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MICROSCOPIC SIMULATION MODEL CONSIDERING PUBLIC TRANSPORT POLICY

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Abstract: The main purpose of this study is to provide a basis for evaluating the public transport policies such as public transport priority systems (PTPS) by developing microscopic traffic simulation model. In this study, two types of public transport policies have been considered for evaluation. They are: *bus lanes and PTPS at traffic signal*. Fuzzy logic reasoning has been incorporated in route choice analysis while choosing the route based on the level of satisfaction of the available routes. To demonstrate the validity and applicability of the developed microscopic simulation model, a part of the Gifu city network (60 nodes and 204 links) has been considered and estimated traffic condition without and with policy options. It can be concluded from the output of the present study that developed microscopic traffic simulation model predicts vehicle movements with fair amount of accuracy and can be used to evaluate various public transport policies particularly PTPS.

Key Words: microscopic traffic simulation, public transport priority system (PTPS), bus lanes, fuzzy logic route choice

1. INTRODUCTION

In the absence of realistic estimation of vehicle operations under different policy measures, the conventional evaluation techniques may tend to undervalue / overvalue the policy measures. To overcome these problems in evaluation, the techniques such as application of microscopic traffic simulation are clearly required. Since two decades, simulation technique is widely used to analyze and represent the actual traffic condition of the road or network. Microscopic simulation analysis has received higher attention in the last decade and it has been acknowledged that they are proven tools for aiding transportation feasibility studies. It is mainly because they try to analyze each individual vehicle behavior and its movement on the

network more realistically in the simulation period. This is not only due to their ability to capture the full dynamics of time dependent traffic phenomena, but also they are capable of using behavioral models that can account for drivers' reactions.

Many researchers all over the world have developed microscopic traffic simulation models. Most of the models have used probabilistic approach especially in selecting the route by the driver. And also the absence of sophisticated model to evaluate different public transport policy measures has necessitated the starting of this study. So in this study, an attempt has been made in developing microscopic simulation model to evaluate different public transport policies particularly public transport priority systems (PTPS).

The main objective of this study is to provide a basis for evaluating the public transport policies such as PTPS by developing microscopic traffic simulation model. The following two types of public transport policies have been considered for evaluation in this study. They are:

- *Bus lanes* i.e. special lanes dedicated to buses to insure high quality transit service and
- *Public transport priority system at traffic signal* i.e. traffic signal would be set to stay green which allows a bus to avoid stopping.

Another objective of the present study is also to incorporate fuzzy logic reasoning in route choice behaviour in selecting the route based on the level of satisfaction for that route.

The outline of microscopic simulation model has been described in the section 2, which includes formulation of various traffic models. In the same section, development and validation of simulation model has also been described by considering the part of Gifu city network. The Section 3 gives the procedure involved in the evaluation of public transport policies and presents the output of the simulation model from these policies. Finally concluding remarks have been discussed in Section 4.

2. MICROSCOPIC SIMULATION MODEL

2.1. Outline of Simulation Model

The basic components and the data on various parameters required for development of microscopic traffic simulation model (Yang and Koutsopoulos, 1996) include:

- Network geometry (nodes, links, segments, zones etc, lane data for each link, link / lane characteristics, other restrictions such as vehicle prohibitions etc.)
- Vehicular characteristics (vehicle length, maximum speed, maximum acceleration, maximum deceleration, desired speed)
- Driver characteristics and behavior data
- Travel demands (O-D matrices based on departure time for different vehicle)
- Data on traffic control systems (signal phases and cycle length etc.)
- Traffic flow models such as car following and lane changing models
- Observed link traffic flow data to validate the developed simulation model

Initially vehicles would be generated on the network from the vehicular, OD and network data and route would be assigned after that. Vehicular movements would be estimated from the traffic models such as car-following and lane changing. The general processes involved in a simulation model have been briefly described in the form of flow chart in Figure 1.

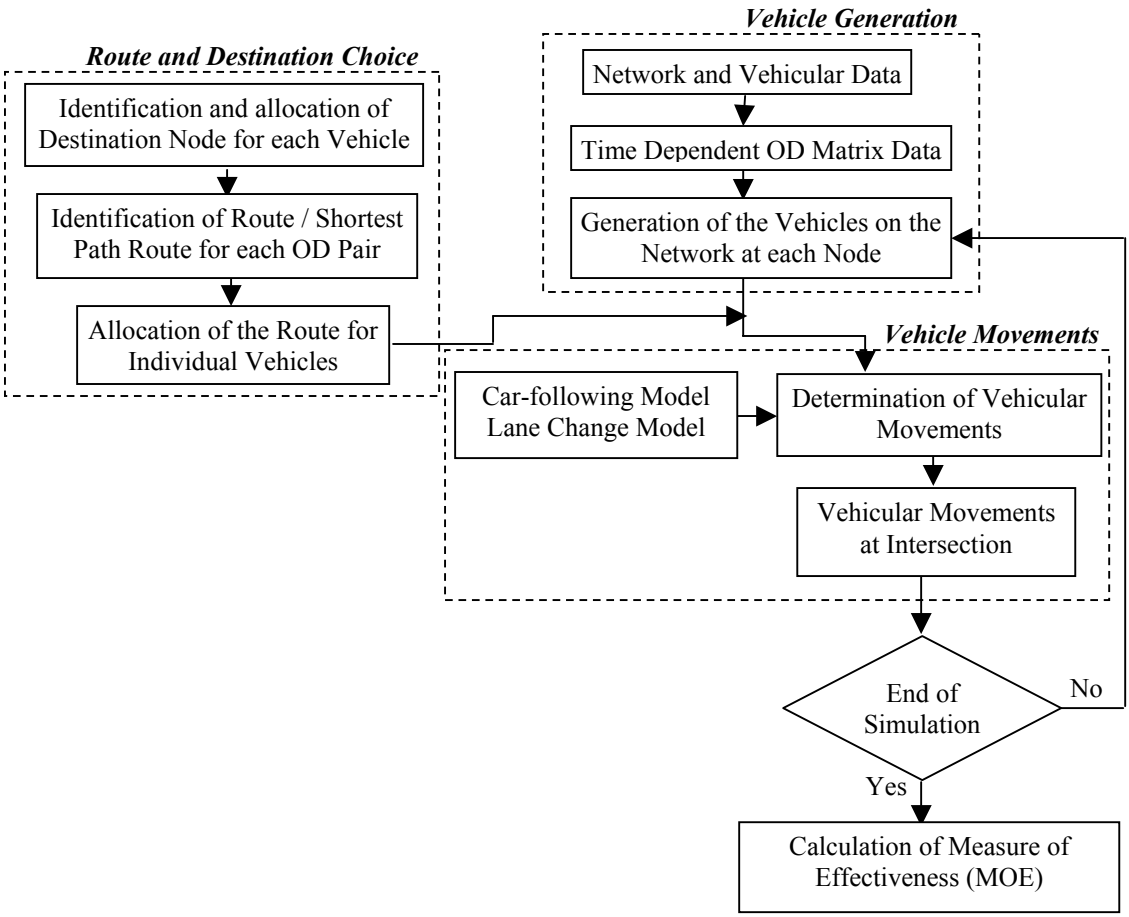


Figure 1. General Processes involved in a Microscopic Traffic Simulation Model

2.2. Formulations of Microscopic Simulation Model

2.2.1. Car-following Model

A fundamental component of any microscopic simulation model is car-following model, which describes the movement of individual vehicles within a platoon. The car-following model computes acceleration or deceleration rate and it is considered to be a function of relative speed and sensitivity of the following driver. If X(n-1,t) and X(n,t) are the positions of the leader vehicle (n-1th) and follower vehicle (nth) respectively at time 't' (as shown in Figure 2), then the basic model is:

