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Using Three-Dimensional (3-D) Physical Models to Improve Public Participation in Transport Planning: Case Study on Integrating BRT Systems with Rickshaws in Dhaka City

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Abstract

Use of 3-D virtual (computerized) visualization techniques is increasing as a tool in public participation; however, this technique involves huge cost to develop and is risky to apply in developing countries. Hence, 3-D physical models possibly could be an alternative, cheaper option, for application in such countries. Even though 3-D physical models are very common and widely used in the field of architecture or urban landscape design yet, there is no publication which demonstrates its use in transport planning for the purpose of public participation.
The paper reports on the use of 3-D physical models to improve public participation in the transport planning process for integrating BRT with rickshaws. An empirical study involving focus group discussions (FGDs) of transport users and rickshaw-pullers, was conducted in Dhaka City (Bangladesh). During the FGDs it was found that the use of a 3-D physical model was very helpful and useful for the participants to relate spatial contexts of the study area in the model; for discussing spatial aspects; for understanding the proposed development in the area; as well as effective facilitation of discussions. The methodology and tool developed in this study is transferable to other cities or for research on other modes/topics in transport of developing countries.

Keywords: Participation, visualization, 3-D, physical model, rickshaw, BRT, integration.

1. Introduction

Public participation and bottom-up approaches have gained a lot of focus and importance in planning and development practice over the past decades. This is because technical approaches alone often fail to engage effectively with the knowledge, value and interests of stakeholders and the wider society (Burgess and Stirling, et al, 2007). Various methods of participation are available in literature to incorporate the views of the public into a decision-making process. These could vary from a simple transmission of information to a complex negotiation, such as: opinion polls and referendum, public hearing, public meetings, surveys, resident's consultation, focus groups, citizens' panels and forums, citizens' juries, participatory action research (PAR), consensus conferences, and stakeholder workshops (Lenaghan and Coote, 1997). A variety of tools and techniques are available for application in each of the methods to ensure effective participation, and have been developed to improve the quality of contemporary democracies (Navarro, 2008). Each of the different tools and techniques has comparative advantages or disadvantages over others on particular issues. For instance, using a three-dimensional (3-D) model helps to demonstrate the engineering design as well as the proposed development easily to the ordinary public who have no specialized or technical knowledge.

The current paper focuses upon participatory planning involving rickshaws. Rickshaws (also known as cycle-rickshaw, pedicab, becak, cyclos, etc. in many countries) are available as a travel mode in many cities, particularly in Asia. As the motorised public transport services in developing cities are often poor and unable to meet the travel demand, rickshaws play an important role in transport. They often provide transport access to otherwise inaccessible areas (particularly where narrow streets deny access to formal public transport), and for certain groups of people (i.e. female or older people) who have difficulties of access to certain overcrowded public transport. Moreover, rickshaws are environment friendly and have an important economic significance (as many families are dependent on rickshaws for their livelihood). Despite these facts, many cities have tried to restrain or prohibit rickshaws from the entire city or from certain roads or parts of the city on the grounds of either reducing congestion for smooth flow of motorized vehicles or enhancing the city image by eliminating traditional modes. For instance, Bangkok, Manila, Jakarta, Karachi, Delhi, and Dhaka have banned rickshaws in the past either from the entire city or from some roads. However, there are arguments that decisions to ban rickshaws have not been based on scientific or technical grounds (see ITDP, 2009; Gallagher, 1992), but rather upon ad-hoc political decisions taken from the top (bureaucrats and richer car-owners). In the case of Dhaka, this argument has been supported by evidence which suggests that the rickshaw ban did not help achieve smooth flow of motorized traffic or reduce travel time (Barakat, et al. 2004; Gallagher, 1992). Also, it was shown that road space use per passenger is less in rickshaws than in cars (Barri, ??; Gallagher, 1992). Furthermore, there were many protests and demonstrations by the rickshaw-pullers (and in a few cases by civil organisations) against the ‘political decision’ of rickshaw bans in each of the cities mentioned above, thus showing that rickshaw bans are ‘controversial’. A rigorous public involvement process or stakeholder consultation while making policy or planning transport could help avoid such controversies. Also, an alternative approach to placing outright restrictions on rickshaws is to try to integrate them in the public transport system by using them as feeder services. Such an option is potentially feasible given that rickshaw trips are usually for short distances (ITDP, 2009; STP, 2005) and they are usually complementary rather than competitive to motorized public transport (Rahman, et al. 2008; Gallagher, 1992).

