BEAD

BRTS Evaluation and Design Tool *Version 1.70*

developed for

Institute of Urban Transport (India)

USER MANUAL

SGArchitects
www.sgarchitects.in

FAZIO
ENGINEERWARE

Under technical advice from

Transportation Research and Injury Prevention Program, IIT Delhi

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Explanation of Terms Used in this Report

BPHPD	Buses per hour per direction
BRTS	Bus Rapid Transit System
Common buses or common lane	Refers to buses in common lane or the lane hosting both straight moving and turning buses
FOB	(Pedestrian) Foot over bridge
No Interchange	Refers to direct route moving both within the BRTS corridor and outside in mixed conditions.
O-D	Origin to Destination; or Origin and/or Destination
PPHPD	Passengers per hour per direction
Straight Bus	Buses moving straight along the corridor at signalized intersection
Tool	Referred to the BEAD tool
Transfer or Interchange	Interchanging routes mainly between feeder and trunk route in a closed system
Turning Bus	Buses turning off the corridor at signalized intersection
Xing	Crossing or Intersection, generally signalized
Segment	Refers to a component or part length of the corridor which has a uniform design of infrastructure and operations across its length. A segment may differ from another segment as one or more of the performance determining design features are differing.
Corridor	Is the entire length of the proposed BRTS infrastructure along a road or a series of roads, and can contain more than 1 segment of differing designs.
MV Lanes	Lanes designated for use by general motor vehicle traffic other than buses.
Bus Lanes	Lanes designated for use by buses only.

1 Background

Bus Rapid Transit System or BRTS is a bus based transit system which allows higher speed, capacity and safety of buses by segregating them from other traffic on a roadway into a separated bus way. As more and more cities throughout the world opted for BRTS, further work into BRTS design and performance has made BRTS evolve into an advanced and optimized "bus" system with increasingly flexible and adaptable, operational and service characteristics. More than 150 cities in the world now operate BRTS corridors. No two systems are identical; their characteristics vary. Their uniqueness is because the system is flexible enough to allow variation and adaptation. A BRTS is custom built to the needs of the city. ***However, BRTS uniqueness leads to debates on which features are better and in which manner is it better.***

The development of BRTS in India has been taken up on a large scale by more than 11 Indian cities and a total of more than 1250 km of BRTS is slated to be developed in the country mostly supported by the Ministry of Urban Development, Government of India (MoUD) under the JnNURM mission.

More than 100 parameters are involved in the design of BRT. About 1/3rd are related to site conditions and hence fixed. The balance 2/3rd parameters are variable and depend on design. There is a perennial controversy on several design features such as;

a) Dedicated lanes in the middle of the road or on the sides

b) Location of stations on the right hand or left hand side

c) Distance of station platform from the road intersection

d) Height of the station platform and the bus floor

e) Signal cycle phasing

Discussion on the merit and demerit of each alternative design feature is at present subjective and a rational decision is not possible.

Thus there exists an urgent need for an evaluation tool, which can provide quantified evaluation of alternative design features to the planners and engineers (or the consultants) and the Municipal and/or development authorities of the city; for a rational decision making.

This has led to the development of the Bus Rapid Transit System (BRTS) Evaluation and Design (BEAD) Tool. This is a *.xls based interactive tool which allows engineers, planners, designers and decision makers to make a comparative evaluation against any proposed changes in the features (and their configuration) in a (BRT) system.

The highlight of the tool is that it provides the effect of design interventions on overall passenger journey speed/time, rather than focussing on vehicle speeds within the corridor. In addition, it provides the impact on throughput capacity of the system and number of buses needed due to change in multiple design parameters. In a typical case the impact on the performance of the system due to the use of alternative design features can be evaluated through comparative assessment. In addition the tool can be used to generate data for research and academic use.

2 Approach

The development of BEAD arises from the need for a tool which can provide planners/designers with a comparative evaluation of BRTS features before its implementation and operations. To allow this the exact details of the system need to be defined in a manner which can form the basis for application of standard public transport theories and formulas. The tool may then use the fed processes to calculate and present the expected performance of the system in a measurable format.

To do so the tool has been designed with three integrated parts which also form the stages of the estimation of final output. These are:

1. Input Fields
2. Calculation
3. Result Output

The project team undertook detailed discussions with its technical advisor, i.e. TRIPP, IIT Delhi on the finalization of the parts of the tool mentioned above. These were based on the experience of the team members in developing and assessing a number of BRTS projects as well as their understanding of best practices from a variety of case studies and other literature.

The second important step was to finalize the performance indicators which would be presented and compared in the output results. It is understood that the key performance indicators mainly focus on a global indicator (defined by agencies such as UNEP) which focuses on the reduction of green house gases (GHGs) and local (such as those set by project operators) who focuses on the increase in the passenger usage. These two are interconnected if the increase in passengers can be shown as a result of migration from private motorized modes or even if the current rate of migration to the private modes is shown to minimize.

This requires that the utility of the proposed BRT system be higher than what is derived from the use of private motorized modes. Transportation models such as proposed by Oort (1969) use the concept of maximizing utility by increasing work time, time for leisure, reducing expenditure (or increasing income) and reducing the unpleasantness of travel (or reducing the time spent in travel when not undertaken for leisure) (Sergio R. Jara-Diaz 303-19). Hence for most work trips served by public transport, utility can be maximized by minimizing the cost of travel, journey time and inconvenience or unpleasantness involved. In other words performance indicator of a good public transport mode can be defined as those which relate to reduced journey time, reduced cost, and increased comfort; thereby maximising the chances of a migration to public transport leading to increased passenger demand (to match the local performance indicator) and increased efficiency leading to reduced GHGs (to match the global indicator).

The common factors affecting all these parameters are delays experienced by transit vehicles and passengers as well capacity of the system. These can be broadly categorized as:

- Faster door to door connectivity,
- Higher capacity for better convenience and comfort

- and resultant reduced out of pocket travel cost

Thus when systems or their features, reduced delays (directly leading to reduced journey time) and better capacity (subject to projected demand) can be used as effective indicators for evaluation.

The performance indicators have been broadly based on the delays involved in different parts of the journey and the expected capacity of the system. These have been broken down in to further details for easy and direct comparison by the users. Using these indicators along with the finalized fields and equipped with standard transit capacity, headway and frequency equations the first Beta version of the tool was developed and the results validated using three well documented BRTS corridors, i.e. Delhi, Ahmadabad and Bogota.

Following this feedback of other experts and consultants in the field was collected as a part of the first BEAD workshop organized by IUT, at TRIPP, IIT Delhi on July 25, 2011. This was used to update the list of input fields and also to upgrade the calculations and processes in the tool, leading to the second Beta version of the tool. This improved version was upgraded using the VBA script in the MS Excel software and allowed additional features of specifying multiple different segment designs on a single corridor to arrive at an overall and segmental corridor performance. The improved version was presented in a two day seminar organized by IUT in Goa on October 21-22, 2011. This workshop was attended by expected users of the tool including Municipal and Development bodies undertaking the development of BRTS in six different cities, consultants, operators, project regulating agencies (UTTIPEC) and NGOs (ITDP). The feedback collected from this workshop has been used to improve the presentation and usability of the results. For example as a part of the feedback received from the participants, the development team undertook a consultation with TRIPP, to finalize the Service Level benchmarking of an input design or a segment design based on the performance criterion.

The current version of the user manual consists of user friendly interface, prepared using VBA script in xls format. This version takes users through a series of sequential forms which allows them to define segment wise corridor details which is then used by the tool to generate a final output data in the form of an xls spreadsheet. This output file/sheet can be prepared and compared by different stakeholders for various design alternatives and configurations.

The first three forms of the tool allow the user to define common corridor features such as length, operation type (open or closed), default parameters (such as average speed of vehicles on the corridor, posted speed limit of buses, etc.), and the description of no. of different design segments that make up the corridor. Following this four sequential forms which allow the user to define the detailed design segment specific features are presented. The user is required to fill in a total of 28 to 48 input fields depending on the design being defined. Results follow after these forms, and the user can select to edit certain system design features (such as signal design, cross section design, bus demand, etc.) and view and save the revised outcome. After each set of results the user is prompted back to the four segment specific forms for each design segment defined by the user in the corridor specific information. For following segments user only needs to change inputs specific to differing design features as the tool reflects values of previous segment in subsequent segment forms. The results for each segment are sequentially presented, and the same can be edited and/or printed. After the final segment details are fed by the user, the system prompts the user to define the location of an output file, which is saved in an xls format (compatible with Windows office 97 and above packages).

The following chapter of the manual presents the guidelines for the use of the output file by city level officials and other stakeholders, which is followed by detailed instructions for filling each form by the designer/consultant.

3 Guidelines for use of BEAD by City Level Officials

It is expected that most of the work for the development of BRTS in the city, including detailed analytical work using BEAD, as well design detailing, will be undertaken by a competent consultant/s. Detailed instructions for use of BEAD by the consultant have been provided in the following chapters. This chapter provides guidelines for the use of BEAD output sheet generated by the consultant and submitted to the city level officials for review or approval. City Officials can use the information provided in this chapter to interpret design weaknesses and possible improvement strategies from the BEAD output file/sheet provided by the consultant. The **output file/sheet** generated by BEAD has a compilation of different corridor segment performance values/indicators (Figure 3-1).

Results for different corridor segments are provided in rows while the values against each indicator are provided in columns for each of these rows. About 19 indicator values for each segment is compiled together in this sheet. Overall corridor results including weighted averages are listed in the last row for each of the 19 indicators (Table 3-2). These values provide information on the overall corridor performance against specific indicators such as operational speed, passenger speed, capacity etc. 'Segment Performance Measure' of the design in each segment is given towards the right most end of each row, for the segments defined. These provide a snapshot of the performance of designs proposed on a scale of 1 to 100, for each one of the different segments constituting the entire corridor.
Overall (Corridor) Performance Measure is presented in an Orange box in the right most end of the last row (including the aggregate corridor results). This is a single overall indicator of design performance of the entire corridor.

The guidelines are provided in a step by step format below (Table 3-2).

- **Step 1** – Look for the number in the right orange box located towards the bottom right corner of the output sheet. The letter indicates overall (Corridor) performance measure on a scale of 1 to 100. More than 70 is considered the ideal performance, while 60 to 70 is good, 50 to 60 is average while less than 50 is poor.

- **Step 2** – Look for possible improvements. To do so follow the following steps:

1. Look for arrows in the last row. These are between a numerical value and some descriptive text corresponding to each indicator. These arrows present the scope of improvement. Up arrow indicates the numerical value should be increased while down arrow indicates that it should be reduced. For example a down arrow at the average walking distance column indicates that the walking distance needs to be reduced. A higher no. of arrows indicates a greater scope for improvement.

2. Look for no. in bold in the blue highlighted row on the top of the sheet, or the blue highlighted boxes at the bottom. These numbers for each column, where an arrow is indicated (in the output sheet) provide a reference to the serial no. in the 'Proposed Interventions for Improvement of Results/Performance' (Table 3-2).

For each of the arrow indications (against different indicators) a series of actions or design changes are suggested in Table 3-2 (row no. relates to serial no. shown in blue highlighted row and boxes in the output sheet) which would lead to improvement in the overall performance of the corridor.

- **Step 3** – Look for rows presenting results for each of the different design segments constituting the overall corridor. Design weaknesses and possible improvements for each of the segments can be understood by repeating steps 1 and 2 above for each of the rows, relating to each segment; or simply for the critical rows with LOS value of C, D, E or F. The arrows against performance indicators for each segment have been shown towards the left of its respective performance indicator for each segment row.

3.1 Interpretation of Results by ULB's/ City Officials:

'The Overall Performance' value on the results sheet indicates the level of performance or service it will provide to society, user and the operator. Here more than 80 is considered ideal while less than 50 is poor. Relative scores for different alternatives allow comparison of impact of changes in features and elements on the overall system performance, and enable an informed selection of an alternative.

This overall performance indicator is derived from specific BRTS design features (of the analyzed corridor) and their respective performance to cater to societal, user and operator requirements. These indicators have been presented below with darkest green as the most desirable values to be met and the darkest brown are the most undesirable.

Corridor segment description

Segment length in Km

Corridor design performance indicator values for each segment of corridor (refer Table 3-1: List of LOS Indicators)

Corridor design performance indicators

Reference to suggested improvements as per serial no. in

Step 3 – Look for LOS for each of the segment, following which look for arrow signs for suggested improvements against each performance indicator.

									Final Results																											
	Refer S.No. in User Manual Table no. 3.2					3				5		8		9		7		10			6		11		12			4		2						
	Average Trip Length	10.000	Km		Model		Results	Results	Results		Results		Results		Results		Results		Results	Results		Results		Results		Results	Results		Results		Results	Results	Results	Results	Results	Results
	Code Referances		E37		Q42		G33	G38	Q36		G42		Q37		Q38		AB34		AB37	AB38		AB39		Q41		AB41	Q39		AB40		Q40	G41	AB1	C2	C3	
Segment No	Segment Characteristics	Bus Stops	Segment length (km)	Average Gap between stations (m)	Per bus per intersection delay for mid block station conditions (sec)	SUGGESTED IMPROVEMENT	Average Total Walking Distance (m)	Max Corridor Bus Throughput Per Hour Per Direction	Capacity in PPHPDT	SUGGESTED IMPROVEMENT	Current demand in PPHPDT	SUGGESTED IMPROVEMENT	Average per bus per station delay (sec)	SUGGESTED IMPROVEMENT	Barrier Free (Disabled Friendly) Infrastructure Score (out of 1.0)	SUGGESTED IMPROVEMENT	Expected average bus operational speed in the corridor (km/hr)	SUGGESTED IMPROVEMENT	Total average passenger delay in accessing station in a round trip (sec)	Point to point passenger travel time for average trip length (min)	SUGGESTED IMPROVEMENT	Average Passenger speed with BRTS (km/hr)	SUGGESTED IMPROVEMENT	Average per passenger access time (min)	SUGGESTED IMPROVEMENT	Average per passenger in vehicle time (min)	Average passenger speed in buses without BRTS (km/hr)	SUGGESTED IMPROVEMENT	Per trip time saved by BRTS over mixed condition bus (min)	SUGGESTED IMPROVEMENT	Per trip time saved by BRTS over private vehicle (min)	Daily Bus Passenger Hours saved by BRTS (hours)	Segment Performance Score (Out of 100)	Station Design Number	Station Type	Time taken by bus to traverse the section (hours)
1	Midblocks No turning	6	5.355	943.0	0.0	↓	1608	360	28800		20640		35.6		0.8		28.0		278.4	43.0	↑	14.0		27.5		15.4	11.4		9.9	↑	-23.0	95110.4	68	4	Staggered, mi	0.191
2	4-arm Roundabouts BRT to BRT	2	1.060	[illegible]28.0			987	160	12800		9600		52.9		1.0		20.5		392.5	41.2	↑	14.6		13.6		27.5	12.7		6.0	↑	-21.2	25683.0	69	4	Staggered, mi	0.052
3	4-arm Signalized BRT to BRT	1	0.629	660.0			1055	184	14720		14720		74.7		1.0		17.6		344.7	44.3	↑	13.5		13.4		30.9	12.5		3.7	↑	-24.4	18107.8	66	2	Staggered, ne	0.036
4	3-arm Signalized No turning	3	1.865	610.0		↓	1242	184	14720		14720		46.0		0.8		21.6	↓	401.0	47.6	↑	12.6		27.6		20.0	11.1		6.5	↑	-27.7	32096.7	57	1	Staggered, ne	0.086
5	3-arm Signalized BRT to BRT	1	0.612	617.0			1011	180	14400		14400		64.6		1.0		18.3		261.9	41.3	↑	14.5		11.3		30.0	12.6		6.3	↑	-21.4	30130.5	73	2	Staggered, ne	0.033
6	Midblock Side bus lane Grade separated b	1	0.666	832.0	0.0	↓	1763	540	43200		5680	↓	76.8	↑	0.8		19.7	↓	515.8	53.5	↑	11.2		31.6		21.9	10.8	↑	1.9	↑	-33.6	27862.6	42	37	Unsegregated	0.034
		14	10.187	0.7	0.0		994.0	540	22491		15857		47.3		0.8		23.6		322.1	43.98		13.6		24.46	10.00	19.52	11.6	40.00	7.93	31.00	-24.50	56744.2	66			0.432
																			↓			↑			↑	↑				↓	↑					
		Total No. of Stations	Total Corridor Length in m (item 15 in the user manual)	Average spacing Between Stations in m	Per bus per intersection delay for mid block station conditions (sec)		Per Pass. Walk distance in m	Max Corridor Bus Throughput Per Hour Per Direction			Weighted average of corridor demand in PPHPDT		Weighted delay per bus per station in sec		Barrier Free (Disabled Friendly) Infrastructure Score (out of 1.0)		Space mean Speed of Buses on Corridor		Weighted average of passenger delay in accessing station in a round trip (in sec)	Weighted average of Point to point passenger travel time for average trip length (in min)		Weighted Average of Passenger speed with BRTS (Km/hr)		Weighted Average of per passenger access + egress time (in min)	Average trip length in the corridor/city (km) (item 13 in the user manaul)	Weighted Average of per passenger in vehicle time (in mins)	Weighted Average of passenger speed in buses (without BRTS) in Km/hr	Legal speed of buses in the corridor (km/h) (item 1 in user manual)	Weighted average of per trip per pass. time saved by BRTS over buses in mixed condition (mins)	Average Speed of Motorized Veh. In city/corridor (Km/h)	Weighted average of Per trip time saved by BRTS over private vehicle (in mins)	Weighted average of Daily Bus Passenger Hours saved by BRTS (in hours)	CONSOLIDATED PERFORMANCE SCORE (OUT OF 100)			Total Trave; Time on Corridor in Sec

Figure 3-1: Image of BEAD output file sheet

Last row prese corridor performance values

Step 2 – Look for the arrow signs for suggested improvements against each of the underperforming indicators

Step 1 – Look for the overall corridor LOS. LOS, C, D, E and F can be improved.

Table 3-1: List of LOS Indicators[1]

Indicators / Score	1.0 (Ideal)	0.8 (Good)	0.6 (Fare)	0.4 (Poor)	0.2 (Very Poor)	0.0 (Un-acceptable)	Unit
Safety	< = 40 (<=30)	41 – 45 (31-35)	46 – 50 (36-40)	51 – 55 (41-45)	56- 60 (46-50)	> 60 (>50)	Peak Bus Speed in Km/h in segregated bus lanes (or un-segregated bus lanes)
Attractiveness for Private two wheeler user	>= 1.1	1.09 - 1	0.99 - 0.9	0.89 - 0.8	0.79-0.65	< 0.65	Ratio of Passenger speed in BRT to that in private vehicles
Total Walking Distance in a return trip	<= 900	901-1050	1051-1200	1201-1350	1351-1500	> 1500	Walking length for passengers in a return trip, m
Attractiveness for users of existing Public Transport	>= 1.5	1.49 - 1.3	1.29 - 1.15	1.14 - 1.05	1.04 - 1.01	<= 1	Ratio of Passenger speed in BRT to that in regular bus service
Capacity	>= 20000	19999 - 12000	11999 - 8000	7999 - 6000	5999 - 4000	< 4000	In passengers per hour per direction (PPHPD)
Passenger Speed	>= 14	13.9-13.0	12.9–11.5	11.4 - 10	9.9 - 8	< 8	Overall Journey speed in Km/h
Operational Average Bus Speed	>= 23	22.9 - 20	19.9 - 18	17.9 - 15	14.9 - 12	< 12	Average speed of vehicle/bus within the corridor, Km/Hr
Total Bus Delay per station (Station+junction delay)	<= 30	31 - 50	51 - 75	76 - 105	106 - 150	> 150	Per station/junction duration for which the bus/vehicle is not moving, sec
Total Passenger Delay	<= 250	251 - 300	301 - 350	351 - 450	451 - 600	>600	Total delay for crossing, waiting, access, etc. in Sec
Barrier Free (Disabled Friendly) Infrastructure Score	1.0	0.8 – 0.99	0.6 – 0.79	0.4 – 0.59	0.2 – 0.39	0 – 0.19	Ratio (on a scale of 0 to 1)

The suggested improvement in performance of each of the critical indicators for BRTS system design are displayed as upward or downward pointing arrows along relevant results. The user can improve the overall design and performance of the BRTS system by improving these values by undertaking the steps suggested below:

[1] These grading of values for each indicator has been achieved through analysis of varying design results generated by BEAD. These results were then categorized from 'best to worst possible' through series of internal discussions.

Table 3-2: Proposed Interventions for Improvement of Results/Performance[2]

S. No.	Arrow Indicator	Performance Indicators	Possible Actions for Improvement
1	↓	Peak Bus Speeds in Corridor	This indicates that the speed of buses in the corridor is too high to be safe for the community residing in the proximity of the corridor. A decision is required to reduce the speeds to safe limits or segregate any un-segregated bus lanes. To do so in the tool; save file, then restart the tool and load corridor data, or re-enter the same. Go to default values tab, on BEAD main form and reduce peak bus speeds. Preferable values are 40km/h or less.
2	↑	Time saved by BRT over private transport	This can be increased by increasing passenger speeds or by active design intervention to reduce average motorized speeds on the corridor/in the city (dis-insentivising measures for private motorized modes). Here expected average motorized speeds in the design year (5-10 years after operations of BRTS begin) may be used, to estimate if the current corridor is attractive for BRTS development. If not it may need to be replaced by a corridor in inner city areas where lower motor vehicle speeds would be a higher incentive to opt for a faster BRTS. Measures to improve passenger speed have been mentioned against serial no. '6' below.

[2] Possible improvement actions have been listed on the basis of comparative analysis of BEAD results from a number of design variables.

3	↓	Average total walking distance	Average total walking distance on the corridor can be reduced by one or more of the following measures: • Reduce average spacing between stations. Optimum spacing between stations can be between 550 to 750m • If mid block stations are used, opt for junction stations, to reduce access walking distance. • If closed bus operations are used, opt for open bus operations and allow bus turning at intersections. This will remove walking distances from transfers between feeder and trunk routes. • Reduce spacing of first bus boarding from stop line to reduce access walking distances. • If grade separated access to station is used with ramps, opt for at grade pedestrian crossing or use of escalators. • If the no. of MV lanes proposed are 4 or more for each direction, reduce the number to 3 or less to reduce crossing distances. • Reduce no. of simultaneous bus boarding to reduce platform/station length
4	↑	Time saved by BRT over mixed condition bus	Total time saved by BRT over mixed condition bus can be improved by one or more of the following measures: • Provide BRTS corridor on the cross roads – strengthen the network. This can be defined in junction model inputs (for junction stations) and junction mid block model inputs (for mid block stations) • Improve passenger speed in BRTS buses (explained in '6' below). • If average motorized trip lengths less than 10-12km, in the city/corridor; opt for an open system to eliminate transfer time involved in closed system.
5	↑	Corridor demand/Capacity in PPHPDT	The tool evaluates the corridor performance against the number of passengers it is benefiting. If the demand input by the user is too low, the tool indicates this by an up arrov meaning the demand is low to justify BRTS. In this scenario the evaluation should include the values under the corrido capacity cell. If the figures against this indicator are the sam as that against the corridor capacity indicator, the up arrow indicates that the design needs to target at increasing the system capacity, else it indicates that a higher demand corridor needs to be selected. In case design improvement to increase capacity is required one or more of the followin measures may be used: • Reduce signal cycle length and/or improve the phase length assigned for straight and turning buses. • For short phase length (less than 20-25 sec) designed for buses, reduce the distance of first bus boarding from stop line to '13m to 26m', for longer phase lengths, opt for 26 to 39m, gap.

			• Provide overtaking lane for buses at intersections. • For long green phase lengths assigned to straight or turning buses, frequency can be improved by increasing the simultaneous bus boarding bays at the station. • For both short or long green phases, simultaneous bus boarding's at the station can be increased along with opting for a parallel station design. *Note: Where current passenger demand is shown significantly low or significantly less than capacity, the corridor evaluation should include comparative scenario between current base year and horizon year (5 to 10 years from base year).*
6	↑	Average Passenger speed with BRT	Average passenger speed for passengers using the BRTS can be improved by one or more of the following measures or design interventions: • Reduce passenger walking distances. Means are discussed above. • Reduce passenger delays in accessing the station. Means are discussed under s.no. '10' below. • Reduce bus delays. Means are discussed under s.no. '9' below. • Reduce signal cycle length and/or improve the phase length assigned for straight and turning buses. • Appropriately adjust the gap between stop line and first bus boarding between 13 and 39m (as discussed in s.no. '5' above) based on the green phase length allotted to bus movement on corridor. • If the system is open and the expected motor vehicle trip length on the corridor or in the city is longer than 12 km, opt for a closed system.
7	↑	Operational or average bus speed in the system.	Operational speed of buses in the BRTS system can be improved by one or more of the following measures: • Reduce junction delay by reducing signal cycle length and/or improve the phase length assigned for straight and turning buses. • Use overtaking lanes for buses at junctions/stations to reduce no. of phases thus reducing delays experience by buses. • For trip lengths longer than 12km (in the corridor or the city) Close more and more junctions to turning buses, or make the system a closed system from an open system. • Use grade separated or signal free junctions or grade separated access to mid block stations to remove junction delays for buses. This option may not be desirable from an accessibility point of view.
8	↓	Per bus delay per	Delays for buses can be reduced by using one or more of

		Station (including intersection and dwell time delay for junction station) - segregated lanes.	the following measures or design changes: • Reduce junction delay by reducing signal cycle length and/or improve the phase length assigned for straight and turning buses. • Use overtaking lanes for buses at junctions/stations to reduce no. of phases thus reducing delays experienced by buses. • Use staggered and near side stations to eliminate time lost in acceleration and deceleration by buses. • Use near side stations for very high demand systems, to remove additional stacking delays. Alternately no. of stations for simultaneous boarding may be increased if far side stations or island stations need to be used. • Use parallel stations to reduce long platforms for very high demand systems.
9	↑	Barrier Free (Disabled Friendly) Infrastructure Score (out of 1.0)	A BRTS or a bus based public transport infrastructure can be made barrier free or disabled friendly for all by making following changes in the infrastructure and operations planning: • In case the system is not designed for level boarding i.e. platform height and bus floor height is the same with no steps inside or within the circulation area of the bus; then planning provisions, including suggestions for fleet selection to allow level boarding, to be made. • For level boarding systems low floor buses should be used. This allows access to wheelchair through door ramp outside the dedicated corridor in open bus operations. Even for closed bus operations low floor buses allow evacuation for wheelchairs (through door ramps) in case of emergency between stations. • In case fleet with steps inside (after entering) the bus is used (either partly of fully), then boarding from platform on to the first step should be used to reduce no. of steps encountered in boarding or alighting. In addition attempts should be made to opt for bus fleet with reduced steps inside the bus.
10	↓	Total average passenger delay to access the bus/system in a round trip.	Delays for passengers in accessing the bus or the bus station can be reduced by one or more of the following measures or design changes: • Reduce signal cycle length to reduce crossing delays for passengers (advisable with reduced MV lanes to reduce crossing distance for pedestrians) • Reduce no. of MV lanes per direction to reduce crossing distance for passengers • Improve the frequency of buses in the system (subject to demand), to reduce waiting time for buses.

			• If off board fare collection is used (in high demand systems), remove the same to reduce additional delays in entering the station.
11	↓	Total average access time.	Average access time to the system can be reduced by using one or more of the following measures/ design changes: • Opt for an open system is a closed system is used and allow bus turns at intersections. • Reduce walking distances by using the measures discussed under walking distance head above. • Reduce total average passenger delays by using the measures described under the head above (S. No. 10).
12	↑	Total average in vehicle time (main line/route).	Average in vehicle time can be increased by one or more of the following measures (it is important to note that average in vehicle time should be relatively higher to average access time): • Opt for an open system (if a closed system is used) and allow bus turns at intersections. • Reduce walking distances by using the measures discussed under walking distance head above. • Reduce total average passenger delays by using the measures described under the head above.
13	↓	Average Trip Length in the city or corridor.	Longer trip average trip length in the city or along a corridor indicates higher dependence on motorized modes. Average trip length requirement can be reduced by opting for an open bus operations if closed bus operations are selected. *Note: BRTS is unlikely to be suitable for trip lengths less than 5-6km even with open bus operations.*
14	↓	Average Motor vehicle speed in the city	In order to reduce the avg. Motor vehicle speed in the city either the no. of motor vehicle lanes to be reduced Or traffic calming measures need to be adopted at regular distances.
15	↑	Total corridor length	A lower corridor length than the average trip length would indicate that higher portion of the journey would be made by buses travelling in mixed condition, resulting in longer passenger journey time. This can be improved by increasing the corridor length to meet the average trip length in the city or that in the proximity of the corridor.

4 Getting Started with BEAD

Requirements: BEAD is a Microsoft Excel based tool. To use BEAD, the user should use a PC with the following configurations:

Operating Systems: Windows XP, Windows Vista or Windows 7 operating systems. BEAD does not work in early Service Packs of Windows XP.

Space: The BEAD tool requires 3 MB of storage. If hard drive space is limited, one can use the BEAD tool from a USB memory stick with at least 10 MB of free space.

Screen Resolution: The BEAD tool will automatically adjust to most screen resolutions. In cases in which BEAD scroll bars and buttons are not visible, the user must exit BEAD and enter Windows Control Panel to change the screen resolution. One should select 1280 x 800 dpi or 1024 x 768 dpi.

Software: Windows Excel 2007 (SP2) or higher version and the BEAD xlsm file. To upgrade your Windows Excel 2007 to 2007 SP2, one can download the update from: http://www.microsoft.com/downloads/details.aspx?displaylang=en&FamilyID=b444bf18-79ea-46c6-8a81-9db49b4ab6e5

Note: For unresolved security alert warnings and trouble enabling macros, refer to http://support.microsoft.com/kb/927150.

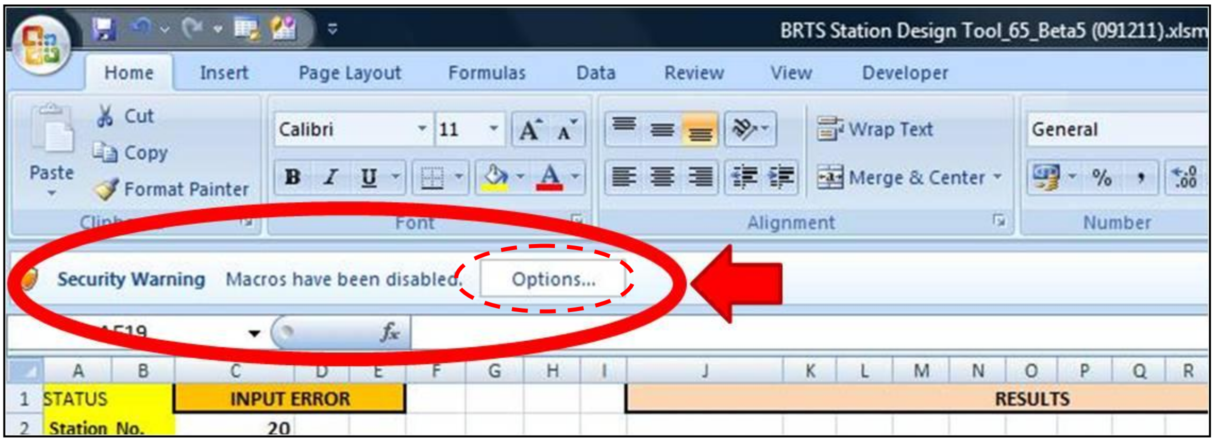
Permission: The BEAD tool requires an opening password which is 'BRTSpassenger'.

