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Introducing of Mass Rapid Transit System (BRT) by using Aggregate and Disaggregate Models

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Abstract: ***In some cities increasing a number of low capacity vehicles (car, para-transit & share-taxi) creates congestion, pollution and traffic accident, especially in developing countries. Therefore, engineers and planners keep looking for solutions to solve this problem. Recently, most of them recommend and propose sustainable urban public transport system in order to mitigate the mentioned concerns. Kabul city is one of those urban areas that the inhabitants are suffering from lack of sustainable and friendly public transport system. Kabul is the overcrowded city with the 5 million population. Para-transits and share-taxis with a very poor level of services and low capacity vehicles (6-20 passengers) are the only options for traveling. The aim of this study is to examine the introduction of Bus Rapid Transit (BRT) in Kabul city. The research covers two parts. In the first part, four-step method has been applied to assess the BRT network based on passenger demand. The result indicates that the route which is originated from Kabul airport and it is ended to the CBD has high demand. Thus, the route number 23 advised for the proposed BRT system. In the second part, the target is to determine the possibility of the BRT for attracting passengers from para-transits, share-taxis and private cars. Stated Preference (SP) survey proposed three scenarios of BRT system for existing para-transit, share-taxi and private car users. Multinomial Models (MNL) results indicate that socioeconomic characteristics (age, sex, occupation) and travel functions (travel time and travel cost) are the fundamental and productive parameters in respect of shifting passengers from existing modes to the proposed BRT system.***

Index Terms: ***Aggregate Models, MNL, BRT, Para-Transit, Private-Car, Share-Taxi***

I. INTRODUCTION

Urban traffic challenge is a very hot topic among planners and traffic engineers. They are looking for solutions to protect residents from this significant problem. Thus, they propose various transit systems to decrease congestion, pollution and fuel consumption. However, due to the lack of enough fund in developing countries, all people could not access to the high-quality transit systems (rail and metro). Therefore, a similar alternative such as BRT system could be the best option for them. ITDP interprets BRT as a high-quality bus-based transit system that delivers fast comfortable and cost-effective urban mobility through the provision of segregated right-of-way infrastructure, frequent operations and excellence in marketing [1]. Currently, around 25 million BRT users with 30,000 buses are existed across the globe [2].

Furthermore, BRT system is operating in over 206 cities and 45 countries [3]. The experiences show that this system has plenty advantages, like positive impact on land-use and land value [4], reduction of travel time, delay time and waiting time [5] and reduction of emissions [6]. Hence, this paper recommends BRT system for Kabul city.

Kabul is located in the north-east part of Afghanistan with the 5 million population [8]. Kabul is one of those cities which the residents are suffering from lack of sustainable public transportation system and the people are faced many problems, like increasing of low capacity modes, loss of mobility, loss of access, peak hour problems, accidents, safety and pollution. Meanwhile, a number of trips, travel length, and a number of vehicles are increased. Unlike, the transport system and its management has been remained in a previous manner.

Bus mode had a long history in Kabul which was funded by central government, served in around 54 routs and made the average service length 8.8km with provision of cheap services for low- income residences during 40 years [8]. By increasing of population and low level of service, through bus system the Milli Bus enterprise was faced to the lack of possibilities to meet the need of people. Consequently, the demand for low capacity vehicles has been increased. Fig. 1 shows dramatically increasing of vehicles which was released by JICA [8].

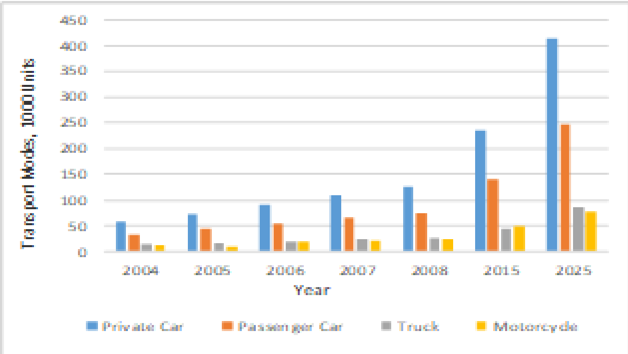

Fig. 1: Growth trend of transport modes in Kabul city

The objective of this study is to improve the public transport system by introducing of BRT system to reduce the role of low capacity mode. In the first part the BRT route introduces based on road density by using travel demand modelling (four-step).

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In second part the study assesses the possibility of a BRT system in order to attract passengers from para-transit, share-taxi and private car by applying SP survey and MNL. The research structured as follows: Chapter 2 dedicates to the literature review regarding the BRT system performances in the world. Chapter 3 explains about data collection and methodology. Moreover, this chapter deals with the procedure of travel demand modelling and MNL models. Chapter 4 presents discussion and results concerning the following study. Chapter 5 deals with the conclusion.