The current paper is concerned with how rickshaws might be used to provide feeder services specifically for bus rapid transit (BRT) systems. Many cities both in the global North and South have implemented such systems as a form of mass transit as a means of improving public transport and tackling increasing transport problems, while others are planning to do so. Several modern BRT systems have modal integration with bicycles (e.g. Guangzho BRT in China, Bogota’s TransMilenio BRT in Colombia); however, there is no BRT system in the world which demonstrates integration with rickshaws. The role of the public transport station is very important for multi-modal transport. Hence, the design and planning of BRT stations is crucial for integrating BRT with rickshaws, particularly because rickshaws require different (special) planning and design requirements.

Putting together the various elements described above, the current paper reports on the use of 3-D physical models to improve public participation in the transport planning process for integrating BRT systems with rickshaws, as tested at particular case study locations in Dhaka. The purpose of the 3-D model was to make the general public understand about the proposed development (design of BRT station for easy, convenient, and safer transfers to/from rickshaws) and to progress the discussion effectively to explore the stakeholders’ opinions during the public involvement process. A qualitative approach, focus group discussions (FGDs) of transport users (both rickshaw and public transport) and rickshaw-pullers, was applied for exploring public opinion and testing the 3-D physical model of visualization.

The case study was conducted in two locations of Dhaka city during August 2011-March 2012. One location is on a major corridor of mixed traffic, close to the inter-city bus terminal with neighbouring areas which are unplanned and low-income residential (*Sayedabad*). The other location is on a rickshaw-free major road, close to a train station and a newly developing commercial area: neighbouring areas are planned and high income residential with higher car ownership rates (*Banani-Kakoli*). Based on a review of literature and good practices of BRT systems as well as on the local spatial and traffic context an initial plan for each study area was prepared; the 3-D models were then constructed as described below in Section 4. Before that, a description is given in Section 2 about the use of focus groups in the study, whilst Section 3 provides an overview of tools that can be used in participatory planning.

2. Focus Groups for Public Participation

2.1. Why FGD?

There are different tools available for exploring the public opinion and ensuring participation in the decision-making process. The number of people involved and the depth of participation for each of the tools are different (see Cohen, 2005; Batheram, et al. 2005). Each of the different tools has comparative advantages or disadvantages over others on particular issues. Some of the tools are used only for awareness or disseminating information whilst a few are used for consultation and others are for participation. For instance, surveys and interviews provide only individual response and do not give any collective opinion. Opinion polls and referendums are non-interactive whilst public meetings, citizen's forums, consensus conference, public exhibition, etc are like consultation and they do not provide deep participation or an opportunity for showing any design to the public as well as receiving their effective feedback. In contrast, FGDs are frequently used in participatory research which uses the interaction among the group of individuals to discuss and give opinions on a particular topic or issue where the researcher or moderator facilitates the discussion. Due to interaction, FGDs are able to provide collective information considering the power structure and dynamics of diverse people in society. Marsden and King (2009) argued that the focus group approach enables the researchers to understand the views of members of the public and they had applied the tool for understanding travel choices in UK cities.