Directories: The BEAD tool will work in any subdirectory except virtual ones such as Windows 7 "Library." External BEAD xlsx files that can be loaded into BEAD must also reside in non-virtual subdirectories such as the "Documents" subdirectory.

BEAD makes use of VBA script and macros in Excel. To run BEAD one needs to enable macros by one of the following means:

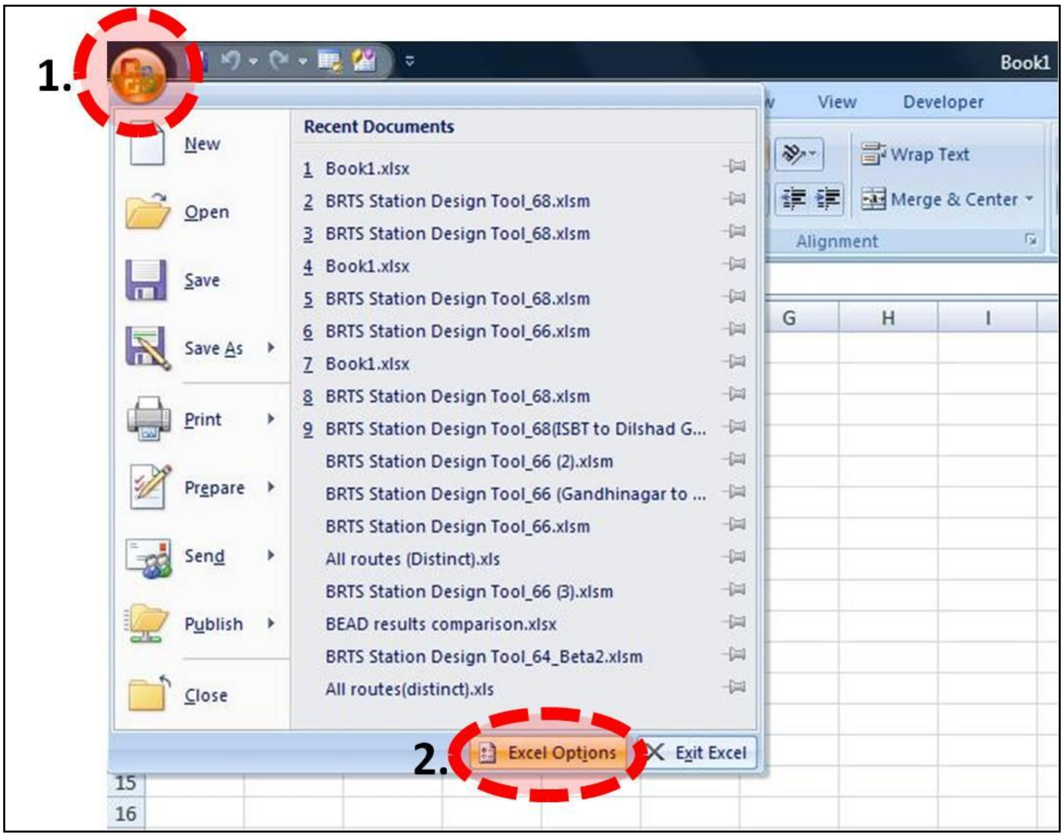
1. Double Click BEAD and then Enable Macros:

1. Double click the Excel (BEAD) file.
2. You will get a ***'Security Warning'*** on main Excel page (on the top, below Tool Bar).
3. Click '***Options..***'.
4. And choose '***Enable this content***' from 'Microsoft Office Security Options' window and then click '***OK***' to start with ***BEAD tool***.



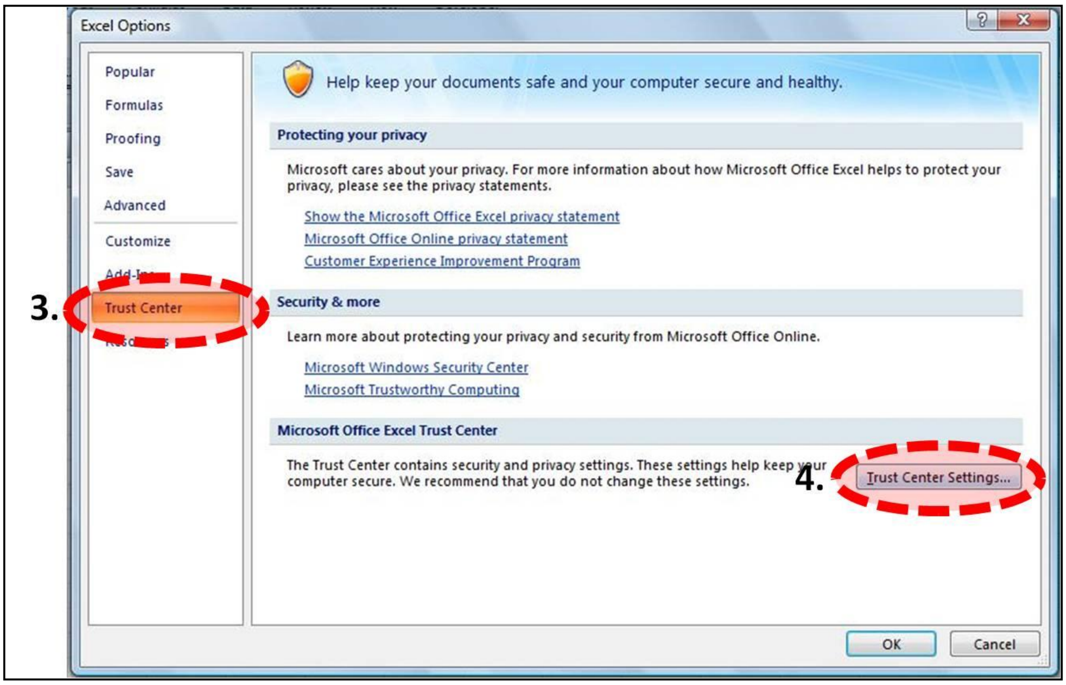
2. Enable Macros before running BEAD:

1. Press ***'Office Button'*** (on the Top, Left corner).
2. Then press ***'Excel Options'*** (at bottom).



3. Go to ***'Trust Center'*** (Lest side column) on 'Excel Option' sheet.

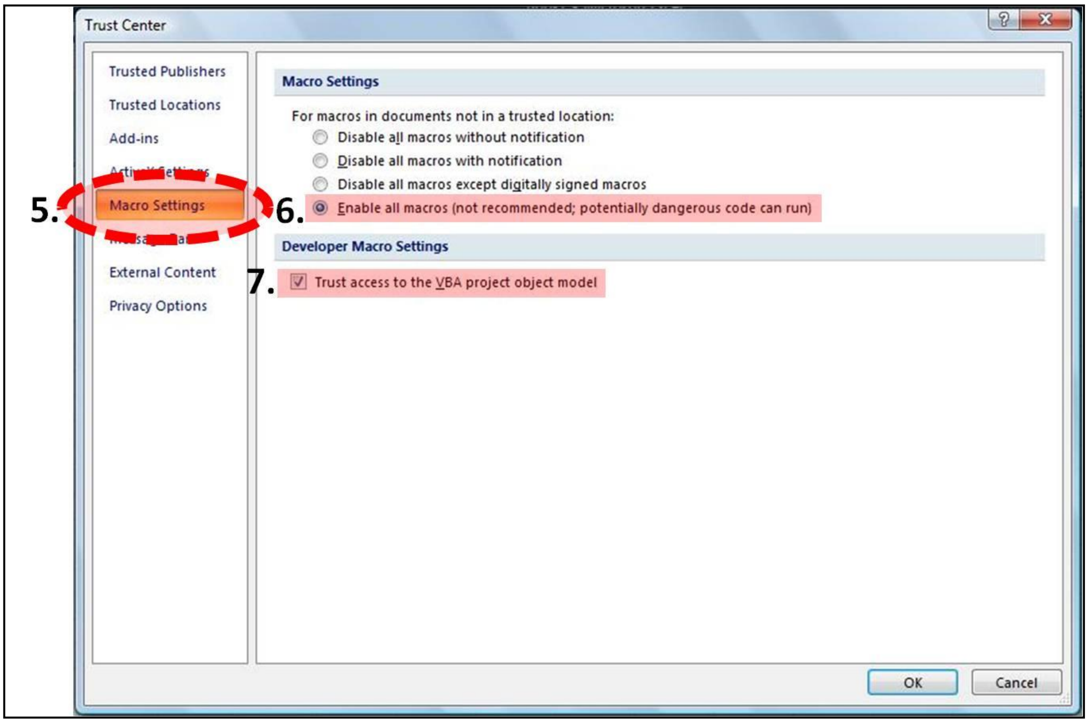
4. Click ***'Trust Center Settings…'***(at Bottom, Right side).



5. Click ***'Macro Settings'*** option on 'Trust Center' page. (Left side column)

6. Choose ***'Enable all macros (not recommended, potentially dangerous code can run)'*** option from 'Macro Settings.'

7. Click ON the ***'Trust access to the VBA project object model'*** option from Developer Macro Settings. Then click **OK** and go further to use **BEAD tool.**



4.1 BEAD User Interface

The user interface of the tool utilizes VBA based input forms for an MS Excel based model. The user is asked to input design parameters related to various BRT components. The inputs required for the tool to generate results have been categorized and grouped in respective user forms. The forms have been divided in the following category and sequencing.

i. **Splash Page**:

This page is the first page that the user views upon enter the tool application. The user is presented with four choices: CONTINUE CANCEL, DEVELOPER, and LOAD:

- **CONTINUE** button allows the user to proceed from where he/she last exited BEAD. All data and inputs till last entry (before closing of the file in a previous session) are retained and the user is directed to the BEAD Main Page, which (and subsequent pages) display previously entered inputs which can be modified or retained.
- **CANCEL** button allows the user to exit the tool without saving any information.
- **DEVELOPER** button allows a proper specialist to enter the tool's spreadsheet mode for modification purposes.
- **LOAD** button allows users to retrieve input values from a previously saved BEAD output file. Tool only save one segment data and rest must re-entre by referring to Output file generated by tool.
- **NEW STUDY** – This button allows a user to start a new analysis and he is directed to the BEAD main page, however all boxes are blank for a new set of data entry.

ii. **BEAD Main Page**:

This form requires the user to input primary information of the corridor to be analyzed. It has two tabs as listed below:

a) ***BEAD model input page***: This is the active tab wherein the user has to input basic corridor information. The total length of the corridor and no. of segments division of the corridor also need to be input on this form. If the tool is being used to compare a conceptual design for the BRT corridor based on different system type or type of bus shelter without going into the detailed design then the user can simply input ‘1’ in the no. of segments field. This would mean that the complete corridor has a uniform design.

The tab presents the user with three choices: SAVE,"OK, CONTINUE," and EXIT BEAD. The SAVE button permits the tool user to save entered values on the screen to the tool's spreadsheet. WARNING messages may appear before saving if the user entered incompatible values. If a WARNING message occurs, the tool will automatically make the necessary correction with information on the entry changed and gray out further changes. The "OK, CONTINUE" button allows the user to continue to the next page after a robust error checking process. During the process, user-friendly ERROR and WARNING messages may appear. If an ERROR message appears, the cursor will become situated in the field where the error occurred with information as to the message cause. The user must make the necessary correction; otherwise, the tool will not permit continuation. The EXIT BEAD or CLOSE button permits the user to leave BEAD and MS Excel very quickly. It is highly recommended that the user click SAVE button before exiting. Otherwise, entry values that the user entered will be lost.

b) ***Default Values***: One can go to this tab in order to change the default values of various system parameters used in the tool. The tab presents the user with three choices: SAVE, "OK, CONTINUE," and EXIT BEAD. The SAVE button permits the tool user to save entered values on the screen to the tool's spreadsheet. WARNING messages may appear before saving if the user entered incompatible values. If a WARNING message occurs, the tool will automatically make the necessary correction with information on the entry changed and gray out further changes. The "OK, CONTINUE" button presents the user with a message to click the Model Input tab on the page's top left corner to continue after a robust error checking process. During the process, user-friendly ERROR and WARNING messages may appear. If an ERROR message appears, the cursor will become situated in the field where the error occurred with information as to the message cause. The user must make the necessary correction; otherwise, the tool will not permit continuation. The EXIT BEAD or CLOSE button permits the user to leave BEAD and MS Excel very quickly. It is highly recommended that the user click SAVE button before exiting. Otherwise, entry values that the user entered will be lost.

iii. Segment Details:

The basic information of each of the segment based on no. of segments entered in the first form requires to be input on this form. The total length of each of the segment should be equal to the total length of the corridor. The number of bus stations per segment must be one or more and less than the segment length divided by 0.2.Depending on the number of corridor segments entered on the Main Page form, the user is allowed to enter values on the exact number of segments onto the segment details form. The remaining segment fields are grayed out and locked from values. If the user wishes to add values to more segments, selecting the BACK button, changing the number of corridor segments, and returning to the edit segment form allows this change.

The page presents the user with four choices: SAVE, "OK, CONTINUE," EXIT BEAD, and BACK. The SAVE button permits the tool user to save entered values on the screen to the tool's spreadsheet. WARNING messages may appear before saving if the user entered incompatible values. If a WARNING message occurs, the tool will automatically make the necessary correction with information on the entry changed and gray out further changes. The "OK, CONTINUE" button allows the user to continue to the next page after a robust error checking process. During the process, user-friendly ERROR and WARNING messages may appear. If an ERROR message appears, the cursor will become situated in the field where the error occurred with information as to the message cause. The user must make the necessary correction; otherwise, the tool will not permit continuation. The EXIT BEAD or CLOSE button permits the user to leave BEAD and MS Excel very quickly. It is highly recommended that the user click SAVE button before exiting. Otherwise, entry values that the user entered will be lost. The BACK button allows the user to return to the previous page to make corrections to be reflected on the current page.

iv. BRTS General Inputs:

On this page, the user has to input the general information of the segment like the intersection type, bus lane type, ROW width, etc. The page presents the user with three choices: SAVE, "OK, CONTINUE," and EXIT BEAD. The SAVE button permits the tool user to save entered values on the screen to the tool's spreadsheet. WARNING messages may appear before saving if the user entered incompatible values.. If a WARNING message occurs, the tool will automatically make the necessary correction with information on the entry changed and gray out further changes. The "OK, CONTINUE" button allows the user to continue to the next page after a robust error checking process. During the process, user-friendly ERROR and WARNING messages may appear. If an ERROR message appears, the cursor will become situated in the field where the error occurred with information as to the message cause. The user must make the necessary correction; otherwise, the tool will not permit continuation. The EXIT BEAD or CLOSE button permits the user to leave BEAD and MS Excel very quickly. It is highly recommended that the user click SAVE button before exiting. Otherwise, entry values that the user entered will be lost.

v. Junction Model Inputs:

This form requires the user to input junction specific design details. The page presents the user with four choices: SAVE, "OK, CONTINUE," EXIT BEAD, and BACK. The SAVE button permits the tool user to save entered values on the screen to the tool's spreadsheet. WARNING messages may appear before saving if the user entered incompatible values. If a WARNING message occurs, the tool will automatically make the necessary correction with information on the entry changed and gray out further changes. The "OK, CONTINUE" button allows the user to continue to the next page after a robust error checking process. During the process, user-friendly ERROR and WARNING messages may appear. If an ERROR message appears, the cursor will become situated in the field where the error occurred with information as to the message cause. The user must make the necessary correction; otherwise, the tool will not permit continuation. The EXIT BEAD or CLOSE button permits the user to leave BEAD and MS Excel very quickly. It is highly recommended that the user click SAVE button before exiting. Otherwise, entry values that the user entered will be lost. The BACK button allows the user to return to the previous page to make corrections to be reflected on the current page.

vi. Junction Midblock Model Inputs:

This form would be active only if Midblock intersection type is selected in the BRTS General Inputs form. Otherwise, this form would not be applicable and the user would simply be directed to the next user form (Station Design).

The page presents the user with four choices: SAVE, "OK, CONTINUE," EXIT BEAD, and BACK. The SAVE button permits the tool user to save entered values on the screen to the tool's spreadsheet. WARNING messages may appear before saving if the user entered incompatible values. If a WARNING message occurs, the tool will automatically make the necessary correction with information on the entry changed and gray out further changes. The "OK, CONTINUE" button allows the user to continue to the next page after a robust error checking process. During the process, user-friendly ERROR and WARNING messages may appear. If an ERROR message appears, the cursor will become situated in the field where the error occurred with information as to the message cause. The user must make the necessary correction; otherwise, the tool will not permit continuation. The EXIT BEAD or CLOSE button permits the user to leave BEAD and MS Excel very quickly. It is highly recommended that the user click SAVE button before exiting. Otherwise, entry values that the user entered will be lost. The BACK button allows the user to return to the previous page to make corrections to be reflected on the current page.

vii. Station Design:

This form requires the user to input bus station specific design details. The page presents the user with four choices: SAVE, "OK, CONTINUE," EXIT BEAD, and BACK. The SAVE button permits the tool user to save entered values on the screen to the tool's spreadsheet. WARNING messages may appear before saving if the user entered incompatible values. If a WARNING message occurs, the tool will automatically make the necessary correction with information on the entry changed and gray out further changes. The "OK, CONTINUE" button allows the user to continue to the next page after a robust error checking process. During the process, user-friendly ERROR and WARNING messages may appear. If an ERROR message appears, the cursor will become situated in the field where the error occurred with information as to the message cause. The user must make the necessary correction; otherwise, the tool will not permit continuation. The EXIT BEAD or CLOSE button permits the user to leave BEAD and MS Excel very quickly. It is highly recommended that the user click SAVE button before exiting. Otherwise, entry values that the user entered will be lost. The BACK button allows the user to return to the previous page to make corrections to be reflected on the current page.

viii. Results:

This form gives the result of the entered segment based on the inputs in the previous forms. The result page would be generated for each segment. The result for the segment is saved and then the user is guided back to the BEAD model input page in order to analyze the next segment depending upon the number of segments the corridor has been divided. One can also go to the ‘Edit Results’ tab on this form and can change certain parameters, namely, cross section element widths, throughput, cycle length, and phase lengths. The results would be recalculated based on the changes made in the ‘Edit Results’ form. No values can be changed on the Results page.

The page presents the user with four choices: "EDIT Result Variables," "OK, CONTINUE," PRINT, and BACK. The "EDIT Result Variable" button permits the tool user to proceed to the Edit Results page to change cross section element widths, throughput, cycle length, and phase lengths. The "OK, CONTINUE" button allows the user to continue to the next segment analysis, or, if it is the last segment analysis, to ask the user for an xlsx file name to save the results of all the analyses to an external file and then quickly exit the tool and MS Excel. Further, this external file can then be retrieved by the user using the LOAD button on the tool's Splash page at a future time. The PRINT button permits the user to send segment analysis results from the tool's Results worksheet to the user's default printer for a hard copy. The BACK button allows the user to return to the previous page to make corrections to be reflected on the current page.

ix. Edit Results:

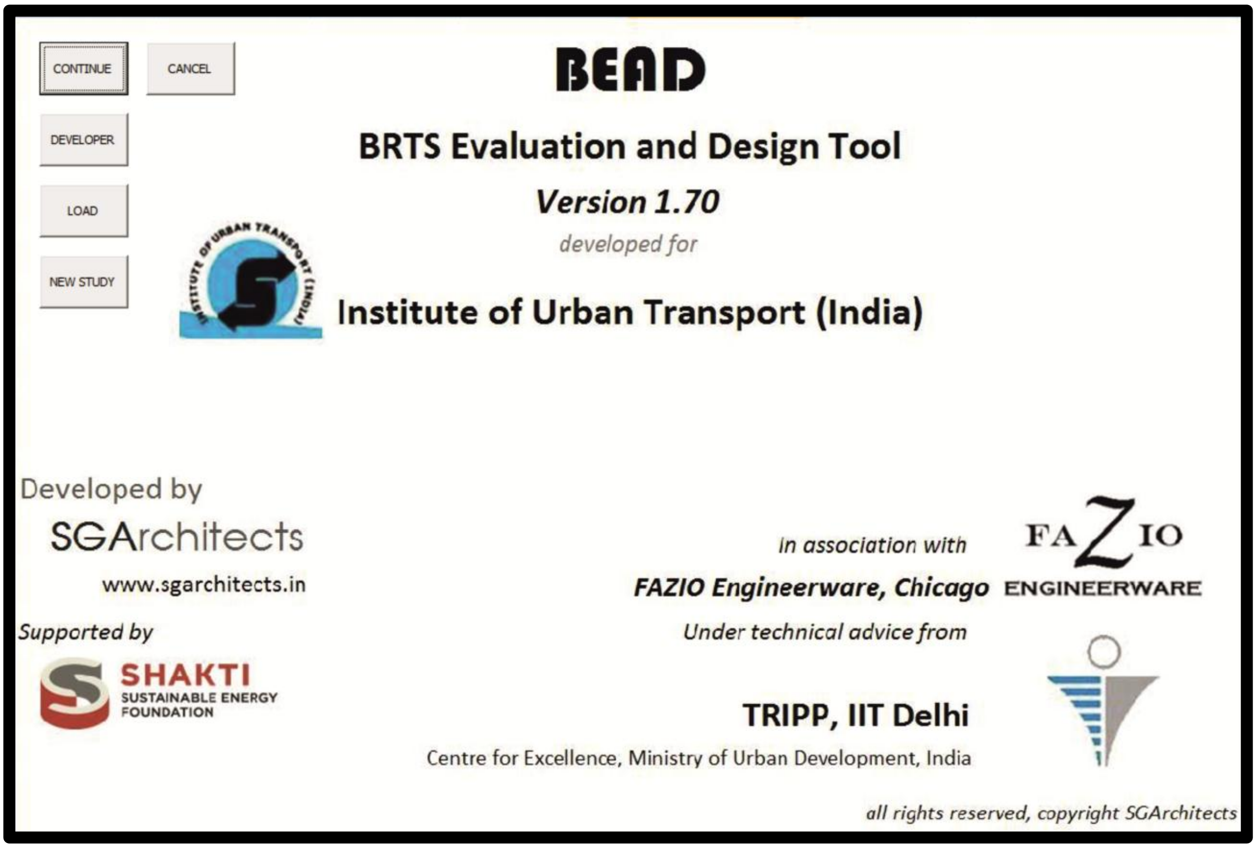
On this form the user can change cross section element width, throughput, cycle length, and phase length values of the generated result and recalculate the result based on these new values.

The presents the user with two choices: "UPDATE Changes and RECALCULATE Results" and BACK. The "UPDATE Changes and RECALCULATE Results" button permits the user to save modified result values and recalculate them on the Edit Results page. By selecting "UPDATE Changes and RECALCULATE Results" button, user-friendly ERROR and WARNING messages may appear. If an ERROR message appears, the cursor will become situated in the field where the error occurred with information as to the message cause. The user must make the necessary correction. Otherwise, the tool will not permit continuation. Selecting the BACK button permits the user to return to the Results page. User-friendly ERROR and WARNING messages may appear. If an ERROR message appears, the cursor will become situated in the field where the error occurred with information as to the message cause. The user must make the necessary correction. Otherwise, the tool will not permit continuation. The BACK button does the same action as the UPDATE button except that changes in result values are shown on the Results page, not the Edit Results page. It is recommended that that the user select the "UPDATE and RECALCULATE" button before selecting BACK so that the user can determine if further result values need to be changed before proceeding.

The tool gives results for each segment type as well as an overall comprehensive result for the complete corridor. One can compare the results in different ways be it based on LOS or system parameters like open vs. closed or staggered vs. common stations, etc. All result comparisons can be done segment-wise by changing design for different segments. Similarly, complete corridor can be compared.

The following sections explain in detail each of the above mentioned user forms and the respective inputs required. Every section explains the respective inputs required in the User form along with the explanation of every type input in detail.

4.2 Splash Page:



This page is the first page that the user views upon enter the tool application. The user is presented with four choices: CONTINUE CANCEL, DEVELOPER, and LOAD:

- **CONTINUE** button allows the user to proceed from where he/she last exited BEAD. All data and inputs till last entry (before closing of the file in a previous session) are retained and the user is directed to the BEAD Main Page, which (and subsequent pages) display previously entered inputs which can be modified or retained.

- **CANCEL** button allows the user to exit the tool without saving any information.

- **DEVELOPER** button allows a proper specialist to enter the tool's spreadsheet mode for modification purposes.

- **LOAD** button allows users to retrieve input values from a previously saved BEAD output file. Tool only save one segment data and rest must re-enter by referring to Output file generated by tool. ***Note: The current version of BEAD allows only the first segment data to be loaded from an output file. Additional segments can be regenerated using data stored in the Model Input.. worksheets.***

- **NEW STUDY** – This button allows a user to start a new analysis and he is directed to the BEAD main page, however all boxes are blank for a new set of data entry.

4.3 User Form 1: BEAD Main Page

4.3.1 Tab A: BEAD Model Input Page

Figure 4-1 shows the image of the first user form. The inputs required in this form have been explained below.

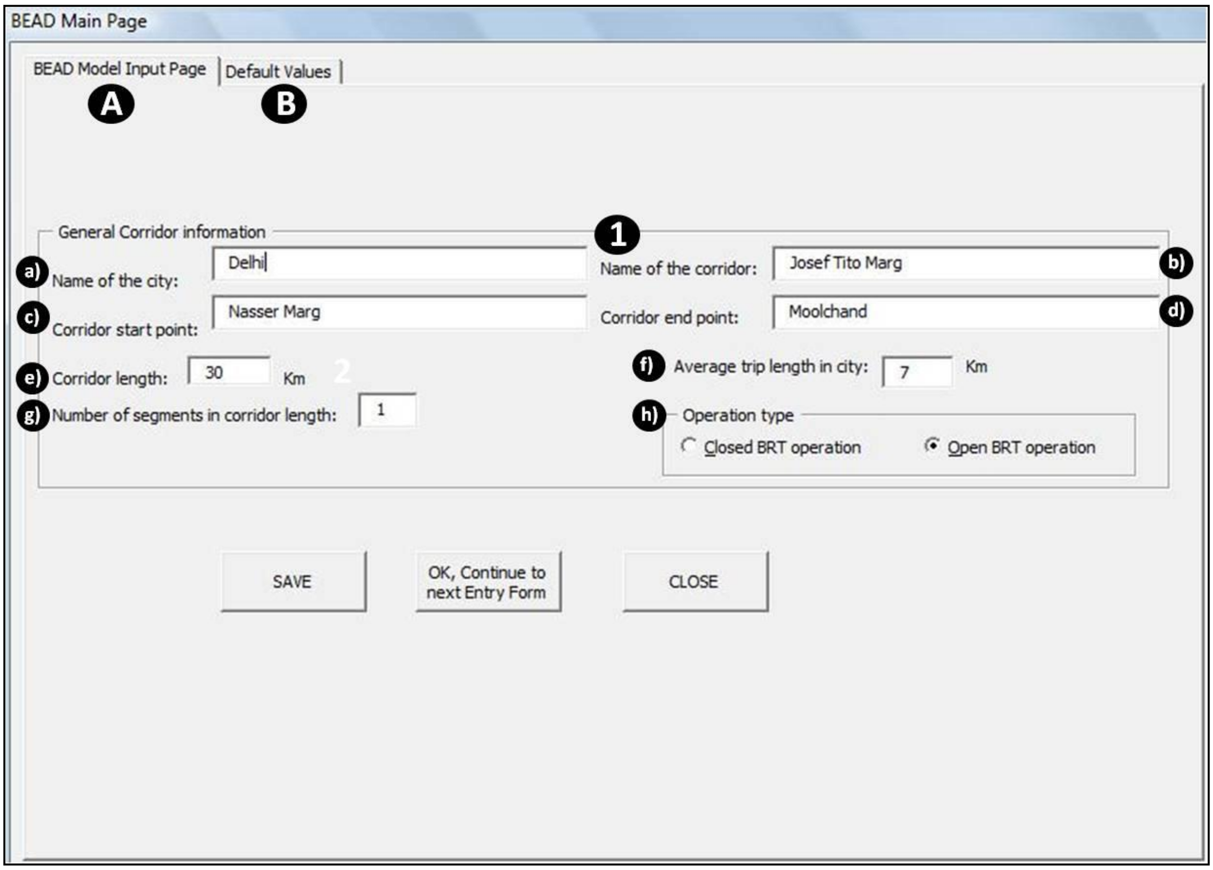


Figure 4-1: First user form

4.3.1.1 General Corridor information:

a) Name of the city: Enter the name of the city where the project under evaluation is proposed.

   Example: 'Pune'.

b) Name of the Corridor: Enter the name given to the BRTS corridor being analyzed.

   Example: 'BRT Pilot corridor 1'.

c) Corridor start point: Enter the start point of the corridor being analyzed.

   Example: 'Katraj'.

d) Corridor end point: Enter the start point of the corridor being analyzed.

   Example: 'Swargate'.

e) Corridor length: Enter the total length from first to last bus stop of the corridor being analyzed. (The value should be +ve, should be numerical and is in Km). Input value must be between 2.5 km and 40 km.

Example: '30.7'.

f) Average trip length in the city: Enter the Average Motorized trip length in the city. (Should be greater than 2.5km and less than 40km).

Example: '7.3 '.

g) Number of segments in corridor length: Enter the Total number of segments in the entire corridor that is required in the analyses. (The value should be +ve number and must be less than 21).

Example: 'if BRTS corridor has five junction segments and three midblock segments, enter '8' for the number of segments'.

Note: For analyzing designs at concept or preliminary planning stage, one common segment may be selected. This would be the predominant design of the corridor based on desired features and elements. Multiple segments should be selected when detailed corridor design is finalized or while reviewing existing/functional BRTS corridor with varying designs along its length.

h) Operation type: Choose the System Operation type for corridor.

Example: 'If turning of buses are allowed (at intersections) in or out of the corridor then Choose Open BRT operation, otherwise Closed BRT operation (for dedicated end to end single route based operations).

Note: Open BRTS allows that the bus operations permit and facilitate turning of buses in and out of the corridor at 1 or more than one (up to all junctions on the corridor). This implies that more than 1 route uses the corridor for differing lengths. When selecting an open system, a user may still choose to not allow bus turning at some junctions (in the 'General Model Input Form'). This allows the user to define a Semi Open or a '**Hybrid System'**.