II. .LITERATURE REVIEW

Dozens of studies have been performed to investigate the introduction of the BRT system and its impacts. Deng et al. [9] were identified that after introduction of Beijing BRT Line one, 75.4 % of bus users, 4.2 % of taxi users, 1.2 % of car commuters, 1.7% of LRT riders, 7.2% of new commuters, 5.7 of walking users and 2.9% of bicycle riders have been attracted by the BRT system. Deng et al. [7] expresses that BRT concept is adopted as a key point for mitigation of traffic problems in Beijing. Furthermore, Lisa et al. [10] stated that, since the implementation of BRT in Orange Line, the traffic flow during the peak hours in southbound has been improved around 7 % and traffic crowd starts 11 minutes later. After the implementation of the BRT system in Latin America, the number of passengers who transported by BRT system, was comparable with LRT users [19]. BRT is a new concept in developing cities. Therefore, better to understand the people behaviours and their attitude [11]. Satiennam et al. [12] were assessed that how commuters attract to the BRT system from motorcycle and passenger cars. Eventually, the authors by using modal split model and SP survey figured out that travel time and travel cost have a significant influence on choice mode. Furthermore, they detected that BRT can attract users from a passenger car. While the number of motorcycle users who interested in the BRT system was higher than the car users. The Attractiveness of passengers for a new transit system can be the most significant factor for the success of a new transit system and needs to be considered carefully. Currie et al. [13] examined travelers attractiveness by using trip attributes between BRT, bus, light rail and heavy rail, finally the research specified that all the systems are favored relative bus system. The finding presented that BRT is very effective like a light rail and heavy rail, but BRT system has more advantage in term of cost. Furthermore, age, gender, travel time, travel cost, household size and income are a fundamental parameters in term of mode choice.

Little study has been handled on introducing of new transit system or overall public transportation system in case of Kabul city. Jalal et al. [14] after analysis of travel demand modelling were reported that Kabul city road network has enough capacity to manage the current vehicles but for reduction of congestion, implementation of the high capacity public transport modes is required. Similarly, Noori [15] was conducted a study regarding challenges of traffic in Kabul city finally the research has been recommended improvement of the bus network, increasing of bus terminals and introducing of the mass rapid transit system. In summation, can be expressed that BRT system is a sustainable public transport system to mitigate urban transport challenges. In addition, the number of users who is interested to shift from other modes to the BRT system depends on the local circumstances, travel features and level of service.

III. DATA AND METHODOLOGY

Data achieved from different sources. Particularly, the main information for estimation of aggregate travel demand obtained from Kabul master plan which the survey has been accomplished by the Japan International Cooperation Agency. Based on JICA information in 2009 the number of population was estimated at 4.01 million and 500,000 households existed within the city. The survey only was covered 5,000 households which represents 1% of the total population. For estimation of travel demand, the information from the year (2009) is considered as a base and then the demand forecasts for the horizon year (2018). Finally, the BRT route identified based on high passenger demand. The second step for understanding of the factors which are affected on modal shift starts after the definition of the corridor for the purposed BRT system. The SP survey has been carried out on the corridor which is specified through estimation of travel demand modelling. Dari language is common and official in Kabul. Therefore, the questionnaires were design based on local language. The survey processes expressed by the detail in section F.

A. *Travel Demand Modelling*

This section provides the travel demand modelling process. Selection of route for transit system has a profound impact on current and future development of the city. In this study travel demand is one of the significant determiner for selection BRT route. Travel demand modelling consists of several theoretical steps which attempts to interpret passengers' behaviour during the trip. The procedure is named four-step method and the process consists of steps such as generation/attraction model, distribution model, mode split model and assignment.

B. *Trip Generation*

Trip generation is the first step of travel demand modelling. The objective of trip generation model is to predict the total number of trips generated by zone i and attracted to zone j. In this research, the multiple linear regression model by using independent variables (population, employment, car ownership, density) extracts trip generation and attraction in 22 districts of Kabul city. The following equations are used to approach trip generation values.

$$y_1 = a + b_1(x_1)j + b_2(x_2)j + b_3(x_3)j \quad (1)$$

$$y_2 = a + b_1(x_1)j + b_2(x_2)j + b_3(x_3)j \quad (2)$$

In Equation (1) y_1 illustrates the values of trip production, x1 indicants population, x2 shows employment and x3 points out the car ownership. In Equation (2) y_2 shows the rate of trip attraction, x1 specifies number of population, x2 shows employment and finally x3 indicates the density. Meanwhile, (b) is a regression coefficient, (a) is an intercept constant, (i) and (j) show production and attraction zones.

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The following Table 2 and 3 reveals Corr. Coefficient, Standard error and T-V rates which indicate the positive relationship between dependent variables and independent variables. Generation and attraction values within the city are displayed in Table 1.

Table. 1: Forecasted trip generation from 2009 to 2018.