$$a(n,t+T) = \lambda[V(n-1,t) - V(n,t)] \qquad \text{----------(1)}$$

Where a(n, t+T) is acceleration of follower in 't+T' time

V(n-1, t) and V(n, t) are the speeds of the leader and follower respectively at time 't'

λ is sensitivity of driver

T is the reaction time

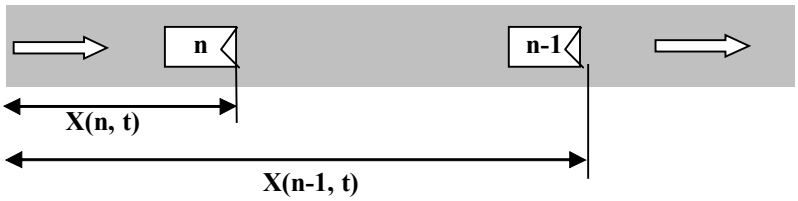


Figure 2. Description of Leader and Follower Vehicles in Car-following Model

The underlying hypothesis behind these models is that a driver will place himself at a distance from the leader vehicle such that in the event of an emergency stop by the leader, the follower will come to rest without striking the lead vehicle. In this study, Gipps model (Gipps, 1981) consisting of two components: acceleration and deceleration, defined as a function of variables that can be measured has been considered. The first represents the intention of a vehicle to achieve certain desired speed, while the second reproduces the limitations imposed by the preceding vehicle when trying to drive at the desired speed. Based on this model $V_a(n,t+T)$, the maximum speed at which a vehicle 'n' can accelerate during a time period 't+T' is given by (Barcelo and Casas, 2002):

$$V_a(n,t+T) = V(n,t) + 2.5a_nT\left[1-\frac{V(n,t)}{V_f(n)}\right]\sqrt{0.025+\frac{V(n,t)}{V_f(n)}} \qquad \text{----------(2)}$$

Where: V(n, t) is the speed of vehicle 'n' at time 't'
$V_f(n)$ is the desired speed of the vehicle 'n'
a_n is the maximum acceleration for vehicle 'n'

On the other hand, $V_b(n,t+T)$, the maximum speed that the same vehicle 'n' can reach during the same time interval 't+T', according to its own characteristics and the limitations imposed by the presence of the leader vehicle is:

$$V_b(n,t+T) = d_nT + \sqrt{d_n^2T^2 - d_n\left[2\{X(n-1,t)-S_{n-1}-X(n,t)\}-V(n,t)T-\frac{V(n-1,t)^2}{d_{n-1}^L}\right]} \text{-----(3)}$$

Where: d_n is the maximum deceleration (< 0) desired by vehicle 'n'
S_{n-1} is the effective length of vehicle 'n-1' includes vehicle length and safety gap
d^L_{n-1} is an estimated desired deceleration of vehicle 'n-1'

The final speed for vehicle 'n' during time interval 't+T' is the minimum of those previously defined speeds (Barcelo and Casas, 2002):

$$V(n,t+T) = Min\{V_a(n,t+T), V_b(n,t+T)\} \qquad \text{----------(4)}$$

In the car-following model, the leader vehicle, would try to drive to its maximum desired speed. Two parameters are used to calculate the maximum desired speed of a vehicle while driving on a particular section; one is related to the vehicle and other to the section: i) $V_{max}(n)$, maximum desired speed of the vehicle 'n' and ii) $S_{lim}(s)$, speed limit of the section 's'. Then $V_{max}(n,s)$, the maximum desired speed of vehicle 'n' on a section 's' is calculated as:

$$V_{\max}(n,s) = Min\{V_{\max}(n), S_{\lim}(s)\} \qquad \text{----------(5)}$$

This maximum desired speed $V_{max}(n,s)$ is the one referred above as $V_f(n)$ in the Equation 2. The position of vehicle 'n' is updated by taking the speed into the following equation:

$$X(n,t+T) = X(n,t) + V(n,t+T)T \qquad \text{----------(6)}$$

2.2.2. Vehicle Generation based on Time Dependent OD Matrix

As the time headway of vehicles is not constant throughout the hour, it is very important to consider the headway in smaller parts of the hour to represent the variations in the demand. In this study, it has been decided to divide the hourly OD traffic into 5-min OD traffic. Basically the hourly OD matrices are calculated from the trip distribution analysis from the Household Travel Survey (also called as Person Trip Survey in Japan) data. The methodology followed to divide hourly OD traffic into 5-min OD traffic, which make a total of twelve OD values per

hour has been shown in the Figure 3. It has been assumed that OD traffic changes uniformly from the previous hour to current hour. The difference between these hourly OD traffic volumes are divided into 12 equal parts and added to previous hour OD traffic to get the hourly OD traffic in that 5-min part. By dividing this OD traffic with 12 again, the absolute 5-min OD traffic can be found. This has been represented in the form of mathematical formulation in equation 7. From this value (vehicles per hour), the average headway (sec per vehicle) in that period can be calculated.

$$OD_5^k(i,j) = \frac{\left\{ OD_{60}^{h-1}(i,j) + 5k\frac{\left[OD_{60}^{h}(i,j) - OD_{60}^{h-1}(i,j)\right]}{60} \right\}}{12} \qquad \text{----------(7)}$$

Where: k is 5-min part (k = 1 to 12 for one hour)

$OD_5^k(i, j)$ is the kth 5-min OD Traffic from Node 'i' to Node 'j'

$OD_{60}^h(i, j)$ is the 60-min OD Traffic from Node 'i' to Node 'j' in Hour 'h'

$OD_{60}^{h-1}(i, j)$ is the 60-min OD Traffic from Node 'i' to Node 'j' in Hour 'h-1'

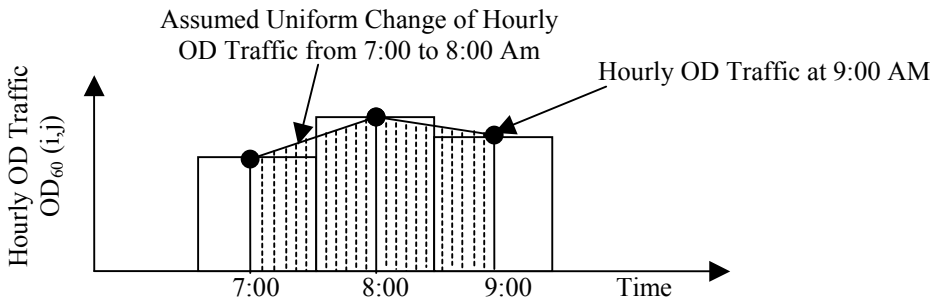


Figure 3. Calculation of 5-minute OD Traffic from Hourly Traffic for each OD pair