4.3.2 Tab B (Optional): Default values

Figure 4-2 shows the image of the default user form. The fields on this form show the value of various parameters to be used in the tool for analysis. These values are based on standard accepted norms and some primary surveys. **Changes to these values are not recommended,** unless required for research and academic applications. Values of interest for general users and city officials might be:

- **Speed Limit of Buses in the city/on the corridor (1 d)**
- **Expected average motor vehicle speeds in the corridor or in the city in mixed traffic (1 w)**
- **No. of distinct bus routes expected to use the corridor (1 y)**

With the exception of these three values all other default values are common for entire corridor (all segments) analysis. The above mentioned three values are editable for each segment and the option appears at the bottom of the 'General Input' form for each segment. If required one can change and save these values. The user also has the option of restoring default values, using the 'Restore Original Defaults' button. **It is strongly recommended that user "Restore Defaults" before proceeding with a new analysis, as values edited in a previous session may have been retained by the tool.**

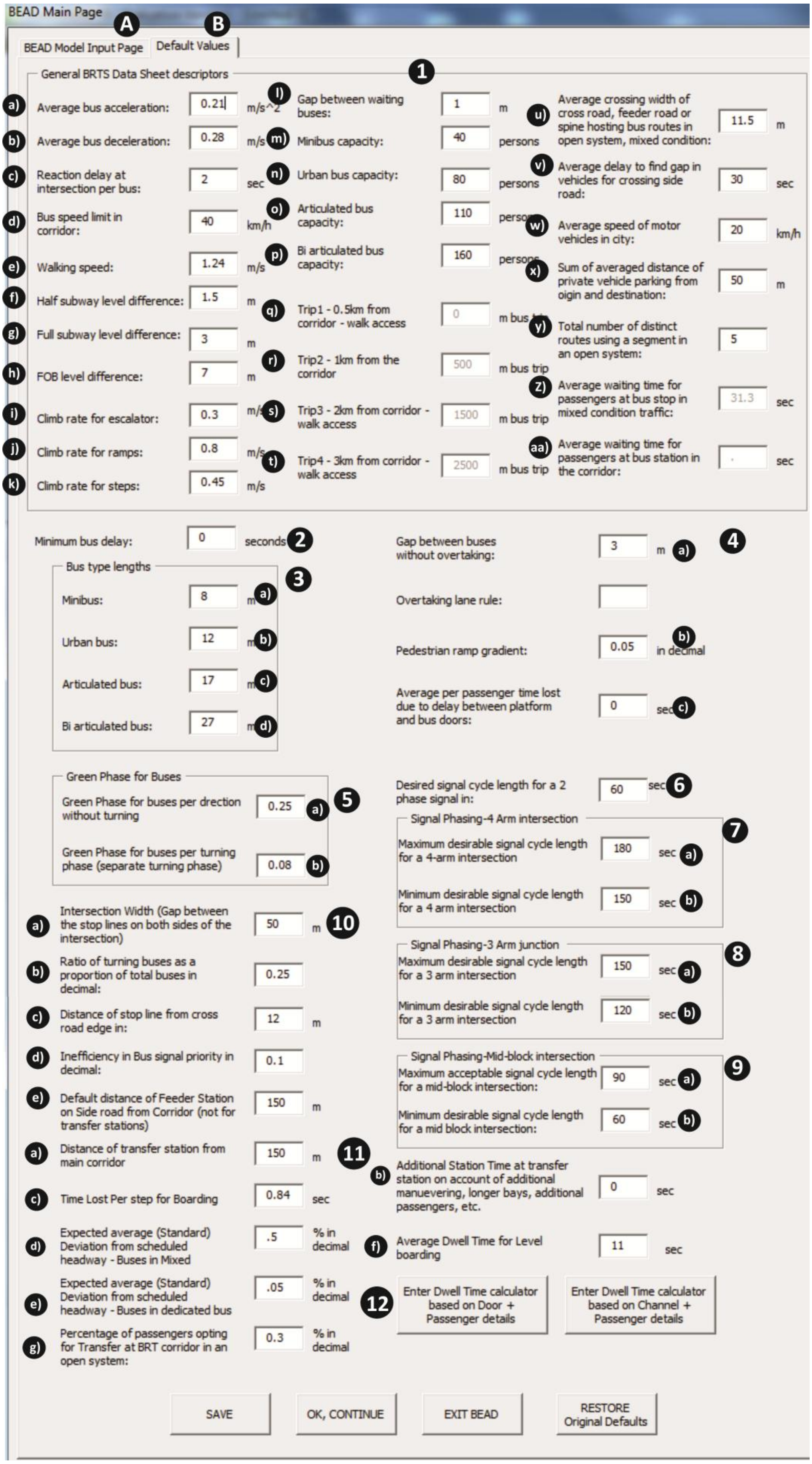
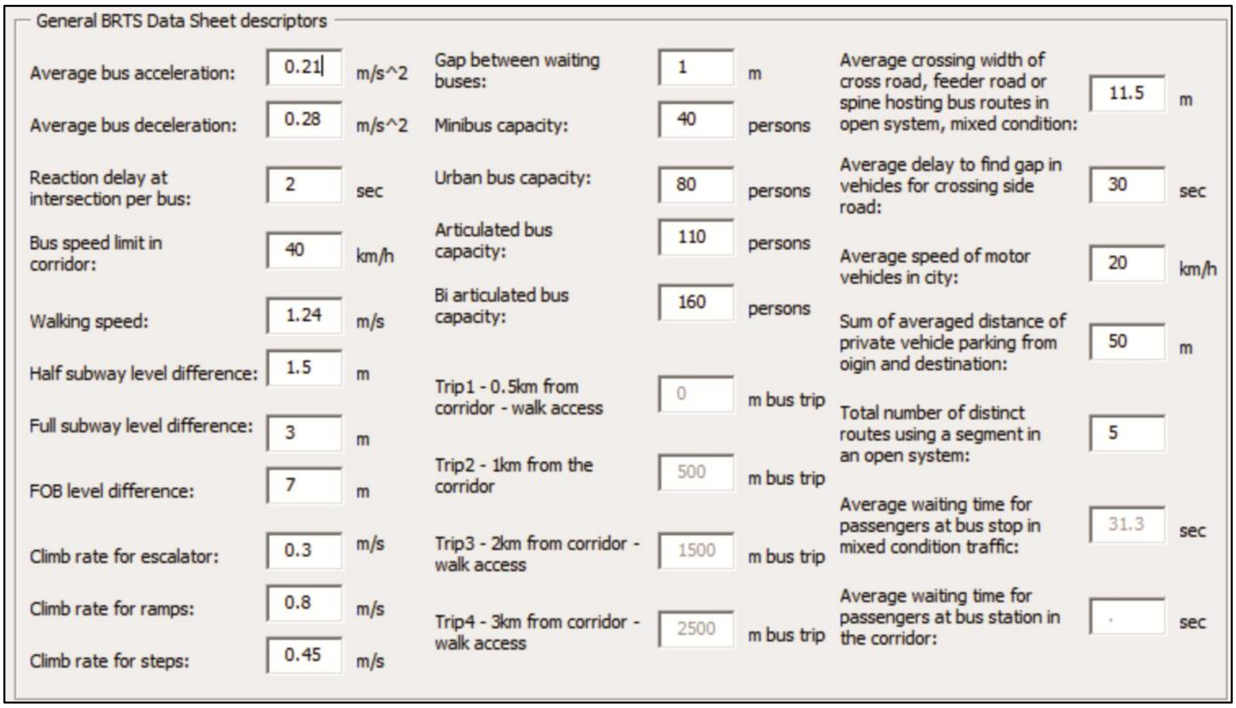


Figure 4-2: Showing Default tab form

4.3.2.1 General BRTS Data Sheet descriptors (1):



a) Average bus acceleration: This is vehicle technology and user comfort value specific value, which is considered as an average of 0.21m/s^2 for segregated bus lanes and 0.20 m/s^2 for un-segregated bus lanes. The tool uses 0.21 m/s^2 as the default value. (The value should be in m/s^2 and between 0.1 m/s^2 and 1.0 m/s^2).

Example: '0.21'.

b) Average bus deceleration: This is vehicle technology and user comfort value specific value, which is considered as an average of 0.28m/s^2 for segregated bus lanes and 0.25 m/s^2 for un-segregated bus lanes. The tool uses 0.28m/s^2 as the default value. (The value should be in m/s^2 and between 0.1 m/s^2 and 1.0 m/s^2).

Example: '0.28'.

c) Reaction delay at intersection per bus: This indicates the reaction delay of the bus driver. A common value of 2 seconds has been used to estimate stopping action and signal response delay for the driver. (The value is in seconds and must be between 1 sec and 3 sec).

Example: '2'.

d) Speed Limit: Enter the Legal or posted speed limit or peak design speed (in case it is less than legal speed limit) of buses in corridor as per design. (As per current motor vehicle norms. The value must be in km/hr and between 10 km/hr and 100 km/hr).

Example: '40'.

e) Walking Speed: Enter the passenger walking speed. It is known that speeds vary with the pedestrian environment. For example average walking speeds on poor, narrow or nonexistent pedestrian infrastructure with high side friction such as market, parking, hawkers etc. is known to be 1.15m/s, that on footpath with low or negligible side friction but with obstacles and/or poor quality surface is known to be 1.24m/s, while pedestrian speeds on high quality wide footpaths with no side friction is known to be 1.40m/s. The tool uses 1.24m/s as the default pedestrian walking speed. (The value must be in m/s and between 0.8 m/s and 2.0m/s).

Example: '1.0'.

f) Half subway level difference: Enter the height difference of the level of half subway below the pedestrian path level, for crossing to access stations. (The value should be in meter and between 1 m and 2 m).

Example: '1.5'.

g) Full subway level difference: Enter the height difference of the level of full subway below the pedestrian path level, for crossing to access stations. (The value should be in meter and between 2.5 m and 4 m).

Example: '3'.

h) FOB level difference: Enter the clear height of Foot over bridge for pedestrian crossing at junction/station – measured from the footpath level. (The value should be in meter and between 6 m and 8 m).

Example: '7'.

i) Climb rate for escalator: Enter the climb speed of escalator (for vertical height) at pedestrian crossing. (The value should be in m/s and between 0.2 m/s and 0.4 m/s).

Example: '0.3'.

j) Climb rate for ramps: Enter the walking speed on ramp (for length of ramp) at pedestrian crossing. (The value should be in m/s and between 0.5 m/s and 1 m/s).

Example: '0.8'.

k) Climb rate for steps: Enter the climbing speed on steps (for vertical height) at pedestrian crossing. (The value should be in m/s and between 0.3 m/s and 0.8 m/s).

Example: '0.45'.

l) Gap between waiting buses: Enter the minimum distance between two adjacent buses in a queue. (The value should be in meter and between 0.6 m and 3 m).

Example: '1'.

m) Minibus capacity: Enter the total expected capacity of persons in minibus (including standing and seated passengers) for single journey. (The value must be a number and between 26 and 60 (passengers/bus).

Example: '40'.

n) Urban bus capacity: Enter the total capacity of persons in Urban bus (including standing and seated passengers) for single journey. (The value must be a number and between 40 and 100 (passengers/bus).

Example: '60'.

o) Articulated bus capacity: Enter the total capacity of persons in Articulated bus (including standing and seated passengers) for single journey. (The value must be a number and between 80 and 160 (passengers/bus).

Example: ’110’.

p) Bi articulated bus capacity: Enter the total capacity of persons in Bi articulated bus (including standing and seated passengers) for single journey. (The value must be a number and between 100 and 200 (passengers/bus).

Example: ’160’.

q) Trip1 – 0.5km from corridor: This is the value, how many kilometers a user is expected to travel in feeder bus if user must travel 0.5 km to access a BRT corridor. (The value must be in meter bus trip). This value can not be edited.

Example: ‘0’.

r) Trip2 – 1km from corridor: This is the value, how many kilometers a user is expected to travel in feeder bus if user must travel 1 km to access a BRT corridor. (The value must be in meter bus trip). This value can not be edited.

Example: ‘500’.

s) Trip3 – 2km from corridor: This is the value, how many kilometer a user is expected to travel in feeder bus if user must travel 2 km to access a BRT corridor. (The value is in meter bus trip). This value can not be edited.

Example: ‘1500’.

t) Trip4 – 3km from corridor: This is the value, how many kilometers a user is expected to travel in feeder bus if user must travel 3 km to access a BRT corridor. (The value is in meter bus trip). This value can not be edited.

Example: ‘2500’.

u) Average crossing width of cross road, feeder road or spine hosting bus routes in mixed condition: Enter the Average crossing width of cross road, feeder road or spine hosting bus routes in, mixed condition and meeting/intersecting the corridor a junction. (The value should be in meter and between 6 m and 14 m).

Example: ’11.5’.

v) Average delay to find gap in vehicle for crossing side road: Enter the Average time of delay for crossing road to find gap in vehicles. This is the time it will take for an average person to cross the road and includes the waiting time to find a gap. The value is provided for cross or access road meeting a corridor at an intersection (The value should be in seconds and between 5 sec and 60 sec).

Example: ‘30’.

w) Average speed of motor vehicle in city: Enter Average motor speed in the base or horizon year (depending on the period of assessment) on the corridor. Where estimates of corridor average speeds are not known the average speed of motor vehicles in the city may be used. (The value should be in km/hr and between 5 km/hr and 50 km/hr).

Example: ’20’.

x) Sum of average distance of private vehicle parking from origin and destination: Enter the Average distance of Private vehicle parking lots from corridor house or an office. This is used to estimate journey times by private motorized vehicles (The value must be in meter and between 5 m and 1000 m).

Example: ’50’.

y) Total number of distinct routes using a segment in an open system: Enter the total number of routes other than BRT using a same segment in an open system. Here routes which overlap for more than the average trip length in the corridor/city, should be considered as common routes or ‘not distinct routes’. The value should be a number and between 2 and 100(routes).

Example: ‘5’.

z) Average waiting time for passenger at bus stop in mixed condition traffic: This is the average waiting time that passenger experiencing at bus stop, in case of bus running in mixed condition traffic. This value presented in seconds.

Example: ’23.8’

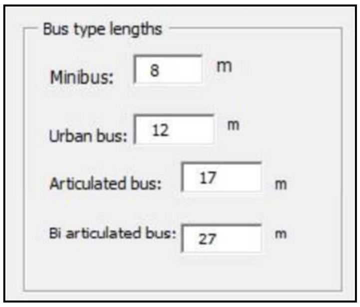
aa) Average waiting time for passenger at bus stop in the corridor: This is the average waiting time that passenger experiencing at bus stop, in case of bus running on corridor. This value presented in seconds.

Example: ’15’

4.3.2.2 Minimum bus delay (2):

Enter the minimum delay that a bus must experience at a signal (**Error! Reference source not found.**).This delay is presented in seconds and must be between 0 sec and 2 sec.

4.3.2.3 Bus Type length (3):



a) Mini bus: Enter the length of minibus used in the fleet. The value is in meter and between 6 m and 9 m.

Example: '8'.

b) Urban bus: Enter the length of urban bus used in the fleet. The value is in meter and between 10 m and 12 m.

Example: '12'.

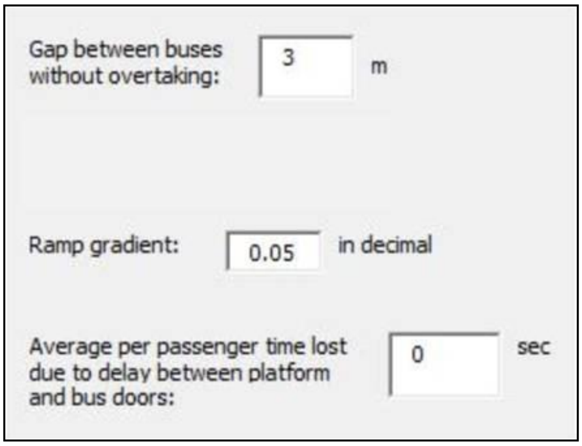
c) Articulated bus: Enter the length of articulated bus used in the fleet. The value is in meter and between 15 m and 20 m.

Example: '17'.

d) Bi articulated bus: Enter the length of Bi-articulated bus used in the fleet. The value is in meter and between 24 m and 30m.

Example: '27'.

4.3.2.4 Bus Lanes and stations (4):

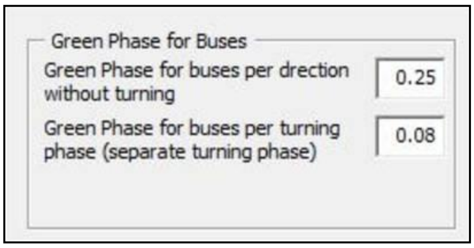


a) Gap between buses without overtaking: Enter the minimum gap between two adjacent buses boarding, in the absence of an overtaking lane at the bus stop. The value is in meter and between 1 m and 6 m.
Example: '3'.

b) Ramp gradient: Enter the pedestrian Ramp gradient. The gradient value is in decimal and must be between 0.01 and 0.08. For example a 0.05 gradient refers to a slope of 1:20, or a 5cm rise in level for every 100 cm of horizontal distance covered.
Example: '0.05'.

c) Average per passenger time lost due to delay between platform and bus doors: Enter the Average per passenger time lost due to delay or difference between platform and bus door opening, at the time of boarding the bus. This delay is presented in seconds and must be between 0 sec and 4 sec.
Example: '0'.

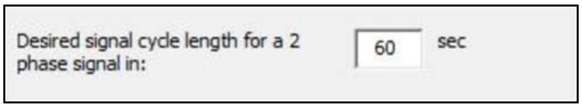
4.3.2.5 Green phase for buses (5):



a) Green phase for buses per direction without turning: Enter the value of Green phase for buses per direction (without turning) as a proportion of Signal cycle time. The proportion of signal cycle time (per direction) must be between 0.15 to 0.35.
Example: ‘0.25’.

b) Green phase for buses per turning phase (separate turning phase or dedicated bus phase): Enter the value of Green phase for buses per turning phase (separate turning phase including yellow) as a proportion of Signal cycle time. The proportion of signal cycle time (per direction) must be between 0.08 to 0.15.
Example: ‘0.08’

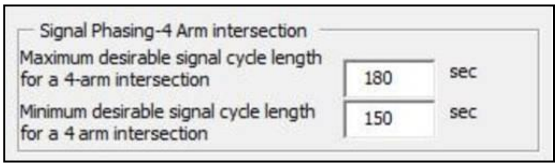
4.3.2.6 Desired Signal cycle length for a 2 phase signal in (6):



Enter the desirable signal Cycle length for a 2-phase signal. The signal cycle length is in second and must be between 30 sec and 90 sec.

Example: ’60’

4.3.2.7 Signal phasing 4-Arm Intersection (7):

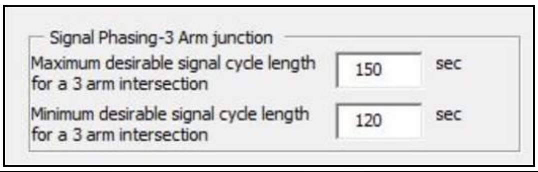


a) Maximum desirable signal cycle length for a 4-arm intersection: Input the maximum desirable value of Signal cycle length for 4-arm intersection. The signal cycle length is in second and must be between 150 sec and 300 sec.

Example: ’180’.

b) Minimum desirable signal cycle length for a 4-arm intersection: Input the minimum desirable value of Signal cycle length for 4-arm intersection. The signal cycle length is in second and must be between 120 sec and 150 sec.
Example: ’150’.

4.3.2.8 Signal phasing 3-Arm Intersection (8):

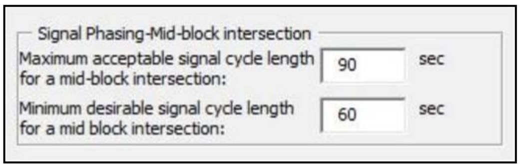


a) Maximum desirable signal cycle length for a 3-arm intersection: Input the maximum desirable value of Signal cycle length for 3-arm intersection. The signal cycle length is in second and must be between 120 sec and 150 sec.

Example: '150'.

b) Minimum desirable signal cycle length for a 3-arm intersection: Input the minimum desirable value of Signal cycle length for 3-arm intersection. The signal cycle length is in second must be between 90 sec and 120 sec.
Example: '120'.

4.3.2.9 Signal phasing Mid-block Intersection (9):



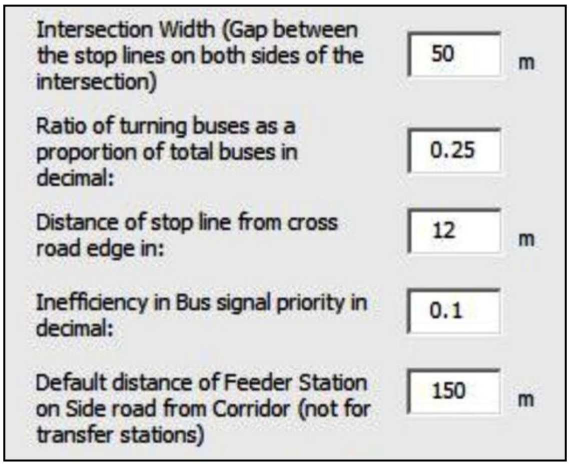
a) Maximum desirable signal cycle length for a Mid-block intersection: Input the maximum desirable value of Signal cycle length for Mid-block intersection. The signal cycle length is in second must be between 60 sec and 90 sec.

Example: '90'.

b) Minimum desirable signal cycle length for a Mid-block intersection: Input the minimum desirable value of Signal cycle length for Mid-block intersection. The signal cycle length is in second must be between 30 sec and 60 sec.

Example: '60'.

4.3.2.10 Intersection information (10):



a) Intersection Width (Gap between the stop lines on both sides of the intersection): Put the value of gap between the stop lines on two sides of the intersection. The value is in meter and must be between 14 m and 75 m.

Example: '50'.

b) Ratio of turning buses as a proportion of total buses in decimal: Enter the ratio of turning buses in comparison to total no of buses. The value is in decimal and must be between 0.01 and 0.99.

Example: ‘0.25’

c) Distance of stop line from cross road edge: Enter the perpendicular distance between the stop line and the edge of the cross road on the intersection. The value is in meter and must be between 1 m and 15 m.

Example: ‘12’

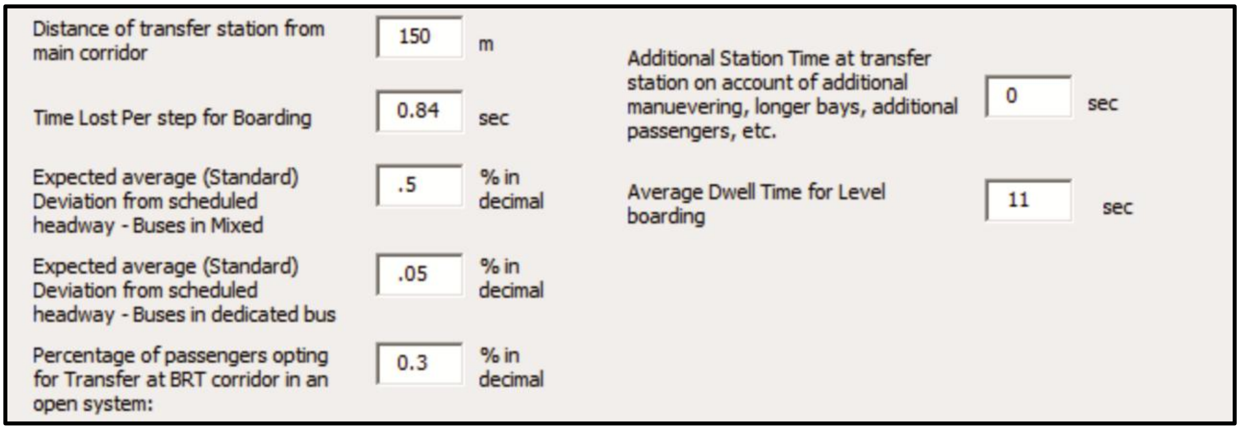
d) Inefficiency in bus priority signal, in decimal: There is bound to be some inefficiency in the bus signal priority. Enter the ratio of this inefficiency as a fraction of 1. For example 0.1 implies 10% times inefficient and 90% times efficient. The value is in percentage and must be between 1% and 50%.

Example: ‘0.1’

e) Default distance of Feeder Station on side road from corridor (not for transfer stations): Enter the average distance of Feeder bus station (i.e bus service that’s picks up and delivers passengers to a BRT system) from the designed BRT corridor. This distance is in meter and should be between 50 to 1000m.

Example: ‘150’

4.3.2.11 Transfer Station and Dwell Time(11):



a) *Distance of Transfer station from main corridor:* Enter the distance of nearest Transfer station (i.e. stations outside the corridor) from the corridor, only in case of closed system. The distance should be in meter and between 50 to 1000 meters.

Example: ‘150’

b) *Additional station time at Transfer station on account of additional maneuvering, longer bays, additional passengers, etc.:* Enter total walking time for passenger required at transfer station in case of additional maneuvering, longer bays, additional passengers, etc. This value measured in seconds and should be between 0 to 120 sec.

Example: ‘0’

c) *Time lost per step for boarding:* Enter the average time that passenger experienced to climb the single step inside the bus. The value presented in seconds and should be between 0 to 5 sec. Please note that the time lost per step used in the default values is 0.84 and is estimated on the basis of 6 alighting passengers at 0.14 second per passenger per step. For boarding from road level or low curb an additional delay of 0.36 seconds per passenger is observed and may be added on the total time lost. For example time lost per step for 6 passengers boarding from road level would be 0.5 X 6 = 3 seconds.

Example: ‘1’

d) *Expected average (standard) Deviation from scheduled headway – Buses in Mixed condition:* Enter the average deviation of buses from their scheduled headway on station, when buses are running in mixed condition, or entering the corridor from mixed condition in an open system. This value is a fraction indication and must be between 0 to 1.

Example: ‘0.50’

e) *Expected average (standard) Deviation from scheduled headway – Buses in dedicated bus lane:* Enter the average deviation of buses from their scheduled headway on station, when buses are running in dedicated bus lanes in a hybrid or a closed system. This value is a fraction indication percentage and must be between 0 to 1.

Example: ‘0.05’

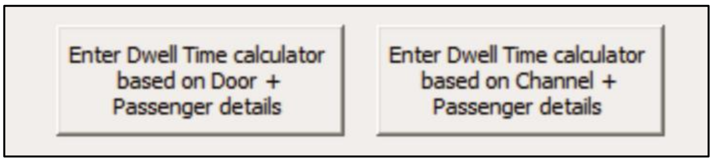
f) *Average Dwell Time for level boarding:* Enter the total dwell time for each bus on station in single file including boarding and alighting time of passenger and opening and closing time per door per operation. The value calculated in seconds and should be between 6 to 50 sec. You can use Dwell Time calculator to calculate the exact Dwell time according to given design. (Press appropriate tab, below this option, to calculate by Door + Passenger Details or by Channel + Passenger Details). The default value is 11 seconds.

Example: ‘14’

g) Percentage of Passengers opting to Interchange/transfer at corridor in an open system: Enter the percentage of passengers (as decimal or fraction) opting to transfer or interchange between bus routes to access or egress from the corridor in an open system. The value should be in decimal. The value should be between 0 and 0.99. The default value is 0.3.

Example” ‘0.25’

4.3.2.12 Dwell Time Calculator Form (12):



Enter Dwell Time calculator: Choose 'Dwell time calculator based on Door + Passenger Details' or 'Dwell time calculator based on Channel + Passenger Details' to estimate the exact Dwell time according to given design. When the user opts for either one of these options then only the dwell time calculator form opens as shown in figure below. In Door + Passenger details form information regarding average per passenger boarding alighting time and no. and width of doors is required. No. of channels is calculated by the tool. In Channel + Passenger details information regarding per passenger boarding and alighting time and no. of channels per door is required. In either case the dwell time calculated is for level boarding. For non level boarding time lost per step in put in 'c' above is added to the dwell time.

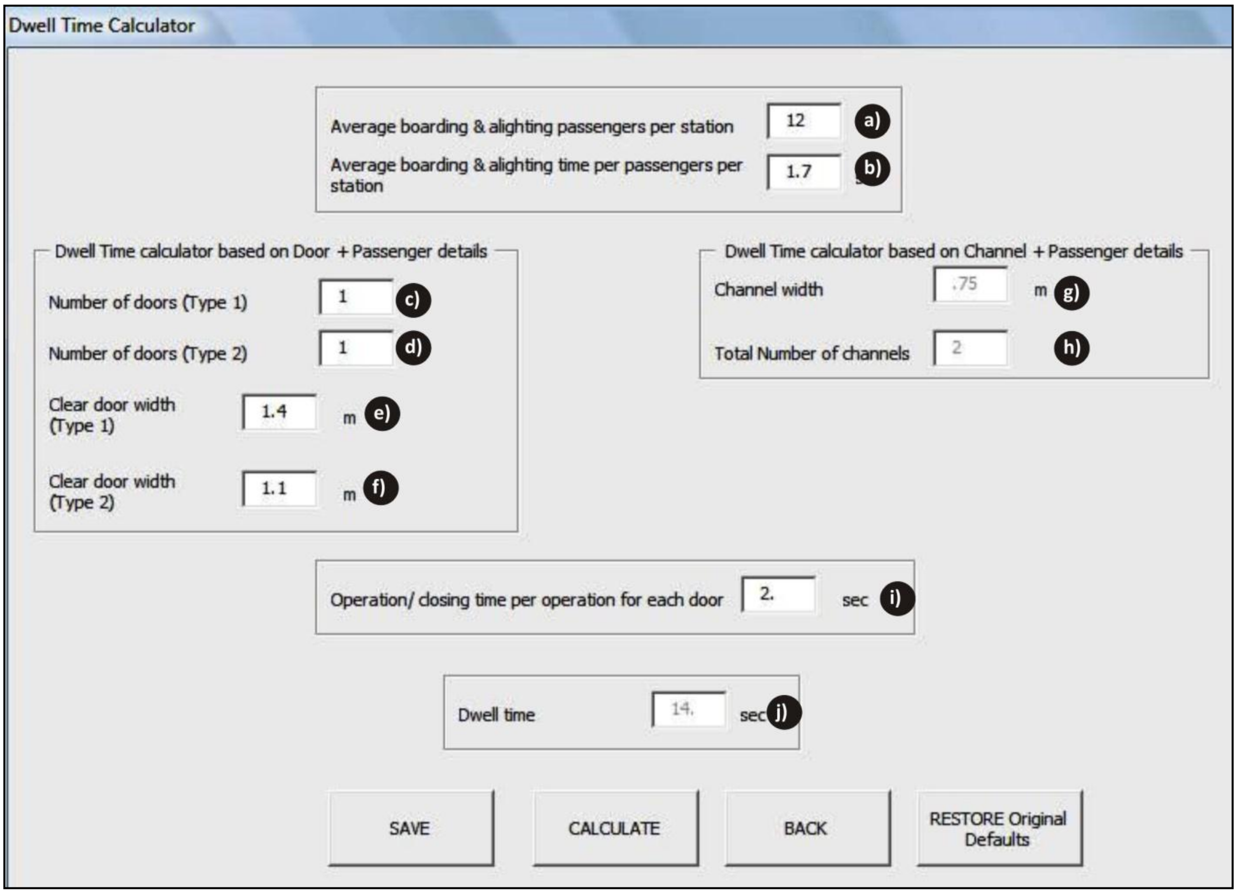


Figure 4-3: Dwell Time Calculator Form

a) *Average boarding + alighting passenger per station:* Enter the average total of passengers boarding or alighting each bus at a station. The value should be positive number and must be between 1 and 50.