Dis No	Generation 2009	Attraction 2009	Generation 2018	Attraction 2018
1	105,362	132,978	123,766	139535
2	164,762	191,969	88,940	104402
3	153,242	152,555	87,535	98286
4	236,698	173,672	237,888	229992
5	255,951	199,636	208,673	198949
6	115,117	135,860	147,735	153533
7	143,106	136,973	212,917	212894
8	138,496	153,837	257,987	257337
9	143,414	140,883	233,864	222894
10	256,907	262,360	345,551	277270
11	166,372	220,141	145,321	141310
12	95,613	97,789	135,836	137642
13	72,080	78,342	116,325	118536
14	72,080	78,342	88,980	88809
15	236,274	189,751	300,943	315609
16	57,708	86,940	114,832	117141
17	50,931	39,880	210,164	217414
18	2,963	7,731	316,854	328698
19	12,436	10,110	301,286	308310
20	26,119	17,487	48,819	50564
21	26,119	17,487	45,093	46064
22	11,222	15,879	49,151	53333
T	2,542,972	2,540,602	3,818,46	3,818,522

Table. 2: Parameters for trip generation.

Variable	Coefficient	Standard Err	T Value
Population	0.33427278	0.1486735	2.2483676
Employment	0.48423789	0.12806593	3.7811608
Car ownership	4.5070613	3.0041898	1.5002585
Constant	398.62850		
Corr. Coefficient	0.94795224		

Table. 3: Parameters for trip attraction.

Variable	Coefficient	Standard Err	T Value
Population	0.50581224	0.07759357	6.5187391
Density	7.4752706	11.221805	0.6661380
Employment	0.38704686	0.15616838	2.4783946
Constant	537.54808		
Corr. Coefficient	0.94269828		

C. *Trip Distribution*

Trip distribution is the second step of travel demand modelling which is used to understand how many trips distribute from one particular traffic zone to another zone. Gravity model is used to estimate trip distribution. The gravity model is very common among planners and traffic engineers since it proposed in 1950 and significantly improved in 1960 [16]. The following equation represents the gravity model. In Equation (3) G_i and A_j are trip production and trip attraction. The desired line or trip distribution for all modes displayed in Fig. 2. Moreover, the correlation coefficient rate (0.79633) in Table 4, indicates the validity of trip distribution model measurement.

$$T_{ij} = K(G_i^{\alpha} * A_j^{\beta}) / D_{ij}^{\gamma} \quad (3)$$

Where

T_{ij} - Trip distribution between zone i and j
G_i - Trip generation in zone i
A_j - Trip attraction in zone j
D_{ij} - Impedance (trip length km from zone i to j)
α, β, γ - Coefficients
K- Constant

Table. 4: Trip distribution parameters

Variable	Coefficient	Standard Err	T Value
α	0.79751	0.06356	12.8455
β	0.82996	0.06827	13.2346
γ	-0.9746	.08133	-8.7462
k	0.0037		
Corr. Coefficient	0.79633		

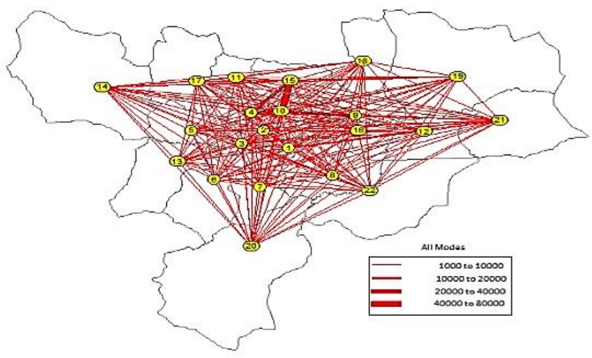

Fig. 2: Desired line for all mode in Kabul city

D. *Mode Split Model*

The modal split can be estimated based on aggregate models by using zonal information and can be estimated through disaggregate models by utilization of household characteristic. Modal split model assesses the number of trips on various modes between distinct traffic zones. Growth Curve Function equation (4) is used to specify the number of users in existing modes. The average speed for existing modes obtained through conversion method by having average travel time for each mode and minimum route distance. The speed of car is considered 45 km/h and the speed of Para-Transit and share-taxi modes is considered 18 km/h. In following equation (4) P_{ij} shows modal split and t_{ij} indicates average travel time from the centre of the zone to zone.