By dividing the number of seconds in 5 minutes with the 5-min OD traffic, which was previously calculated from the equation 7, the average time headway (sec / veh) for each node in every 5-min is calculated as given in the equation 8.

$$\lambda_i = \frac{5*60}{\sum_{j=1}^{Total\_Nodes} OD_5(i,j)} \qquad \text{----------(8)}$$

Where: λ_i is the Average Time Headway for Node 'i'

$OD_5(i,j)$ is the 5-min OD Traffic from Node 'i' to Node 'j'

To calculate absolute time of generation of each individual vehicle, the following procedure was introduced. It is normally assumed that the time headway between the vehicles is considered to be following Poisson distribution. From the average time headway λ_i and random numbers, the time headway between each vehicle is calculated from the equation 9 (Yang and Koutsopoulos, 1996).

$$t_n^i = -\left[\frac{1}{\lambda_i}\right]\log[r(0,1)] \qquad \text{----------(9)}$$

Where: t_n^i is time headway of nth vehicle (time gap between n^{th} and $n+1^{th}$ vehicles)

r(0,1) is a random number between 0 and 1

The schematic diagram representing calculated headways between each vehicle at each origin node is shown in the Figure 4.

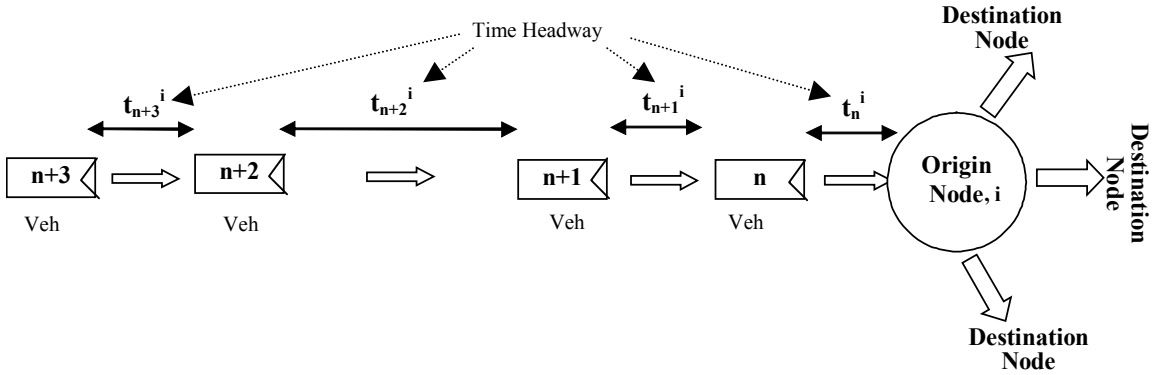


Figure 4. Calculated Headways between Each Vehicle at Every Origin Node

The vehicles would be continuously generated at origin node based on these calculated headways. The destination node is assigned to each of the vehicle based on the probability of choosing a node from every node as explained in equation 10. The probability of choosing a destination node 'j' at origin node 'i' is calculated from the 5-min OD volumes.

$$p(i,j) = \frac{OD_5(i,j)}{\sum_{k=1}^{Total\_Nodes} OD_5(i,k)} \qquad \text{----------(10)}$$

Where: p(i, j) is probability of choosing a destination node 'j' from origin node 'i'
OD_5(i, j) is 5 minute OD traffic from node 'i' to node 'j'

The cumulative probability of choosing a node 'j' is calculated by summing up the probabilities of choosing a destination node less than or equal to node 'j' as given in the equation 11.

$$P(i,j) = \sum_{k=1}^{j} p(i,k) \qquad \text{----------(11)}$$

Where: P(i, j) is cumulative probability of choosing a node 'j' from node 'i'

The destination node is finally selected by generating random number and compared with the cumulative probabilities at the origin node as shown in the equation 12.

$$\textit{Destination Node} = j \;\; [\text{ if } P(i, j-1) < r(0,1) < P(i, j)\,] \qquad \text{----------(12)}$$

Where: r(0,1) is a random number between 0 and 1

2.2.3. Vehicle Movements at Signal

Traffic signals have been considered at all the intersections where more than two roads are meeting. In this simulation model, provision has been given to consider two types of intersections. They are 3-arm and 4-arm intersections. The process involved in simulation model when a vehicle reaching the intersection in its way has been shown in the form of a flow chart in the Figure 5. It checks the signal status in every time interval and proceeds to another link when the signal is green.

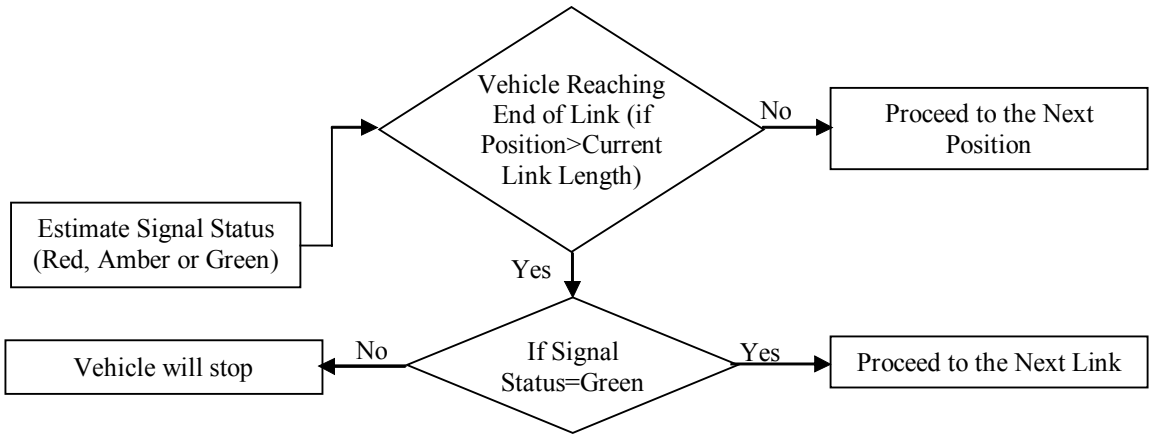


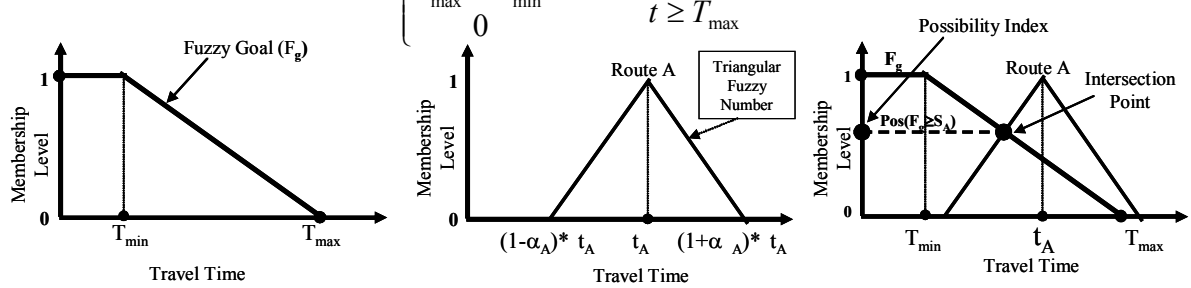
Figure 5. Processes involved when a Vehicle is near the Intersection in the Simulation Model