   Example: '12'

b) *Average boarding /alighting time per passenger per channel:* Enter the average time taken per passenger to board the bus or alight from bus (in a single file) in base (level boarding) condition. The value measured in seconds and must be positive number and between 0.5 to 3 sec.

Example: '1.67'

c) *No. of doors (Type 1):* Enter the total number of specific door type (type 1) in a bus. The number should be positive and between 1 to 8. Care should be taken to input a value which is physically possible on the bus fleet type selected for the corridor. This option can be editable only if you choose 'Dwell time calculator based on Door + Passenger Details' tab.

Example: '1'

d) *No. of doors (Type 2):* Enter the total number of another specific door type (type 2) in a bus (if two types of doors exist otherwise put '0'). The number should be positive and between 0 to 8. Care should be taken to input a value which is physically possible on the bus fleet type selected for the corridor. This option can be editable only if you choose 'Dwell time calculator based on Door + Passenger Details' tab.

Example: '1'

e) *Clear door width (Type 1):* Enter the clear width of door excluding any railing, folded doors etc. for Type 1 door. (Sum of all doors in a single bus cannot exceed beyond 70 % of the length of the bus.) The value should be positive and between 0.6 to 4 meter. This option can be editable only if you choose 'Dwell time calculator based on Door + Passenger Details' tab. This entry may return an error if "Continue" option is chosen on the flash page. This is because the tool checks the total opening width against the bus length as selected during previous BEAD operations. In such a scenario, it is advised to input the calculated dwell time value directly in the "Default Values Form" and not use dwell time calculator.

Example: '1.4'

f) *Clear door width (Type 2):* Enter the clear width of door excluding any railing, folded doors etc. for Type 2 door if exist, otherwise put '0'. (Sum of all doors in a single bus cannot exceed beyond 70 % of the length of the bus.) The value should be positive and between 0.6 to 4 meter. This option can be editable only if you choose 'Dwell time calculator based on Door + Passenger Details' tab. This entry may return an error if "Continue" option is chosen on the flash page. This is because the tool checks the total opening width against the bus length as selected during previous BEAD operations. In such a scenario, it is advised to input the calculated dwell time value directly in the "Default Values Form" and not use dwell time calculator.

Example: '1.1'

g) *Channel width:* Enter the Clear width required for single file movement of passengers in and out of the bus door. (Should be higher than or equal to clear door width.) The value should be positive number and between 0.6 to 1.2 meters. This option can be editable only if you choose 'Dwell time calculator based on Channel + Passenger Details' tab.

Example: '0.75'

h) Total no. of channels: Enter the total number of channels required for single file movement of passengers in and out of the bus door. (Product of number of channels and width of channel cannot exceed 70 % of bus length.) The number should be positive and between 1 to 32. This option can be editable only if you choose 'Dwell time calculator based on Channel + Passenger Details' tab. This entry may return an error if "Continue" option is chosen on the flash page. This is because the tool checks the total opening width against the bus length as selected during previous BEAD operations. In such a scenario, it is advised to input the calculated dwell time value directly in the "Default Values Form" and not use dwell time calculator.

Example: '2'

i) Opening/Closing time per operation per door: Enter the total time required for single file movement of passengers in and out of the bus door. The value is in second and should be between 0.5 to 4 sec.

Example: '2'

j) Dwell Time: Enter the total dwell time for each bus on station in single file including boarding and alighting time of passenger and opening and closing time per door per operation. The value calculated in seconds and should be between 6 to 50 sec.

Example: '14'

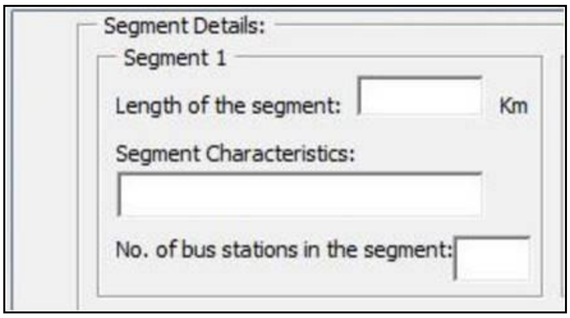
NOTE: Note: After inputting the values from a to j, press the calculate button to generate the Dwell time. To use the calculated dwell time in the (4.3.2.11-f) above on Default form , use the 'Save' button. Press back button after finishing operations on this form to go back to Default Values Form.

4.4 User Form 2: Segment Details:

Figure 4-4 shows the image of the second user form. The inputs required in this form are related to the no. and type of segment division of the corridor. A maximum of 20 and a minimum of 1 different segments (differing by design features) can be defined for each corridor.

Figure 4-4: Showing the 2nd user form

4.4.1.1 Segment Details (1 to 20):



a) Length of segment: Enter the length of the segment in kilometer. The total of all the segment lengths should be equal to the total length of the corridor as entered in 'BEAD Model Input Page. Only numerical value should be entered here and greater than 0 km.

   Example: '5'.

b) Segments Characteristics: Enter the characteristic of the segment. The characteristic type can be decided by the user based on different design type or existing site condition type.

   Example: '4-arm roundabout intersections with cross BRT'

c) No. of bus station in the segment: Enter the no. of bus stations falling in this particular segment. The value must be numerical and greater than 0.

   Example: '10'.

- Note: The number of active segment details fields would be equal to the no. of segments entered in 'BEAD Model Input Page.' The rest of the fields would be inactive. The tool can take a maximum 20 segments for analysis.

4.5 User Form 3: BRTS General Inputs:

Figure 4-5 shows the image of the third user form – BRTS General Inputs. The user now starts building the case for analysis of all the segments in a sequential manner. The tool would now ask for the inputs for the first segment (using five forms - forms 3 to 7) and generate results for that particular segment. Once the analysis is complete for that segment the user would be brought back to this form in order to analyze the next segment.

On this form the user has to input the general information of the segment like the intersection type, bus lane type, ROW width, etc. Each of the inputs required have been explained in detail below. It is important to know that details entered for junctions, stations, etc. in the segment forms 3 to 7 is considered common for all locations in the segment.

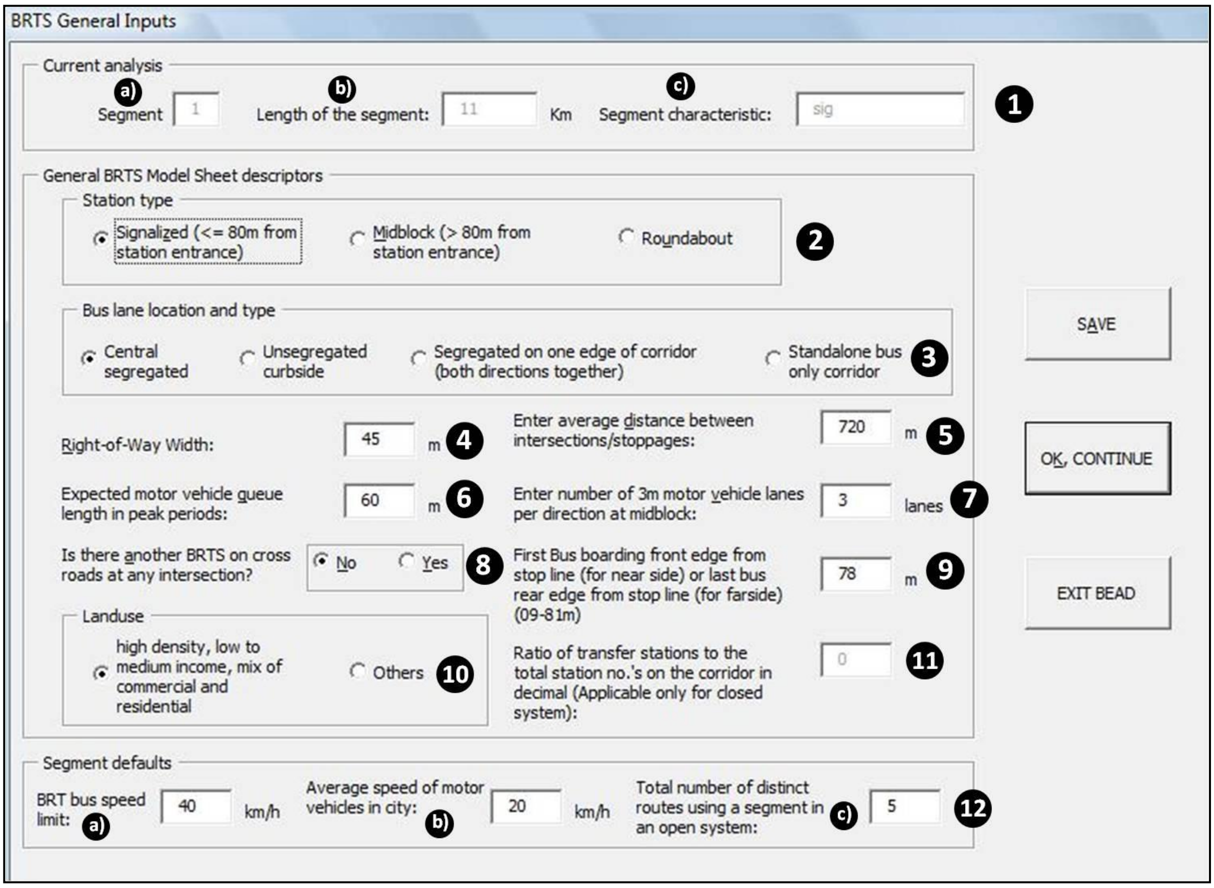
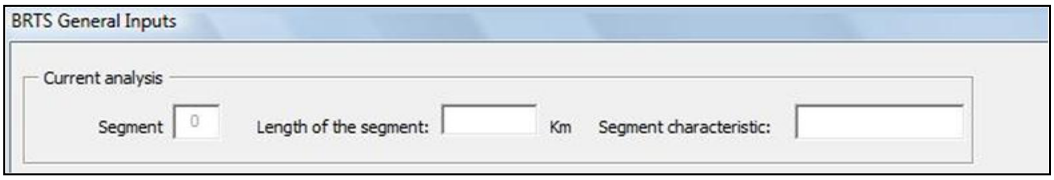


Figure 4-5: Showing User Form 3: BRTS General Inputs

4.5.1 Current Analysis (1):

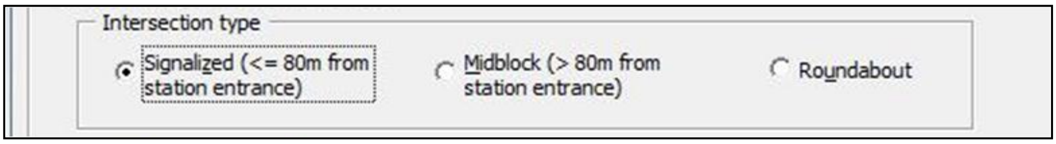


a) **Segment-**The value would be self generated from the previous form and it would show segment no. currently being analyzed.

b) **Length of the segment-** The value would be self generated from the previous form and it would show the length of the segment currently being analyzed.

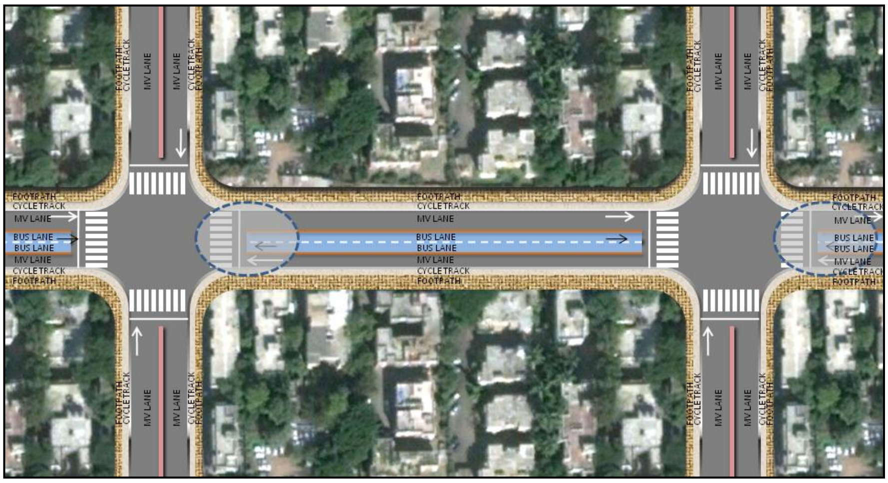
c) **Segment characteristic -**The value would be self generated from the previous form and it would show the characteristics of the segment currently being analyzed.

4.5.2 Station Type (2):

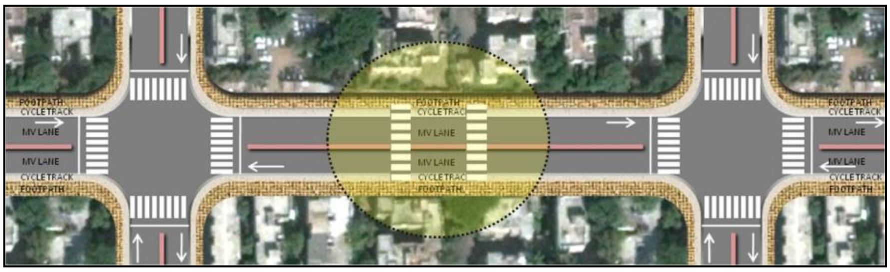


This segment defines the BRTS station type based on its proximity to a type of intersection or crossing. Select any one type of intersection type from the given three options. For stations located close to the intersection, this form provides common inputs for pedestrian access, crossing (to station) as well as inputs for junction control. For midblock station the inputs presented in this form are used to define the pedestrian crossing/access at the station only while a separate form is activated to allow inputs for vehicular crossing that may be located between two mid block stations.

- Intersection type in corridor depends upon the distance of a controlled full cross road (vehicular intersection) from station entrance. If the distance is less than or equal to 80m from station entrance and the junction is a signalized junction, then it is considered '***Signalized'***. If it is greater than 80m from station entrance it is '***Midblock'***. If the station is less than 80m from the intersection but the junction is a roundabout, then click '***Roundabout'***.
- If ***Midblock*** intersection type is selected then an additional user form (form 5) specifically related to midblock intersection would be activated after the completion of the next user form.
- The figure below show conceptual layout of a signalized intersection.

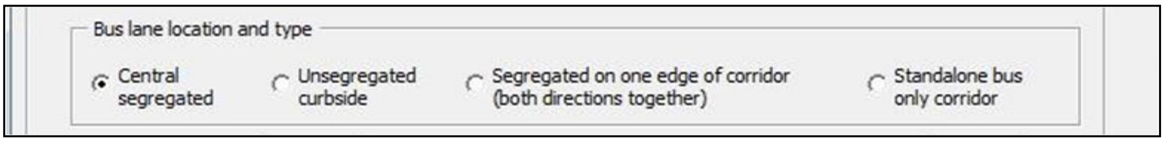


- The figure below show conceptual layout of a midblock intersection with signalized pedestrian crossing.



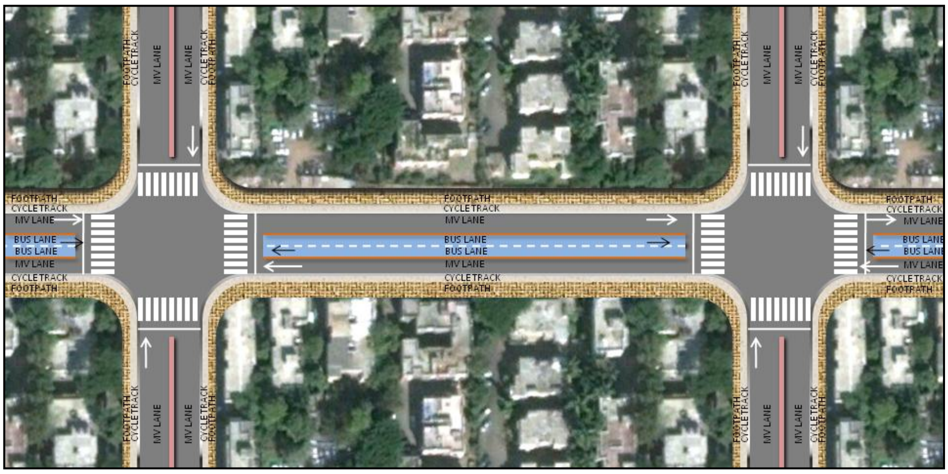
- The figure below show conceptual layout of a roundabout intersection.

4.5.3 Bus lane location and type (3):



Select one of the options, from the given four choices, depending upon the type of bus lane location provided/proposed in the segment being analyzed. Each of the bus lane type has been explained diagrammatically below:

- **Central Segregated Bus Lanes (Shown in figure below)**



- **Un-segregated Bus Lanes (Shown in figure below)**

- **Segregated Bus Lanes on one edge (Shown in figure below).**

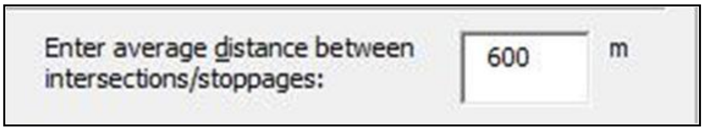
- **Standalone bus lanes (Shown in figure below).**

4.5.4 Right of Way width (4):-

Enter the width of ROW for the segment being analyzed in meters.

- Right of Way (ROW) of the corridor is the usable width of the corridor (between the property edges on either side) which is available for street development including carriageway, bus lanes, cycle tracks, footpath, service lane, etc.
- This width is to be input in meters and must have a value between 9m and 150m.
- Widths less than 24m are only usable by stand alone bus lane (in 4.5.3 above) design.

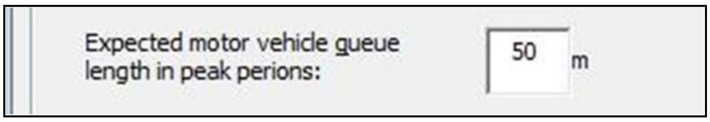
4.5.5 Enter average distance between intersections (5):



Enter the average distance between intersections/stoppages in meters and must have a value between 200m and 1000m.

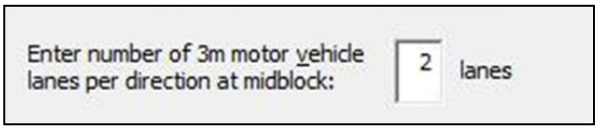
- This is the average distance between two bus stops in segment.
- Average distance can be calculated by dividing total length of the segment by the number of bus stops/stations in the segment.

4.5.6 Motor vehicle queue length (6):



Enter the length of the expected motor vehicle queue in peak periods (meters). It must have a value greater than 0 and less than average distance between two bus stops or intersections (4.5.5).

4.5.7 No. of 3mtr wide MV lanes per direction at mid-block (7):



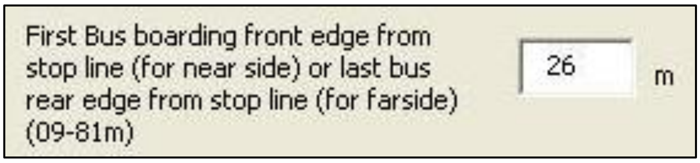
Enter the number of 3m MV lanes for each direction.

- It is depend upon the width of the carriageway in final cross section. (Width/3m, 0). Value should be 0 for standalone BRTS.

4.5.8 BRTS on cross road at a junction (8):

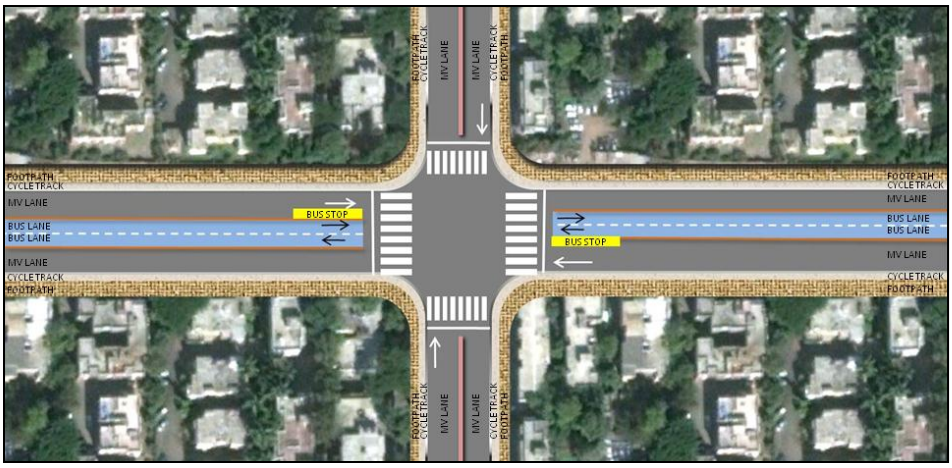
Click ***Yes*** or ***No*** depending on whether there is another BRT crossing at intersections in the segment currently being analyzed. If BRTS on cross road option is selected, then intersection type can only be a 4 arm intersection.

4.5.9 Distance from front of first bus or rear of last bus (9):

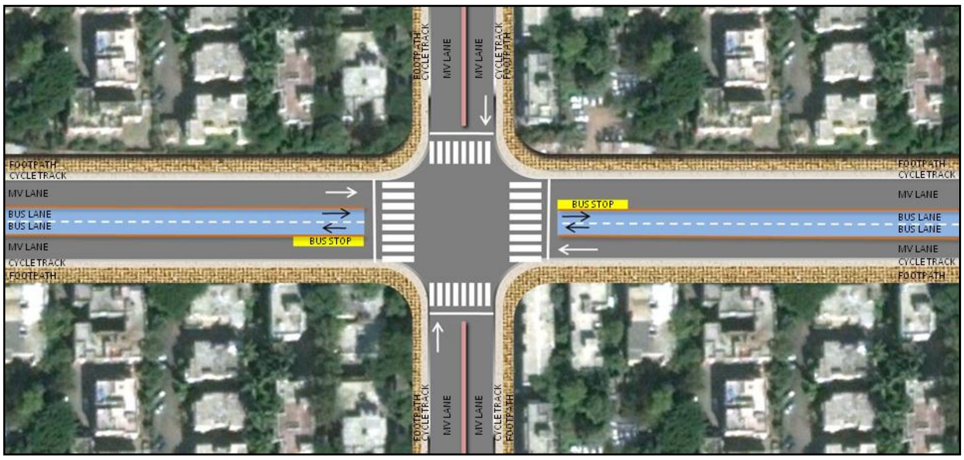


Enter the distance of front edge of first bus stop from stop line or nearest intersection for near side (explained below) stops in meters. Or rear edge of last bus stop from stop line or nearest intersection for far side (explained below) stops. The value should be between 0 to 80m.

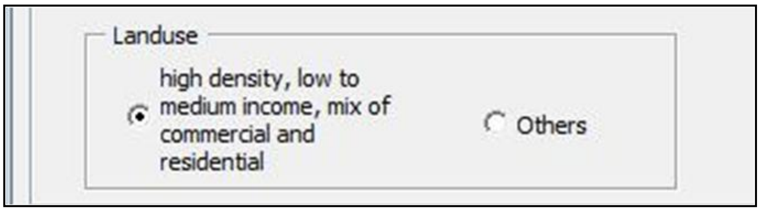
Near side station layout (Shown in figure below):



Far side station layout (Shown in figure below):



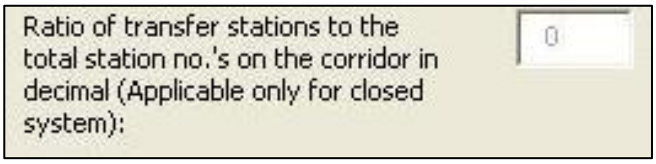
4.5.10 Land use (10):



Enter the predominant type of land use along the segment being analyzed.

Here first option is for high catchment on the periphery of the corridor. In Indian context bus mode catchment is low or medium income communities. These are generally dense neighbourhoods with smaller dwelling units, and mixed land use. All other indicators of land use point to a high catchment of private motor vehicle traffic along the corridor, and this is what refers to 'others' (or the second option). These two broad categories were used to divide the percentage of expected commuter catchment from the corridor in to two groups.

4.5.11 Ratio of transfer stations to the total station no.'s (11):



Enter the ratio of transfer stations (i.e. stations outside the corridor) to the total bus stations on corridor, only in case of closed system. The ratio must be in decimal.

4.5.12 Segment Defaults (12):

The user input fields under segment defaults have been provided with default values and are repeated from the default tab on the main BEAD page. These boxes reflect values from those edited in the defaults page (above). However the user is allowed to change them here and include segment specific values. These are:

a) **BRT bus speed limit:** Enter the Legal or posted speed limit or peak design speed (in case it is less than legal speed limit) of buses in corridor as per design. (As per current motor vehicle norms. The value must be in km/hr and between 10 km/hr and 100 km/hr). Example: '40'.

b) **Average speed of motor vehicles in city:** Enter Average motor speed in the base or horizon year (depending on the period of assessment) on the corridor. Where estimates of corridor average speeds are not known the average speed of motor vehicles in the city may be used. (The value should be in km/hr and between 5 km/hr and 50 km/hr). Example: '20'.

c) **Total number of distinct routes using a segment in an open system:** Total number of distinct routes using a segment in an open system: Enter the total number of routes other than BRT using a same segment in an open system. Here routes which overlap for more than the average trip length in the corridor/city, should be considered as common routes or 'not distinct routes'. The value should be a number and between 2 and 100 (routes). Example: '5'.

4.6 User Form 4: Junction Model Inputs:

Figure 4-6 shows the image of the fourth user form – Junction Model Inputs. This form requires the user to input junction specific design details for the segment being analyzed. Where mid-block stations are selected, station cum pedestrian crossing details are entered in this form; for junction stations, station cum intersection details are entered in this form.

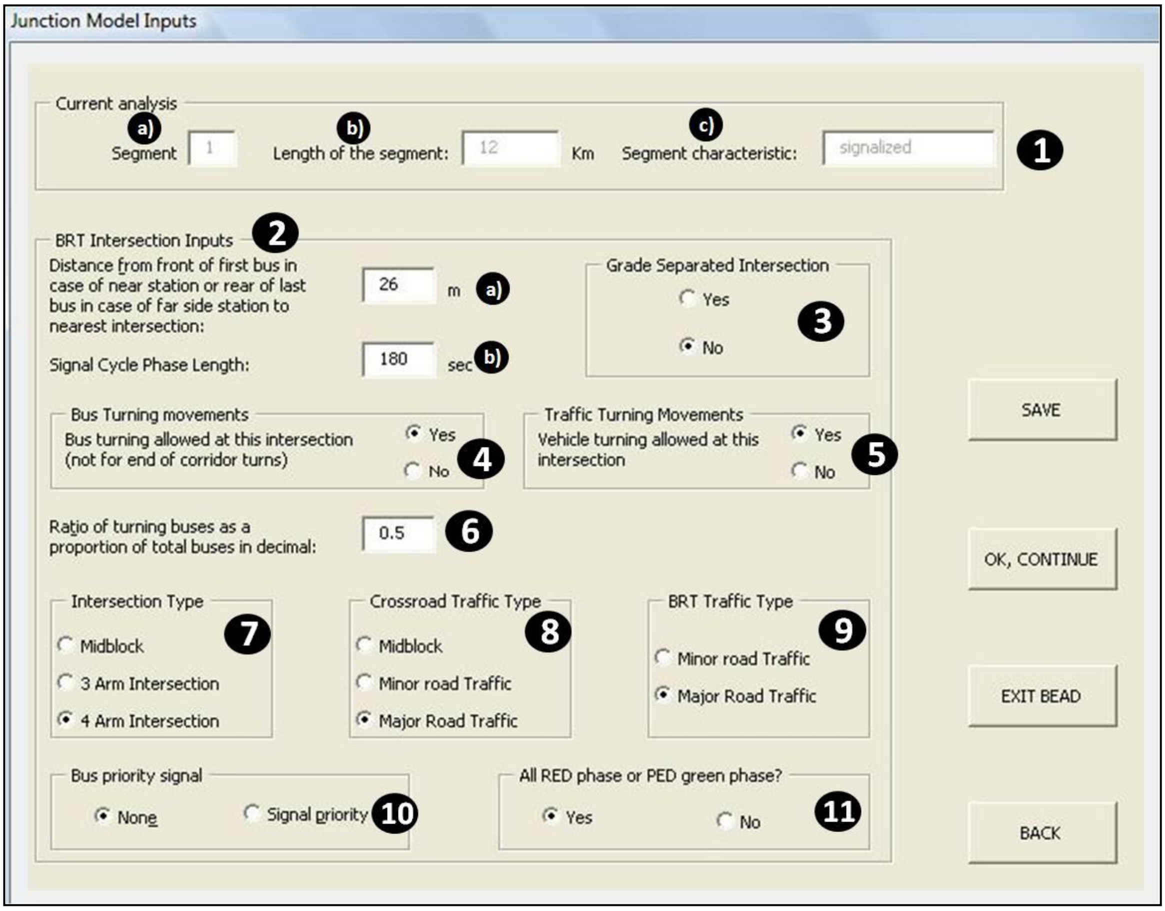
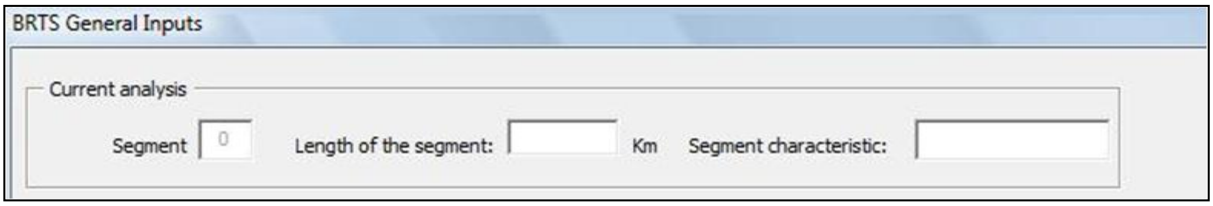


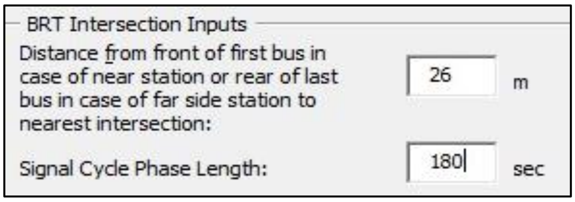
Figure 4-6: Showing user form 4: Junction Model Inputs

4.6.1 Current Analysis (1):



a) **Segment-** The value would be self generated from the previous form and it would show segment no. currently being analyzed.
b) **Length of the segment-** The value would be self generated from the previous form and it would show the length of the segment currently being analyzed.
c) **Segment characteristic** - The value would be self generated from the previous form and it would show the characteristics of the segment currently being analyzed.

4.6.2 BRT Intersection Inputs (2):

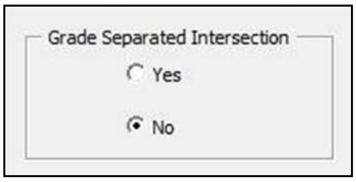


a) **First Bus boarding front edge from stop line (for near side) or last bus rear edge from stop line (for far side) (9-80 m):** Enter the distance between front edge of first bus boarding at the station (for near side stations) or rear edge of last bus (for far side stations) from stop line. The distance should be in meter. The value must be between 9m to 80m. The standard value is 26 meter.