2.2. Category of groups

For the case study, considering the aim of the research the 'passengers' of rickshaws and public transport as well as the 'rickshaw-pullers' were the key stakeholders. Transportation literature suggests that there is a significant difference in use and pattern of transport facilities and services between different genders (see Venter, et al. 2007; Turner and Grieco, 2006; Hamilton, et al. 2005; Turner and Fouracre, 1995). Even, there is a greater difference in travel between men and women of the same household in developing countries (Peters, 2001). Given that the provision of transport facilities is highly gendered and that often the voices of women are not listened to in a mixed-group (Turner and Grieco, 2006), groups of 'women only' and 'men only' were formed. However, all the members of 'rickshaw-puller' group were male, as there are no females pulling a rickshaw in Dhaka. Research on transport reveals that there is a difference in travel pattern as well as usage of travel modes with the difference of household income (see Reference). Hence, 'middle-income' and 'poor-income' passengers were involved in separate groups. Disabled people may have particular needs in public transport usage; hence, a separate group was formed for them. However, unlike the other groups, the 'disabled-group' was not location specific and included both men and women. Thus, the different stakeholder groups for FGDs in the two study locations are summarized in Table 1.

Table 1: Different groups for FGDs

Category of the Stakeholder Groups	FGDs	
	Location A (Sayedabad)	**Location B (Banani-Kakoli)**
Men-only middle-income group	**FGD 1**	**FGD 6**
Men-only poor-income group	**FGD 2**	**FGD 7**
Women-only middle-income group	**FGD 3**	**FGD 8**
Women-only poor-income group	**FGD 4**	**FGD 9**
Rickshaw pullers	**FGD 5**	**FGD 10**
Disabled (gender balanced)	**FGD 11**	

While recruiting the members for each group, it was ensured that they had knowledge about the study location and either used the area on a regular basis or lived close to the area. There were 5 to 8 people in each group (e.g. as seen in Fig. 3 and Fig. 6). It was ensured that the members in each group varied in age as well as having different educational and employment characteristics. Except the disabled, each of the user groups included at least a student, elderly person, employed person, job seeker, housewife (only for 'women-only' groups), and business person.

The venue for conducting FGDs was very close to the site (study area), and widely known to all. Seating arrangements of the participants were in circular shape so that everyone could see each other. A format of discussion topics was followed during FGDs to cover different aspects of the research. The discussion was made in the local language (Bangla) and the session was recorded on video tapes. Discussion of each group lasted for about 90 minutes. A break for about 10 minutes in the middle was given; and tea and refreshments were provided during the break.

3. Tools Considered for Visualization

Visualization is the simulated representation of a proposed project and its associated impacts in such a way that is sufficient to convey the full extent of the development to the layperson (Hixon, 2006 cited in Cheu, et al. 2011). It is a method that combines a variety of different tools or techniques and applications to generate and portray the existing and proposed project conditions in a realistic manner. Visualization can be presented with two-dimensional (2-D) or 3-D techniques.

3.1. Two-dimensional (2-D) Techniques

Maps, photographs, artist's renderings, charts, maps, architecture and engineering drawings etc are examples of 2-D visual techniques where only the horizontal and vertical references of the project are portrayed. Two-dimensional plans are often prepared by the landscape architects or urban planners. In transport planning also 2-D maps are used to show the location, alignment of road, directions of traffic flow, etc.

3.2. Three-dimensional (3-D) Visualization Techniques

3-D visual techniques provide viewers an additional dimension - depth/height. This extra dimension in 3-D makes it easier for the viewers to understand the representation and spatial context of the proposed project more realistically. As argued by Knoll and Hechinger (2007: 121), "the ability of a model to document a spatial concept and the essence of a design scheme in three-dimensional form represents a considerable advantage over drawings".
Use of 3-D visualization techniques is increasing in the public involvement process as more planners and engineers become familiar with GIS, AutoCAD, Google SketchUp, and similar tools (Cheu, et al.

2011). Several successful applications of 3-D visualization tools in the public involvement process are notable (i.e. Cheu, et al. 2011; Gibson, et al. 2002; Howard and Gaborit, 2007; Lai, et al. 2011). The 3-D model for visualization could be a virtual model (prepared with computer aided software for viewing on a computer screen) or a physical model (prepared with paper or materials).