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$$P_{ij} = 1/e^{(atij+b)} \quad (4)$$

Where

P_{ij} – Modal share

t_{ij} – Average Travel Time between district i to j

a b – Parameters

Table. 5: Mode split model results in 22 districts of Kabul city

Dis No	Para-Transit	Private Mode	Share-Taxi
1	89846	17977	15934
2	63282	12881	11371
3	64216	13139	11585
4	173214	34222	30452
5	151418	30353	26902
6	107886	21181	18868
7	155200	30558	27213
8	187865	37105	33017
9	170162	33724	29978
10	252275	49286	43990
11	104611	21670	19040
12	97773	19849	17532
13	83647	17407	15271
14	62585	14206	12189
15	219969	42759	38215
16	83152	61816	14864
17	153200	30124	26840
18	228503	46984	41317
19	213679	46963	40644
20	34078	7957	6784
21	31884	7092	6117
22	35381	7330	6440
Total	**2763627**	**559583**	**494626**
Percentage	**72 %**	**15 %**	**13 %**

E. *Trip Assignment*

Selection of corridor for public modes is a key factor for urban transportation. The proper selection of corridor can keep down trip distance and trip time for the population. In this study, travel demand has key role concerning the selection of corridor for purposed BRT system in Kabul city. Furthermore, an effort has been made to consider the significance of major destinations such as workplace, universities, schools and shopping area. Route assignment is the final step of travel demand modelling that identifies commuters driving path when they run between particular traffic zones. The All-or-nothing method has been used to estimate the route assignment. The All-or-nothing method assumes that commuters chose the shortest running path, there are no crowd impacts, and drivers consider the identical attributes for route selection. For the route assignment estimation, all modes (except walk) are considered. As expected, the route assignment result (Fig. 3) demonstrates that demand for all modes is quite high in routes 23. Therefore, based on assignment result, the 13 km corridor which originates from Kabul airport and ends in CBD (route 23) purposed for BRT route.

There are no tough regulations regarding the necessary road width for the BRT system. Because BRT Planning Guide (2007) determined the good and minimum right of way for a BRT system [1]. According to the feasibility study the width of existing right of way which is considered for the BRT system presents in Fig. 4.

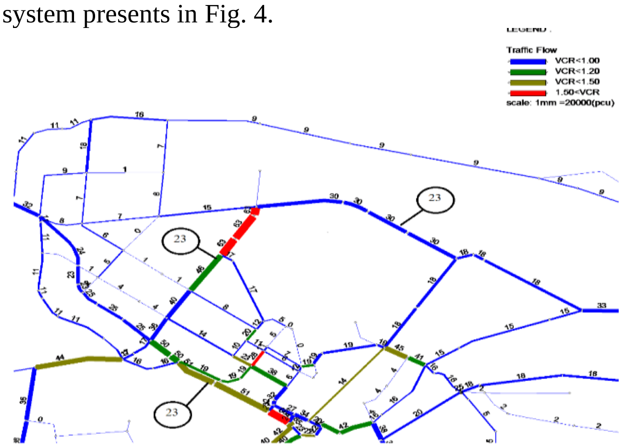

Fig. 3: Trip assignment by all modes in 22 districts of Kabul

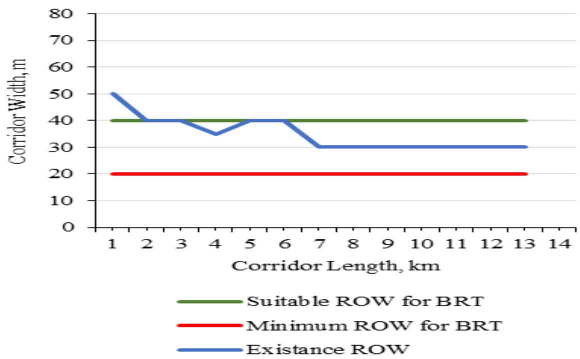

Fig. 4: The width of the existing ROW for proposed BRT.

F. *Stated Preference*

SP survey is used to estimate the responses of the people in hypothetical and actual situations. SP method involves the group of techniques which uses each person statements regarding their preferences in a set of transport opportunities [17]. The survey was led by the author in January 2019. In total, 600 respondents (for each mode 200 samples) were engaged to respond the questions. The locations of the survey were considered in 9 high trip generating points along the proposed BRT route which was determined based on high travel demand (Fig. 5). In SP method, the questionnaires were designed to examine the factors which affect the choice of commuters. Considering BRT standard, personal characteristics and travel features three different BRT scenarios were included in each questionnaire which are displayed in Table 6. The questionnaires incorporated socioeconomic characteristics and trip features (travel time and travel cost). Based on pilot survey the personal characteristics (gender, age and occupation) and trip features (travel time and travel cost) are considered as a significant variables. The respondents are selected based on random sampling method. The inspection started by using individuals' statement regarding their preference in a set of BRT scenarios and existing modes.