- In case of Mid-block station, the value should be less than half the average gap between stations. (Distance measured from pedestrian crossing at mid-block station). And if Mid-block is at intersection, then value can be estimated by adding 10m in Distance of first bus from start line of bus stop ***(4.5.9).***

b) **Signal cycle length:** Enter the Signal cycle time at junction/mid-block. The cycle length is in seconds. The value can be between 30 sec to 600 sec. If the junction is grade separated or signal free (4.6.3) this value **must be** ‘60’ sec. The user is advised that, the tool adjust the input signal cycle length as per the other design inputs provided. This revised signal cycle is presented on Result Form and can be modified as per requirement of user on Edit Result Form.

4.6.3 Grade separated Intersection (3):



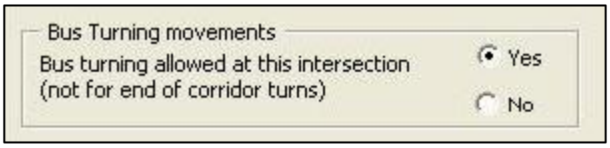
Note: Grade separated intersections shall be read as intersections where no signal control exists (mainly for straight moving buses and other motor vehicles) and which are signal free, due to design interventions which may include being grade separated.

Choose whether the junction in the segment is grade separated or not.

The option should be NO in case of vehicular turning is allowed in corridor (4.6.5). The tool allows defining turning buses on a grade separated intersection, to account for full cloverleaf, which act as signal free junctions, but where turning of buses is possible on exit ramps.

Note: This option can be used to define an elevated or underground (tunnel) BRTS, by selecting grade separated intersection, grade separated pedestrian crossing (4.8.10) and grade separated intersection between mid block stations (4.7.3), if mid block station option is selected in 4.5.2 above.

4.6.4 Bus Turning at Intersection (4):



Select the option whether bus turning is allowed at the intersection or not.

- Bus turning is not allowed in any segments in a closed system (4.3.1.1). For an open system at least one of the segments shall have bus turning option selected. The tool runs this checks and returns an error in the last segment user form no. 4; if none of the segments in a corridor (with an open option selected in 4.3.1.1) have bus turning allowed option selected.

Note: If bus turning option is selected then the tool assumes that all turns for buses are allowed (including all turns for cross BRTS if cross BRTS option is selected 0). It is not possible to selectively allow or disallow certain turns. Also Bus turning option cannot be selected at a grade separated intersection in any form of segregated bus lanes as turning of buses at such intersections or cloverleaf would only be possible in mixed conditions. Hence where cloverleaf situations on BRTS are to be simulated an imaginary signal free intersection should be defined at the start of exit ramps and un-segregated bus lanes with overtaking lanes should be selected.

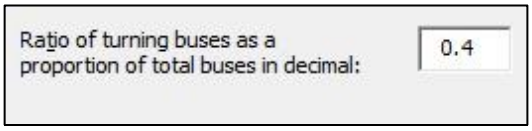
4.6.5 Traffic turning movements (5):

Choose whether vehicular turning is allowed at this intersection or not.

- Vehicular turning is allowed (at least one of the segments) in an open system and in case junction type is selected as a 3 arm intersection (4.6.7).
- The tool does not allow vehicle turning when it is closed system, grade separated junctions or when mid block station option is selected.

Note: If vehicle turning option is selected then the tool assumes that all turns for vehicles are allowed. It is not possible to selectively allow or disallow certain turns.

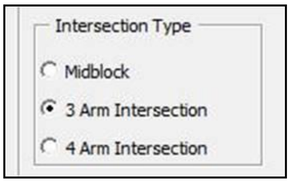
4.6.6 Bus turning movements (6):



Enter the percentage of turning buses as compared to the total number of buses in decimal.

- This field would be active only in case of open system selected in 4.3.1.1.

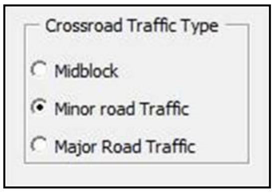
4.6.7 Intersection Type (7):



Choose the type of intersection associated with the station type selected (4.5.2).

- If BRTS on cross road option is selected, then intersection type can only be a 4 arm intersection.
- Mid block should be selected if the station location/type selected is mid-block in 4.5.2 above.

4.6.8 Crossroad traffic type (8):



Choose one of the crossroad traffic types.

- Mid block should be selected if the station location/type selected is mid-block in 4.5.2 above.
- Minor Road Traffic is selected when traffic meeting at intersection is considerably less than the expected capacity or considerably less than the traffic along the BRTS corridor on which the study segment is located.
- Major Road Traffic is when traffic meeting at intersection is up to the capacity of the road or considerably higher than the BRTS corridor under study.

Note: This option is for Vehicular traffic lanes running along the corridor. Traffic condition for BRT lanes can be different from those in MV lanes on the corridor or along the cross road.

4.6.9 BRT Corridor (analysis corridor) traffic type (9):

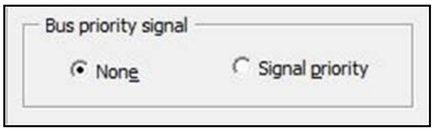
Choose the type of BRT corridor traffic.

- BRT corridor (general vehicular or MV lane) traffic conditions can be different from vehicular traffic condition at cross road.
- Minor road traffic is selected when traffic of general motor vehicles (in MV lanes) along the BRT corridor (under study) meeting at intersection is considerably less than the expected capacity or considerably less than the traffic along cross road.

- Major road Traffic is selected when traffic of general motor vehicles (in MV lanes) along the BRT corridor (under study) meeting at intersection is considerably higher than the expected capacity or considerably more than the traffic along cross road.

Note: This option is for Vehicular traffic lanes running along the corridor. Traffic condition for BRT lanes can be different from those in MV lanes on the corridor or along the cross road. Also it is possible to select both minor and both major roads for 4.6.8 and 4.6.9.

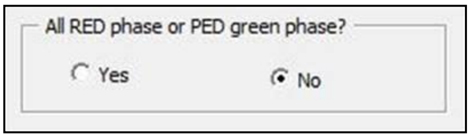
4.6.10 Bus Priority Signal (10):



Choose whether bus priority signal would be adopted for signal design at the intersection/ped. crossing.

- Bus priority signal prioritizes buses over general traffic at a signalized intersection in order to reduce delays for bus passengers.
- Bus priority signal cannot not be selected when it is a Grade separated or signal free junction or when there are no segregated bus lanes for buses (buses running in mixed condition).

4.6.11 All RED phase for vehicles or dedicated Pedestrian Green phase (11):



Choose whether dedicated pedestrian phase will be included in the signal system design, allowing pedestrians to cross in all directions in a single phase. All red phase cannot be selected if grade separated (or signal free intersection) option is selected in 4.6.3 above.

4.7 User Form 5: Junction Midblock Model Inputs:

This form would become active only if in 4.5.2; Intersection Type is selected as ***Midblock (junction >than 80m from station entrance)***.

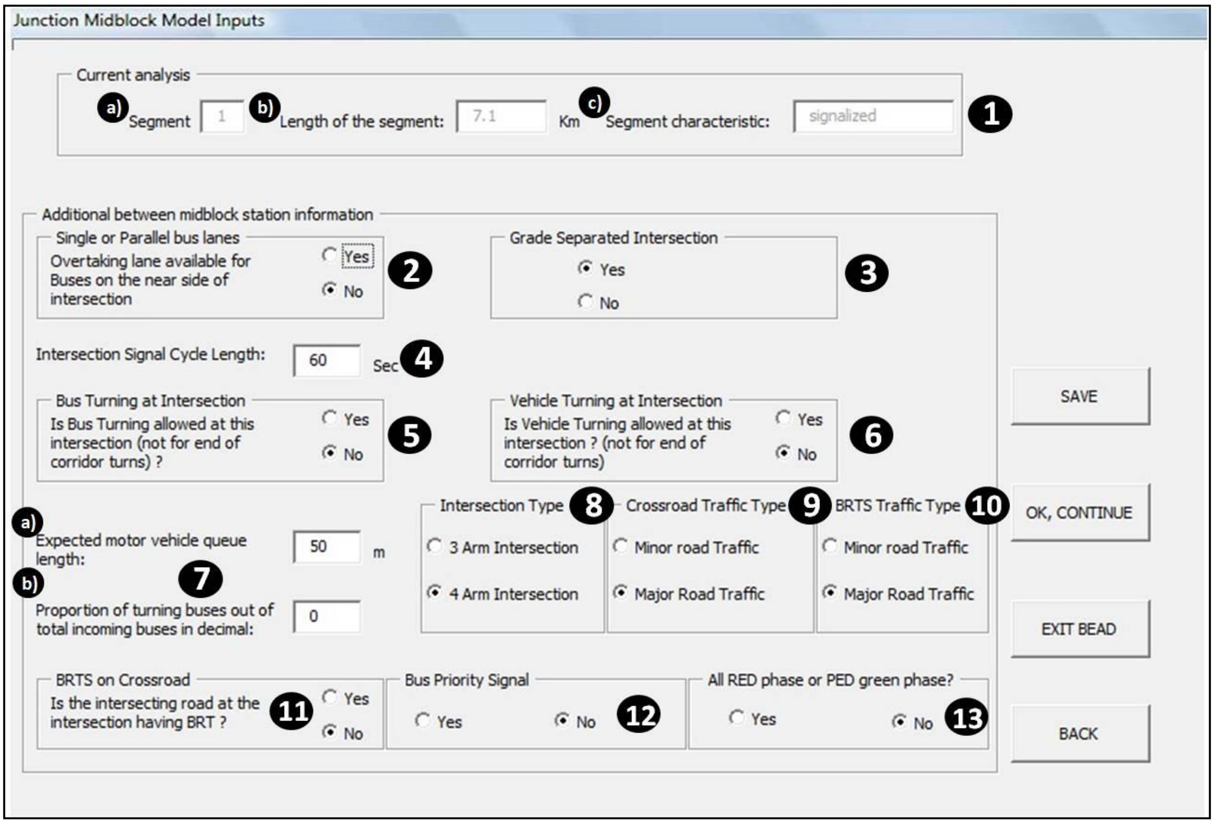
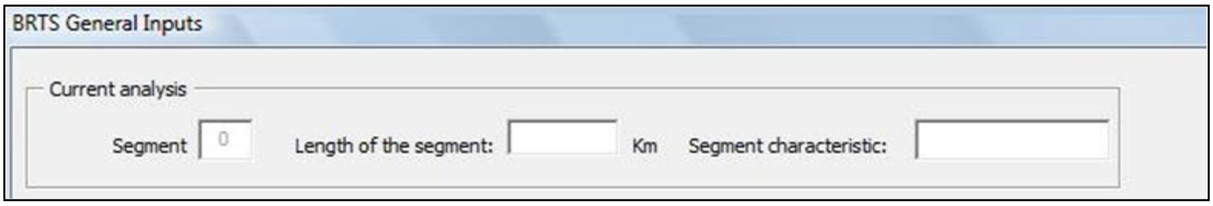


Figure 4-7: Showing User Form 5: Junction Midblock Model Inputs

4.7.1 Current analysis (1):

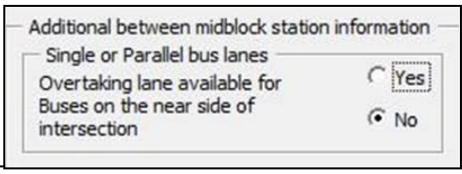


a) **Segment-** The value would be self generated from the previous form and it would show segment no. currently being analyzed.

b) **Length of the segment-** The value would be self generated from the previous form and it would show the length of the segment currently being analyzed.

c) **Segment characteristic** - The value would be self generated from the previous form and it would show the characteristics of the segment currently being analyzed.

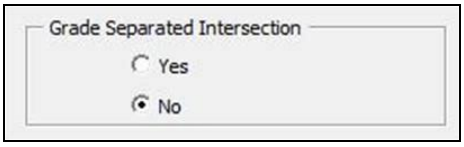
4.7.2 Single or parallel bus lanes (2):



Choose either ***single*** or ***parallel*** bus lane type depending on whether overtaking lane is present/ proposed for buses on the ***Near side (Refer 4.5.9)***of intersection between two ***mid-block stations (Refer 4.5.9)***.

- Overtaking lane requirement, on near side, may be based on whether the system allows bus turning at junctions or not.
- Where bus turning is permitted at junctions, the tool designs the signal phasing with the overtaking lane as a dedicated turning lane (with common bus turning phase for both directions).
- The bus boarding lane is treated as straight bus movement lane with a common phase with straight moving vehicles; or both lanes moving together in a common phase with straight motor vehicles (for a closed system or for segments where bus turning is not allowed at intersections even with an open system).

4.7.3 Grade Separated Intersection (3):



Note: Grade separated intersections shall be read as intersections where no signal control exists (mainly for straight moving buses and other motor vehicles) and which are signal free, due to design interventions which may include being grade separated.

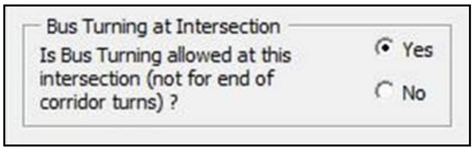
Choose whether Yes or No; If a particular junction between two midblock stations in corridor is grade separated (or signal free) or not.

Note: For mid block stations between two junction stations, where no intersection exists between two consecutive stations, grade separated option shall be selected as 'yes', at an imaginary intersection location which can be an important side/feeder road meeting the corridor or at the entrance of an important complex/institution which acts as major trip generator. In that scenario the tool will estimate performance based on 'zero' delay for buses due to an intersection between two mid block stations; while walking distances will be estimated from the important side road or property entrance, designated as an imaginary intersection location.

4.7.4 Intersection Signal cycle length (4):

Enter the Signal cycle time at intersection between two mid-block stations in seconds (Sec). The value can be between 30 sec to 600 sec. The user is advised that, the tool adjust the input signal cycle length as per the other design inputs provided. This revised signal cycle is presented on Result Form and can be modified as per requirement of user on Edit Result Form.

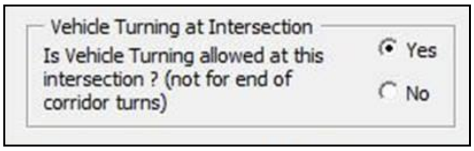
4.7.5 Bus Turning at Intersection (5):



Select the option (Yes/No) whether bus turning is allowed at intersection between two mid-block stations or not. The option must be selected as ‘No’, if closed system operations are selected in 4.3.1.1 above.

Note: Also Bus turning option cannot be selected at a grade separated intersection in any form of segregated bus lanes as turning of buses at such intersections or cloverleaf would only be possible in mixed conditions. Hence where cloverleaf situations on BRTS are to be simulated an imaginary signal free intersection should be defined at the start of exit ramps and un-segregated bus lanes with overtaking lanes should be selected.

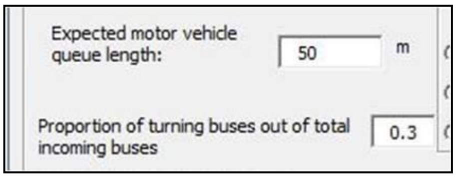
4.7.6 Vehicle Turning at Intersection (6):



Choose whether (Yes/No) vehicular turning is allowed at intersection between two mid-block stations.

- Vehicular turning is allowed in open system and in case of 3-Arm junction.
- It is not allowed when it is closed system or grade separated junction or if semi low floor urban bus running in corridor.

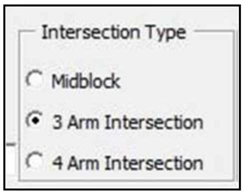
4.7.7 Vehicle queue length and Turning buses (7):



a) ***Expected motor vehicle queue length:*** Enter the vehicle queue length on MV lanes during peak hours at intersection between two mid-block stations in meter (m).
   - This value should be less than average spacing between stations

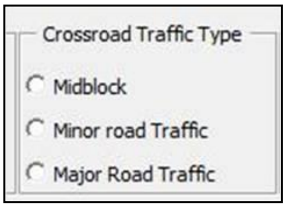
b) ***Proportion of turning buses out of total buses operating on the corridor:*** It is the ratio of turning buses at intersection between two mid-block stations to the total number of buses running on the corridor. This will have a value less than 1. The value must be 0 if the system operation selected is closed or if bus turning is not allowed at intersections for this segment. If bus turning is permitted at junctions in this segment, a value between 0 and 1 should be input here.

4.7.8 Intersection Type (8)



Choose the type of intersection associated with the station type selected (4.5.2). If BRTS on cross road option is selected (4.7.3), then intersection type can only be a 4 arm intersection.

4.7.9 Cross road Traffic Type (9)



Choose one of the crossroad traffic types.

- Minor Road Traffic is when traffic meeting at intersection is considerably less than the expected capacity or considerably less than the traffic along the BRTS corridor on which the study station is located.
- Major Road Traffic is when traffic meeting at intersection is up to the capacity of the road or considerably higher than the BRTS corridor under study. This option is for Vehicular traffic lanes running along the corridor. Traffic condition for BRT lanes can be different from those in corridor.

Note: This option is for Vehicular traffic lanes running along the corridor. Traffic condition for BRT lanes can be different from those in MV lanes on the corridor or along the cross road.

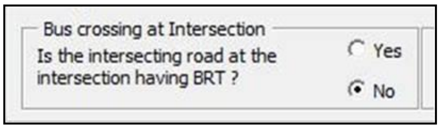
4.7.10 BRTS Traffic Type (10)

Choose the type of BRT traffic.

- BRT corridor (general vehicular or MV lane) traffic conditions can be different from vehicular traffic condition at cross road.
- Minor road traffic is selected when traffic of general motor vehicles (in MV lanes) along the BRT corridor (under study) meeting at intersection is considerably less than the expected capacity or considerably less than the traffic along cross road.
- Major road Traffic is selected when traffic of general motor vehicles (in MV lanes) along the BRT corridor (under study) meeting at intersection is considerably higher than the expected capacity or considerably more than the traffic along cross road.

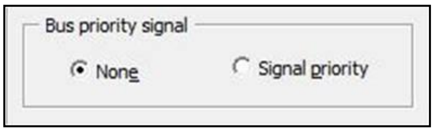
Note: This option is for Vehicular traffic lanes running along the corridor. Traffic condition for BRT lanes can be different from those in MV lanes on the corridor or along the cross road. Also it is possible to select both minor and both major roads for 4.7.9 and 4.7.10 4.6.9.

4.7.11 BRTs On Cross Road (11)



Choose whether any other BRT corridor intersects (at intersection) the segment being analyzed.

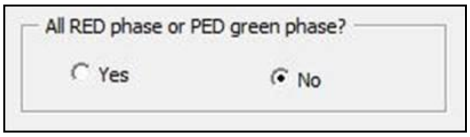
4.7.12 Bus Priority Signal (12)



Choose whether bus priority signal would be adopted for signal design at the intersection/ped. crossing.

- Bus priority signal prioritizes buses over general traffic at a signalized intersection in order to reduce delays for bus passengers.
- Bus priority signal cannot not be selected when it is a Grade separated or signal free junction or when there are no segregated bus lanes for buses (buses running in mixed condition).

4.7.13 All RED phase for vehicles or dedicated Pedestrian Green phase?(13):



Choose whether Pedestrian priority signal would be adopted.

4.8 User Form 6: Station Design:

Figure 4-8 shows the image of the sixth user form – Station Design. This form requires the user to input station specific design details for the segment being analyzed.

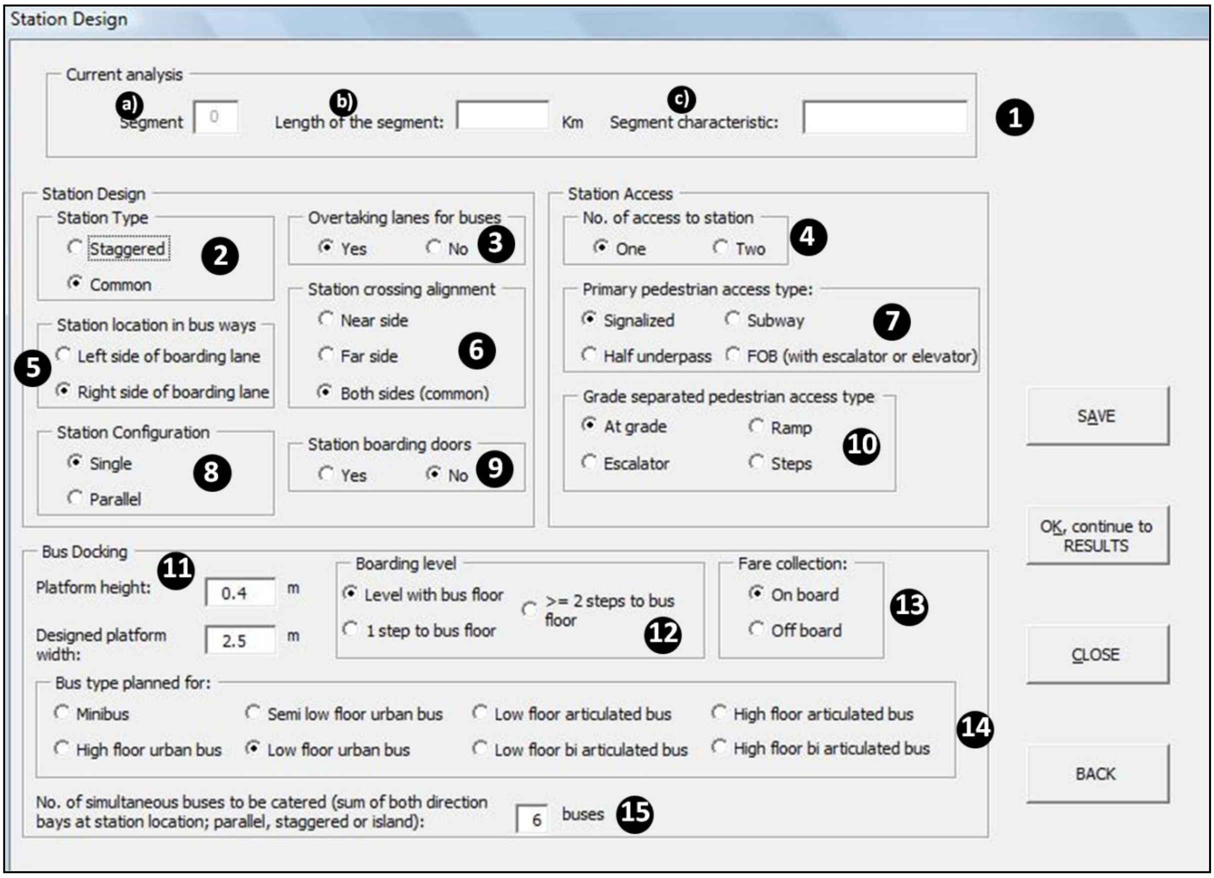
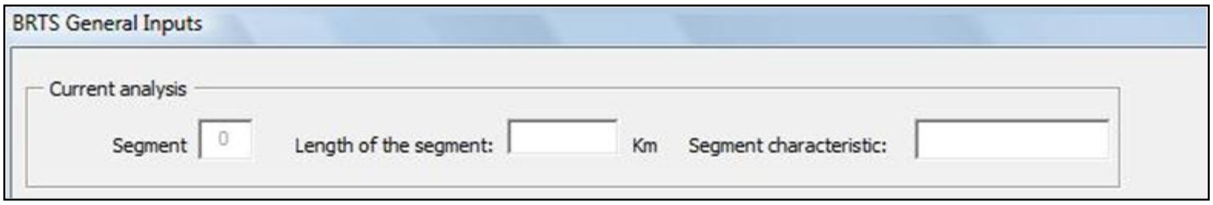


Figure 4-8: User Form 6: Station Design

4.8.1 Current analysis (1):

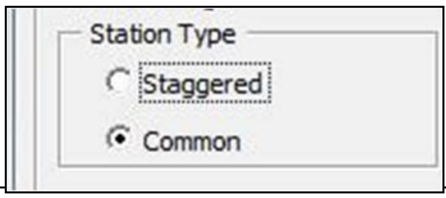


d) **Segment-** The value would be self generated from the previous form and it would show segment no. currently being analyzed.

e) **Length of the segment-** The value would be self generated from the previous form and it would show the length of the segment currently being analyzed.

f) **Segment characteristic** - The value would be self generated from the previous form and it would show the characteristics of the segment currently being analyzed.

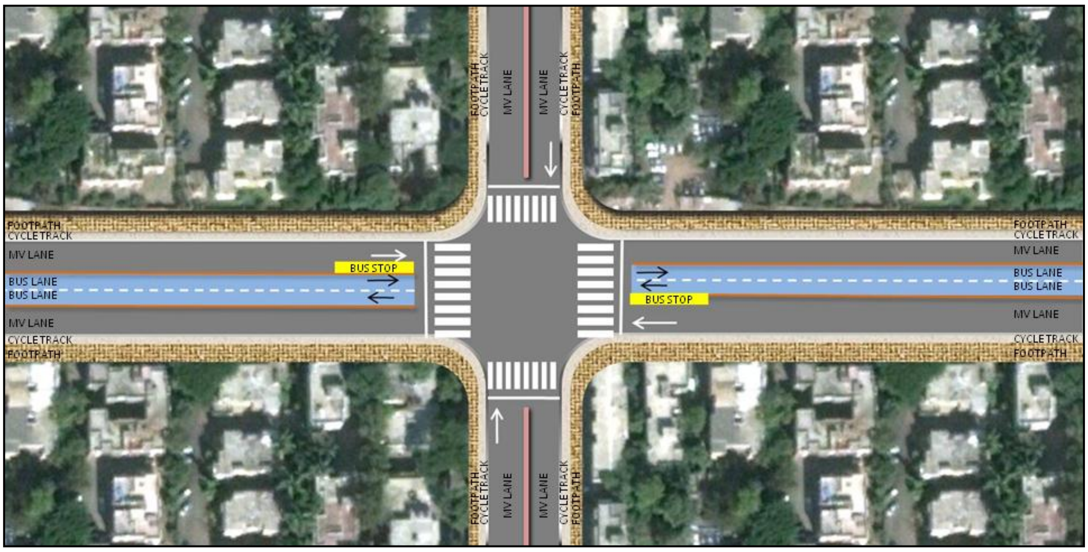
4.8.2 Station Type (2):



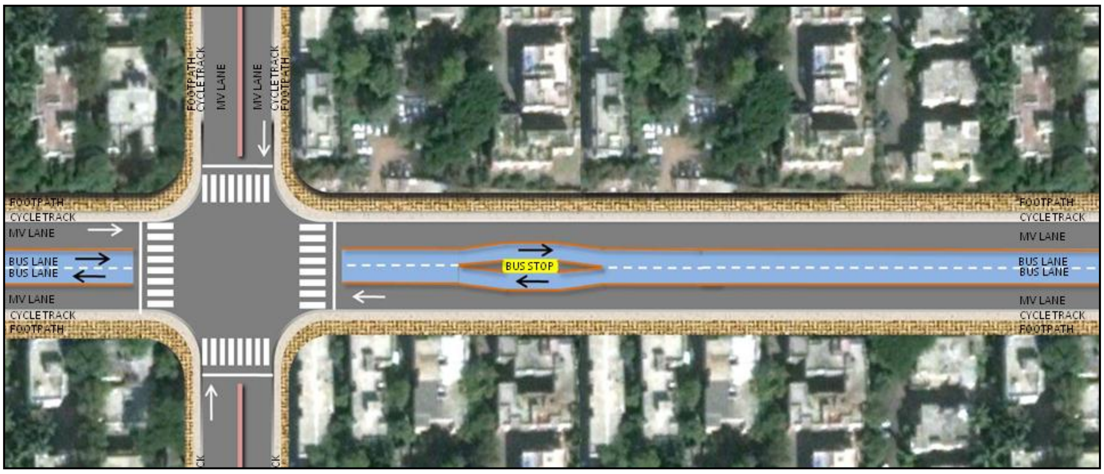
Choose one type of station.

- Staggered stations are stations dedicated to or serving only one direction bus movement. Hence two stations are provided at each location for two different direction of bus movement.
- Common stations are stations dedicated to or serving both directions of bus movement along the two longitudinal edges of the station.

Figure below presents the graphical representation of **staggered station**s.



Common: Common that is at the center of BRT bus lanes (Figure below).



4.8.3 Overtaking Lanes for buses (3):

Choose whether designed bus stations are with overtaking lanes or without overtaking lanes.

- Overtaking lane is used for turning buses while the boarding lane is designated for straight moving buses.
- Overtaking lanes help in decreasing delays for straight moving buses.

- Over taking lane option should be selected when parallel bus station option is selected (4.8.6) or un-segregated curbside bus lane is chosen (4.5.3) on the General Input Form.

Figure below presents the graphical representation of station with ***Overtaking Lanes***

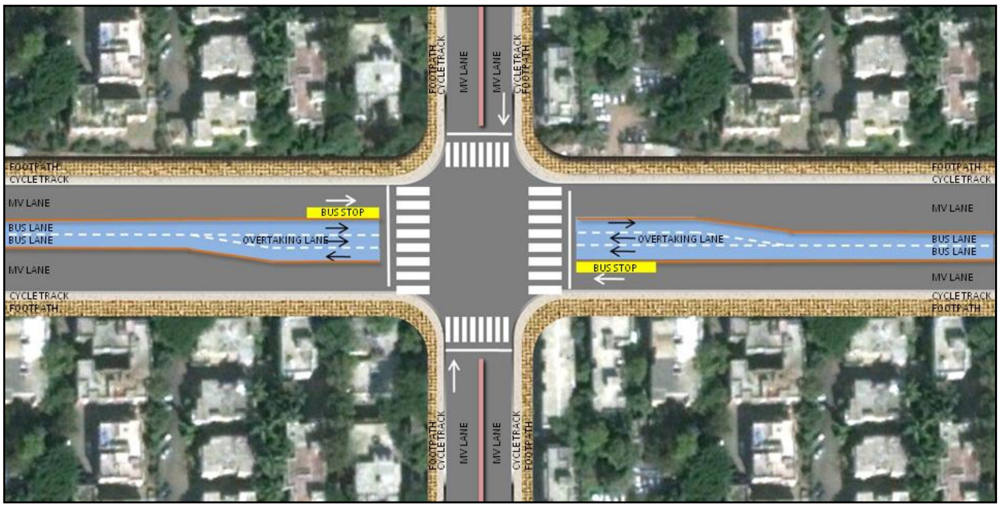
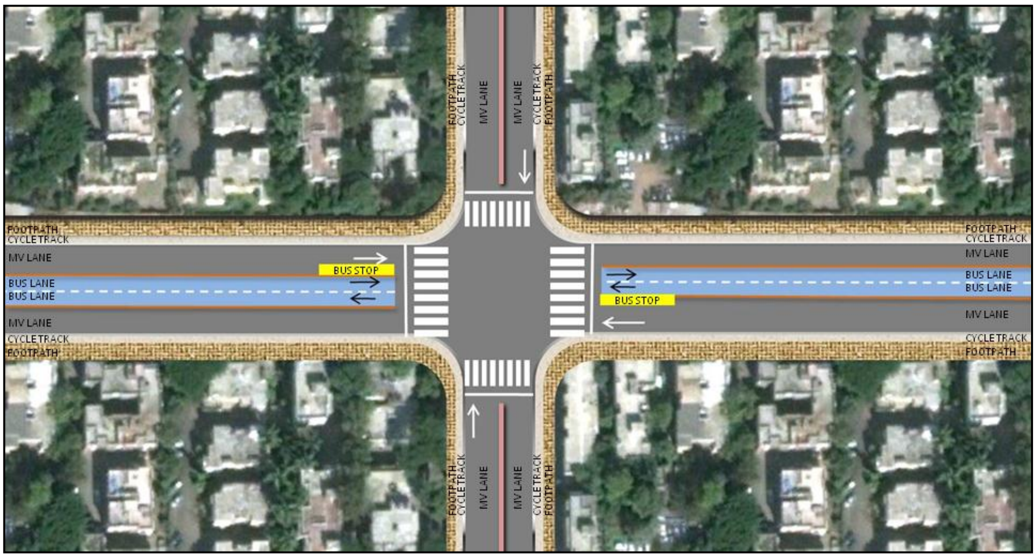
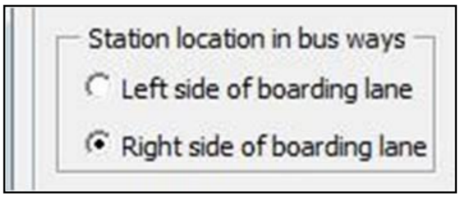


Figure below presents the graphical representation of ***stations Without Overtaking Lanes***



4.8.4 Station location in bus ways (4):



Station location in corridor is ether Left or side of boarding lane accordingly the doors on the buses need to be located either on the left or the right side (in the direction of movement) of the buses.

