APPLING GIS ON TRANSPORT DEMAND FORECAST: FUSING SOFTWARE FOR CASE STUDY OF WESTERN REGION OF SRI LANKA

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ABSTRACT:

Transport is a vital problem in Sri Lanka especially in Western Region (WR). There were several studies done in past few decades but only a few projects have been implemented. Recent transport studies done for WR shows necessity of introduced new public transport modes to cater this high demand and should take transport demand management measures in to an action.

Future traffic demand is estimated by comprehensive studies done with several traffic surveys. Transport demand forecast models calibrated using Biogeme and demand analysis done using JICA STRADA. STRADA is software used for demand analysis and trip assignment with 18 different modules. Software is flexible to work with different text editors, Excel, ArcGIS or MapInfo.

Road network plays major role in demand forecast and trip assignment. STRADA has module Network Editor to preparing road network, but using GIS is convenient since it facilitates editing network and update attributes simultaneously. Tracing errors is time consuming but easily can monitor with GIS software.

Bus routes information prepare using “Transit Line Editor” module. Bus stops should be identified and enter information. In here one of the basic facilities of GIS, using multiple layers as back ground is very helpful.

When preparing railway network, each stations should be connected to the closest Traffic Analysis Zones (TAZ) using imaginary links. Basic GIS facility of buffering can be utilized for such work. By changing the buffer distance from railway stations, can check how much will be the railway passenger share from public transport. This is helpful to improve railway stations and accessibility to railway stations.

Road network is changed rapidly when testing new transport modes in different scenarios. To do such comprehensive work, GIS is very helpful to manage the limited time. Also GIS is helpful to present the output in meaning full way to the audience.

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Transport is a vital problem in Sri Lanka especially in Western Region (WR) in the country. There were several studies done in past few decades but only a few projects have been implemented. Transport statistics shows from 2002 to 2012 vehicle registration is increased from 564,496 to 1,279,616 in WR (**R1**: CoMTrans Final Report, 2014) and daily trips which cross the Colombo Municipality Council (CMC) boundary are increased from 1,061 thousand to 2,066 thousand from year 1985 to year 2013 respectively (**R2**: 5th Steering Committee, CoMTrans, 2013). These numbers gives an idea how much of vehicles and vehicle trips increase in Colombo and suburbs.

Recent transport studies done for WR shows that, it should be introduced new public transport modes to cater this high demand and should take transport demand management measures in to an action (**R3**: Feasibility Study on SKYTRAIN Project, 2014).

Urban Transport System Development Project for Colombo Metropolitan Region and Suburbs (CoMTrans) study done several traffic surveys and Home Visit Survey (HVS) to collect necessary data to analyze recent traffic condition of the WR of the country. These data was used to develop transport models to predict future transport demand. Several transport demand forecast models calibrated using Biogeme and demand analysis done using JICA STRADA.

STRADA is software which use for traffic demand analysis and trip assignment with 18 different modules. Software is flexible to work with Microsoft Excel, Arc GIS or with MapInfo. Most of the input and output files of the software are text formatted which can open and work in different text editors.

Road network plays major role in preparing data for demand forecast and trip assignment. There are different road categories such as A, B, C and other roads according to the Road Development authority (RDA). STRADA has its own module called Network Editor for preparing road network. For each road segment STRADA maintain attributes like road name, starting ending nodes, length, maximum capacity, maximum velocity, in which direction each vehicles are passable, what are the vehicles allowed to go on each road segment, the amount of fare charge per each mode type etc.

GIS is software, which gives the graphical user interface (GUI) and attribute table simultaneously as its basic facility. Also GIS allows displaying the multiple data layers at once. With these additional facilities, editing STRADA road network in GIS is much easier and saving a time.

In STRADA there is a module called “GIS Converter” which facilitate user to convert STRADA data to GIS or vice versa. There are more than 4000 road links covers the WR, just by considering main roads. STRADA does not allow duplicate road link names, and specific for starting and ending points of the links. Tracing such errors is time consuming but easily can monitor with GIS software. Keeping unique link names and joining correct starting and ending nodes to make links, is a hectic work for short term projects. **Figure 1 and 2** shows the road network which used for traffic assignments in STRADA software and GIS software with software interfaces.

