response rate of 63.9% and 40.7% were observed from office-bases and households respectively, and those of 116 and 44 in terms of number of respondents. As this number was not as high as expected, the analysis was performed carefully. Though drop-off and pick-up method was selected purposely, this lessened the responses and might have been improved if face-to-face interviews were carried out, because that is the common practice and familiar method in this area.

#### 4.1 Characteristics of users

It can be seen from Figure 3, that male participation is higher than female participation because the household head is generally male and the others are usually not responsible for such activities in developing countries due to culture. The same reason holds for age distribution,
and participation is also concentrated on parents’ age of 30 - 40 years. Unlike developed countries, in these areas those who are aged roughly above their 60s are almost dependents and that is why their participation is also poor. This problem could be solved by using an interview type survey, as the respondents are selective. In the vehicle ownership, the term vehicle also includes motorbikes. If motorbikes are excluded, then the no-vehicle percentage will be higher. Non-response for income field is high as it is common even in developed countries.

4.2 Aggregation of responses

a) Simple Aggregation
Trip to the CBD consists of both commuting and non-commuting trips. However, workers’ trips (destination based) could be considered as commuting trips. In Figure 4, by comparing mode share of the general group and car-owned group from their trip to the CBD, it can be said that mode share of public buses is higher as a common phenomena in developing countries. In addition to that, public bus share among car-owner commuters is also higher and it is an attractive output for assuring the transportation improvement necessity of the city.

b) Aggregation of SP results
The existence of jokers (bad respondents: those who answer in a unique or rhythmic manner and/or responded with the same alternative for all the six cases of SP questions) was checked by cross-checking their responses whether all selection went in the same mode of alternative number or not. The aggregation made in this context is given in Figure 5. From the higher percentage (68%) of “not same” answer– neither always blank nor always the same mode, it is clear that many respondents did not select their alternatives by favoring any mode but by trading-off among alternatives. The right side of Figure 5 shows the BRT preference among those who traded-off (not the same). Reduced percentage in “Equally Ans”-mode selection goes equally- could be taken as IMAGE increases response reliability. Effect of users on preference had a vast difference, even though the information given for both media was the same. This immediately points out one important message that every single element of the whole survey has to be designed more carefully in developing cities.

The social variation is also considered based on different personal attributes and that of age group is de-
picted in Figure 6. It could be seen that there was an effect of media on preference and always an increased percentage for IMAGE while along the segment it is not a predictable trend. Among the small elderly sample, IMAGE media attracted more BRT especially due to its elimination power of visual inability. BRT demonstration media effect was experimented further in detail by concerning each six cases individually and the effect on non-response rate was also checked. As similar distributional patterns were observed for all cases, only the first two cases are shown for illustration. The results for household (HH) and commuters who did not own a car and who owned a car are depicted in Figure 7, Figure 8, and Figure 9 respectively. A reduced non-response rate was always observed for IMAGE from households (HH). On the other hand, for IMAGE, non-car owner commuters showed an increased non-response rate while car owner commuters showed a reduced rate. There was also one notable and interesting variation dependent on media type. Commuters’ non-response rate difference depending on car ownership implied that car ownership is an important attribute for commuters and car ownership seems to correlate with commuters’ literacy.

4.3 Utility function considered

In this study, SP outputs were analyzed further using a binomial logit model to derive users’ utility function and thereby to check the significance of selected attributes. A linear form of formulation was used and is given in Equation (1):

\[
U(EBus) = a_1(TT) + a_2(TTV) + a_3(F) \\
U(BRT) = a_1(TT) + a_2(TTV) + a_3(TTF) + C 
\]

Where,

\(a_i = \text{parameters (i = 1, 2, 3, \ldots)}\)

\(C = \text{Specific constant}\)

In addition to the above mentioned basic attributes, when personal attributes (\(V_i\)) like: gender, age, income, car ownership, etc are considered, the formula was modified by adding a summation of those attributes and parameter coefficient to the utility of BRT, as in Equation (2):

\[
U(EBus) = a_1(TT) + a_2(TTV) + a_3(F) \\
U(BRT) = a_1(TT) + a_2(TTV) + a_3(TTF) + a_i(V_i) + C 
\]

Analysis of results for basic attributes (without any socio-economic variables) are shown in Table 3. It can be seen that all parameters gained, expected signs and their t-statistics, adjusted Rho-squared values, goodness of fit, are also significant.