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Table. 6: Three scenarios of the BRT system that proposed to each respondent

Scenario 3 (Gold)	Scenario 2 (Silver)	Scenario 1 (Bronze)
The segregated right of way, two-way, median-aligned in all of busway route length.	Segregated ROW, physical segregation used to over 75 % of the busway route length.	Colourized pavement with no other constraints used to all over the route length.
80 % of stops on the route have turnstile-controlled off-board fare gathering.	The off-board fare gathering should be used in 60 % of the corridor length.	The off-board fare gathering should be used in 20 % of the corridor length.
Some turns banned across the corridor and certain signal priority.	No turns banned but the Signal priority is used at all intersections.	Signal priority is used at some of the intersections.
100% of buses are covered by the platform	60% of buses are covered by the platform	None of the buses is covered by the platform
The bus systems are include of the full-service control centre	bus systems are covered by a few services control centre	The bus system with the lack of services control centre
The BRT run during the holidays and late night	The BRT only run during the late night	The BRT system run during holiday also
The gap between stations is considered around 0.3km to 0.8km.	The gap between station is considered around 0.8km	Space between stations are placed more than 0.8km
The BRT stations should be wide, good-looking and weather-saved	The BRT system stations should be wide.	The weather-protected should be considered at all stations
Bicycle parking and passenger information should be considered at all stations.	The BRT stations should be covered at least by poor passenger information and bicycle parking at some stations	The BRT stations with a lack of information and parking.
Travel Time (TT) = 1 * times existing for Para-Transit and share-Taxi users	Travel Time (TT) = 1 * times existing for Para-Transit and share-Taxi users	Travel Time(TT)= 0.6 * times existing for Para-Transit and share-Taxi users
Travel Cost (TC) = 1 * costs existing for Para-Transit and share-Taxi users	Travel Cost (TC) = 0.6 * costs existing for Para-Transit and share-Taxi users	Travel Cost (TC) = 1 * costs existing for Para-Transit and share-Taxi users
Travel Time (TT) = 1.2 * times existing for private car users	Travel Time (TT) = 1.2 * times existing for private car users	Travel Time (TT) = 0.8 * times existing for private car users
Travel Cost (TC) = 0.8 * times existing for private car users	Travel Cost (TC) = 0.4 * times existing for private car users	Travel Cost (TC) = 0.8 * times existing for private car users

Before applying the MNL models to understand the parameters that influence on commuter's behaviour in term of choice mode, primary data analysis has been conducted. Fig. 6 indicates that currently 46% of non-employees are using private-car, 15 % of them are taking advantage of para-transit and 39 % of non-employees are practicing share-taxi. While, only 21 % of employees are dedicated to the private-car, 52 % of them are using para-transit and 27 % of employees are engaged with the share-taxi. Fig. 7 shows employee and non-employee reaction concerning their mode choice after introducing of BRT systems (scenarios 1, 2 and 3). The survey revealed that a few numbers of non-employees are interested to the proposed BRT system (6 % to Scenario 1 and 8 % to scenario 2). However, according to the survey result after the introducing of the BRT system, a considerable numbers of employees interest to shift from existing mode to the BRT system, for example as Fig. 7 indicates 39 % of employees switch to the new transit system (scenario 1). In addition, 14 % of them are attracted by scenario 2.

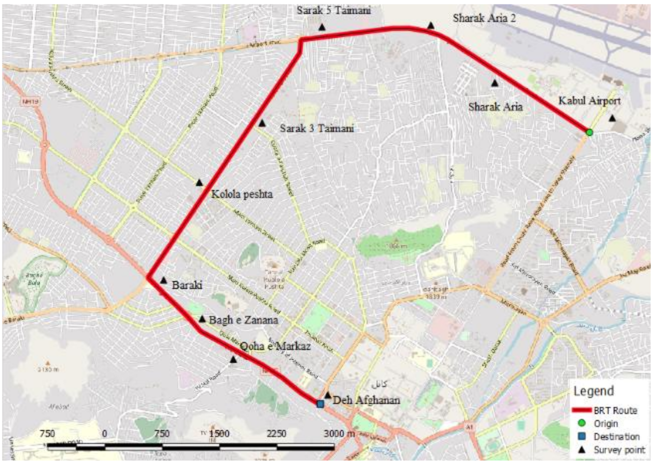

Fig. 5: A proposed BRT route based on high travel demand

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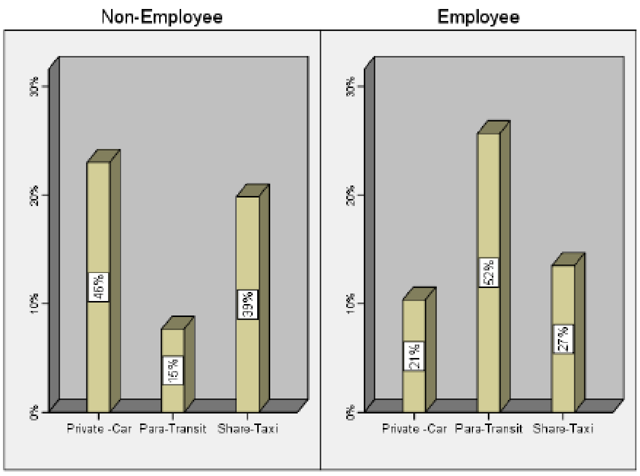