2.2.4. Route Choice with Fuzzy Logic

In the absence of crisp values of travel times by different modes, drivers use perceived times in choosing the route to their destination. There are some uncertainties involved which are unable to address under the traditional probabilistic methods which considers randomness. These can be overcome by applying fuzzy logic technique in route choice behavior of the individual driver in choosing the route to their destination. In this model, fuzzy logic is considered because in case of implementation of various policy measures, drivers may get the information about the travel times which generally include fuzziness i.e. travel time from origin to destination is "about 15 min". Hence, it is considered to be appropriate to use the fuzzy logic in choosing a route in this study.

In the present study, it is assumed that drivers choose their route based on the level of satisfaction or possibility index, which represents the possibility of choosing that route. To compare the satisfaction levels / possibility indexes of all available routes, it is necessary to have a fuzzy goal (F_g). For a route, it is determined based on standard travel time i.e. shortest path travel time (ST) based on its desire speed. From this value T_{min} (=a*ST) and T_{max} (=b*ST) are determined. In this study, a=1 and b=2 has been considered. The shape of a fuzzy goal function for a route has been shown in the Figure 6(a) and mathematically it is represented as given in the equation 13. The fuzzy goal function is assumed to have the value '1' when travel time is less than T_{min}, it is '0' when travel time is greater than T_{max} and varies linearly between T_{min} and T_{max} as given below (Akiyama, 2000):

$$F_g(t) = \begin{cases} 1 & t \le T_{\min} \\ \dfrac{T_{\max} - t}{T_{\max} - T_{\min}} & T_{\min} < t < T_{\max} \\ 0 & t \ge T_{\max} \end{cases} \quad \text{----------(13)}$$



(a) (b) (c)

Figure 6. Fuzzy Goal and Level of Satisfaction / Possibility Index for a Route

The route travel time is considered as triangular fuzzy number as shown in Figure 6(b). The possibility index for a route is the superior of the minimum of membership functions of fuzzy goal and route travel time and in other words it is the meeting point of these two curves i.e. fuzzy goal line and route fuzzy membership function (S_A) as shown in Figure 6(c). The possibility index [Pos($F_g \geq S_A$)] can be represented mathematically as given in equation 14 for route A (Akiyama and Nomura, 1999).

$$Pos\left(F_g \geq S_A\right) = Sup \cdot Min.\left\{F_g \geq S_A\right\} \qquad \text{---------- (14)}$$

At the beginning, link travel times have been considered as fuzzy values and route travel time is the sum of all link travel times. To get the spread for a route, the spreads (α_A as shown in Figure 6(b)) of all links will also be summed up. Different spreads were assumed based on the characteristics of the link and fuzzy route travel time would be calculated. The possibility indexes for all the available routes have been calculated and finally driver selects the route, which has maximum possibility index.

2.2.5. Lane Changing

In the present simulation model the lane changing process is considered, however it has some limitations. It has been considered when the vehicle is entering into new link only and the situations where the lane change is considered has been explained below:

- Choosing a lane is considered to be dependent on the turn at next intersection. If the turn at the next intersection is left or straight, then the vehicle chooses left lane (presently all links are assumed to have two lanes) and if the turn is right, then it chooses right lane before starting of its movement on the new link (as shown in Figure 7(a)).
- In case of the current link consisting of bus lane (always considered as left lane of link), then vehicle chooses right lane and enter that lane according to the gap availability which is explained in Section 3.1 and as shown in Figure 7(b).
- In case bus stopping at a bus stop (it was assumed that bus stops for about 15 sec at each bus stop), then vehicles choose right lane and enter that lane according to the gap availability as shown in Figure 7(c).

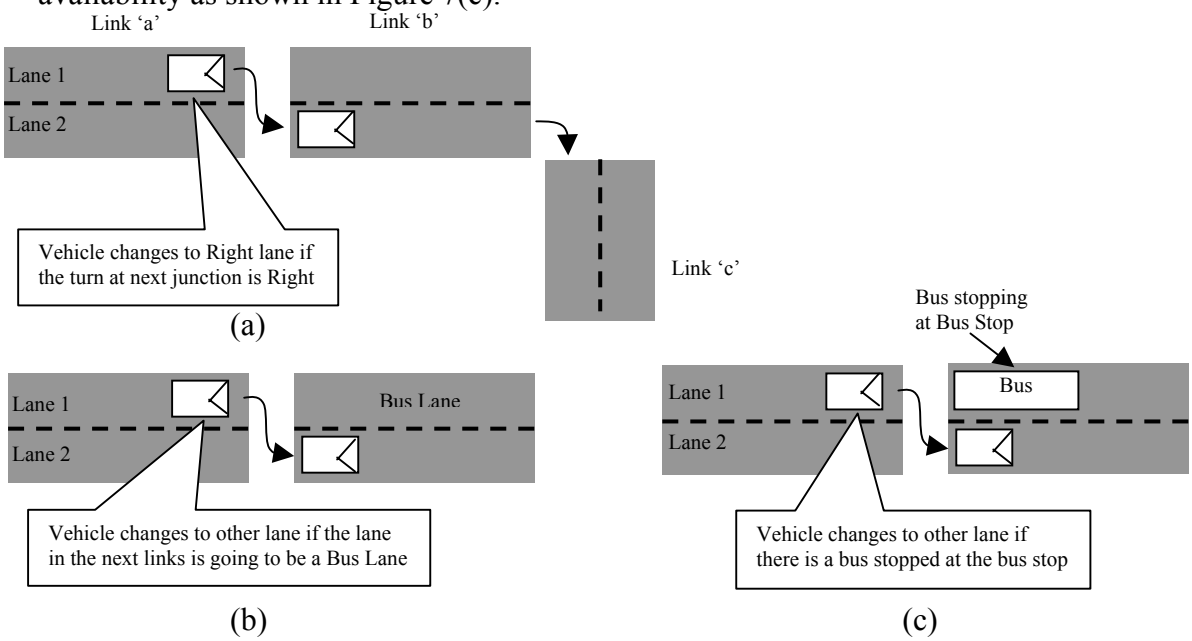
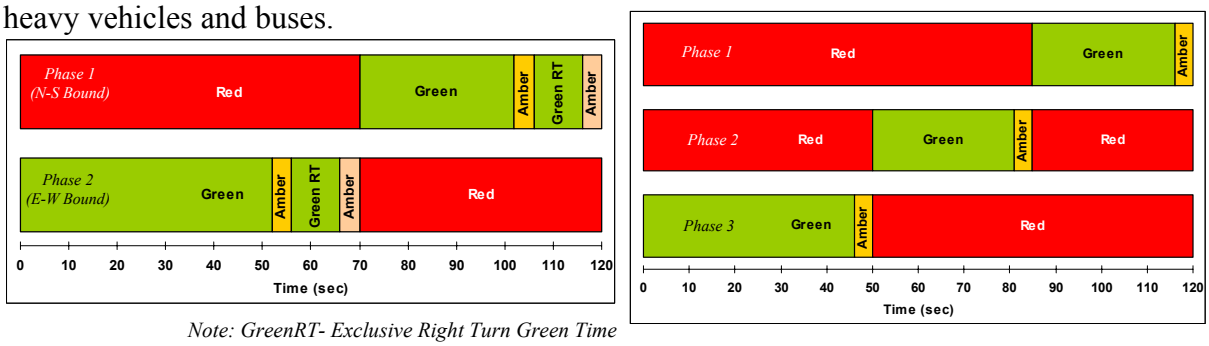