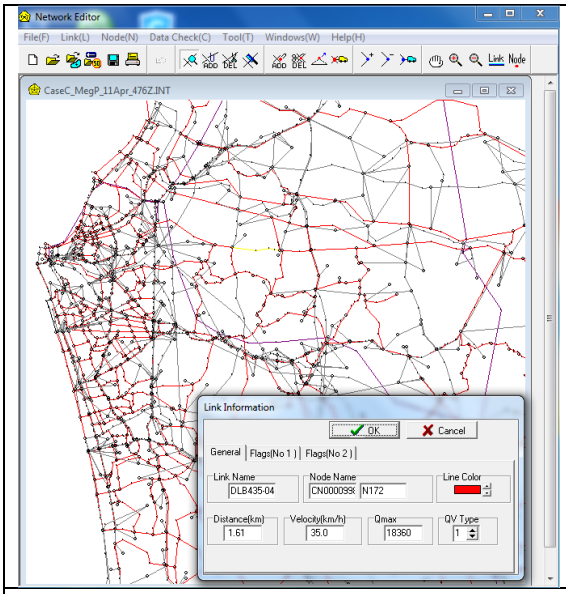

Figure 1:Road network in JICA STRADA Network Editor

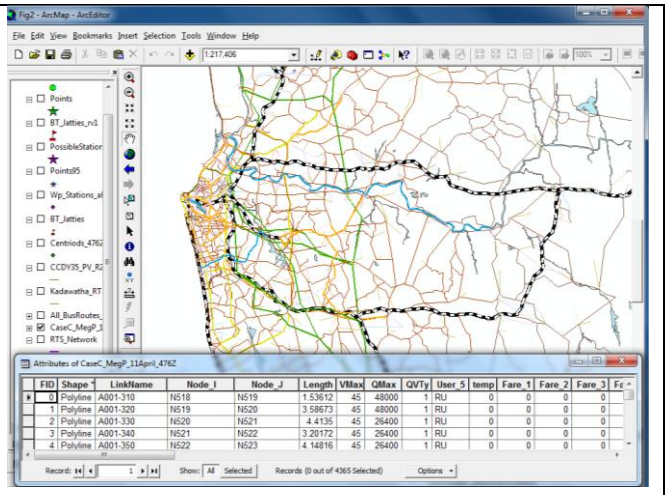

Figure 2: Road network in GIS GUI

In traffic assignments, study area is divided into smaller areas called traffic analysis zones (TAZ). There are 462 TAZ in WR and 34 additional zones to assign trips outside to the WR as shown in **Figure 3**. In trip assignments, trips are assigned into imaginary zone centroids. Those centroids should connect to a closest road junction to distribute trips to the road links. If any of such connection links are not drawn in road network, those trips in the centroid won't assign to the roads. To check such situation GIS is very useful. These can be checked using its basic facility, symbology. There are various types of links exist in road network. For this links types unique coding can be used; then by querying, can search how many links for each type and so on. **Figure 4** shows the different road types which used in the road network with GIS symbology.