Fig. 6: Existing share mode considering occupation

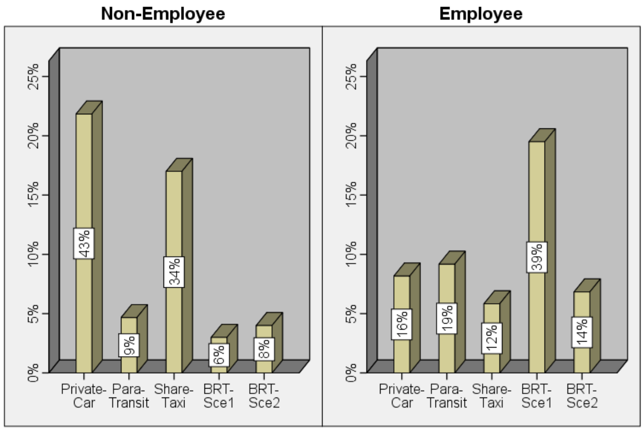

Fig. 7: Share mode after the introducing of BRT considering the occupation

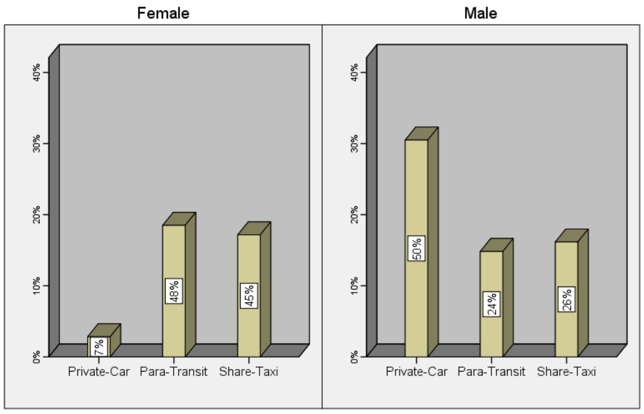

Fig. 8: Existing share mode considering gender

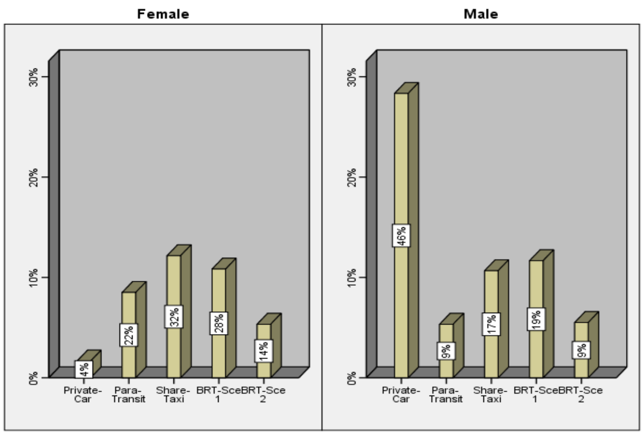

Fig. 9: Share mode after the introducing of BRT considering gender

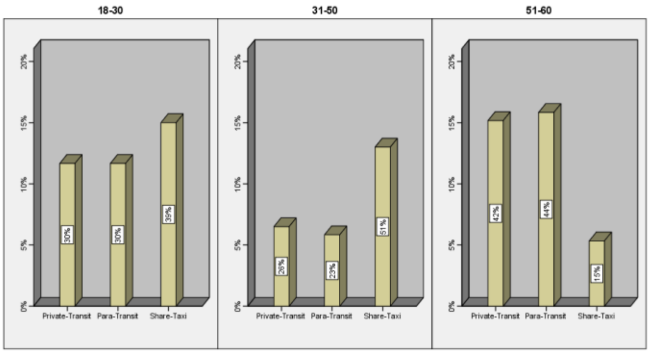

Fig. 10: Existing share mode considering age level

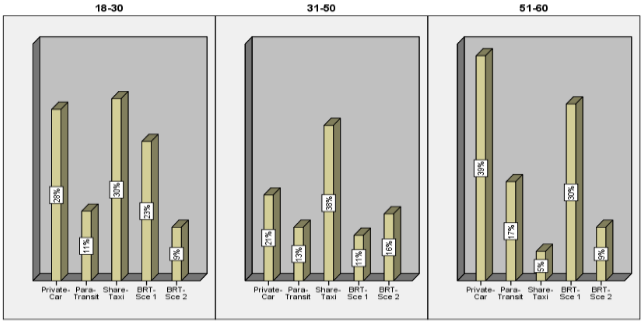

Fig. 11: Share mode after the introducing of BRT considering age level

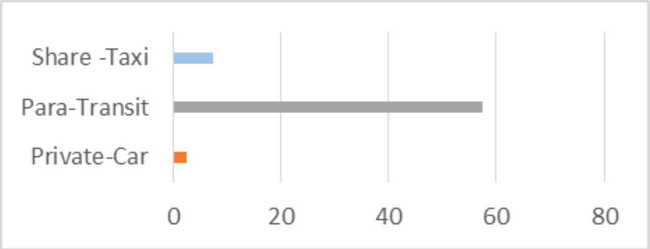

Fig. 12 Percentage of existing modes' users who are interested to shift BRT system (Scenario1)