- Right side stations cannot be selected with un-segregated curbside bus lanes.
- Right side stations must be selected for common station type (4.8.2).

- Staggered stations with segregated bus lanes can either be left or right side of the bus boarding lane. Right side stations (for Indian driving conditions) will always be on the median between the two opposing bus lanes.

Figure below presents the graphical representation of ***left side of boarding lane.***

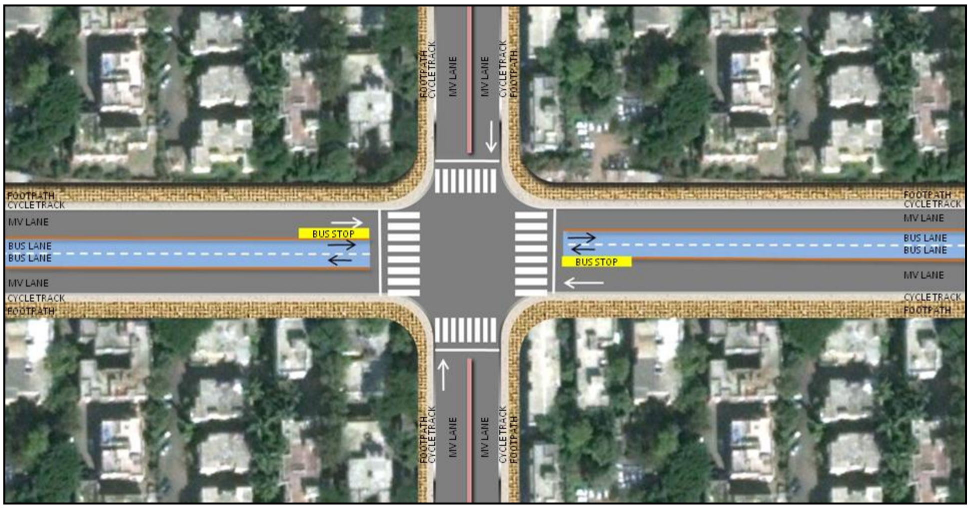
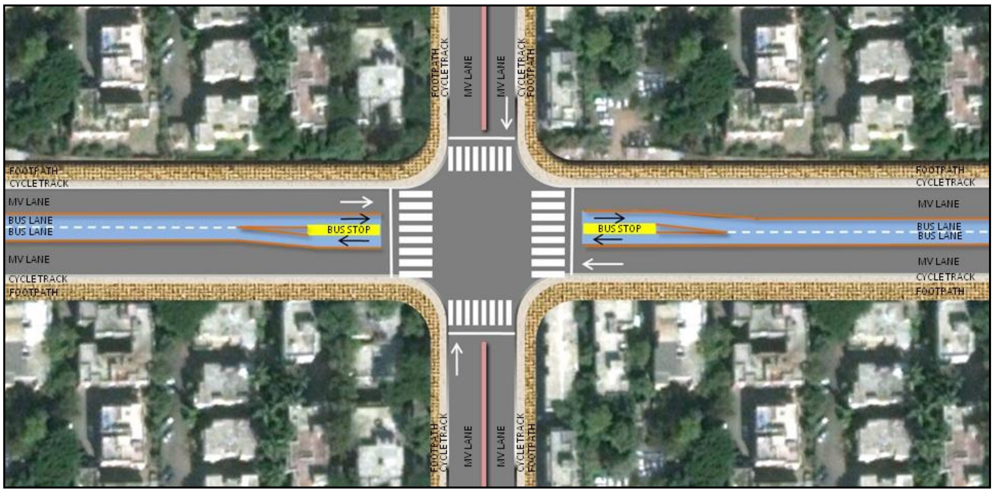
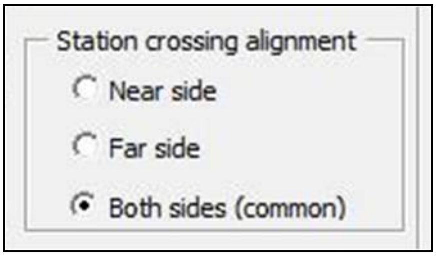


Figure below presents the graphical representation of ***right side of boarding lane.***



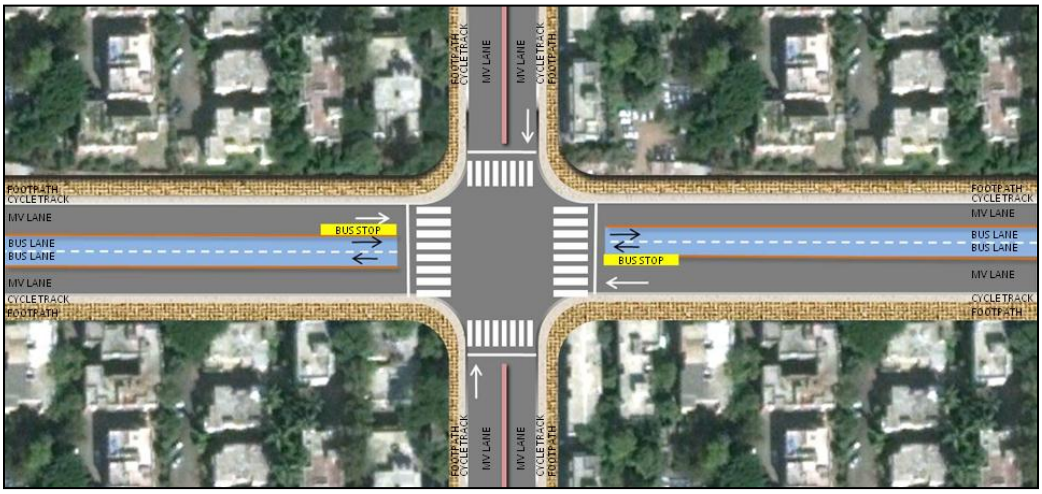
4.8.5 Station crossing alignment (5):



Choose whether designed bus station is on near side or far side.

- Staggered stations can be near or far side stations.
    - If the station in corridor is before (for a bus approaching an intersection) a junction then it is referred as a near side station.
    - If the station (for a bus approaching an intersection) is after a junction then it is referred as a far side station.
- Both side (common) option should be selected if common station type is selected in 4.8.2 above.

Figure below presents a graphical representation of ***Near Side Station:***



- Figure below presents a graphical representation of ***Far Side Station:***

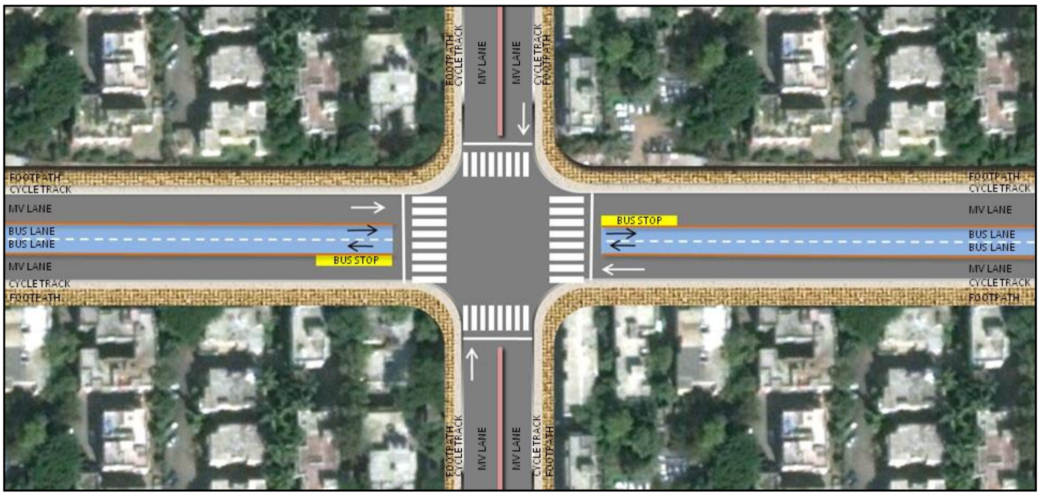
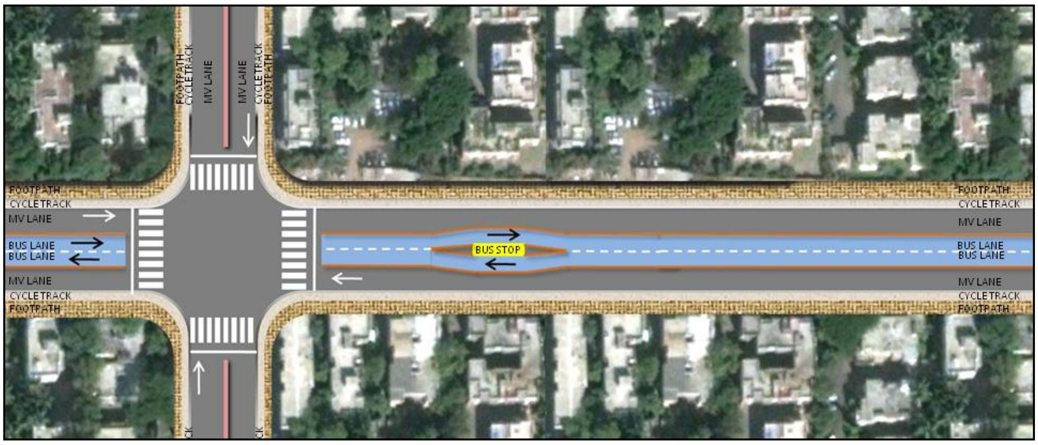
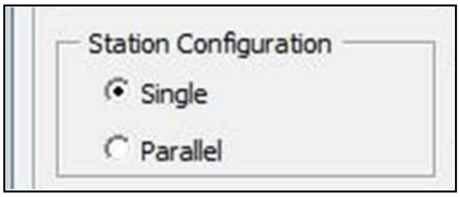


Figure below presents a graphical representation of ***Common (Island) Station:***



4.8.6 Station Configuration (6):



Choose the number of stations at each location (for each direction) i.e. whether it is single or two parallel stations. Parallel station option can only be selected for staggered stations and cannot be uses with common or island stations if selected in 4.8.2 above.

- It is depend upon the number of buses standing on stations at a time. In cases of right side of bus boarding lane or un-segregated curbside bus lanes, choose a Single station option.

Figure below presents a graphical representation of ***Single Station***

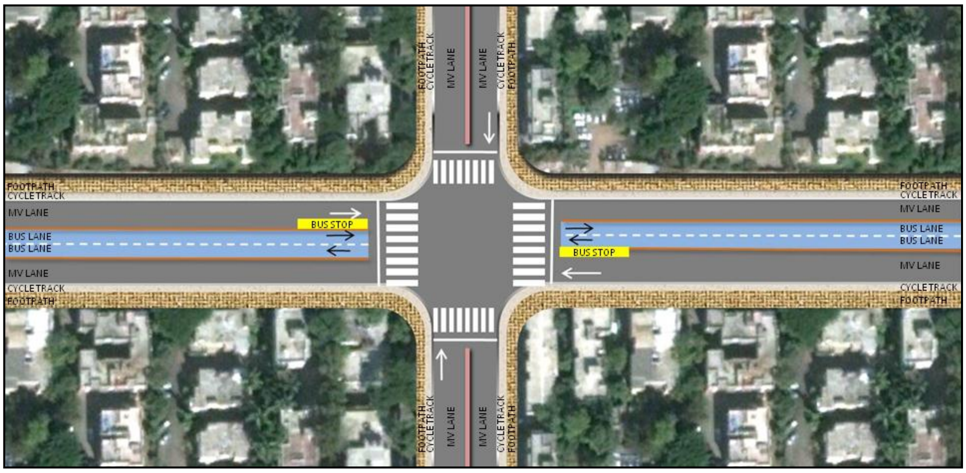
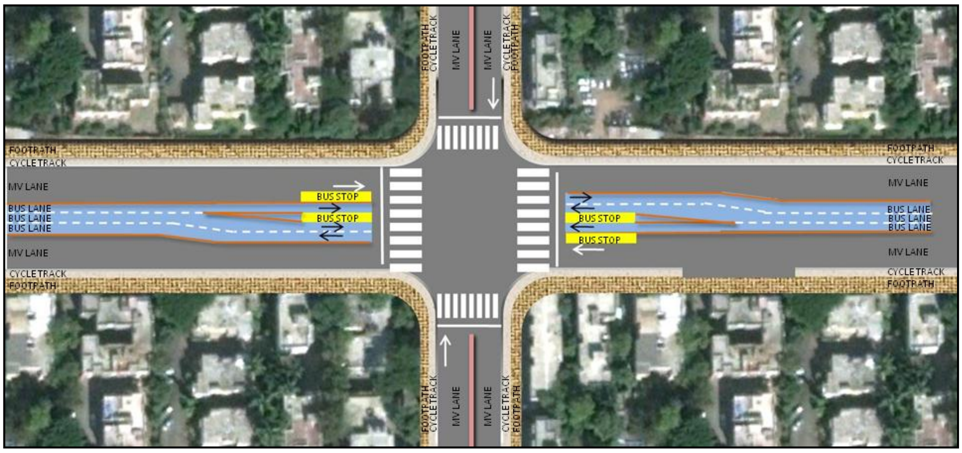


Figure below presents a graphical representation of ***Parallel stations***



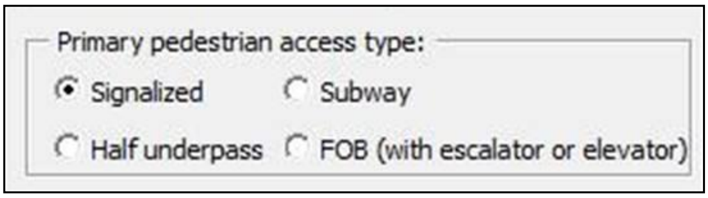
4.8.7 Station Boarding Doors (7):

Choose whether bus stations have automated bus boarding doors (or access control to buses from the station)

4.8.8 No. of access to station (8):

Choose total no. of access to the station. One access is selected when access is only from the direction of intersection (in case of junction stations) or primary side road or important trip generator (in case of mid block stations). When two access stations is selected, the second access is assumed at the other (longitudinal) end of the station.

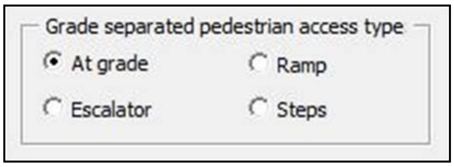
4.8.9 Primary pedestrian access type (9):



Choose the type of pedestrian access on bus stop in corridor whether it is: Signalized crossing/ Subway/ Half underpass / Fly over bridge with escalator of elevator).

- Signalized crossing should not be used in case of Grade separated or signal free junction (no signal delay for buses).
- If more than one access to station is selected in 4.8.8 above, one of the accesses is assumed as primary at grade access.
- If bus turning is allowed at junction or more than one access exists for pedestrians then Signalized pedestrian access should be selected.

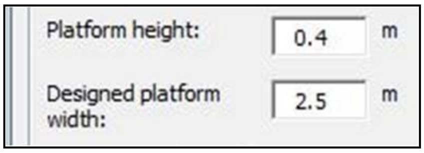
4.8.10 Grade separated pedestrian access type (10):



Select the Pedestrian access type in corridor whether is with grade crossing/ with Ramp /with Escalator / with Steps. The tool assumes that grade separated facilities include elevators for wheelchair access.

- At Grade access type should be used in case of Signalized pedestrian crossing is selected in 4.8.9 above.

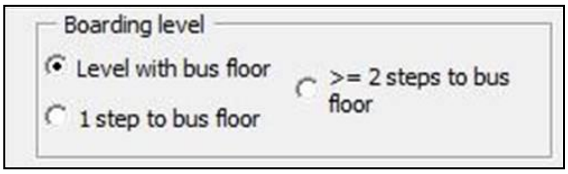
4.8.11 Bus Docking (11):



Select the Height and Width of platform of bus station in meters (m).

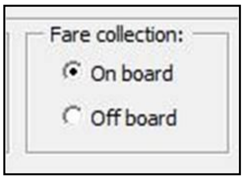
- Height of platform may depend upon Bus type and should be between 0 to 1.2m.Width of platform should be between 1.8m to 10m.

4.8.12 Boarding level (12):



Select the Boarding level of bus whether it is boarding equal to level of bus stop or 1 step, 2 steps or 3 steps to bus floor.

4.8.13 Fare collection (13):



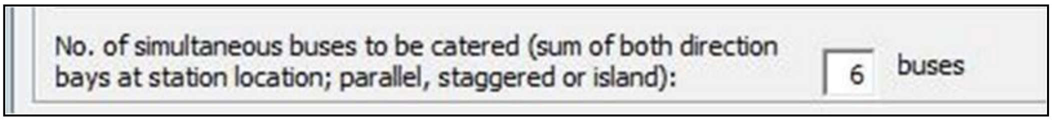
Select the type of Fare collection whether it is on-board or off-board. Off board fare collection is assumed with validators at bus station entry. If more than one entry is selected (in 4.8.8) in combination with off board fare collection, both entries are assumed to have validators. One validator each for entry and exit, for each access to the station is assumed.

4.8.14 Bus type planned for (14):

Select the Primary bus type prescribed for the designed corridor.

- Select low floor bus if the bus floor height (between the doors) is 400mm or less from road surface. Select high floor buses, if the floor height of the bus (between doors) is higher than 400mm.
- In case a combination of high and low floor buses, resulting in step entry to buses, is used, an average no. of steps may be used. For example, if 50% buses have level boarding and 50% 2 step entry, 1 step entry may be selected for 4.8.12 above.

4.8.15 No. of simultaneous buses to be catered (15):



Enter the total number of buses that can dock at one time on both direction bays at station location.

- Value should be even number and Between 2 to 20 if single station option is selected in 4.8.6 above.
- Value should be even number and Between 4 to 20 if parallel station option is selected in 4.8.6 above.

4.9 Results:

Figure 4-9 shows the image of the Segment Results page which gets generated after the user has input all segment design details in forms 3 to 6. The user can use edit results form (no. 7) override design values generated by the system such as those for signal cycle, phase length allocation and expected bus demand (frequency) inputs.

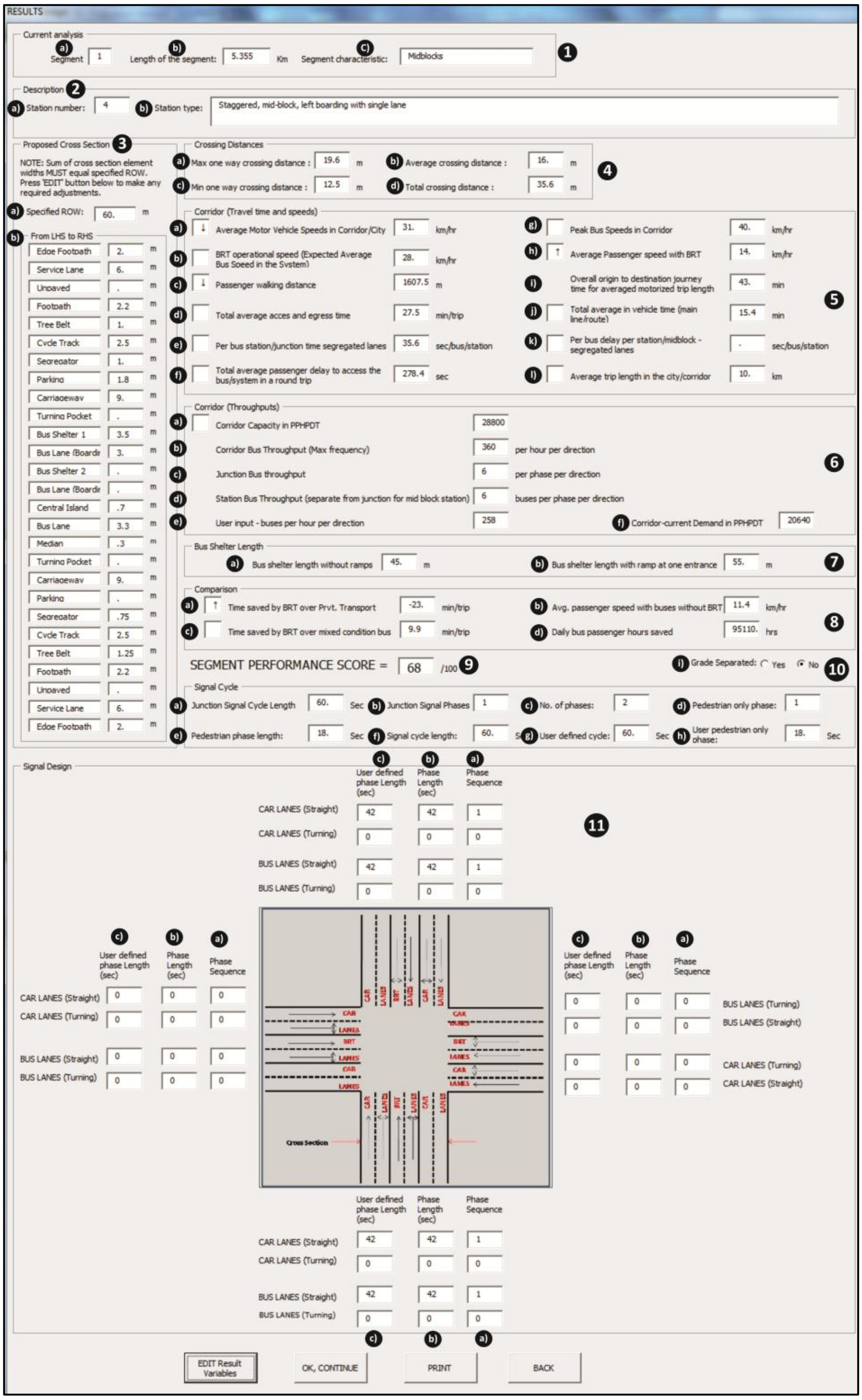
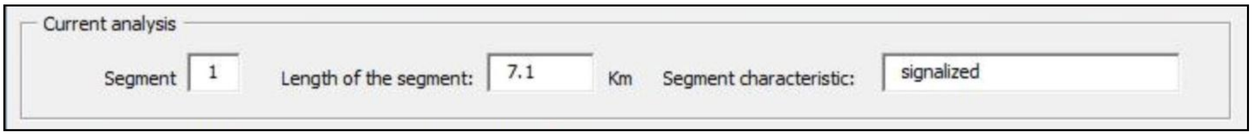


Figure 4-9: Showing User Form 7: Results

4.9.1 Current analysis (1):

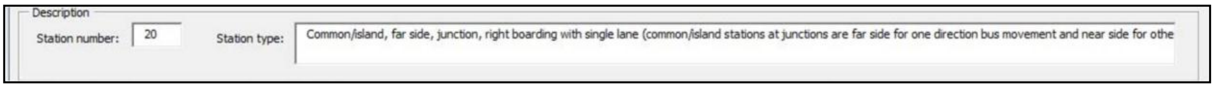


g) **Segment-** The value would be self generated from the previous form and it would show segment no. for which the results are displayed.

h) **Length of the segment-** The value would be self generated from the previous form and it would show the length of the segment for which the results are displayed.

i) **Segment characteristic** - The value would be self generated from the previous form and it would show the characteristics of the segment for which results are displayed.

4.9.2 Description (2):



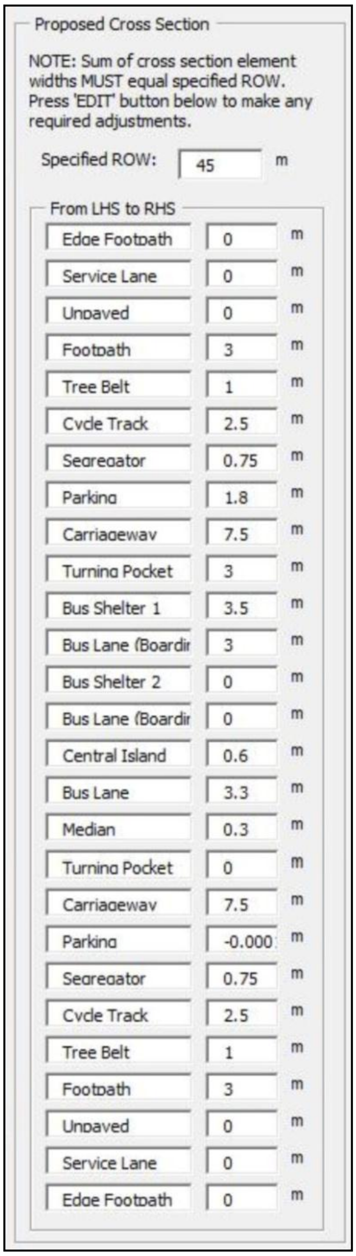
a) **Station Number-** This is a number designated by the tool to a particular station design type as specified by the user through inputs in different BEAD user forms. Station design type associated with each design no. has been presented below:

1. Staggered, near, junction, left, single lane
2. Staggered, near, junction, left, Overtaking lane
3. Staggered, near, junction, left, Parallel Stations
4. Staggered, mid-block, left, single lane
5. Staggered, mid-block, left, Overtaking lane
6. Staggered, mid-block, left, Parallel Stations
7. Staggered, near, junction, Right, single lane
8. Staggered, near, junction, Right, Overtaking lane
9. Staggered, mid-Block, Right, single lane
10. Staggered, mid block, Right, Overtaking lane
11. Common, near, junction, Right, single lane
12. Common, near, junction, Right, Overtaking lane
13. Common, mid-Block, Right, single lane
14. Common, mid block, Right, Overtaking lane
15. Staggered, far, junction, left, single lane
16. Staggered, far, junction, left, Overtaking lane
17. Staggered, far, junction, left, Parallel Stations
18. Staggered, far, junction, Right, single lane
19. Staggered, far, junction, Right, Overtaking lane
20. Common, far, junction, Right, single lane
21. Common, far, junction, Right, Overtaking lane
22. Both on one side, staggered, near, junction, left, single lane
23. Both on one side, staggered, near, junction, left, overtaking lane
24. Both on one side, staggered, near, mid block, left, single lane
25. Both on one side, staggered, near, mid block, left, overtaking lane
26. Both on one side, Island, junction, single lane

27. Both on one side, Island, junction, overtaking lane
28. Both on one side, Island, mid block, single lane
29. Both on one side, Island, mid block, overtaking lane
30. Both on one side parallel Staggered junction
31. Both on one side , parallel staggered mid block
32. Standalone Staggered single lane
33. Standalone Staggered Overtaking lane
34. Standalone Island Single lane
35. Standalone Island overtaking lane
36. Standalone Staggered parallel stations
37. Curbside Un-segregated Bus Lanes

b) **Station Type-** This is a one sentence explanation/description of bus stop design used/associated with the particular segment under analysis.

4.9.3 Proposed Cross-section (3):



a) ***Specified ROW:*** This is the existing average road width entered for the particular segment in the General input form. This value cannot only be edited by using the back button to go to the general input form, and by generating the results again.

b) ***Cross-section dimensions (from LHS to RHS):***These are the order of arrangement of functions/features (cross section design) and the widths allocated to the same (in meters) by the tool. The functions/features include footpaths, service lanes, unpaved surfaces, tree belts, cycle tracks, parking lanes, Carriage ways, Turning pockets, Medians, Bus stations, Bus lanes, etc. The order of arrangement of features cannot be changed, however allocated width can be modified by using the edit results button.

4.9.4 Crossing Distances (4):

Crossing Distances					
Max one way crossing distance :	17.95	m	Average crossing distance :	15.85	m
Min one way crossing distance :	13.75	m	Total crossing distance :	35.2	m

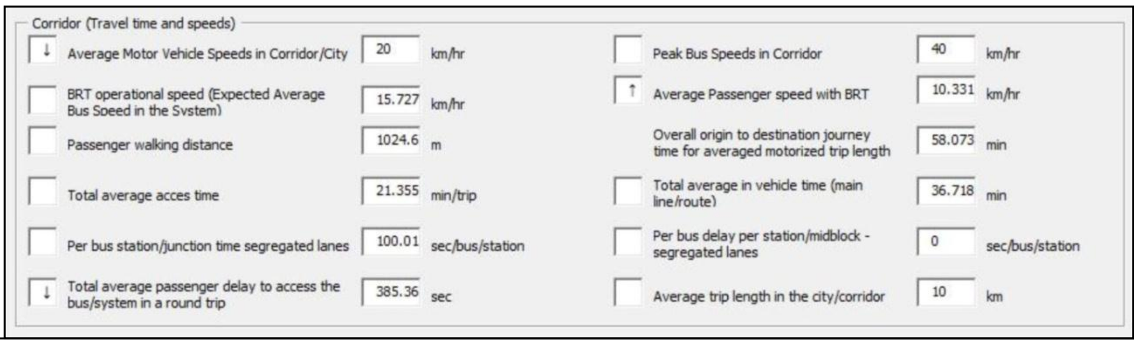
a) ***Max one way crossing distance**:* This is the maximum crossing distance passengers accessing the station from one of the two sides of road. This value is derived from the cross-section (proposed by the tool) which includes widths of Cycle track, Segregator, Carriageway, Turning pocket, Median and Bus lanes, etc. This value estimated by tool, is in meter. This value gets edited if the user overrides the widths allocated by the tool, using the edit results button.

b) ***Min one way crossing distance:*** This is the minimum crossing distance for passengers accessing the station, from one of the two sides of road. This value is derived from the cross-section (proposed by the tool) which includes widths of Cycle track, Segregator, Carriageway, Turning pocket, Median and Bus lanes, etc. This value estimated by tool, is in meter. This value gets edited if the user overrides the widths allocated by the tool, using the edit results button.

c) ***Average crossing distance:*** This is the average crossing distance for passengers accessing the station from either side of road. This value is derived from the cross-section proposed by the tool, which includes average widths of Cycle track, Segregator, Carriageway, Turning pocket, Median and Bus lanes, etc. This value estimated by tool, is in meter. This value gets edited if the user overrides the widths allocated by the tool, using the edit results button.

d) ***Total crossing distance:*** This is the total crossing width or full carriageway (cum cycle track) crossing distance for pedestrians, across the designed corridor including widths of Cycle tracks, Segregators, Carriageways, Turning pockets, Median, Bus station and Bus lanes of the both sides of road from proposed cross-section. This value estimated by tool is in meter. This value gets edited if the user overrides the widths allocated by the tool, using the edit results button.