Figure 7. Lane Changing Situations considered in the Present Simulation Model

Generally, lane change occurs not only while changing links but also while moving on the links. In the present study, as all the vehicles are considered to be having the same characteristics in terms of their desired speed and other features, the lane change based on desired speed and speed advantage by changing lane has not been considered as it will be ineffective in that case. After examining the output of the model (comparison of the observed and simulated link flows), fair amount of accuracy has been found and from that it can be said that the developed simulation model is able to predict the vehicular movements with sufficient accuracy though lane change is considered in the limited situations as mentioned above. However, by considering the importance of the lane change process in a simulation model, in future, it would be considered extensively in all possible situations (for example based on its desired speed, queue length at intersection and with traffic control measures etc.) to represent the exact behavior of the drivers on the road network.

2.3. Development of Microscopic Simulation Model

To estimate the vehicular movements and interactions on the network, microscopic simulation model has been developed considering car-following model based on Gipps formulation as explained in the Section 2.2.1. To estimate vehicle movements near intersection, in this study a constant cycle length has been considered for all the intersections (4 and 3 arm) i.e. 120 sec and 2 phases for 4-arm intersection and 3 phases for 3-arm intersection have also been assumed. The details of assumed cycle length, phases and their timings are given in Figure 8. In this study, exclusive right turn phase also considered in case of 4-arm intersection. The main processes involved in the simulation model have been given in the Figure 9 in the form of flow chart. In this model, three vehicle types have been considered; they are private cars, heavy vehicles and buses.



Note: GreenRT- Exclusive Right Turn Green Time

(a) 4-arm intersection (b) 3-arm intersection

Figure 8. Phase Diagrams considered for Different Types of Intersections

2.4. Model Validation

After the development of model, the next step is validation. For this purpose, a part of Gifu city network has been considered. Gifu city, which is located in Central Japan, has the population about 0.4 million. The considered part of Gifu city network consisting of 60 nodes and 204 links has been presented in Figure 10. Each link assumed to be having two lanes in both directions.

To analyse route choice behaviour, three different spreads (α) were assumed in this study based on the characteristics of the link. They are 0.05 for loop and surrounding roads, 0.1 for major roads and 0.15 for other roads. In this study, the fuzzy route travel times have been

calculated for the three alternative routes; they are shortest path by distance, shortest path by time and dynamic shortest path from the latest link travel times. The possibility indexes for these three routes have been calculated and finally driver selects the route, which has maximum possibility index.