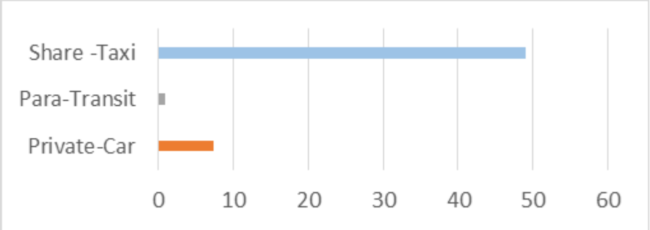

Fig. 13 Percentage of existing modes' users who are interested to shift BRT system (Scenario2)

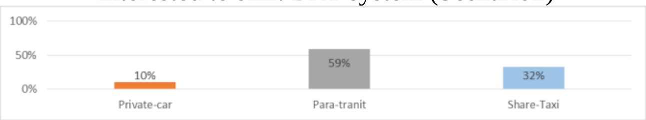

Fig. 14 Percentage of existing modes' users who are interested to shift the BRT system by considering both seniors' factors.

Collected data disclosed that males who are using private car, are more than the females. While 48 % of total women use para-transit, 45% of them travel with the share-taxi and only 7 % of women use private-car. As well as Fig. 9 indicates the total number of males and females who are attracted by the BRT system (scenario 1 and 2).

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The examinations display that 28% of total women interest to shift from existing modes to the scenario 1. Similarly, 14 % of them are attracted by scenario 2. In case of male users, 19 % of existing modes users are switched up to the scenario 1 and 9 % users are attracted by scenario 2. Fig 10 and 11 express the mode share among the commuters in respect of their age level in existing circumstance and after the introducing of the BRT system. Generally, the primary data analysis specifies that 58 % of para-transit, 7 % of share-tax and 2 % of private-car users are attracted by the scenario 1 (Fig. 12). Furthermore, the outcome (Fig. 13) discloses that 49 % of share-taxi users, 1 % of para-transit users and 8 % of private-car users are interested to shift scenario 2. However, by considering all parameters which are impacted on model shift in scenarios 1 and 2 can be revealed that 59 % of para-transit, 32% of share-taxi and 10% of private-car users are interested to shift in BRT system.

G. *Discrete Choice analysis*

Discrete choice models are used to predict the commuter's choice based on utility function. The MNL model is used to assess the factors which are affected on mode choice. MNL is expressed in many literatures. In this study the MNL models was estimated by using SPSS software. The results of model show in Table 7. The concept of MNL meddles determines by equation 5. Furthermore, Table. 8 shows the summary of statistics and finally Tables. 9 and 10 point out dummy variables and independent variables respectively.

Table 7. The result of MNL models

Mode		B	Std. Error	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
						Lower Bound	Upper Bound
Private- Car	Intercept	-29.834	6.755	0.000			
	TC	2.806	0.613	0.000	16.543	4.979	54.963
	TT	-2.789	0.599	0.000	0.061	0.019	0.199
	A	2.997	1.387	0.031	20.017	1.321	303.283
	Occ	-2.546	1.293	0.049	0.078	0.006	0.988
	G	-4.981	1.102	0.000	0.007	0.001	0.060
Para-Transit	Intercept	5.057	2.454	0.039			
	TC	-0.778	0.130	0.000	0.459	0.356	0.593
	TT	0.718	0.137	0.000	2.051	1.567	2.684
	A	-4.018	1.242	0.001	0.018	0.002	0.205
	Occ	-1.492	0.710	0.036	0.225	0.056	0.905
	G	1.887	0.866	0.029	6.597	1.208	36.021
BRT-Scenario 1	Intercept	5.402	2.557	0.035			
	TC	-1.198	0.145	0.000	0.302	0.227	0.401
	TT	1.047	0.147	0.000	2.848	2.133	3.802
	A	-4.540	1.316	0.001	0.011	0.001	0.141
	Occ	-2.072	0.842	0.014	0.126	0.024	0.655
	G	1.925	0.937	0.040	6.853	1.093	42.980
BRT-Scenario 2	Intercept	-27.824	6.690	0.000			
	TC	2.458	0.609	0.000	11.682	3.544	38.508
	TT	-2.340	0.593	0.000	0.096	0.030	0.308
	A	2.603	1.318	0.048	13.506	1.020	178.907
	Occ	-3.953	1.256	0.002	0.019	0.002	0.225
	G	2.336	1.015	0.021	0.097	0.013	0.706

Table. 8: Summary of Statistics

Number of Observation	600
-2	1858
(-2)	446
Cox and Senll's R^2	0.905
Nagelkerke Value	0.948
McFadden's Value	0.76

Table. 9: Dummy Variables for MNL models

Variables	Interpretation
Gender	Dummy variable for Male (1) and woman (0)
Age	Dummy variable for age (51-60 (2), 31-50 (1), 18-30 (0)
Occupation	Dummy variable for employee (1) and non-employee (0)