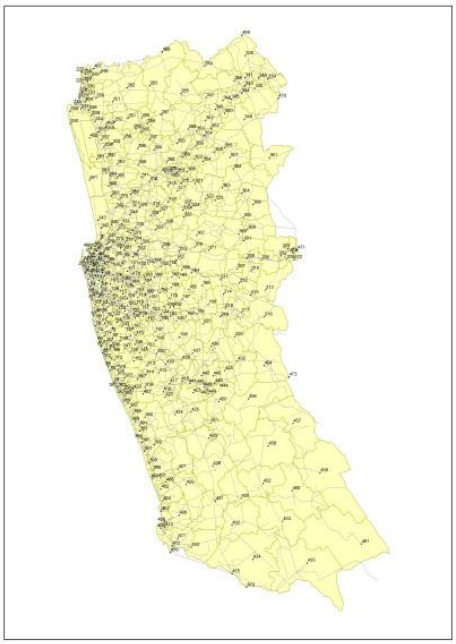

Figure 3: Traffic assigned zones in WR

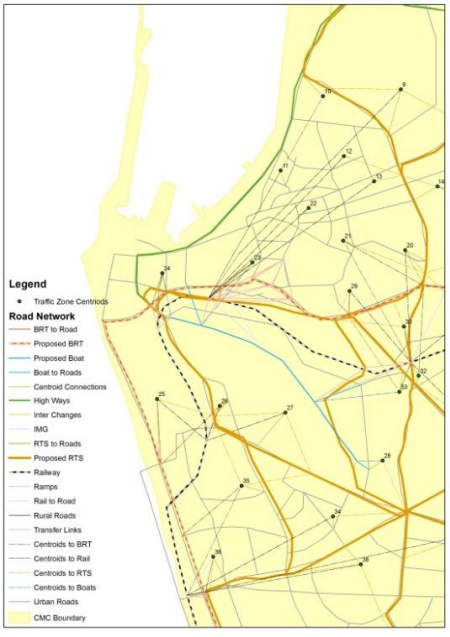

Figure 4: Road Symbology

In public transport network, once bus route network in module called Transit Line Editor is prepared, bus stops should be identified and enter information accordingly. In STRADA, public transport network called as "Line File". To identify bus stops some other topographic data layers such as place names, classified roads and land use etc., can used as show in **Figure 5**. For this purpose, one of the basic facilities of GIS that is using multiple layers as back ground is very helpful.

When considers public transport, mode share between two different modes is very important to cater efficient service. As an example, in Kandy corridor (A001) there should be reasonable passenger share for bus as well as railway. If bus passengers share is comparatively higher than railway, it is more difficult to cater such demand with limited road capacity in future demand estimation. To get maximum return or revenue there should be reasonable share to railway too. In practice these can be done by railway electrification or improving the signal system. In STRADA just by improving railway speeds or lower the fare, passenger trips won't sufficiently attract to the railway.

One outcome that we observe is, when zone connections are increase to the railway stations; more passengers make use of railway. In practice question arise what is the distance from railway station to the zone centroid that should connect. To check such conditions basic analytical tool "buffering" in GIS was used. Using different buffer distances as shown in **Figure 6**, railway stations can connect to zone centroids and same scenario has run several times with different road networks.

Also main railway stations can connect with large number of zone centroids and miner stations can connect with lower number of stations by varying the buffer distances. This was tested in main line Gampaha and Veyangoda stations as well as Coast Line with Moratuwa and Panadura stations. By doing so, number of passengers in same links was monitored for bus and rail to calculate the mode share. For such work GIS is a good tool. Such estimations are helpful to improve railway stations and improve the accessibility to selected railway stations.

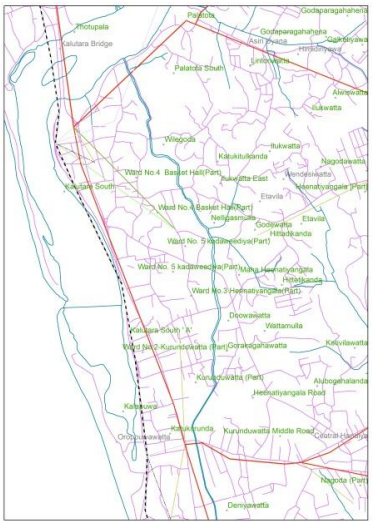

Figure 5: Identify bus stops using multiple data layers

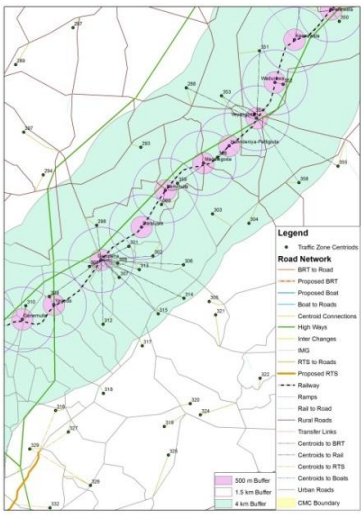

Figure 6: Different buffers around Railway stations

When testing new modes such as SKYTRAIN (monorail), Rapid Transit System (RTS), Bus Rapid Transit (BRT) or Boats, which are currently not available as a transport mode in Sri Lanka lot of preparation needs on road network. Also it should be possible to test the alternative tracing for each new mode. This also possible with GIS, with its basic facilities by drawing alternative routes and close the unnecessary links using attribute as required. **Figure 7 and 8** shows the alternative routes check for RTS in Battaremulla area and CMC area.

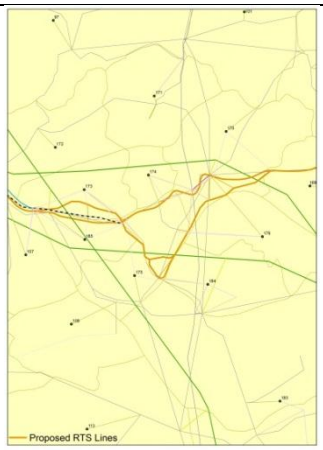

Figure 7: Proposed alternative routes of RTS in Battaramulla

Figure 8: Proposed alternative routes of RTS in CMC

Once introducing new modes, stations of such modes should connect to the centroids by imaginary links. If such links are missing there are no boarding or alighting of passengers from such stations. Also there should be transfer links between different modes, which are closely aligned, to facilitate passengers to transfer between two modes. In such situation the road network is complex and GIS is facilitate quick check with query facility, symbology etc.