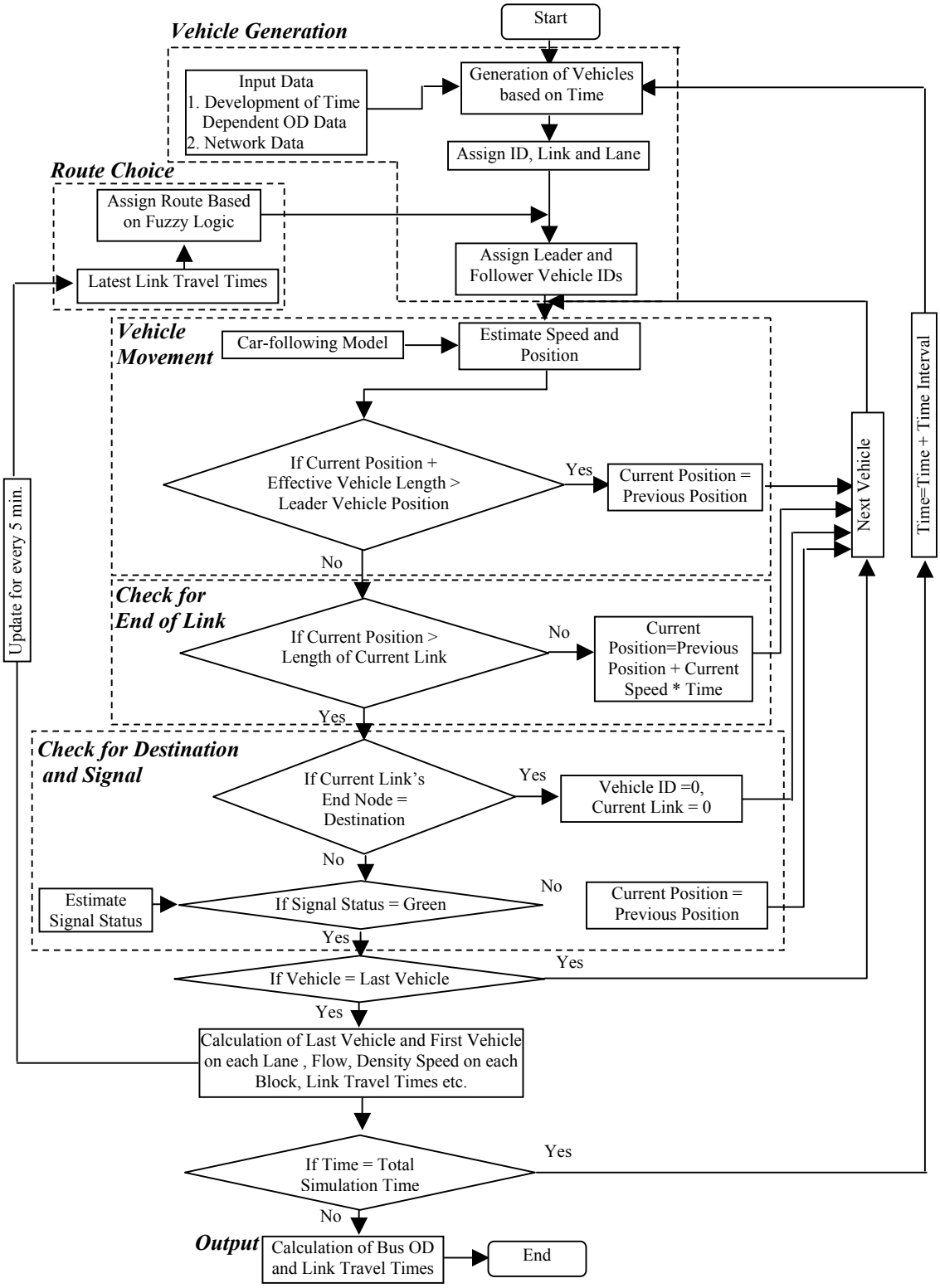


Figure 9. Flow Chart for the Present Microscopic Simulation Model

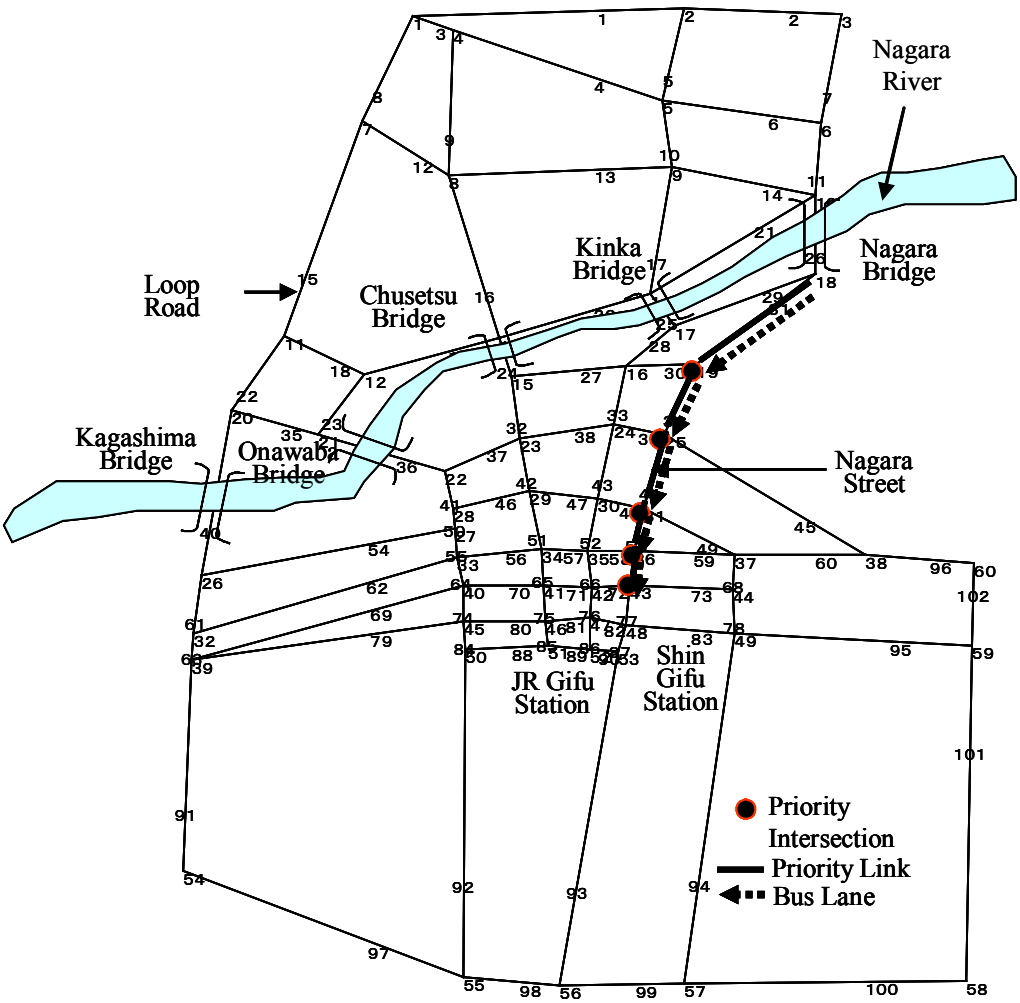


Figure 10. Part of Gifu City Network Considered for Application of Simulation Model

To validate the developed microscopic simulation model, it has been applied on this selected network and estimated the hourly link flows. For this purpose, 3-hour OD matrix (from 06:30 to 09:30) has been generated from recent Household Travel Survey data of Gifu city. As explained in Section 2.2.2, generation of vehicles on the target network based on the time has been carried out. The developed simulation model has been applied to estimate link flows (vehicles per hour) for the peak hour for the Gifu city network. After the thorough investigation, the observed peak hour link flows in the field for certain links of the Gifu city network have been obtained from the reliable sources. These values have been used here to validate the present simulation model, which estimated simulated hourly link flows (vehicles per hour). The comparison between observed and simulated values has been shown in the Figure 11 for about 115 links spreading through out the network. From the statistical analysis, it has been found that average error in estimation is about 21% with RMS value about 274 Veh/Hr and R^2 is 0.8. Therefore, it can be said that the developed simulation model is able to predict the vehicular movements with a fair amount of accuracy. Each link has been divided into 100 meter segments (blocks) to estimate the traffic characteristics (such as volume, density and speed) and the blocks that has density more than critical density is considered as congested and they have been identified and presented in the Figure 12. After the validation step the present model has been applied to evaluate the public transport policies. The description and evaluation of public transport policies have been presented in the subsequent sections.

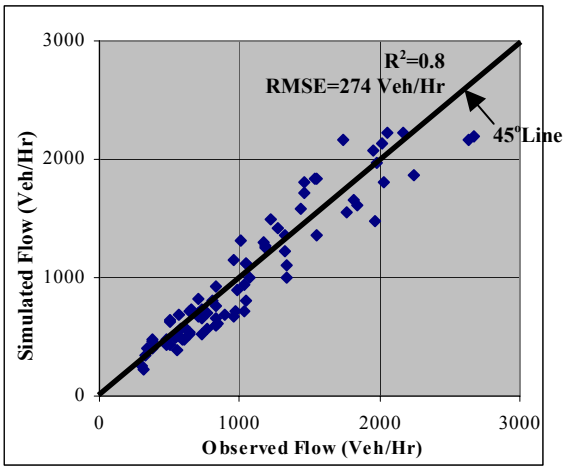


Figure 11. Comparison of Observed and Simulated Link Flows to Validate Microscopic Simulation Model