Table. 10: Independent Variables

TC	Travel Cost
TT	Travel Time
OCC	Occupation
A	Age
G	Gender

$$p_n(i) = e^{vin} / \sum_{J=1}^{K} e^{vjn} \quad (5)$$

$$0 < p_n(i) =< 1 \quad (6)$$

$$V_{in} = a_{0j} + a_{1j}x_{1n} + a_2x_{2n} + a_{3j}x_{3n} .... + a_{nj}x_{sn} \quad (7)$$

Where

$P_n(i)$ = Probability of decision maker n choosing mode i,

V_{jn} = mode's utility,

k = Number of modes,

a_{0j} = constant for mode j,

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a_{1j}, a_{2j}, a_{3j} …..a_{nj} = Coefficient of the explanatory variables
x_{1n}, x_{2n}, x_{3n}… x_{sn} =Explanatory variables for decision maker n
s = Number of explanatory variables

IV. RESULTS AND DISCUSSION

In this research, two types of models applied to develop public transport system through the introduction of the BRT system. Aggregate travel demand models were used to determine the BRT route based on high travel demand. Finally, by using four-step method the route which origins from Kabul airport and ends to CBD was targeted for BRT system (Fig. 3 and 5). As well as, the proposed corridor is situated in the greater trip generation and attraction points (universities, schools, shopping malls, hospitals, recreation territories). Simultaneously, the feasibility study exhibits that the existing width of the corridor is applicable for BRT system based on standard (Fig. 4). Consequently, the corridor with 13 km length based on high travel demand was selected as a BRT route. In second part of the study, the SP survey proposed three scenarios of BRT system for the specific corridor users which was selected for BRT route. The outcome from SP survey reveals that people are not interested to shift from existing modes to the scenario 3. The most likely reason could be users' high preference for travel time and travel cost than another characteristic. Furthermore, lack of attraction on BRT system (scenario 3) conveys the message that travel characteristics (travel time and travel cost) are more substantial factors, in term of mode choice. Because the BRT system (scenarios 1 and 2) was designed based on travel characteristics (travel time and travel cost) and BRT standards modifications. While scenario 3 was designed only based on BRT standards modifications and very less consideration has been taken on travel characteristics.

The summary of MNL presents in Table 7. The result indicates that most of the explanatory variables which are introduced to build up the model are significantly effective in respect of choice mode. Table 7 shows that travel cost coefficient for scenario 1 bears negative sign. It means, by decreasing of travel cost more para-transit users are attracted by BRT scenario 1, but the result shows that travel cost was less consequential variable for car and share-taxi users in term of shifting to the scenario 1. In addition, as expected for scenario 2, the travel time coefficient holds negative sign.

This shows, by reduction of travel time, the probability of choosing the scenario 2 can be increased.It was understood that the scenario 1 users preferred travel cost reduction and scenario 2 users preferred decreasing of travel time. Similarly, the outcomes show that the age coefficient for scenario 1 gets negative sign. Therefore, older people (50-60) are more interested to shift scenario 1 than the middle-aged users (31-50). Unlike, the positive sign of age parameter in scenario 2, shows that middle-aged and young people are more attracted to the scenario 2. As a result, can be claimed that travel cost and travel time have a significant impact on age level in term of mode shift. The gender coefficient with the positive signs denotes that female users are greater attracted to the scenarios 1 and 2 than the male users. Therefore, both travel time and travel cost can be a notable parameter for women users. Similarly, the probability of choosing scenario 1 and scenario 2 can be decreased in case of employee reduction. Because the coefficient for the occupation variable had a negative sign. Therefore, employee users are further interested in BRT systems than non-employee. The SP survey presented that the majority of commuters who are interested to shift scenario 2, currently are using share-taxi and private-car. Unlike, the greater proportion of para-transit users are attracted by the scenario 1. Hence, travel cost can be a substantial factor for para-transit users in term of model shift. While travel time is a significant factor for share-taxi and private-car users. In summation, can be expressed that travel time, travel cost, age, gender and occupation are a significant variables in term of modal shift, and by considering all these factors entirely or a combination both of scenarios' factors can be presented a unique BRT system to attract notable existing modes users.

V. CONCLUSIONS

This research paper has determined the BRT route based on high travel demand. It was disclosed the route 23 is applicable for introduction of BRT system in term of demand. As well as the SP survey and MNL models measurements were fount that BRT system could attract users form para-transit, share-taxi and private-car. The study was revealed that para-transit users who are interested to shift to the BRT systems are higher that share-taxi and private-car users. Furthermore, the examination discovers that travel features (travel time and travel cost) and personal characteristics (age, gender, occupation) are fundamental parameters regarding the shifting of people to the BRT system. However, this study was measured the impact of travel features and personal characteristics on modal share. While the location of households, business areas and level of service also can be a significant. Therefore, this research suggests more study in term of modal shift.

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