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Impact Assessment of Sustainable Public Transportation System on Quality of Life in Tehran

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1 ABSTRACT

Quality of life Indicates the satisfaction of people about living conditions, and in sustainable urban development, continuity of citizen's life with social welfare is considered. Quality of life in cities and approaches related to sustainable urban development are associated together. In recent years, increasing use of vehicles in major cities has had many effects on citizen's quality of life. In this case, large cities in developing countries such as Tehran are faced with more problems than modern cities. One of the impressive aspects of urban sustainable development is using sustainable public transportation system. So, the development of public transportation as a sustainable approach not only encourages people to make use of it, but also it is on the agenda for policy makers and city managers to enhance and make it sufficient for the city's demand. This paper will assess the impact of the use of sustainable public transportation systems on citizen's quality of life in Tehran by using indicators such as security, health, citizen's costs, and so on. Among the existing public transportation systems in Tehran, the subway and Bus Rapid Transit (BRT) systems are chosen to be assessed, because of their important function in this city. In the field, needed Information are obtained from two sources, first from available data in the relevant organizations and the second from people's opinions. The results of this assessment indicates the impact of these two public transportation systems on each of the indicators and the role they play to enhance citizen's quality of life.

2 INTRODUCTION

Nowadays, the necessity of attention to sustainable development is one of the issues that all people agree on. Future generations are at great risk and dangerous due to the ways in which humans are tapping into the earth's natural resources. Cities are the main place in which the human activities are done; therefore, achieving the highest possible stability in cities is a vital issue. Carrying goods and transporting the passengers, as one of the most essential human needs, has always been considered as an important index in the comprehensive planning of each society. At the moment, due to the growth of the population and urbanization in the developing countries, development of transportation systems seems necessary. In the recent century, people have expanded the transportation systems in accordance with developments and improvements and developing the roads and mass production of vehicles have resulted in activity and movement in the society, improvement in the life level of the citizens and the guild and economic structure of the countries. On the other hand, many of the problems resulting from the traffic as a means of transportation, and increase in congestion and damage to the environment have appeared. Transportation systems are regarded as one of the basic elements of the sustainable development in each country and one of the axes of the sustainable development in the transportation in the cities, especially in the developing countries, is the decrease in the amount of dependency on private vehicles towards public transportation such as subway, bus, etc. using private cars has resulted in the fuel-consumption increase, and hence, the fuel-cost increase, traffic, the environmental pollution such as air pollution, noise pollution, etc., which is against the principles of development. Nowadays what the world transportation experts agree on is achieving the sustainable transportation model in the cities to provide the perspective of a healthy and quiet city having a fast, safe and efficient transportation for all the citizens.

2.1 The purpose of the paper

In this paper, it is attempted to describe the reasons why different ethnic groups use different public transportation systems and to assess the effects of using public transportation systems on the quality of life of the citizens in Tehran by means of indices such as safety, accessibility, the cost, etc. In general, this paper

tries to discover some of the important issues that as a result of the sustainable public transportation can be effective on the life quality of the citizens in Tehran.

To pursue the appropriate investigation the following questions can be posed:

- What are the differing trends of various socio-economic groups towards using public transportation systems
- How do public transportation indices influence citizen's quality of life in Tehran?

2.2 Definition of sustainable transportation

Dependency on cars is a phenomenon in most cities of the world, a phenomenon which can be detected mainly in the underdeveloped and also less developed countries. Immethodical use of non-recyclable energy, the creation of pollutants and greenhouse gases, noise pollution, decreased feelings of security, and decrease in human relations and interactions in the cities are the results of dependency on cars. Regarding the points which are mentioned, cities that have high volume and dependency on private vehicles have greater traffic, yet when policy makers and urban developers ignore this issue and fail to find a solution to manage the traffic, one cannot regard their city as a sustainable city.

It is reasonable to begin a volume on sustainability with some of the definitions of sustainability and sustainable transport that have appeared in the literature over the past 15 years or so. One of the first of these clarifying phrases was used in the so-called Brundtland Report of 1987 (United Nations World Commission on Environment and Development, 1987). That report discussed what was referred to as "sustainable development," which was defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Without major changes this definition can be extended to sustainable transport, which may be defined as transport that satisfies "the current transport and mobility needs without compromising the ability of future generations to meet these needs" (Black, 2010).