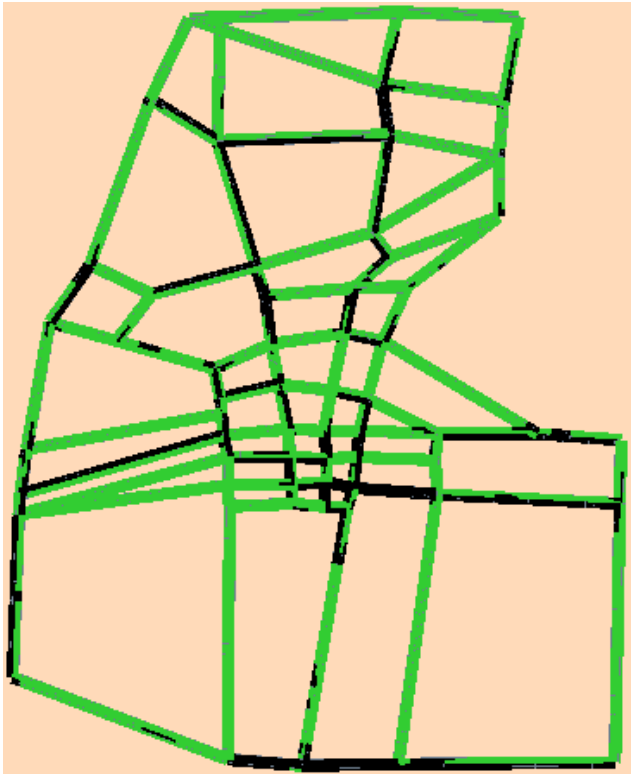


Figure 12. A Display of Congested Blocks on the Network at 8:30 am

3. PUBLIC TRANSPORT POLICY

3.1. Bus Lane Policy

Recently in the year 2003 in Gifu city, a social experiment of implementing the bus lanes on some of the links has been carried out. Provision has been given in the present model to evaluate such kind of policies. In the present study, bus lanes have been assumed in some part of the links (links associated with the priority intersections as shown in Figure 10) to ensure high quality of service. Only buses are permitted to use these lanes and other vehicles will change their lane from existing lane to adjacent lane. Hence, lane changing phenomenon is applied only at these places. The decision of changing lane is entirely depend on the gaps available in the adjacent lane and the processes involved in lane changing situation have been shown in Figure 13. If a vehicle changes lane, the leader vehicle of the lane-changed vehicle will become leader vehicle of next vehicle in the adjacent lane. And the lane-changed vehicle will become a leader vehicle for next vehicle in the adjacent lane. The leader vehicle of follower vehicle of lane-changed vehicle will be leader vehicle of lane-changed vehicle in the previous interval. The simulation model has been applied by including and excluding Bus lanes and compared the both cases to evaluate the policy.

According to the procedure explained in the previous paragraph, the bus lane policy is introduced near the selected priority intersections (Node 19, 25, 31, 36 and 43) from north to south directions only and estimated the results using developed microscopic simulation model. The two evaluation indexes have been considered, they are travel time and punctuality index.

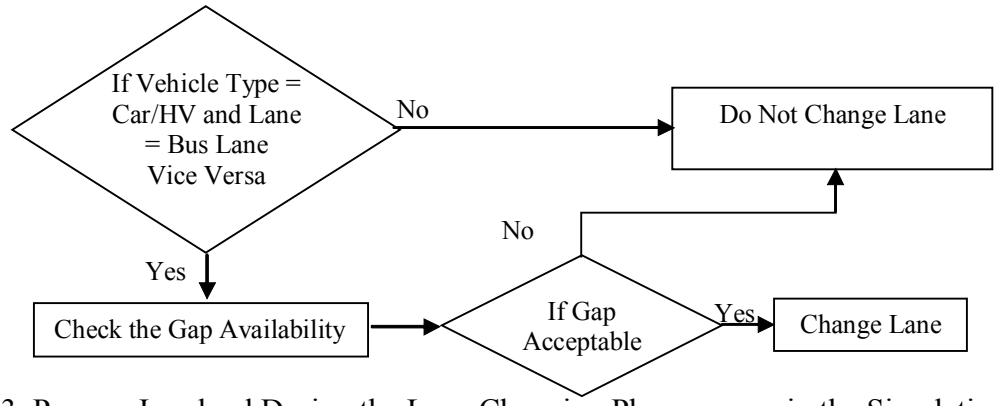


Figure 13. Process Involved During the Lane Changing Phenomenon in the Simulation Model

The comparison of typical OD and link travel times for existing (without bus lanes) and with bus lane policy has been presented in Figure 14. From the figure, it can be observed that about a maximum of about 53% and 88% of reductions in travel time in case of OD and link travel times respectively. From this analysis, it can be said that similar tendency might be observed on the other links also because of this policy.

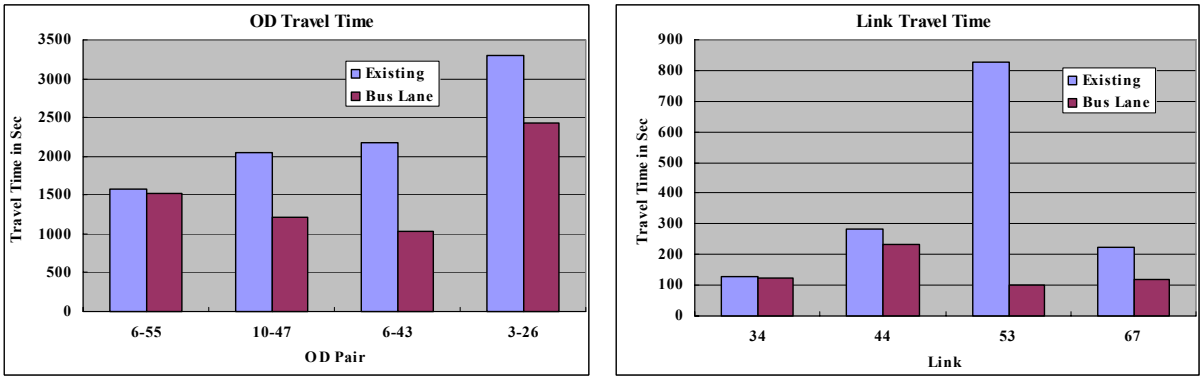


Figure 14. Comparison of OD and Link Travel Times for Existing and Bus Lane Policy

The punctuality index is defined as the time difference between the arrival time of bus at bus stop and scheduled arrival time. The value of punctuality has increased in case of bus lane policy and it can be seen in Figure 15. The punctuality index has reduced as much as about 8 min. for the bus stop 8 (link 67) as shown in the Figure 15. As the bus stop 8 is located on the bottom link of the bus lane, the maximum impact might have observed at this place under this policy.

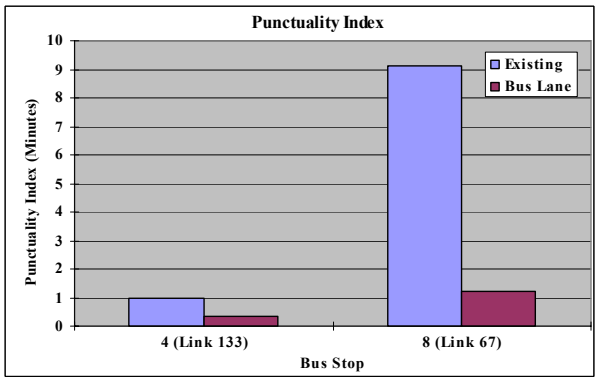


Figure 15. Comparison of Punctuality Index for Existing and Bus Lane Policy

The congestion level before and after bus lane policy on these links have been calculated and presented in Figure 16. As the volume of buses is very small compared to other vehicles, the bus lane policy made the drastic reduction in congestion level in the bus lanes thus increase in level of service of buses. At the same time the level of congestion has increased on the adjacent lane as the other vehicles have changed their lane from bus lane. This can be observed in the comparison figure. This phenomenon has affected the route choice behaviour of the drivers. In the present situation, it has been observed that about 7.5% of vehicles have changed their route due to the implementation of the bus lanes in one hour.