For a comprehensive study, presenting outputs to an audience in meaningful way is an important task. In CoMTrans study there are around 50 maps in technical report 5 as a separate appendix to present the outputs of various scenarios that they have tested. In STRADA module called "Highway Reporter" which facilitates display traffic assignments' outputs as maps. GIS was used in CoMTrans study because GIS maps are more attractive as show in **Figure 9 and 10**.

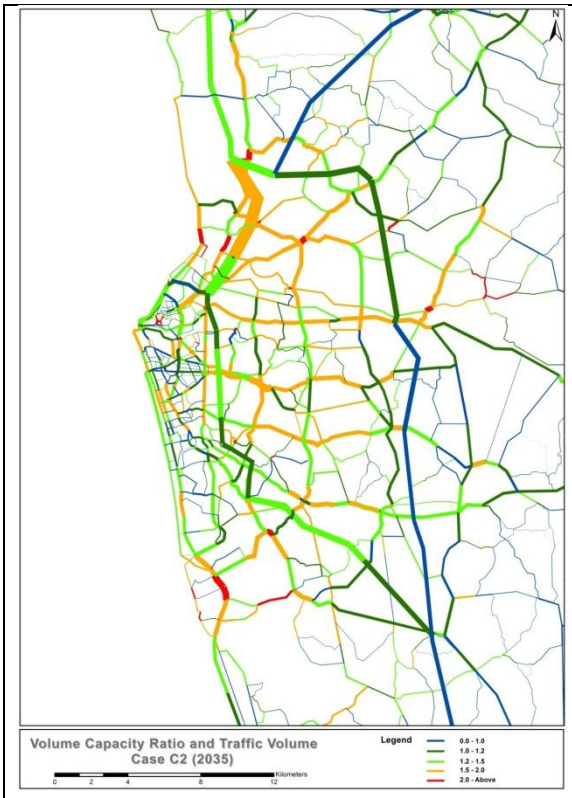

Figure 9: Volume Capacity Ratio and Traffic Volume Maps of Case C2 in 2035

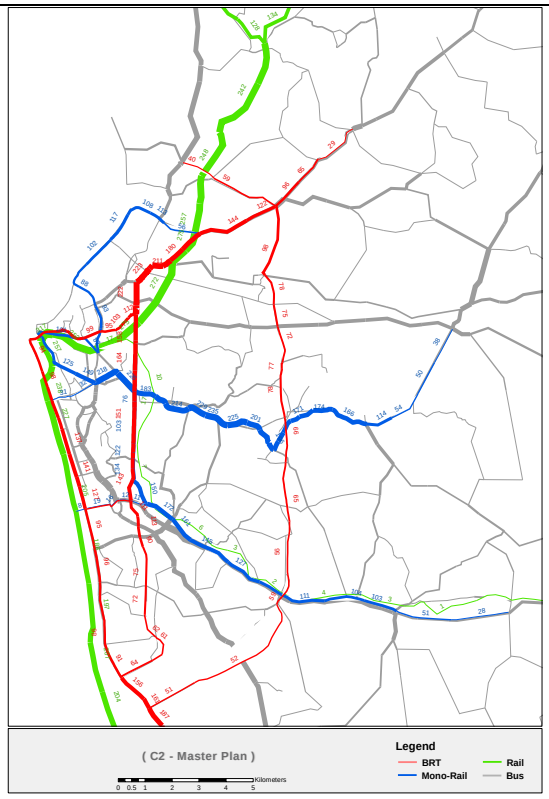

Figure 10: Sectional Volume Map of Master Plan Case C2 in 2035

Soure: CoMTrans technical report chapter 5 - Appemdix: Figure 25 and 50

Acknowledgement

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R2: 5th Steering Committee, CoMTrans, 18th November, 2013.

R3: Feasibility Study on SKYTRAIN Project Integrated Transport System with Monorail, under Urban Transport System Development Project for Colombo Metropolitan Region and Suburbs (CoMTrans), Final Report, October 2014, Japan International Cooperation Agency (JICA), Prepared by Oriental Consultants Co., Ltd., Tokyo, Japan, 2014, Pg. (30).