4.9.5 Corridor (Travel time and speed) (5):



Corridor (Travel time and speeds)					
↓ Average Motor Vehicle Speeds in Corridor/City	20	km/hr	Peak Bus Speeds in Corridor	40	km/hr
BRT operational speed (Expected Average Bus Speed in the System)	15.727	km/hr	↑ Average Passenger speed with BRT	10.331	km/hr
Passenger walking distance	1024.6	m	Overall origin to destination journey time for averaged motorized trip length	58.073	min
Total average acces time	21.355	min/trip	Total average in vehicle time (main line/route)	36.718	min
Per bus station/junction time segregated lanes	100.01	sec/bus/station	Per bus delay per station/midblock - segregated lanes	0	sec/bus/station
↓ Total average passenger delay to access the bus/system in a round trip	385.36	sec	Average trip length in the city/corridor	10	km

a) ***Average Motor Vehicle Speed in Corridor/City****:* This is the average motor speed in the base or horizon year (depending on the period of assessment) on the corridor. Where estimates of corridor average speeds are not known the average speed of motor vehicles in the city may be used.

   Look for the **Arrow sign** (↓) for suggested improvements against each of the underperforming indicators for a given segment. ***(Refer Table 3-2: Point no. 14).*** User may choose to edit the segment design based on the suggestions provided in Table 3-2, by pressing the back button at the bottom of this and respective forms (as required) and making changes in the relevant form/s.

b) ***Peak Bus Speed in Corridor:*** The vale estimated by the tool is the desirable speed limit in bus lanes during peak hours in corridor.

   Look for the **Arrow sign** (↓) for suggested improvements against each of the underperforming indicators for a given segment. ***(Refer Table 3-2: Point no. 1).*** User may choose to edit the segment design based on the suggestions provided in Table 3-2, by pressing the back button at the bottom of this and respective forms (as required) and making changes in the relevant form/s.

c) ***BRT operational speed (Expected Average Bus Speed in the System)****:* This is the average operating speed of buses for this segment of the corridor; in km/h. Higher operational speeds reduce perceived passenger travel time though its effect on the actual travel time may be limited. Thus higher operational speeds are indicators of better performance of a BRTS system.

   Look for the **Arrow signs** (↑) for suggested improvements against each of the underperforming indicators for a given segment. ***(Refer Table 3-2: Point no.7).*** User may choose to edit the segment design based on the suggestions provided in Table 3-2, by pressing the back button at the bottom of this and respective forms (as required) and making changes in the relevant form/s.

d) ***Passenger speed with BRT:*** This value indicates average speed in km/h experienced by the passenger (for this segment) in undertaking the total journey including walk trips, feeder bus trip and transit trip. This is considered an important measure in the performance of the system as it aggregates the delay experienced by the passenger in the entire journey (and not just the journey within the BRTS corridor – which is represented by operational speed and which does not account for important factors such as access and egress delays) and presents it as speed for easy comparison with other modes such as private motorized modes.

   Look for the **Arrow signs** (↑) for suggested improvements against each of the underperforming indicators for a given segment. ***(Refer Table 3-2: Point no.6).*** User may choose to edit the segment design based on the suggestions provided in Table 3-2, by pressing the back button at the bottom of this and respective forms (as required) and making changes in the relevant form/s.

e) ***Passenger walking distance:*** Total passenger walking distance in meters (averaged over different trip types) in a one way trip (for this segment) are estimated and presented by the tool here. This is an important indicator for comparison between different designs as it directly relates to passenger inconvenience and perceived time. This value is mainly dependent on average spacing between stations, crossing widths, crossing type (grade separated pedestrian crossing facilities with ramps add to walking distances), etc.

Look for the **Arrow signs** (↓) for suggested improvements against each of the underperforming indicators for a given segment. ***(Refer Table 3-2: Point no.3).*** User may choose to edit the segment design based on the suggestions provided in Table 3-2, by pressing the back button at the bottom of this and respective forms (as required) and making changes in the relevant form/s.

f) ***Overall origin to destination journey time for average motorized trip length****:* Under this head the overall passenger journey time between origin and destination is estimated by the tool and presented in minutes. The journey time is estimated after accounting for passenger speeds (for passengers with origin and destination in this segment) in different trip components or using different modes, waiting delays, crossing delays, etc. The average journey length specified by the user on the BEAD main page. The journey time is estimated, specific to this segment.

g) ***Total average access time:*** The point to point journey time for an average passenger undertaking a trip and trip length equivalent to average trip length in the city or along the corridor (specified on BEAD main page); is broken in to two components, i.e. 'Total Access and Egress Time' and total 'in vehicle time'. Total Access and egress time specific to this segment of the corridor, is presented under this head in minutes, and includes time spent in any feeder bus to access the transit station and also accounts for any changeover delays.

Look for the **Arrow signs** (↓) for suggested improvements against each of the underperforming indicators for a given segment. ***(Refer*** Table 3-2***: Point no.11).*** User may choose to edit the segment design based on the suggestions provided in Table 3-2, by pressing the back button at the bottom of this and respective forms (as required) and making changes in the relevant form/s.

h) ***Total average in vehicle time (main line/route):*** Total average in-vehicle time for this segment, is the time spent on the main line transit vehicle. This can be a vehicle operating on the trunk route of a closed operation BRTS corridor or a vehicle operating on any one of the routes, using a BRTS corridor for any length; in an open/hybrid system. Thus in an open system it includes the journey (for direct routes) outside the BRTS corridor. This time is estimated after subtracting the total access and egress time from the total journey time (discussed above) and presented in minutes.

Look for the **Arrow signs** (↑) for suggested improvements against each of the underperforming indicators for a given segment. ***(Refer Table 3-2: Point no.12).*** User may choose to edit the segment design based on the suggestions provided in Table 3-2, by pressing the back button at the bottom of this and respective forms (as required) and making changes in the relevant form/s.

i) ***Per bus delay per station/junction - segregated lanes:*** This head presents the delay experienced by an average bus per station junction combination for junction stations or just junction delay for intersections between mid block stations (as per user inputs defining BRTS design in the user input forms). These values are presented in seconds.

Look for the **Arrow signs** (↓) for suggested improvements against each of the underperforming indicators for a given segment. ***(Refer Table 3-2: Point no.8).*** User may choose to edit the segment design based on the suggestions provided in Table 3-2, by pressing the back button at the bottom of this and respective forms (as required) and making changes in the relevant form/s.

j) ***Per bus delay per station/mid-block – segregated lanes:*** This heads presents the delay experienced per bus per mid block station (in combination with a pedestrian signal delay if defined in the user input). This delay is presented in seconds. In case of junction stations this delay value appears as '0', whereas in case of mid blocks stations this delay is aggregated with the junction delay (explained) above for the specified number of stations (derived from the average station spacing input by the user).

   Look for the **Arrow signs** (↓) for suggested improvements against each of the underperforming indicators for a given segment. ***(ReferTable 3-2: Point no.9).*** User may choose to edit the segment design based on the suggestions provided in Table 3-2, by pressing the back button at the bottom of this and respective forms (as required) and making changes in the relevant form/s.

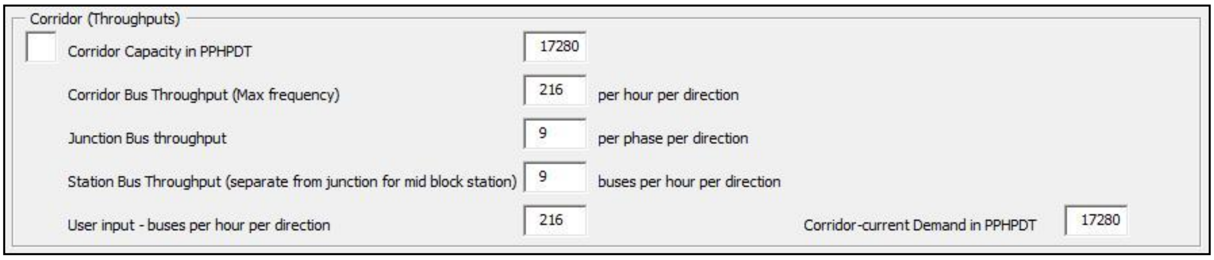
k) ***Total average passenger delay to access station in a round trip:*** This head presents average passenger delay encountered for an average trip length, excluding time spent in walking, but including time lost for waiting for the bus, crossing the road, and reaching the bus boarding bay from the middle of the cross road. This value is presented in seconds.

   Look for the **Arrow signs** (↓) for suggested improvements against each of the underperforming indicators for a given segment. ***(Refer Table 3-2: Point no.10).*** User may choose to edit the segment design based on the suggestions provided in Table 3-2, by pressing the back button at the bottom of this and respective forms (as required) and making changes in the relevant form/s.

l) ***Average trip length in City/Corridor:*** The estimated value by the tool is the average trip length of the passenger experienced with bus in corridor.

   Look for the **Arrow signs** (↓) for suggested improvements against each of the underperforming indicators for a given segment. ***(Refer Table 3-2: Point no.13).*** User may choose to edit the segment design based on the suggestions provided in Table 3-2, by pressing the back button at the bottom of this and respective forms (as required) and making changes in the relevant form/s.

4.9.6 Corridor (Throughputs) (6):



a) ***Corridor Capacity in PPHPDT :***Corridor PPHPDT implies Peak per Hour per Direction Trips transported by the BRTS system as per the specified corridor design, and relates to the peak hour peak direction capacity (in terms of passengers) offered by the corridor.

Look for the **Arrow sign** (↑) in the box, indicating underperformance against this indicator; for this particular segment. Suggested steps for improvement are provided in Table 3-2, ***Point no.5.*** User may choose to edit the segment design based on the suggestions provided in Table 3-2, by pressing the back button at the bottom of this and respective forms (as required) and making changes in the relevant form/s.

b) ***Corridor Bus Throughput (max frequency):*** Peak passenger carrying capacity is derived from the vehicle type (specified by the user in the user forms) and the peak corridor bus throughput. This value is presented separately so as users can relate to the fleet volume handling capacity of the system.

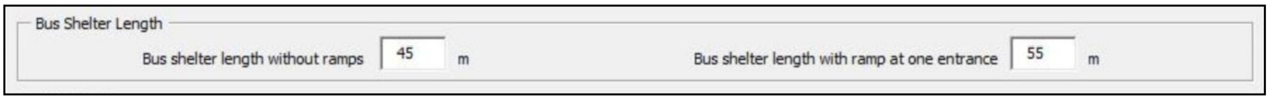
c) ***Junction Bus throughput:*** Corridor bus throughput is derived from the per cycle throughput of buses, which is based on the minimum headway calculations for the data input by the user. This value is presented separately for mid block throughput (at pedestrian signal cycles) and at junction throughput (for junctions between mid block stations or junction stations).

d) ***Station Bus Throughput (separate from junction for mid-block station):*** This is the same as junction bus throughput for junction stations (as it acts as a combined unit) whereas for mid block stations it is presented separately. This is also based on the minimum headway estimates calculated from the user input.

e) ***User input-buses per hour per direction:*** By default this value is set the same as Corridor Bus Throughput or Maximum Frequency derived by the tool. However the user can use the edit results button and set this to a lower value as per estimated design. This will override the Maximum frequency value derived by the system and other performance measures such as delay; speeds etc. are recalculated as per the user input value.

f) ***Corridor current demand in PPHPDT:*** Corridor current demand in PPHPDT indicates peak per hour per direction trips transported by the BRTS system as specified by user in edit result form. (in terms current observed number of buses per hour per direction on the corridor). In case no current or estimated demand is input by user (in edit result form), the tool sets value in box same as Corridor Capacity in PPHPDT (as defined in part (a) above).

4.9.7 Bus Shelter length (7):



a) ***Bus shelter length without ramps:*** Bus shelter length without ramps is mainly depend on two factors, whether it is single or parallel station type and also whether Bus turning at junction is allowed or not (i.e. open/close system). The value estimated by tool is in meter.

b) ***Bus shelter length with ramp at one entrance:*** Bus shelter length with ramp at one entrance can be calculated by multiplying Platform Height with Pedestrian Ramp Gradient and adding it with 2 meter landing and total bus shelter length (above 1). The value estimated by tool is in meter.

4.9.8 Comparison (8):

a) ***Time saved by BRT over Private Transport :***This uses the average motor vehicle speed in the corridor or the city (from default values – set as 20km/h but editable by the user) and estimates the passenger speed on the basis of walking distance to access parked vehicle (50m in the default values). It then compares this with the passenger speeds estimated by the tool for the proposed BRTS design. The difference time per passenger trip is presented as the time saved by using BRTS over private transport.

Look for the **Arrow signs** (🡑) for suggested improvements against each of the underperforming indicators for a given segment. ***(Refer Table 3-2: Point no.2).*** User may choose to edit the segment design based on the suggestions provided in Table 3-2, by pressing the back button at the bottom of this and respective forms (as required) and making changes in the relevant form/s.

b) ***Avg. passenger speed with buses without BRT:*** Under this head the passenger speed for bus transit in mixed conditions is estimated as per the process defined above. The values are presented in Km/h.

c) ***Time saved BRT over mixed condition bus:*** Under this sub head the time savings are calculated in daily hours saved. This is done by deriving the time difference (in hours) per passenger trip (using passenger speed values derived by the tool) between buses using the BRTS system and those moving in mixed condition.

Look for the **Arrow signs** (🡑) for suggested improvements against each of the underperforming indicators for a given segment. ***(Refer Table 3-2: Point no.4).*** User may choose to edit the segment design based on the suggestions provided in Table 3-2, by pressing the back button at the bottom of this and respective forms (as required) and making changes in the relevant form/s.

d) ***Daily bus passenger hours saved****:* This value is multiplied by the total passenger trips expected in the segment (using the corridor PPHPDT value estimated by the tool and multiplying it by 10 * 2 to arrive at daily two directional trips) to arrive at a an estimate of total hours saved per day.

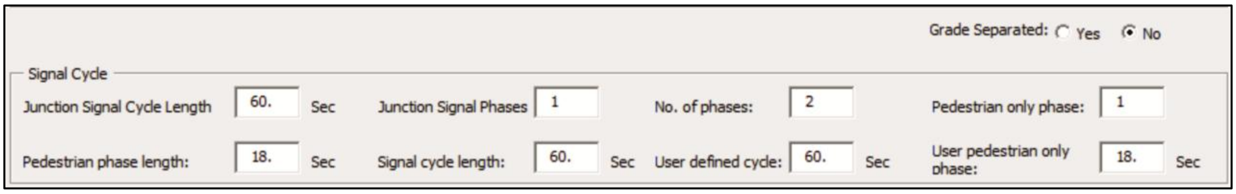
4.9.9 LOS – Level of Service (9):

BEAD tool employs a sub 'Segment Performance Score' estimator tool, which derives the values from the output sheet under 10 different heads, and the same are divided in to three categories, based on the main recipient of benefits under that head. These categories are:

- Societal
- User
- Operator

To estimate the overall segment performance, the performance under each indicator has been benchmarked. This has been done by giving a score, ranging from 'A to F' to each indicator. 'A' is for best performance and 'F' for worst. These have been presented in Table 3-1. The overall performance is estimated by assigning predetermined weights to each indicator and aggregating the results as a value on a scale of 1 to 100. A score of more than 80 is considered ideal while less than 50 is poor. The weights for each indicator have been derived based on inputs gathered from four stakeholder categories.

4.9.10 Signal cycle (10):



a) ***Junction Signal Cycle Length:*** This is the Signal cycle length at intersection between two adjacent junction stations for whole traffic including BRT buses, motorized and non-motorized vehicles, pedestrian crossing, etc. The cycle length is in seconds and can be between 120 sec to 600 sec. Example '150 sec'.

b) ***Junction Signal Phases:*** This is the number of signal phases at intersection between two adjacent junction stations. It is depending on intersection type. Example if it is 4-arm intersection Junction Signal Phases can be '4'.

c) ***No. of Phases:*** This is the number of signal phases at intersection between two adjacent Mid-blocks. It is depending on intersection type. Example if it is 4-arm intersection Junction Signal Phases can be '4'.

d) Pedestrian only phase: This is the number of pedestrian Signal phases at intersection if it is Signalized Crossing at intersection.

e) Pedestrian phase length: If the intersection is with Signalized Pedestrian Crossing then this is the Pedestrian phase length at that intersection. The phase length is in second. Example '20 sec'.

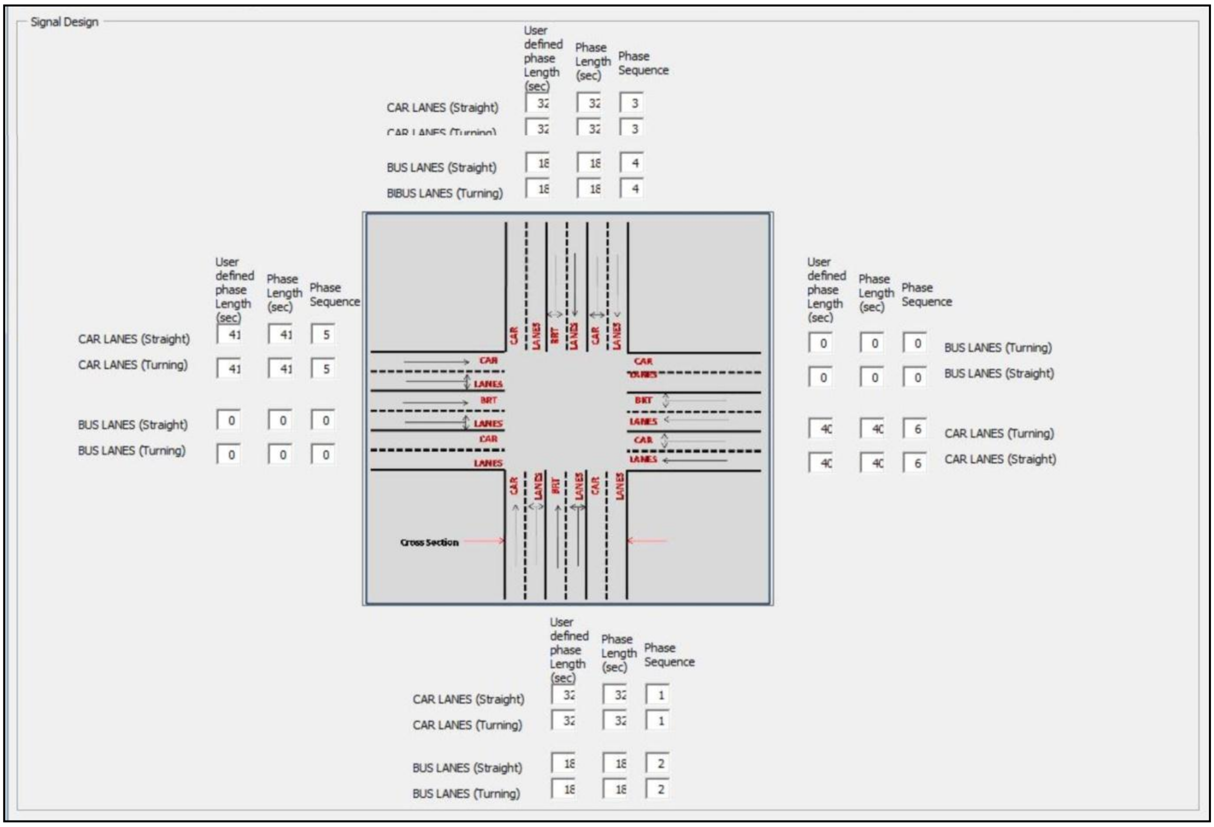
f) Signal Cycle Length: This is the Signal cycle length at intersection between two adjacent Mid-blocks for whole traffic including BRT buses, motorized and non-motorized vehicles, pedestrian crossing, etc. The cycle length is in seconds. Example '60 sec'. The user is advise that, to check the signal cycle length as it may have been modified by tool from the input provided on Junction Model Inputs Form. If required signal cycle can be modified by going on Edit Result Form.

g) ***User defined cycle:*** Enter the user defined Signal cycle length at intersection. This can be affects the result values. The cycle length is in seconds and can be between 120 sec to 600 sec. Example '150 sec'.

h) ***User pedestrian only phase:*** Enter the user defined Signal cycle phase for Pedestrians. Example '18 sec'.

i) Grade Separated: Choose whether pedestrian crossing at intersection is Grade separated or not. Pedestrian crossing can be signalized as well as grade separated at one time.

4.9.11 Proposed Plan (11):



a) ***User defined phase length:*** Car lanes (straight)/ Car lanes (Turning)/ Bus lanes (straight) / Bus lanes (Turning): Enter the separate user defined Signal cycle length for Turning and Straight Car lanes and Turning and Straight Bus lanes at intersection according to total signal cycle length designed for that intersection. This can be affects the result values.

b) ***Phase length:*** Car lanes (straight)/ Car lanes (Turning)/ Bus lanes (straight) / Bus lanes (Turning): This are the separate values of Signal cycle length for Turning and Straight Car lanes and Turning and Straight Bus lanes at intersection according to total signal cycle length designed for that intersection given by tools.

c) ***Phase Sequence:*** Car lanes (straight)/ Car lanes (Turning)/ Bus lanes (straight) / Bus lanes (Turning): This is the separate values of Phase sequence for Turning and Straight Car lanes and Turning and Straight Bus lanes at intersection according to total signal cycle length designed for that intersection given by tools.

4.10 User Form 7- Edit Results:

Figure 4-10 shows the image of the seventh user form – Edit Results. This form can be recalled by the user by pressing the edit results button on the results sheet for each particular segment (defined); and allows the user to define width of different cross section elements, expected bus frequency or per hour per direction demand of buses on the corridor as well signal cycle length and phase length for signals located at station access/junction. The form reproduces the results page but allows user to edit or enter inputs in the boxes related to variables that can be changed/edited.

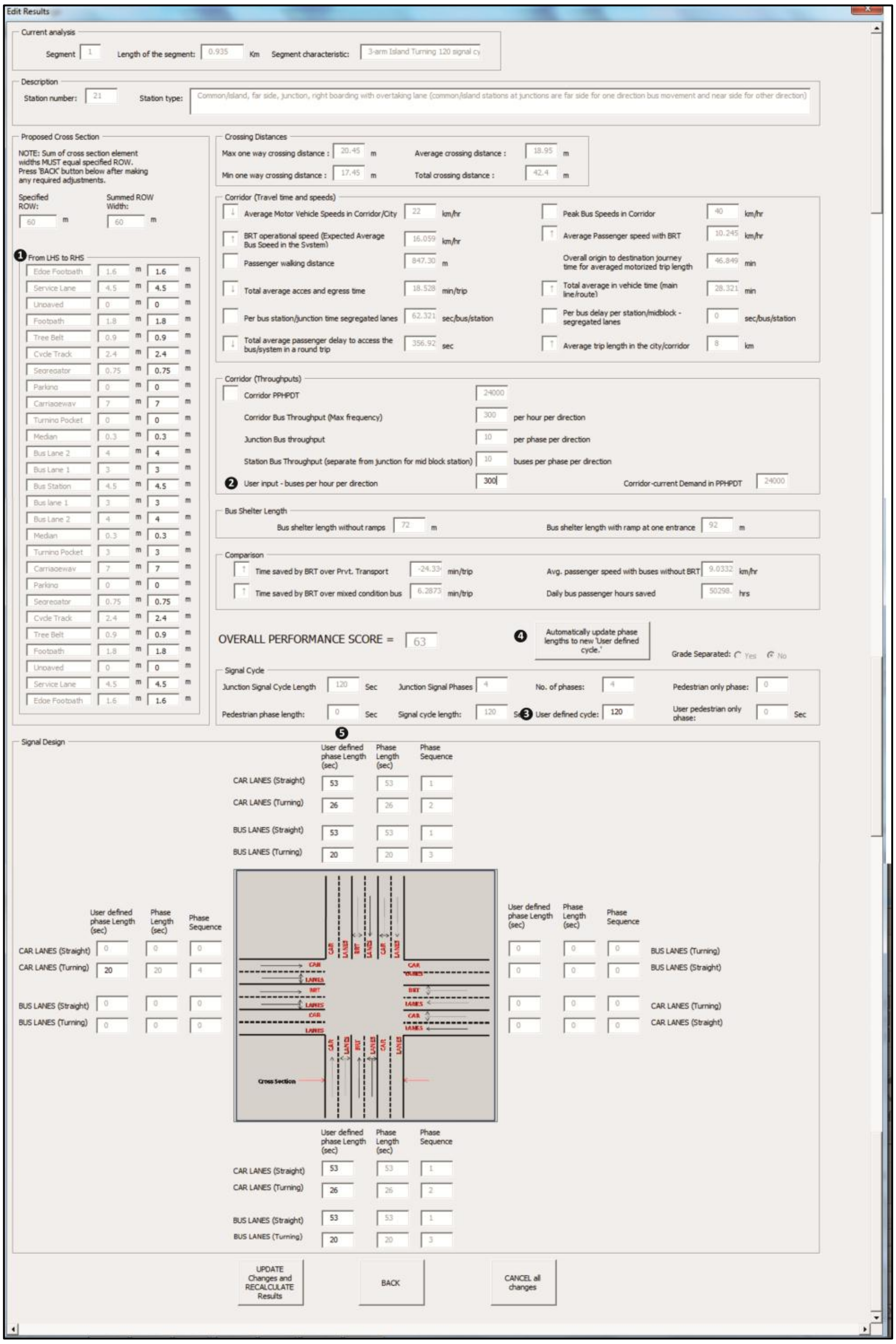
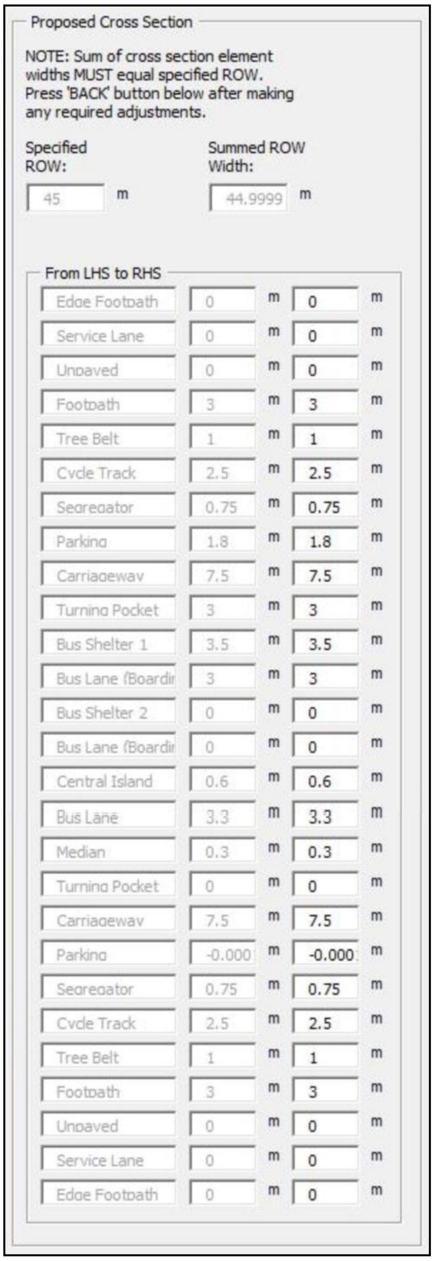


Figure 4-10: Showing User Form 8: Edit Results

4.10.1 Proposed Cross-Section (1):



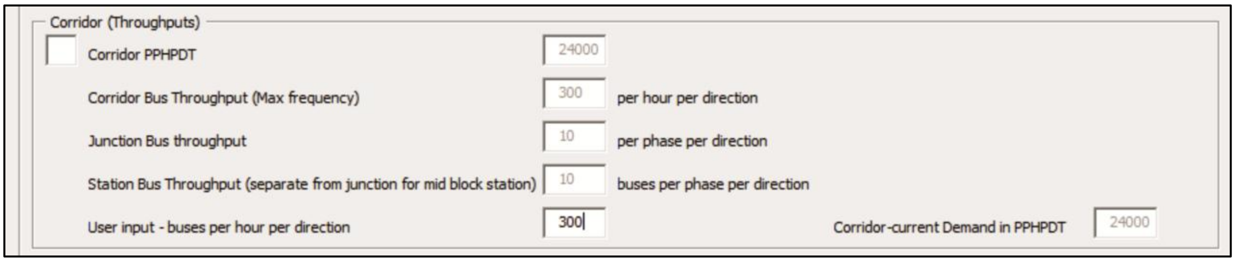
a) ***Cross-section dimensions (from LHS to RHS):***The default values included in the boxes corresponding to each cross section element are estimated by the tool for the ROW width of the segment, defined by the user in the general BRTS user input form. These values can be edited here, however the user should take the following care in inputting the values:

(a) The sum of widths allocated to all cross section elements should equal to the ROW width defined by the user in General inputs form. This can be checked by using recalculate button at the bottom of the sheet. The summed up value show up in the summed ROW box at the top of this section.

(b) User should enter only positive values in the boxes.

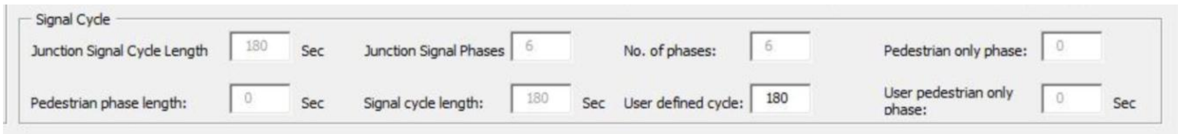
(c) The units of all values input are assumed in meters.

4.10.2 Corridor (Throughputs) (2):



a) ***User input-buses per hour per direction:*** By default this value is set the same as Corridor Bus Throughput or Maximum Frequency derived by the tool. The user edit this value here and set it to a lower value as per demand requirements as estimated in the design/operational plan. This will override the Maximum frequency value derived by the system and other performance measures such as delay; speeds etc. are recalculated as per the user input value. This value cannot be less than the total no. of signal cycles expected per hour at intersections in this segment of the corridor and cannot be higher than the maximum frequency value estimated by the tool. User may use the recalculate button at the bottom of the sheet to check if the input is valid or not.

4.10.3 Signal cycle (3):



a) ***User defined cycle:*** By default this value is set the same as Signal Cycle length which is estimated by the tool. The user may edit this value here to set to the desired signal cycle length for junctions in the design segment. The signal cycle length should be set as following:

i) For 4 arm signalized junctions – between 120 to 600 seconds

ii) For 3 arm signalized junctions – between 90 to 300 seconds

iii) For mid block pedestrian crossings and for roundabouts - between 30 to 150 seconds

iv) For Roundabout – between 45 to 120 seconds

v) The user is not allowed to change this value if grade separated or signal free intersections option is selected in the 'Junction Model Input' form.