Different definitions are proposed for this idea but sustainable transportation can simply be defined as; satisfying the current needs of transportation without putting the power of satisfying these needs by the future generation at risk; however, this definition has other aspects as well as the Sustainable Transportation Center defines the sustainable transportation system as: satisfying the essential needs of people and societies as well as the justice in each generation and between the generations. Sustainable transportation means following a model that despite the growth of the population and the city and the development and growth of it's economy, social and other activities of the society (which naturally are traffic-making factors) is suitable for transporting passengers and goods without causing the traffic problem. This model is capable of managing the demands and growth of the society and human activity because it remains sustainable and efficient.

The wide understanding of sustainable transportation as reflected in the sentence above is compatible with the definition given by Rietveld and Stough: 'Sustainable transportation is the maintenance of mobility and accessibility at some socially predetermined level and perhaps subject to selected social and environmental constraints, for example, maintaining predetermined levels of environmental residuals'(Rietveld & Stough,2010).

Schipper (1996) states that sustainable transport is transportation where the beneficiaries pay their full social costs, including those that would be paid by future generations. He further notes that changes in travel are associated with a number of potential externalities, including accidents, air pollution, congestion, noise, damage to the species' habitat, increases in carbon dioxide production, and the importing of oil. "It is these externalities, not transportation or travel per se that threaten the sustainability of the system" (Black, 2010).

2.3 The importance of sustainable public transportation and the hindrance it faces

Public transportation is used to refer to the set of networks and transportation systems that are the means of transporting people in a city. One of the effective ways for increasing the efficiency of the transportation systems is the improvement of the public transportation and directing it towards sustainable publication and this is possible through designing public transportation systems. The purpose of designing the public transportation systems if its improvement for the current users and then attracting the interest of the passengers of the private transportation. The daily increase in the population of the cities and therefore, increase in the enquiries for journeys causes all the urban plans, such as public transportation system, face

various problems. These problems are created because of the increase in the demand for inner city travels, the available facilities would not be enough for the needs, and they lack the capacity for this demand. Therefore creating a smooth movement which satisfies the needs society requires an appropriate preparation, exact and organized planning, and using state-of-the-art technologies and knowledge to achieve this goal and countless economic, social and environmental benefits, using public transportation system are unavailable. Bus and subway networks comprise the main part of the public transportation system. Less cost for transportation, less pollution, less fuel consumption and less occupation of the streets, in comparison with private cars regarding the transport capacity of the buses are the reasons that show the necessity of the public transportation development.

2.4 Transportation systems and urban planning

Urban planning and its processes are continuous, constant and sustainable issues that cannot be treated in a temporary and stationary level. Part of the urban planning is urban transportation planning that accompanied with planning for the usage of the lands, substructures and other parts makes the main dimension of the complete urban planning. Transportation besides housing, job and spending leisure is regarded as one of the four essential functions of the city so that the present urban life cannot be imagined without them. The inadequacy in the trend of urban planning and urban transportation has created massive destructive effects such as high energy consumptions, delays in arriving at the destination, decreases in the safety of the city and increases in life loss, destruction of the traditional structures and connections of the city, and the like.

The increasing trend in the growth of the metropolises accompanied with the increase in the population of these cities has made various problems; for instance traffic problem and disorder in the inner city transportation system. Therefore, this problem has been one of the main challenges that the urban planning has faced within the late 20th century and the achievement of the sustainable urban development has been affected by it. Easy, fast and safe access for the citizens to all parts of the city and to benefit from different land-use available in the city is one of the characteristics and indices of a desirable urban environment. Hence, it can be stated that systematic relation of transportation planning and urban planning from the perspective of the contemporary urban management should be regarded seriously.

3 THE PUBLIC TRANSPORTATION SYSTEM IN TEHRAN

The public transportation system in Tehran includes buses, subway, taxies and minibuses. In the recent decades, the mentioned system did not have an appropriate development regarding the simultaneous fast population growth in Tehran; therefore access to the public transportation for the general public became harder day by day. Considering this fact that in those years because of the incompleteness of the network of lines and limitation of the equipments for transporting passengers, buses used to be regarded as the main means of public transportation. In the recent decade, a considerable change has happened in the transportation system in Tehran. For example, Subway organization by exploiting its fifth line and going beyond three million journeys a day has a significant role in transporting the citizens in Tehran. The main barrier to the development of the public transportation in Tehran is the present limitations in public transportation fleet. These limitations have made the municipality and the organizations which need public transportation fleet provide it from domestic procedures. This issue has resulted in problems such as excessive increase in fleet, the low quality of the products, not taking the timing into consideration in producing the fleet, inappropriateness of fleet with transportation needs.