3.2.1. Virtual (Computerized) 3-D Model

3-D virtual environment of visualization has been used in many research projects (see Howard and Gaborit, 2007; Lai, et al. 2011; Cheu, et al. 2011). Most of the studies describe the development of the virtual visualization models and report the successful use of the models at public events whilst a few describe changes in public opinion on projects and the positive attitude towards visualization. In all the studies the 3-D virtual environment was applied for individual interviews but not for collective group responses.

No reference or literature was yet found which demonstrates the application of 3-D virtual models in a group environment like FGDs to gather a collective response. The main drawbacks of a 3-D virtual model are that it requires a huge cost and specialized skills to prepare and develop. In many developing countries, this may not be affordable by the researchers or city authorities. Moreover, using computer-based tools in developing cities is risky. This is because computers and internet are not readily available or accessible to everybody (general public) in many developing countries and those people who have never before seen or used a computer may find it difficult to use one for expressing their opinion.

3.2.2. Physical 3-D Model

3-D physical models of visualization are very common in the profession or field of architecture or urban landscape design. Gibson et al (2002) explained the potential applications and limits of rapid prototyping (RP) technology, which deals with constructing architectural physical models. However, there is no publication which describes the use of a 3-D physical model in the field of transport planning for public consultation. Nevertheless, "[3-D] models speak a different language than do [2-D] drawings, and consequently they articulate and describe architectural design concepts in a different way" (Knoll and Hechinger, 2007: 121).

4. Three-dimensional (3-D) Physical Model Used in FGDs for the Study

As discussed in the previous section, preparing 3-D virtual models involves high cost and using computer-based virtual techniques in developing countries is risky; hence, a 3-D physical model would be better rather than a virtual model for public participation in transport planning. It was hypothesised that a 3-D physical model would be helpful to explain the proposed development (how BRT looks) to the participants of FGDs and help them understand better (or more easily) what changes might occur in the locality. Hence, 3-D physical models of the case study areas were prepared (e.g. as seen in Fig. 2, Fig. 5 and Fig. 10) and used in FGDs for the public participation.

An initial 2-D plan of the proposed BRT station was prepared with AutoCAD; and then it was printed in a large size paper and placed on a hard base. To construct the 3-D model, then the building blocks, trees, and other objects of the study area were made with hard paper and materials and then placed on the map and stuck with glue which gave a 3-D view.

4.1. Cost

In order to reduce costs, the model was prepared by undergraduate (4th year) students of architecture school in Bangladesh University of Engineering and Technology (BUET). The model prepared was of a lower standard than is used for professional purposes in architecture. However, it was of a sufficiently high standard to help laypersons (general public) to understand how the study area (particularly the spatial arrangement of the location) and the proposed development of BRT would look. Thus the model enabled better discussion and participation of the public in FGDs. The students were given only Tk 5,000 (Tk 79 = US$ 1) for each model to cover their expenditure for purchasing materials required to prepare the model and a token lump sum as a gift for volunteering their time (3 students spent 2 days). In comparison, the researcher ascertained from professional architects that preparing each of these models to a professional standard would have cost Tk 25,000 to 30,000.

4.2. Colour

Colours of a model are very important. A few researchers mentioned proper consideration must be given about colouring of a model. For instance, Gibson et al (2002) emphasised the necessity of realistic colouring. This is because, "Just as the materials and colours of a real architectural space influence human perception, the coloring of architectural models substantially determines the way they are perceived and understood" (Knoll and Hechinger, 2007: 107). As mentioned earlier, the purpose of the 3-D model was more about showing the existing spatial contexts and proposed development of BRT to facilitate the discussion; hence, the distinct colours for the BRT lanes, BRT station, roads, pedestrian paths and pedestrian crossings were given in the model (e.g. as seen in Fig. 1, Fig. 4). All other structures (buildings) were recognizable by their different size and heights.