Different combinations of the above mentioned attributes were checked and it was found that the responses for directly asked personal attributes were not always showing significant outcomes due to sensitivity of these attributes among users. Therefore, as an alternative, sev-

<table>
<thead>
<tr>
<th>Table 3 Parameters estimated for basic attributes</th>
</tr>
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<tbody>
<tr>
<td>Media</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>TT (min)</td>
</tr>
<tr>
<td>TTV (min)</td>
</tr>
<tr>
<td>F (Rs)</td>
</tr>
<tr>
<td>Constant</td>
</tr>
<tr>
<td>L(0)</td>
</tr>
<tr>
<td>L(\beta)</td>
</tr>
<tr>
<td>Adj.(R^2)</td>
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<tr>
<td>N</td>
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</table>
eral other attributes drawn indirectly, were checked and car ownership was found to be an acceptably useful attribute. Car ownership (CO) was given as a dummy variable (=1 if car available, 0 else ). Table 4 shows the parameter estimations obtained for TEXT and IMAGE from the additional attribute of car ownership.

This model also confirmed the correct sign and significant t-statistics and Rho-square values. T-statistic value of travel time for IMAGE is comparably low because BRT preference dominates even though a slightly longer travel time exists and car ownership makes the travel time attribute insignificant. In other words, car owners will not mind even the travel time being slightly longer compared to public bus and a comfortable BRT. The higher value is observed for the parameter of car ownership. It can be said that car owners are a high income group and their preferences are always on BRT between the two given modes.

4.4 Model comparison

In order to understand these derived models easily, in this section some example values of attributes are considered for both EBus and BRT and given here within parentheses in pairs respectively; TT=(20, 20) min, TTV=(5, 10) min, F=(30, 20) Rs. According to these reasonably assumed values, the BRT preferences are calculated and given in Table 5. It portrays the media effect at a glance regardless of model consideration. Then in detail, the IMAGE always attracts more BRT and car ownership magnifies this further.

5. CONCLUSION

Overall, the trade-off behavior has ensured the feasibility of SP surveying. SP questionnaire works well in making users understand about an unfamiliar NTS in developing countries. BRT categorization made in this study was found to be more appropriate. In these areas, generally, users used to be suspicious about data collection purposes and therefore confidential information like personal attributes are less or wrongly responded to. Therefore, carefully designed indirect questions are necessary.

To study the media effect, in which a new system is introduced in the context of system demonstration, TEXT and IMAGE were used and a clear effect was found. Non-response rate and response reliability are important indices and improved by using IMAGE. The BRT media effect, with the same information, has to be taken as a lesson and the questionnaire design should be done with added care in the case of developing countries.

Purposely adopted drop-off and pick-up method influenced on the reduced response rates and on the segmental concentration. Therefore, interview type of familiar methods is a better option. Due to this segmental concentration, indirect personal attributes were used and car ownership was found to be one useful attribute and it also dictated commuters’ literacy too.

Segmental variation always shows an increased percentage preference on BRT while the cross-sectional trend is unpredictable.

The pictorial superiority found in this SP survey can be further developed to study the demonstration effect of BRT system elements’ dynamic character with a gathered group of people from different segments so that the above mentioned problems of segmental concentration, response rate etc., could also be minimized.

REFERENCES


### Table 4 Parameters estimated with additional attribute of car ownership (CO)

<table>
<thead>
<tr>
<th>Parameters (Real)</th>
<th>Media</th>
<th>TEXT</th>
<th>IMAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>TT(min)</td>
<td>-0.043 (-3.606)</td>
<td>-0.009 (-1.059)</td>
<td></td>
</tr>
<tr>
<td>TTV(min)</td>
<td>-0.066 (-2.174)</td>
<td>-0.082 (-3.630)</td>
<td></td>
</tr>
<tr>
<td>F (Rs)</td>
<td>-0.052 (-3.517)</td>
<td>-0.081 (-6.323)</td>
<td></td>
</tr>
<tr>
<td>CO (1 ~ 0)</td>
<td>0.501 (-2.049)</td>
<td>0.700 (-3.321)</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>0.910 (-4.791)</td>
<td>1.547 (-9.216)</td>
<td></td>
</tr>
</tbody>
</table>

### Table 5 Percentage of BRT preference

<table>
<thead>
<tr>
<th>Preference (%)</th>
<th>TEXT</th>
<th>IMAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eq 1</td>
<td>71</td>
<td>78</td>
</tr>
<tr>
<td>Eq 2 CO = 1</td>
<td>77</td>
<td>86</td>
</tr>
<tr>
<td>CO = 0</td>
<td>67</td>
<td>76</td>
</tr>
</tbody>
</table>