3.1 The introduction of rapid bus system and its role in the public transportation system in Tehran

Bus rapid transit (BRT) is a high quality bus based transport system seems like a sustainable option for many cities and urban areas; BRT is very cost effective and therefore affordable, especially for passengers with low income. (BRT) systems are proving able to keep pace with rapid motorization and metropolitan growth while providing a service comparable to metros. Like a metro, BRT combines high quality stations, including level boarding and real time information systems, with exclusive bus lanes and clean and comfortable high capacity buses.

The opponents mention the reduction in movement space of the vehicles in the streets, the creation of BRT lines and likelihood of creating traffic in these streets as the reason for the inefficiency of this system and the proponents name fast movement, comfort and safety, easy access and time savings as its' benefits. Perhaps

BRT can be deemed doing justice in offering the same services to the different groups of the society. BRT, from the psychological point of view, has also been quite effective due to providing comfort and safety in offering services and creating a good image within society. One of the features of this system is the low cost of running this project comparing with other options. This system does not require unique equipments or installation, therefore not only is it effective but also economically a profound choice.

 To improve the traffic in Tehran, developing the bus lanes and organizing the bus fleet is one of the main solutions which is short-term regarding the running time, effectiveness and its' cost. At the moment, seventy-three-kilometers of bus lanes exist in Tehran, however to have a secure and smooth transport for public transportation means in a metropolis like Tehran, more than two-hundred-kilometers of lanes are needed. Bus Rapid Transport is a modern way in this regard which for the first time in Iran was run in Tehran.

Due to the provided benefits and advantages of the bus rapid transport in organizing and improving the city transportation, Bus Rapid Transit (BRT) project, provided the preparation for designing and initiating this system, and is one of the most crowded East-West routes in the center of Tehran and is seriously taken into account. In the present time, eighty-three-kilometers of rapid-bus lanes have been created and exploited. Lines 1 and 2 of this transit, each with the length of more than 83 kilometers is actively running from Azadi Square to East Terminal, passing through Azadi, Enghelab, and Damavand streets and from Azadi Square to Khavaran Terminal, passing through Ayattolah-Saeedi highway and Qazvin, Helal-e-Ahmar and Molavi streets respectively. By having a fleet comprising of more than 600 buses which have more than 100 modern fleets, with its' transport capacity which is 2.5 times more than ordinary bus lanes, these lines are producing effective service. Lines 3 and 4 of the bus rapid transit are also designed and are in their administration phase. By forming the complete networks of rapid buses, the city is taking the right steps towards improving the time consuming and hectic traffic in Tehran (TMSI, 2009).

3.2 Subway system in Tehran

In 1958, a discussion over rail transport for Tehran was observed in the first comprehensive city plan. In 1971, to solve the traffic problem in the city, Tehran municipality assigned the examination of the city transport situation to the French companies, Sofrethu- RATP. On the basis of the gathered information and statistics and also the anticipations related to the development and expansion of Tehran in 1974, the institute proposed a comprehensive report suggesting the creation of seven subway lines with the length of 147 kilometers. The first inner city subway in Tehran with a nine-kilometer length and nine stations was exploited in Feb, 1999.

On average the tunnel making for the subway inside Tehran was 2.5 kilometers per annum in 2009. By adding 46 kilometers to the subway lines are 125 kilometers in Tehran. 214 million people were transported by subway in 2004 and it is anticipated that this amount will increase to the peak of 500 million people. Meanwhile, 493 subway compartments were added in Tehran between 2005 to 2010 (TMSI, 2009).

4   THE MEANING OF THE LIFE QUALITY AND THE ROLE OF THE PUBLIC TRANSPORTATION IN THE IMPROVEMENT OF THE LIFE QUALITY CRITERIA

Basically, the quality of life is a complicated, multi-dimensional and qualitative term in relation to the conditions and situation of the population in a specific geographical scale (city, region, neighborhood, area, etc.) which relies on both mental or qualitative indices and concrete or quantitative ones. With regard to the various definitions proposed for the quality of the life in cities and also because of the lack of consensus on its definition, it can be noted that the quality of life in cities is one of the ambiguous terms which can be interpreted differently and according to the application area and type of the study differs. Even though the definition of the quality of life is different in different countries and even in the different parts of a country, its common essence is providing the materialistic and spiritual essential needs in both abstract and concrete dimensions, at the same time.