4.3. Scale

The scale of a map or a model could be of various sizes. However, its choice depends on how much detail is needed. A small scale model could be of 1:500, whilst the figures in profile could be 1:100 to 1:10 and the figures of paper and pins could be 1:200 to 1:100 scales (Knoll and Hechinger, 2007: 96). The scale of the model prepared for this study was 1:700. With this scale, it was possible to keep the model to a reasonable size (about 1m by 0.5m) to transport it to the venue for FGDs conveniently on public transport. This scale also allowed visualizing and distinguishing the major aspects of the BRT station (modal interchange areas for integrating between rickshaws and BRT systems) and the surrounding area. However, the model prepared was not in a great detail.

5. Major Findings from the FGDs

This section reports the major findings concerning use of the 3-D physical model during the FGDs to facilitate the discussion. FGDs followed a set format which included firstly (by way of an ice-breaker): an introduction and explanation of the BRT system by the facilitator, followed by discussion of the participants' frequency of trips on rickshaw and bus. This was then followed by discussions about: the need for pedestrian crossings to access BRT station; the maximum distance for comfortable changes between BRT and rickshaws and requirements for safe and secure changes; service facilities needed at BRT stations; the possibility of a pre-determined fixed fare structure for rickshaws; participants' knowledge about existing road signs and markings; and the signs and symbols needed at the interchange area. In addition, the rickshaw-pullers group discussed: space requirements for rickshaws at the BRT station; and how to organize rickshaws in and around BRT station areas. These topics were discussed in general terms and then again in the particular context of the case study area. After conducting the FGDs the video records were transcribed and translated in English for qualitative analysis. The major findings from the analysis are discussed below.

5.1. Physical 3-D Model Enables to Relate or Explain the Spatial Contexts Easily

Using the 3-D model was very helpful for the facilitator to discuss and explain easily about the study area, spatial location of the major buildings and roads as well as the proposed BRT station and BRT lanes. For instance, pointing to the model he could say "Here is the bus terminal" or "This is BRT station and in two sides the red lanes are for the BRT" (Fig. 1). The participants of FGDs just looked at the model and listened to what the facilitator was saying. They were also using their visualization skills as well as their knowledge from their previous travel to that location to understand whether the spatial contexts of the reality were represented in the model. For instance, pointing to the model, one lady of 'poor-income' group said "This is rail line, ya; there – the junction of *Janapath*". This indicates she was able to relate the spatial context in the model. The participants also asked questions to clarify whether their understanding about the model was right. Such as, the businessman of middle-income group pointing towards *Janapath* junction asked "Is it *Janapath More*?". It was observed that the majority of participants were able to understand and recall the area very well with the help of 3-D model.

Fig. 1: Pointing to BRT station

Fig. 2: Participant pointing to *Janapath*

However, a few of the participants needed some time to relate the spatial contexts correctly and exactly at the precise points in the model themselves. For instance, a participant of 'male-only poor-income' group asked, pointing to the *Janapath* junction (Fig. 2) in model "Which place is this?" whilst another participant of 'male-only middle-income' group pointing in the wrong locations (Fig. 3) in the model asked "Is this *Kakoli* and this *Mohakhali*?". Nevertheless, after explanation or clarification of few locations in model by the facilitator they were able to navigate the 3-D physical model very well.

Fig. 3: Pointing wrong

Fig. 4: Pointing to Road 4

Fig. 5: Pointing rickshaws

It was observed that the rickshaw-pullers knew the location and roads very well and were alos very good at navigating in the 3-D model. For instance, one participant of *Banani* location pointing towards the model was telling "This is Road 4 (Fig. 4), that side also it is Road 4 and in the middle this is divided [by] *Kamal Ataturk*. In that side (Fig. 5) about 100 rickshaws are operating…….". On the contrary, the participants who travelled less often or mostly used private cars for their trips were very poor in navigating the 3-D model. For example, while discussing modal interchange from rickshaws at *Sayedabad* the housewife of 'middle-income' group, pointing to the wrong side of road in model said "Well, when I'll come from *Jatrabari*, must get off here". She mostly uses private car or rickshaw from home to destinations for her travels; uses buses only 1-2 times in a year, and very rarely changes the mode in this study area.