The user can check whether the input is valid or not by pressing the re-calculate button at the bottom of the form. Using the recalculate button will revise the phase length allocation in all phases as per the edited signal cycle length. This allocation can also be changed in the 'user defined phase length' in **Error! Reference source not found.** below.

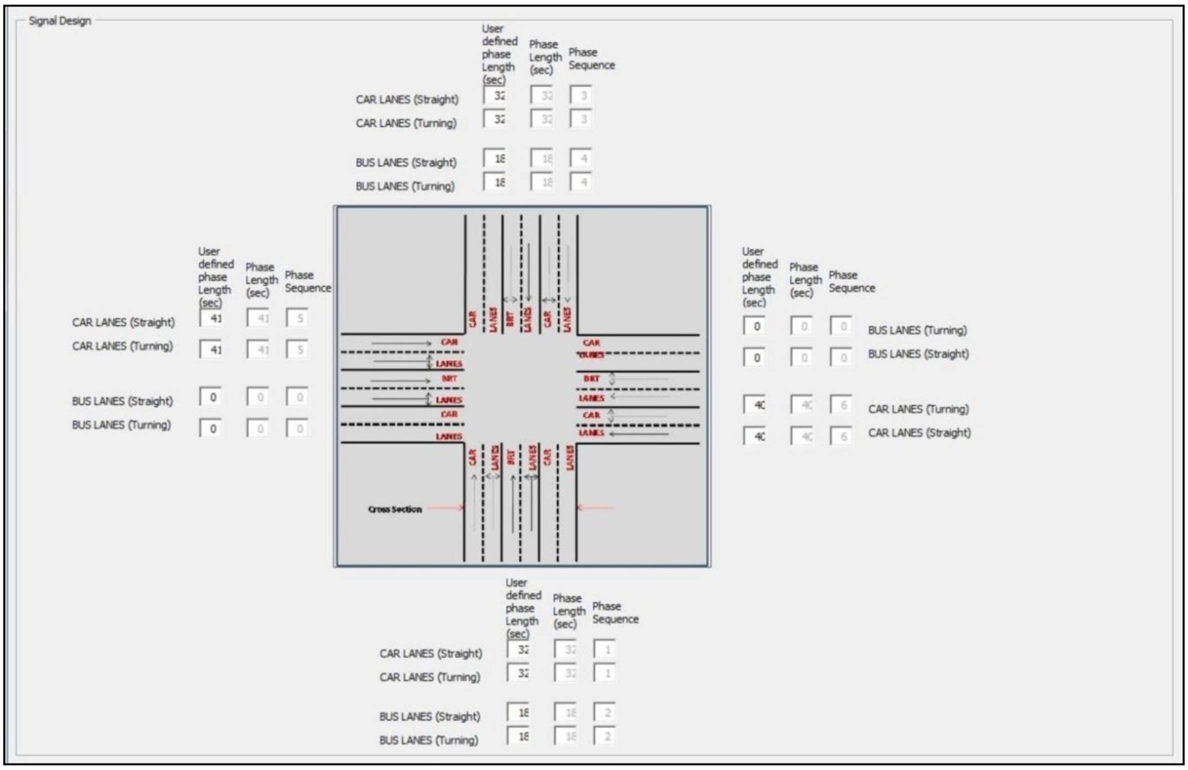
Note: If the user intends to edit the phase length allocation for each turning movement in (4.10.5 below), it is strongly advised that he/she uses the 'automatically, update phase lengths to new user define cycle' button after inputting the desired signal cycle length.

b) User Pedestrian only:

4.10.4 Automatically update phase length to new 'User defined Cycle.'(5):

The user can click this button to adjust phase lengths automatically after inputting a desired signal cycle length against the 'User defined Cycle' box. Using this button automatically assigns revised phase length as per the user input signal cycle in the 'user defined phase length box' below.

4.10.5 Proposed Plan (6):



a) ***User defined phase length:*** By default, the values set in this box are the same as the phase length calculated by the BEAD tool for the signal cycle length defined by the user in **Error! Reference source not found.** above. The user can edit these values, here by following he following rules:

(a) Phase length for common phase sequence no., should be same.

(b) The sum of phase lengths for each phase sequence no. should total to the signal cycle length defined by the tool or the user in **Error! Reference source not found.** bove.

(c) The user is not allowed to edit phase length of turns or movements not allowed by design and marked by '0' as phase sequence no.

(d) None of the phase lengths can be less than 10 seconds value. *Note – phase lengths here represent the green phase+ yellow time for the phase.*

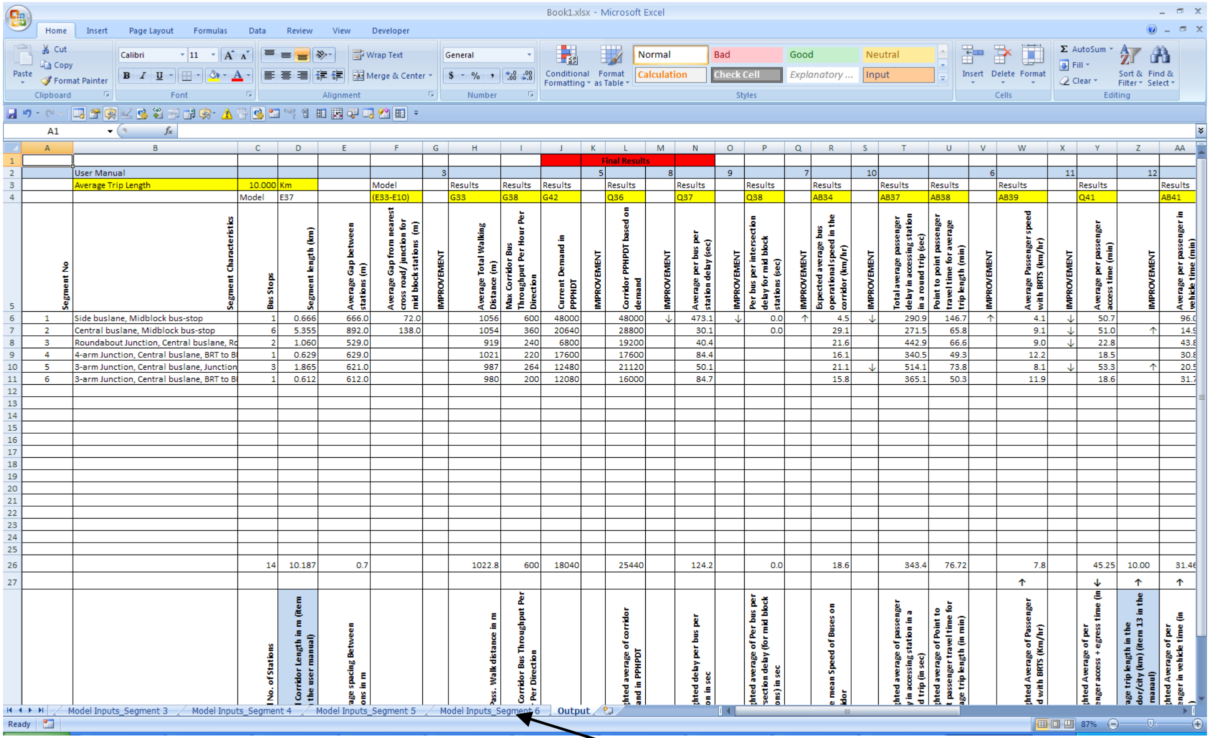
(e) When the segment design involves a mid block station or 'all red phase or pedestrian phase' has been activated in the 'junction model input form' (Section 4.6.11) the total phase length calculation must include the 'user defined pedestrian phase length' (provided adjacent to 'user defined cycle length' box) and the total should match the user defined signal cycle length.

After editing the results the user may recalculate to validate the inputs or may simply use the back button to go back to the revised results sheet. Using back button automatically checks and validates all inputs and returns an error message for an unacceptable value.

Note: The user can cancel all inputs and return to tool generated values on the results sheet by using the 'Cancel' button.

4.11 BEAD – Output Sheet:

The tool generates an excel based output file (compatible with MS Excel 2007 and above versions) containing a compilation of all input data and output results. This file can also be used to load data back in the BEAD tool (for segment 1 only in the current version). The file includes multiple work-sheets (Figure 4-11), one of which is named 'Output' and includes the compilation of all segment results, while others are named Model Input_Segment # (specific segment no.)' and includes data for each of the specific segment including user edited values in the results sheet. This excel file can be used for comparison among various segment type or between various system types. The same files also contain the Input and Default sheets and a sheet titled 'Default Data'. Any changes to these sheets are not recommended, but one can copy it and then analyze the same against results for other corridors. Data included in these worksheets is discussed below.



Worksheets containing output and input data for analysis corridor

Figure 4-11: Image of the output file

4.11.1 Default Values (1):

Default data input by the user in the BEAD main page, default data tab is stored in the 'Default Values' worksheet along with relevant error check results. Apart from the user editable default values the worksheet also includes description of all values along with additional calculated values used by the tool in various processes. Figure 4-12 presents sample of default data worksheet.

Figure 4-12: Default Values Worksheet

S.No.	Item	Value	Comments and Units	Additional Notes		Error Check
	Assumptions and Base Calculations					
1	Green phase for buses per direction without turning	0.25	proportion of signal cycle time (per direction)			OK
2	Green phase for buses per direction turning phase (separate turning phase)	0.08	proportion of signal cycle time (per direction)	including yellow		OK
3	Green phase for buses common lane, turning buses	0.10	proportion of signal cycle time (per direction)			
4	BRTS - current design (dwell time)	14.0	sec	Between stop and start of bus		
5	Minimum bus delay	0.0	sec			OK
6	Average bus acceleration	1.00	m/s^2			OK
7	Average Bus Deceleration	1.00	m/s^2			OK
8	Junction width	50.0	m	Gap between the stop lines on both sides of the junction		OK
9	Minibus length	8.0	m			OK
10	Urabn Bus length	12.0	m			OK
11	Articulated bus length	17.0	m			OK
12	Bi articulated bus length	27.0	m			OK
13	Gap between bus without overtaking	3.0	m			OK
14	Gap between buse with overtaking	3.0	m			
15	Reaction delay at junction per bus	2.0	sec			OK
16	Ratio of turning buses as a proportion of total buses	0.25				OK
17	Overtaking lane rule		Straight buses remain in left lane and straight bus boarding bays are ahead of turning bus bays			
18	Speed limit	11.11	m/s or Km/Hr. --------------------------------------	40.0		OK
19	Pedestrian Ramp gradient	5.0%				OK
20	Walking speed	1.00	m/s			OK
21	Half Subway level difference	1.5	m			OK
22	Full subway level difference	3.0	m			OK
23	FOB level difference	7.0	m			OK
24	Climb rate for Escalator	0.30	m/s (For verticle height)			OK
25	Climb rate for Ramps	0.80	m/s (for length of ramp)			OK

		0.30				OK
25	Climb rate for Ramps	0.80	m/s (for length of ramp)			OK
26	Climb rate for steps	0.45	m/s (for vertical height)			OK
27	Minimum Pedestrian green phase	13.4	Seconds	Time to cross up to station		
28	Desirable Pedestrian Green Phase	23.6	Seconds	Time to cross the carriageway		
29	Gap between waiting buses	1.0	m			OK
30	Minibus Capacity	40				OK
31	Urabn Bus Capacity	80				OK
32	Articulated bus Capacity	110				OK
33	Bi articulated bus Capacity	160				OK
34	Lost Crossing time due to yellow pedestrian Phase	5.0	Sec			
35	Distance of stop line from cross road edge	12.0	m	Share		OK
36	Average Motorized vehcile trip length in city	10000	m			
37	Trip1 - 0.5km from corridor - walk access	0	m bus trip	30.0%		
38	Trip1 - 9km on corridor - walk access	400	m. Walk trip			
39	Trip1 - length in BRTS corridor	9000	BRT Trip			
40	Trip2 - 1km from the corridor	500	m. Bus Trip	30.0%		
41	Trip2 - on corridor - walk access	400	m. Walk trip			
42	Trip 2 - Length in BRTS corridor	8000	BRT Trip			
43	Trip3 - 2km from corridor - walk access	1500	m. Bus Trip	25.0%		
44	Trip3 - 6km on corridor - walk access	400	m. Walk trip			
45	Trip3 - length in BRTS corridor	6000	BRT Trip			
46	Trip4 - 3km from corridor - walk access	2500	m. Bus Trip	15.0%		
47	Trip4 - 4km on corridor - walk access	400	m. Walk trip			
48	Trip4 - length in BRTS corridor	4000	BRT Trip			
49	Average Distance of side feeder station from corridor	150.0	m			
50	Average Crossing delay of cross road	91.9	sec			

		150.0				
50	Average Crossing delay of cross road	91.9	sec			
51	Average Crossing distance	7.6	m			
52	Average Bus speed outside corridor	3.75	m/sec or Km/hr. -------------------------------------	13.5	km/hr	
53	Average bus wait time in open system	47.0	Sec			
54	Average Bus Wait time in closed system	28.0	Sec			
55	Expected % of passengers opting for interchange at corridor in an open system	21.0%				
56	Avg. crossing width of cross road, feeder road or spine hosting bus routes in open	11.5	m			OK
57	Average delay to find gap in vehicles for crossing side road	30.0	sec			OK
58	Minimum gap between buses (including bus length)	61.4	m			
59	% inefficency in bus signal priority	10.00%				OK
60	Average speed of motor vehicles in the city	5.56	m/s or Km/Hr. --	20.0	km/hr	
61	Desired signal cycle length for 2 phase signal	60.0	sec			OK
62	Maximum desirable signal cycle length	180.0	sec			OK
63	Min desirable signal cycle length for 4 arm BRT corridor	150.0	sec			OK
64	Maximum desirable signal cycle length for 3 artm junction	150.0	sec			OK
65	Minimum desirbale signal cycle length for 3 arm junction	120.0	sec			OK
66	Maximum desirable signal cycle length for 2 arm or mid block junction	90.0	sec			OK
67	Minimum desirable signal cycle length for 2 arm or mid block junction	60.0	sec			OK
68	Indicative cycle length for no signal (or single green phase)	150.0	sec			
69	Avg. per passenger time lost due to offboard fare collection	0.0	sec			
70	Avg. Per passenger time lost due to delay between platform and bus doors	0.0	sec			OK
71	Sum of average Distance of Pvt. Vehicle parking from Origin and destination	50.0	m			OK
72	Total No. of Distinct routes using a segment in an open system	5				OK
73	Default distance of Feeder Station on Side road from Corridor (not for transfer stations)	150	m			OK
74	Distance of transfer station from main corridor	150	m			OK
75	Additional Station Time at transfer station on account of additional manuevering, longer bays, additional passengers, etc.	0.0	sec			OK
76	Time Lost Per step for Boarding	1.0	sec			OK
77	Average Dwell Time for Level boarding	14.0	sec			OK

4.11.2 Model Inputs (2):

The values in these excel sheet is what defines each particular segment design in a BRTS corridor. These values can be used to crosscheck the input values given by user during analysis (upto Sr. No. 51) and also to recreate the design for any further analysis. Changes to these values in this file are not recommended however the same can be copied and edited. Figure 4-13 presents a representative image of worksheet containing BEAD segment specific user input data.

Figure 4-13: Image of BEAD Input Data form for specific segment no.

INPUT DATA

S.No.	Category	Input	Unit	Input Status	Explanation
1	Signalized or roundabout	2		OK	more than 80m from entrance (considered mid block), 2 if junction is a roundabout junction
2	Operation Type	1		OK	1 for open, 0 for closed. Value cannot be 1 for grade seperated junction
3	Location and Type	1		OK	segregated bus lanes, 2 for segregated bus lanes on one edge of the corridor (both directions
4	common station	1		OK	stations not possible with unsegregated curbside lanes
5	or right side of bus boarding	1		OK	value for 3 above is 0. Right side stations are not possible with unsegregated curbside lanes
6	Parallel or single station	1		OK	1 for single, 2 for parallel. Value has to be 1 if value of 4 is 2 or value of 3 above is 0
7	without overtaking	0		OK	If previous input is 2, it should be 1 here. Value should be 1 if physically segregated bus lanes are
8	boarding front edge from	26.0	m	OK	Minimum value should be 50 if physically segregated bus lanes are not used. Maximum value
9	Simultaneous buses to be	6	No.	OK	Even value only - 4 or more
10	Platfrom Height	0.4	m	OK	
11	platform width (each)	3.0	m	OK	
12	seperated Junction (no	0		OK	1 for yes, 0 for no. Should be 0 for open system or when bus or vehicle turns are allowed.
13	Junction signal cycle	150.0	Sec	OK	signal cycle. Should be 60 if grade seperated junction
14	Near side or far side	1		OK	1 for near side 2 for far side 0 for common platform (for both sides)
15	With or without doors	0		OK	1 with doors, 0 without doors
16	Bus Type planned for	4		OK	low floor urban bus, 4 for low floor urban bus, 5 for low floor articulated bus, 6 for low floor bi
17	Off board fare collection	2		OK	1 for yes, 2 for no
18	allowed at this junction	1		OK	above. Value cannot be 1 for grade seperated junctions
19	turning allowed at	1		OK	above. Should be 0 for grade seperated junction. Value Cannot be 1 if it is 3 in 3 above. Vehicle
20	Pedestrian access type	1		OK	full subway, 4 for FOB (with elevator and escalator). Input the lower value if more than 1
21	Seperated Pedestrian	0		OK	3 for steps. Input for primary access type if more than 2 types of access are available. Elevators
22	Row Width	45.0	m	OK	BRTS or too wide to be a urban road. Input Error may also indicate error in cross section
23	distance between	600.0	m	OK	Input Error may mean average BRTS station spacing not conducive to BRTS functioning
24	motor vehicular	50.0	m	OK	Input Error may mean que length greater than average spacing between stations
25	lanes desired per direction	2	no.	OK	possible in ROW and station design type. You may want to modify cross section on the results page to
26	turning buses as a	0.30		OK	0 if no turning buses else fraction value
27	on cross roads at intersection	0		OK	1 if yes, 0 if no. Cross BRT is only possible on 4 arm Junction
28	Junction Type	4		OK	2 if mid block, 3 if 3 arm junction, 4 if 4 arm junction
29	Cross Road traffic type	2		OK	(traffic meeting at intersection is considerably less than the expected capacity or considerably less
30	BRTS corridor Traffic Type	2		OK	considerably less than the expected capacity or considerably less than the traffic along cross road;
31	first bus front (in case of	26.0	m	OK	in 7 above for junction stations and should be less than half the average gap between stations in case
32	Boarding level	0	no.	OK	same, no steps after enetring bus), 1 for 1 step inside bus, 2 for 2 and 3 for 3 steps inside bus

32	Boarding level	0	no.	OK	inside bus, 2 for 2 and 3 for 3 steps inside bus
33	No. of access to the station	1	No.	OK	2 for 2 accesses. Should be 1 for grade seperated junctions
34	Corridor Length	10.000	Km	OK	Should be greater than 2.5km, and less than 40km
35	Motorized Trip length in	10.000	Km	OK	Should be greater than 2.5km, and less than 40km
36	Bus priority signal	0		OK	seperated junctions. Value should be 0 if buses are in mixed condition
37	for vehicles or dedicated	0		OK	is less than 4 (0 if grade seperated junction). Should be 0 for grade seperated junctions
38	Landuse along the corridor	1		OK	1 for high density, low to medium income, mix of commercial and residential, 0 for others
	Additional Corridor				
39	parallel lanes on near side	0	no.	OK	0 without overtaking lane, 1 with overtaking lane. If previous input is 2, it should be 1 here.
40	seperated Junction (no	0		OK	1 for yes, 0 for no. Should be 0 for open system or when bus or vehicle turns are allowed.
41	Junction signal cycle	150.0	Sec	OK	Should be 60 seconds if Grade seperated junction
42	allowed at this junction	1		OK	1 for yes, 0 for no. Value should be 0 if it is 1 in 1 above
43	turning allowed at	1		OK	1 for yes, 0 for no. Value should be 0 if it is 1 in 1 above. Should be 0 for grade seperated junction
44	motor vehicular	50.0	m	OK	Input Error may mean que length greater than average spacing between stations
45	turning buses as a	0.30		OK	0 if no turning buses else fraction value. Should be 0 for grade seperated junctions
46	on cross roads at intersection	0		OK	1 if yes, 0 if no
47	Junction Type	4		OK	2 if mid block, 3 if 3 arm junction, 4 if 4 arm junction
48	Cross Road traffic type	1		OK	(traffic meeting at intersection is considerably less than the expected capacity or considerably less
49	BRTS corridor Traffic Type	2		OK	considerably less than the expected capacity or considerably less than the traffic along cross road;
50	Bus Priority Signal	0		OK	0 for no, 1 for Signal Priority. Should be 0 for grade seperated junctions
51	for vehicles or dedicated	0		OK	is less than 4. Should be zero for grade seperated junctions
52	Jurisdiction of BRTS corridor	Delhi		OK	Jurisdiction in which BRTS would be located
53	BRTS Corridor name	ISBT-Dilshad garden		OK	BRTS Corridor name
54	Begin point of BRTS corridor	ISBT		OK	Begin point of BRTS, e.g., cross street or landmark
55	End point of BRTS corridor	Dilshad		OK	End point of BRTS, e.g., cross street or landmark
56	Number of segments in corridor length	1		OK	Total number of segments in the entire corridor that is required in the analyses. For example, if BRTS corridor has five junction segments and three midblock segments, enter eight for the number of segments.
57	Segment 1 length	10.000	km	OK	Length of Segment in kilometers.
58	Segment 1 characteristic	Roundabout-central-Roundabout		OK	Segment characteristic is one word that best describes the segment
59	Number of bus stations in the segment	1		OK	Must be an integer 0 or greater
60	Segment 2 length	0.000	km	OK	Length of Segment in kilometers.
61	Segment 2 characteristic			OK	Segment characteristic is one word that best describes the segment
62	Number of bus stations in the segment	0		OK	Must be an integer 0 or greater
63	Segment 3 length	0.000	km	OK	Length of Segment in kilometers.
64	Segment 3 characteristic			OK	Segment characteristic is one word that best describes the segment

65	Number of bus stations in the segment	0		OK	Must be an integer 0 or greater
66	Segment 4 length	0.000	km	OK	Length of Segment in kilometers.
67	Segment 4 characteristic			OK	Segment characteristic is one word that best describes the segment
68	Number of bus stations in the segment	0		OK	Must be an integer 0 or greater
69	Segment 5 length	0.000	km	OK	Length of Segment in kilometers.
70	Segment 5 characteristic			OK	Segment characteristic is one word that best describes the segment
71	Number of bus stations in the segment	0		OK	Must be an integer 0 or greater
72	Segment 6 length	0.000	km	OK	Length of Segment in kilometers.
73	Segment 6 characteristic			OK	Segment characteristic is one word that best describes the segment
74	Number of bus stations in the segment	0		OK	Must be an integer 0 or greater
75	Segment 7 length	0.000	km	OK	Length of Segment in kilometers.
76	Segment 7 characteristic			OK	Segment characteristic is one word that best describes the segment
77	Number of bus stations in the segment	0		OK	Must be an integer 0 or greater
78	Segment 8 length	0.000	km	OK	Length of Segment in kilometers.
79	Segment 8 characteristic			OK	Segment characteristic is one word that best describes the segment
80	Number of bus stations in the segment	0		OK	Must be an integer 0 or greater
81	Segment 9 length	0.000	km	OK	Length of Segment in kilometers.
82	Segment 9 characteristic			OK	Segment characteristic is one word that best describes the segment
83	Number of bus stations in the segment	0		OK	Must be an integer 0 or greater
84	Segment 10 length	0.000	km	OK	Length of Segment in kilometers.
85	Segment 10 characteristic			OK	Segment characteristic is one word that best describes the segment
86	Number of bus stations in the segment	0		OK	Must be an integer 0 or greater
87	Segment 11 length	0.000	km	OK	Length of Segment in kilometers.
88	Segment 11 characteristic			OK	Segment characteristic is one word that best describes the segment
89	Number of bus stations in the segment	0		OK	Must be an integer 0 or greater
90	Segment 12 length	0.000	km	OK	Length of Segment in kilometers.
91	Segment 12 characteristic			OK	Segment characteristic is one word that best describes the segment
92	Number of bus stations in the segment	0		OK	Must be an integer 0 or greater
93	Segment 13 length	0.000	km	OK	Length of Segment in kilometers.
94	Segment 13 characteristic			OK	Segment characteristic is one word that best describes the segment
95	Number of bus stations in the segment	0		OK	Must be an integer 0 or greater

96	Segment 14 length	0.000	km	OK	Length of Segment in kilometers.
97	Segment 14 characteristic			OK	Segment characteristic is one word that best describes the segment
98	Number of bus stations in the segment	0		OK	Must be an integer 0 or greater
99	Segment 15 length	0.000	km	OK	Length of Segment in kilometers.
100	Segment 15 characteristic			OK	Segment characteristic is one word that best describes the segment
101	Number of bus stations in the segment	0		OK	Must be an integer 0 or greater
102	Segment 16 length	0.000	km	OK	Length of Segment in kilometers.
103	Segment 16 characteristic			OK	Segment characteristic is one word that best describes the segment
104	Number of bus stations in the segment	0		OK	Must be an integer 0 or greater
105	Segment 17 length	0.000	km	OK	Length of Segment in kilometers.
106	Segment 17 characteristic			OK	Segment characteristic is one word that best describes the segment
107	Number of bus stations in the segment	0		OK	Must be an integer 0 or greater
108	Segment 18 length	0.000	km	OK	Length of Segment in kilometers.
109	Segment 18 characteristic			OK	Segment characteristic is one word that best describes the segment
110	Number of bus stations in the segment	0		OK	Must be an integer 0 or greater
111	Segment 19 length	0.000	km	OK	Length of Segment in kilometers.
112	Segment 19 characteristic			OK	Segment characteristic is one word that best describes the segment
113	Number of bus stations in the segment	0		OK	Must be an integer 0 or greater
114	Segment 20 length	0.000	km	OK	Length of Segment in kilometers.
115	Segment 20 characteristic			OK	Segment characteristic is one word that best describes the segment
116	Number of bus stations in the segment	0		OK	Must be an integer 0 or greater
117	Ratio of transfer stations to the total station no.'s on the corridor	0.00		OK	Should be less than 1 for closed systems and 0 for open systems
118	Edge Footpath	0.00	m		User cross section element width input from Result sheet
119	Service Lane	5.00	m		User cross section element width input from Result sheet
120	Unpaved	0.00	m		User cross section element width input from Result sheet
121	Footpath	1.80	m		User cross section element width input from Result sheet
122	Tree Belt	0.90	m		User cross section element width input from Result sheet
123	Cycle Track	2.50	m		User cross section element width input from Result sheet
124	Segregator	0.75	m		User cross section element width input from Result sheet
125	Parking	1.80	m		User cross section element width input from Result sheet
126	Carriageway	7.00	m		User cross section element width input from Result sheet
127	Turning Pocket	0.00	m		User cross section element width input from Result sheet
128	Bus Shelter 1	0.00	m		User cross section element width input from Result sheet

129	Bus Lane (Boarding 1)	0.00	m		User cross section element width input from Result sheet	
130	Bus Shelter 2	0.00	m		User cross section element width input from Result sheet	
131	Bus Lane (Boarding 2)	1.10	m		User cross section element width input from Result sheet	
132	Central Island	0.00	m		User cross section element width input from Result sheet	
133	Bus Lane	0.00	m		User cross section element width input from Result sheet	
134	Median	0.00	m		User cross section element width input from Result sheet	
135	Turning Pocket	0.00	m		User cross section element width input from Result sheet	
136	Carriageway	7.00	m		User cross section element width input from Result sheet	
137	Parking	0.00	m		User cross section element width input from Result sheet	
138	Segregator	0.75	m		User cross section element width input from Result sheet	
139	Cycle Track	2.50	m		User cross section element width input from Result sheet	
140	Tree Belt	0.90	m		User cross section element width input from Result sheet	
141	Footpath	1.80	m		User cross section element width input from Result sheet	
142	Unpaved	5.00	m		User cross section element width input from Result sheet	
143	Service Lane	4.50	m		User cross section element width input from Result sheet	
144	Edge Footpath	1.70	m		User cross section element width input from Result sheet	
145	Cross road/crossing Car lane - straight traffic eastbound	29.0	seconds		User phase length input from Result sheet	
146	Cross road/crossing Car lane - turning traffic eastbound	29.0	seconds		User phase length input from Result sheet	
147	Cross road/crossing BRT lane - straight traffic eastbound	0.0	seconds		User phase length input from Result sheet	
148	Cross road/crossing BRT lane - turning traffic eastbound	0.0	seconds		User phase length input from Result sheet	
149	Main corridor BRT lane - turning traffic southbound	16.0	seconds		User phase length input from Result sheet	
150	Main corridor BRT lane - straight traffic southbound	16.0	seconds		User phase length input from Result sheet	
151	Main corridor Car lane - turning traffic southbound	19.0	seconds		User phase length input from Result sheet	
152	Main corridor Car lane - straight traffic southbound	19.0	seconds		User phase length input from Result sheet	
153	Main corridor Car lane - straight traffic northbound	19.0	seconds		User phase length input from Result sheet	
154	Main corridor Car lane - turning traffic northbound	19.0	seconds		User phase length input from Result sheet	
155	Main corridor BRT lane - straight traffic northbound	16.0	seconds		User phase length input from Result sheet	

156	Main corridor BRT lane - turning traffic northbound	20.0	seconds		User phase length input from Result sheet
157	Cross road/crossing BRT lane - turning traffic westbound	0.0	seconds		User phase length input from Result sheet
158	Cross road/crossing BRT lane - straight traffic westbound	0.0	seconds		User phase length input from Result sheet
159	Cross road/crossing Car lane - turning traffic westbound	40.0	seconds		User phase length input from Result sheet
160	Cross road/crossing Car lane - straight traffic westbound	40.0	seconds		User phase length input from Result sheet
161	User bus throughput in buses per hour per direction	85			User bus throughput input from Result sheet
162	User cycle length	60.0	seconds		User cycle length from Result sheet
163	User pedestrian phase length	0	seconds		User pedestrian phase length from Results sheet
164	Bus Speed limit	40.0	km/h		Bus speed limit in BRT corridor
165	Average speed of motor vehicles in the city	5.9	km/h		Average speed of motor vehicles in city
166	Total No. of Distinct routes using a segment in an open system	11	routes		Total number of distinct routes using a segment in an open system

Note: Rows 161 to 163 contain user edited values on the results page. These values are not restored when the file is loaded in BEAD and can be referred from the output file. Similarly rows 164 to 166 of this sheet contain the segment default values which are also not restored when the file is loaded, and can be manually adjusted using values from the output sheet.

4.11.3 Outputs (3):

The Output worksheet contains the compilation of all segment results (based and including user edited values on the results sheet for each segment). This sheet has been discussed in detail in chapter 3 above. A negative value indicates time penalty for using BRT over private transport as average speed on BRT is lower than the average passenger speed on private transport. (Cars, Motors, 2-wheeleeeer).