Perhaps the following definition about the quality of life in cities can be the basis for study and interference: the quality of life means paying attention to the social, cultural, economic, environmental and psychological indices in both concrete (quantitative) and abstract (qualitative) dimensions in the trend of urban planning (like better educational conditions, the quality of access, housing and the places for spending the leisure time, creating opportunities for mutual social action, social opportunities, occupation, welfare, social participation, etc.). The essential essence of the life quality in cities is providing the human materialistic and spiritual needs

at the same time. As a matter of the fact, planning for housing, job, and employment or transportation without providing the psychological, emotional, and social needs of the citizens (for example, the need for security, beauty, tranquility, social belonging, happiness, entertainment, etc.) will be incomplete. Quality of life is reflective of the values that exist in a community. Indicators therefore could be used to promote a particular set of values by making clear that residents' qualify of life is of vital importance (Budruk &Phillips, 2011).

4.1 Extrapolation of quality of life criteria in relation with public transportation by Delphi method

The Delphi technique has many strengths (Mullen, 2003), particularly in utilizing expert knowledge to collect and discuss data, and in establishing consensus in situations where there is insufficient or contradictory information (Hasson, Keeney, & McKenna, 2000). The original Delphi, developed in the 1950s by the Rand Corporation for technological forecasting, has been modified over the years, creating flexibility in the design and format of the technique (Keeney, Hasson, & McKenna, 2006), which often produces rich and carefully considered material that might otherwise be difficult to access with other research methods (Hasson et al., 2000).

As defined earlier Delphi is a procedure for structuring a communication process among a large group of individuals. In assessing the potential development of say, a technical area, a large group (typically in the tens or hundreds) is asked to "vote" on when they think certain events will occur. The procedure is about as pure and perfect a Lockean procedure as one could ever hope to find because, first, the "raw data inputs" are the opinions or judgments of the experts; second, the validity of the resulting judgment of the entire group is typically measured in terms of the explicit "degree of consensus" among the experts. What distinguishes the Delphi from an ordinary polling procedure is the feedback of the information gathered from the group and the opportunity of the individuals to modify or refine their judgments based upon their reaction to the collective views of the group. Secondary characteristics are various degrees of anonymity imposed on the individual and collective responses to avoid undesirable psychological effects (Turoff, Linstone, 2002).

A typical Delphi study collects data using three rounds of questionnaires (Skulmoski et al., 2007), and care is needed to ensure meeting the aims of the research without causing participant fatigue and increased attrition rates (Walker & Selfe, 1996). In my research I proposed three rounds and the Delphi stages for this research are highlighted in Table I to illustrate the process.

4.1.1   Selection of the expert panel

The success of Delphi method depends primarily on the careful selection of the panel. A group of experts was selected to provide opinions on the suitability of a certain procurement path for a given criterion. Since the information solicited requires in-depth knowledge and sound experience about the various procurement options, a purposive approach was adopted to select this focused group of experts (Morgan, 1998). The nine members of the panel represent a wide distribution of professional people, with three from public transportation organizations, three from private consultant groups, and three who were academics in the universities of Tehran. The composition of this group of experts provides a balanced view for the Delphi survey.

4.1.2   Process of Delphi round in the research

The Delphi method adopted in this research consisted of three rounds. In the first and second rounds of Delphi questionnaire, it was intended to gather a set of exclusive selection criteria for public transportation system in the Tehran transportation section. The respondents were asked to provide a minimum of six criteria for the selection of the most appropriate transportation system in the first round Delphi. The criteria suggested by the experts were carefully analyzed and a list of criteria was formed. They were included in the list of the important factors in the selection of most appropriate transportation system. The second round of the questionnaire dealt with all the criteria provided in the first round, and experts were asked to state the importance of each criterion using a simple 3-levelscale: very important, important and not important. In the third round of questionnaire, a list of criteria with corresponding questions was presented, and the respondents were requested to assess the suitability of each transportation system against each selection criterion.