5.2. Physical 3-D Model Helps Understanding the Proposed Development

The physical 3-D model helped the participants to understand the new things or proposed development in the study area – how it would be looking after the implementation of project. For instance, the elder housewife of 'middle-income' group of *Banani* wanted to understand the proposed BRT; hence, pointing in model (Fig. 6) she asked "… the bus will move in the middle; won't it?". About the location of proposed BRT station at *Sayedabad*, one lady of 'middle-income' group told pointing in model "Here is the rail crossing, …… if this [BRT station] is located little bit this side (Fig. 7) then it will be just for 2 minutes distance to arrive in this [BRT] stand .... ya, little bit far from this point".

While discussing about modal interchanges between rickshaws and proposed BRT, showing in model one participant of ‘male-only poor-income’ group told “After alighting either have to come here (Fig. 8) or have to come here”. Without having a 3-D physical model it would be impossible for them to understand the spatial arrangements of proposed BRT and to explain these.

Fig. 6: Pointing to the BRT lane at model

Fig. 7: Pointing different locations at the model

Fig. 8: Pointing the modal interchange areas

Fig. 9: Pointing at model where need rickshaw stand

Fig. 10: Showing the circulation path of rickshaw

Fig. 11: Demarcating an area at model

However, one lady of ‘middle-income’ group of *Sayedabad* told rickshaws will wait in “that side, beside the Ideal School”. As she had mentioned a well-known point, this might be possible to explain without having a 3-D model or 2-D map. Nevertheless, 3-D model would provide better reasoning with the location and spatial contexts of other objects. On other occasions it was found that a participant of ‘female-only middle-income’ group mentioned referring to *Kawranbazar* that underpass is safer whilst another also referred to *Farmgate* that all pedestrians are bound there to use overpass for crossing road. These reveal a few participants can navigate in their memory (mind map) and able to talk about their previous experience; hence, someone may think that it is not necessary to have a 3-D model during discussion. However, this should be kept in mind that it may be possible for someone (who travels often) to discuss about some aspects without a map or 3-D model but it would not be possible to explain the spatial contexts. For example, to mention the necessity of rickshaw stands (for boarding and alighting passengers) at particular points of BRT station a puller of *Banani* pointing in the model told “We need place for parking. ….. in this area. ……. Here we need space for parking; …. for queuing and dropping passengers” (Fig. 9) whilst another told “[rickshaws] will come from this side, after arriving here and dropping the passenger again [will take passenger and] pass through that side towards there” (Fig. 10). In another occasion, pointing in the model one participant said “Rickshaws of this point will serve only within this area” (Fig. 11). Above discussions reveal that the 3-D physical model helped the participants for understanding the proposed development about BRT and relate it with the spatial contexts of the location.

5.3. Physical 3-D Model Facilitates Discussion on Spatial Contexts

It was observed that using a 3-D physical model in the FGDs was very helpful to facilitate an effective discussion with spatial reference. About pedestrian access to the proposed BRT station, one participant of 'male-only middle-income' group was showing in model where the pedestrians in *Sayedabad* will cross the road to access BRT station and where the rickshaws will wait. On same topic, an elder lady of 'female-only poor-income' group pointing in the model (Fig. 12) told "here give a traffic signal". She explained very quickly and easily what she wants. Without having a 3-D model it would be very difficult for them to explain the spatial locations and even they would not able to realize what is required in a particular place.

However, this should be noted that using the 3-D model always did not ensure effective discussion among the participants automatically. When the facilitator asked the participants to discuss about the proposed design of BRT station; the 'poor-income' groups did not discuss much rather they often mentioned the model is "ok" or "seems ...... right". Even, surprisingly one participant of 'male-only poor-income' group of *Sayedabad* told "This [the plan] is right; [because] there is specific measurement, requirements, and given according to that. So, this is right". Hence, the facilitator had to play a crucial role to make them discuss further on the topics.

Fig. 12: Pointing in the model where traffic signals needed

Fig. 13: Demarcating an area at model

Nevertheless, it was found that the 3-D physical model was very useful for participants in FGDs to explain the spatial location or demarcating a particular area very easily and conveniently. For instance, the professional lady of 'middle-income' group was explaining from which points and locality usually the pedestrians walk towards *Banani* bus station. Demarcating the area in model (Fig. 13) she was telling "people of this side will come from here ..…. from this side"; and again pointing the location in model she added "during [morning] office hours from this portion toward this direction goes the majority...…". These explanations would not be possible without having a 3-D physical model during discussion.

5.4. Difference in Understanding the 3-D Physical Model among the Groups

Previous sections explained using a 3-D physical model in FGDs helped discussing with spatial contexts as well as understanding the possible spatial changes from proposed developments and facilitating effective participation while discussing with spatial reference. However, it was found that the understanding or usefulness of the model varied in different socio-economic groups; which have been summarized below in Table 2.

Table 2: Difference among the Groups

Observations or criteria	Middle-income group		Poor-income group		Disabled (mixed gender)	Rickshaw-pullers (all male)
	Male groups	Female groups	Male groups	Female groups		
Relate spatial contexts in model themselves	Yes	Yes	No	No	No	Yes
Asked questions to understand model	Not many	Many	Many	Too many	Not many	Very little
Pointed to the model to locate spatial contexts	Frequently	Frequently	Not often	Very rarely	Not often (dumb, blind)	Frequently
Understanding the proposed development	Very good	Very good	Good	Poor	Moderate	Very good
Effective discussion with spatial contexts	Very effective	Very effective	effective	Less effective	Less effective	Very effective
Referred to other parts of city	Yes	Yes	Yes	No	No	Yes
3-D model helped to progress discussion	Yes	Yes	Yes	Yes	Yes (very challenging)	Yes
Participants engagement during discussion	Very good	Very good	Good	Moderate	Good	Very good
Suggestions about proposed development	Suggested many	Suggested many	Suggested less	Suggested very less	Suggested less	Suggested less

6. Discussions and Conclusions

While designing the research methods and tools, it was hypothesized and expected that using a 3-D physical model would greatly help to progress the discussion and the participants would use it frequently while talking particularly about the case study areas to point to the locations. The model helped to progress the discussion with spatial contexts very well. During the discussion, participants frequently used the words ‘this’, ‘here’, ‘this side’, ‘that area’ etc and pointed to the respective locations in the model. Without having the model it would be difficult or impossible for them to explain properly those locations. Rickshaw-pullers have used the same roads several times a day over the last few years – hence they were very familiar with the spatial contexts of the area. Even so, they pointed to the model while discussing about different locations.

However, using a 3-D physical model in disabled group, particularly for the blind and dumb, was challenging. It was assumed that as the blind could not see the model, they would not take part in the discussion. However, the blind lady asked to explain the model and she was able to touch it for realizing the location of different structures and took part in discussion. This indicates she can navigate the model through her previous experience of travel in that area and touching the model even though she is unable to see with her eyes. For the case of dumb man, he showed physical expression pointing in model and made a sound (Fig. 14) (which the facilitator did not understand) but other disabled people understood and explained.

Fig. 14: Physical expression of dumb person during FGD

Fig. 15: A participant is holding (along with facilitator) the model

While conducting the FGDs, participants of all the groups were very active and supportive. For instance, the facilitator was holding the model during discussion with rickshaw-pullers at *Sayedabad* and disabled-group; and the participants were also holding the model to support him (Fig. 15). Participants in FGDs were very engaged with the 3-D physical model; while talking, they were pointing the respective locations in model. Even, in addition to model, participants of 'middle-income' groups in a few occasions were using paper and marker to draw/write what they were discussing. While a member of the group was talking and pointing in model, others were listening or watching what (s)he was telling and showing. However, there were a few occasions when several members either started to talk, or were pointing to the same location at the same time and arguing one against another. It was noticed that almost everybody in the middle-income groups looked at 3-D model very carefully whilst the facilitator was showing and discussing the proposed BRT station and the spatial aspects of its surrounding area. In contrast, the poor-income groups, particularly the 'women', were not so attentive. For instance, a few of the participants of *Banani* were whispering or talking among themselves or laughing on a few occasions. Hence, it should be noted that even though 3-D physical model facilitates effective participation; there is also a risk that participants may talk over cell-phone or look away from the model (outside, something else) during discussion unless the facilitator is capable of managing the group effectively.