While analyzing the data, the focus should be on the opinion of the group rather than that of individuals. Therefore a concordance analysis, which measures the consistency of the experts' responses over successive rounds of the Delphi, was adopted. The consistency of the results over the last two rounds were analyzed and compared. The questions asked in the two rounds of the Delphi survey are detailed in Appendices A, B respectively.
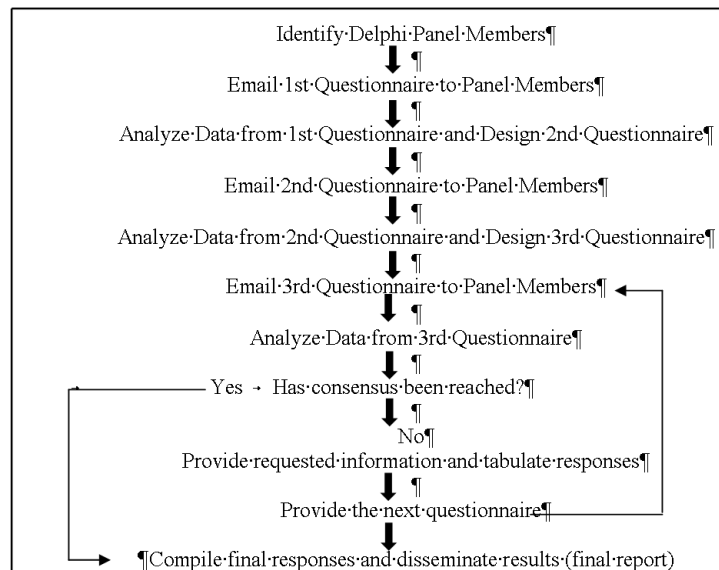

Fig. 1. Delphi Process

4.2 Existing problems of public transportation system in relation with life quality

We now briefly introduce in an informal way some of the problems occurring in public transportation. Three of them – locating stops, delay management, and tariff planning. (SchÖbel, 2006)

A quality criterion for the customers which is influenced by the number of stops is the door-to-door travel time of their journeys, including the time they need to get from home to their departure stations and the time they need to reach their final destinations. A priori it is not clear if this time will increase or decrease by opening new stops along the track system .A major reason for complaints about public transportation is the missing punctuality, which - unfortunately - is a fact in many transportation systems. Since it seems to be impossible to avoid delays completely, it is a necessary issue in the dispositive work of a public transportation company to deal with delayed vehicles. If a vehicle reaches a station with a delay, one consequence is that customers getting out there will reach their destination with this delay. This is annoying, but it is not worth a complaint if the delay is rather small. The situation becomes worse if customers who wish to change from the delayed vehicle into another bus or train miss their connection, and this can happen even in the case of small delays (SchÖbel, 2006).

5 METHOD OF INVESTIGATION AS APPLIED IN THIS PAPER AND PRACTICE OF CRITERIA IN ASSESSING QUALITY OF LIFE

The criteria of the quality of life which are attained by Delphi method include all the social, economic and environmental dimensions and these criteria are an introduction to assessing the quality of using public transportation system by the citizens of Tehran. In the next step, we make a questionnaire to achieve the amount of the citizens' satisfaction from the public transportation system in Tehran. The designed questionnaire involves questions about the proposed criteria of the life quality. The research limit in the subway system is Line 1 of this system which is 28.1 kilometers long and consists of 22 stations and the limit in BRT system assessing Tajrish route to Rah-AAhan square which is 17.5 kilometers long and consists of 27 stations and is one of the longest traffic routes of the city. The (shape) amount of the required samples for achieving the suitable subjects is determined proportional to the number of passengers in each station in order to obtain a logical and correct conclusion. The forms were distributed in all of the stations in 20 days and during all the official hours among 250 respondents – in several steps. The date and the turn of sampling were determined randomly. Respondents, or in other words, the public transportation system users are

divided into two groups. The negative aspect of this study was that the education level of the respondents was not included in the division.