The facilitator had to explain the model several times to the poor-income groups, particularly the women, to make them understand the proposed plan. The participants of *Sayedabd* asked many questions to understand the model and spatial contexts, but did not give many suggestions and opinions; rather, often they mentioned what have shown in the model is all right. Similarly, in *Banani* apart from the student all other participants mentioned the location of proposed BRT station is in right place. Beside this, it was observed that compared to other groups (apart from the student) the participants of 'female-only poor-income' group of *Banani* did not point the locations in the model so much. Surprisingly, even whilst they were talking about 'middle of the road', 'here', 'there', etc., they did not point in model. Nevertheless, the male groups used the model very often while discussing the spatial contexts.

It is interesting to find whether the size or scale and colour of the model had any influence on understanding and discussion of the participants. The colour was not important as long as it is possible to distinguish the different objects with different colours (e.g. the red lane was used to show the BRT lanes). This helped very well for the participants to understand different objects in the study area and distinguish them. Hence, even though the model was not in a quality of professional standard (as discussed in Section 4.1), there was no problem for understanding to navigate the model and locating the spatial contexts on it for the participants.
However, it was found that the scale of model is very important. A few of the participants were showing (or trying to show) outside the model whilst talking. For instance, a rickshaw-puller was trying to show on the ground (land) beside the model (Fig. 16) to explain the queuing of rickshaws and space requirement at *Banani* BRT station. From this, it could be understood that the model is small size and hence the width of lanes in model is not wide enough to put fingers and showing the vehicle circulation. Having a bigger size model could solve this problem as the participants could show the circulation of traffic in each lane on the model. However, a bigger size will cause problems of higher

cost and transporting the model to the venue and moreover the participants would not able to point to the locations with their hands. So, a trade-off is needed between the size (or scale) of model and convenience of transporting as well as cost. Nevertheless, one lady of 'middle-income' group was pointing outside the model and told "if the bus stops here, if get off here, and ..…." about the location of BRT station at *Sayedabad*. As the facilitator reminded her to show within the model, then she was pointing on model. This, in the contrary, reflects the size of model was not a problem but a few participants were just not pointing on it.

Fig. 16: A participant trying to show on ground outside the model

Fig. 17: Participant pointing a location outside the model and study area

In another occasion, while discussing about walking distance for modal changes, a professional lady of 'middle-income' group was telling about a location from where she walks to *Banani* bus station and tried to point in the model. However, as the model covered only about 650 m by 300 m of the study area, that point does not fall within the model. So, she showed that location outside of the model but in the same direction (and with approximate proportional distance). For example, showing outside the model (Fig. 17) she told "not only here; for this point,..…. from this point also, here". This indicates, it would be better if the model could cover a bigger area (large catchment area of BRT station). However, again, there should be made trade-off with other issues if the model is of a bigger size, as mentioned earlier.

In conclusion, it could be said that the discussion with the help of a 3-D physical model went well during the FGDs. The participants understood the proposed development plan and the spatial location. Compared to the computerized virtual model, a 3-D physical model is very cost effective and efficient to use in transport planning in developing countries. The 3-D physical models could be prepared by locally produced materials and local manpower (i.e. architecture students) without requiring any sophisticated knowledge on computer or software skills. On the contrary, computer based techniques require additional training or knowledge on computer and software as well as purchasing of the software and hiring the skilled professionals. Hiring of computer professionals also costs much. However, in future if the computer technologies are widely available in developing countries and become cheaper to use, computerized-visualization techniques could be tested if possible applying in FGDs. The further research could be the comparative analysis of public participation during FGDs (same study with same group) with and without using a 3-D physical model.

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