5.1 Results of the investigation

To analyze the obtained information from the questionnaire, some procedures were employed. The results from the questionnaire indicate that those who own a car have more access to the subway in comparison with BRT. From the environmental point of view, both systems had positive functions. BRT, in comparison with the old and worn-out buses in Tehran which are one of the main pollution factors resulted in the decrease in the pollutants and the lowest amount of fuel consumption. Subway by decreasing the different types of gasses that make the air polluted (NOX, CO, SO2), decrease in the tire and brake shoe particles of the vehicles that are suspending in the air and the lowest damage to the green nature environmentally is a forerunning system in this regard. Safety is another important criterion. The more trustable the system is, the more that the users will benefit from it. Considering the attained statistics from the Tehran and Suburb Railway Company and the completed questionnaire, subway has got a shining record with regards to both the social safety of the passengers and the security. The criterion of saving time or in other words, the lowest waste of time in the two systems which were under investigation, after examining the results of the questionnaires and the proposed reasons is as follows: due to the high time delays in the stations and also not covering 2.4 kilometers of the route, BRT system causes traffic delay and the passengers' waste of time while subway by decreasing the time intervals in each stop in the stations from 12 to 7 seconds is the forerunner. Another important criterion employed in this study on which the specialists had a great emphasis was the economic cost of the intended system. The positive economic effects of subway include savings in the fuel cost and compensations which should be paid for the accidents, wearing-out and spare parts of the vehicles, also a reduction in the costs of the route repairs. The obtained results from the questionnaire showed 72% of the respondents believed that the cost of subway ticket is reasonable. In this study, considering the financial situation of the users is of high significance from the journey cost point of view. In comparison with the subway, the BRT system has driven the satisfaction of 92% and this is of high importance in Iran because of its own economic issues.

Respondents Characteristics/Criteria for Quality of Life (%)	Age Group			Sex Group		Car owner-ship		1.mobility for non-drivers	2.mobility for people with disabilities	3. High commute speed	4. suitable Consumer transport costs	5.Saving Time	6. Eco-friendliness	7. Safety	8.Comfort	9. High accessibility
	20-35	35-50	50+	Female	Male	Yes	No									
Bus Rapid Transit	106	91	53	116	134	68	182	%86	%6	%56	%92	%56	%54	%65	%10	%88
Metro	96	102	52	121	129	108	142	%92	%65	%75	%72	%79	%88	%86	%36	%68

Table1. Characteristics and satisfactory percent of respondents from BRT and Metro system.

6 CONCLUSION

The public transportation in Tehran has got a rather good situation and comparing with some countries has made significant changes towards stability. The subway and BRT system have place Tehran at the forefront of the sustainable transportation so that the use of the public transportation has had an increasing trend especially for low-income people who comprise almost the main group that use the public transportation in Tehran. Overall, based on the obtained criteria, subway in comparison with BRT system is more efficient, and plays a bigger role in transporting the citizens in Tehran.

At the end, we'll point to the two of the indirect reasons that reduce people's interest in using the public transportation system. Sex discrimination in Iran's transportation system (both in subway and BRT) and also the weak social dimension of Iranian citizens in participation and attendance in gatherings that root in the formed historical structure of Iran's society are the tangible reasons about which the majority of the authorities are ignorant towards. The social effects of this phenomenon in general and the case tendency of the citizens in chief use of private cars and the reluctant use of the public transportation and consequently the daily increase in the traffic prove this claim.

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8 APPENDICES

Questionnaire of second round and the results.

Criteria adopted for selection of transportation system

Delphi Round 2: Questionnaire

Name of Respondent: …………………………

Guidance on completion: The following are the criteria for the selection of transportation system, which you have provided, in the round one questionnaire. We now also attached herewith the analyzed set of criteria, which were selected by other experts. We would like you to reconsider the criteria which you have included last time.

Criteria	To what extent do you think the criterion influence the choice of transportation system?		
	Very important	Important	not important
1.mobility for non-drivers	7	2	0
2.mobility for people with disabilities	9	0	0
3.Commute speed	6	3	0
4.Consumer transport costs	8	1	0
5.Saving Time	6	2	1
6. Eco-friendliness	7	2	0
7. Safety	6	3	0
8.Comfort	5	3	1
9.Accessibility	7	2	0

Questionnaire of third round

Delphi Round 3: Questionnaire- Utility factors for different transportation system

Name do Respondent: …………………….. …. (Please enter a score from 10 to 110 for the utility

Selection Criteria (results from Round 2)	Utility Factors(suitability of each criterion against each transportation system)	
	Bus Rapid Transit	Metro
1.mobility for non-drivers: Quality of accessibility and transport services for non-drivers	76.5	85.2
2.mobility for people with disabilities: Quality of transport facilities and services for people with disabilities, such as wheelchair users	65.9	79.1
3.Commute speed: Average commute travel time	75.3	81.8
4.Consumer transport costs: Portion of household expenditures devoted to transport	55.8	42.1
5.Savin time: Per capita traffic Congestion delay	68	88.3
6. Eco-friendliness: reduces emissions and minimizes consumption of fuel and resources	62.1	91.9
7.Safety	88.7	102.4
8.Comfort: Public transit service quality	49.3	77.1
9. Quality of overall accessibility : ability to reach desired goods, services and activities	81.5	98.7