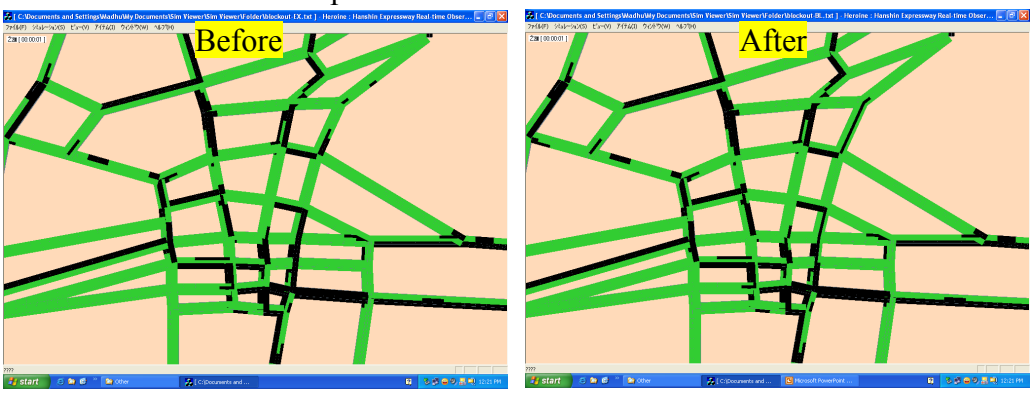


Figure 16. Comparison of Congested Blocks for Before and After Bus Lane Policy

3.2. PTPS at Intersections

Priority for public transport can be given by introducing new priority phase, which allows a bus to avoid stopping at traffic light. In the present study, priority phase has been introduced whenever the Bus near the intersection is detected. The timings for red, green and amber in priority phase is same as existing phase, but during the priority, the phase will restart with green to give the access for priority direction and priority vehicle i.e. bus. When the priority phase is applied for the priority direction, non-priority phase is applied for the cross direction. The procedure incorporated in the simulation model has been described in Figure 17.

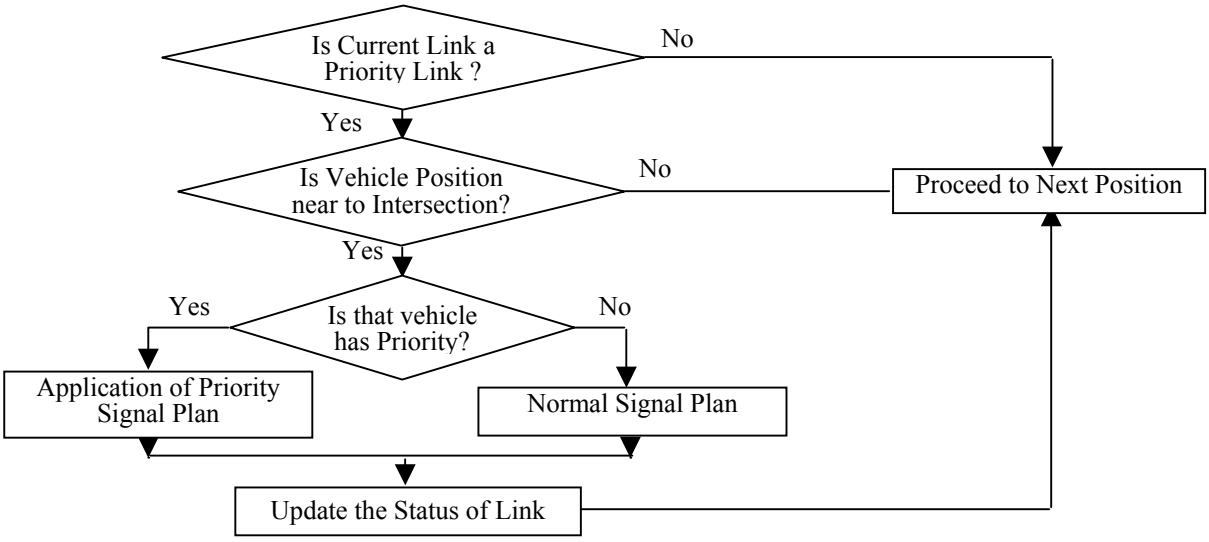


Figure 17. Procedure Involved during the Application of Signal Priority in Simulation Model

The signal priority has been applied at the selected nodes as shown in the Figure 10 according to the procedure explained above. The results have been estimated using developed microscopic simulation model. The same evaluation indexes have been considered as Bus

lane policy and presented in the Figure 18 and 19 respectively. The comparison of typical OD and link travel times for existing (without PTPS policy) and with PTPS policy has been presented in Figure 18. From the figure, about a maximum of 29% and 58% reduction in travel time in case of OD and link travel times respectively can be observed. From this analysis, it can be said that similar tendency might be observed on the other links also because of this policy.

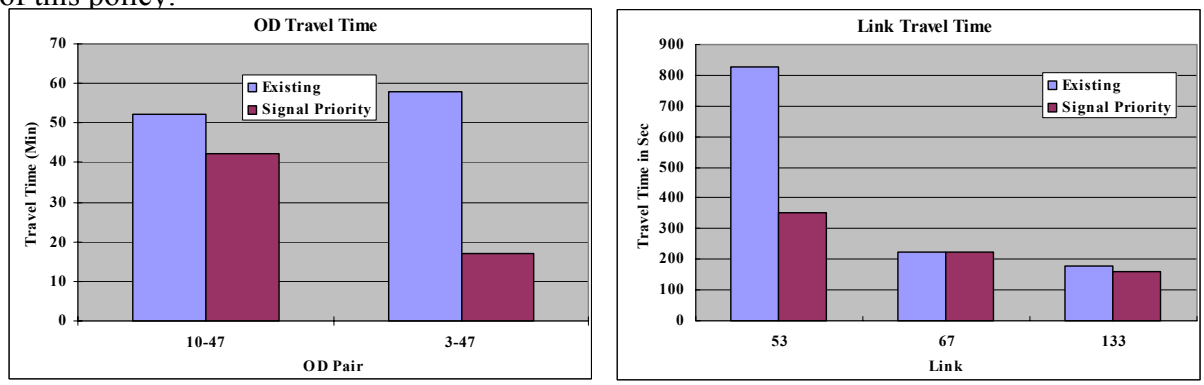


Figure 18. Comparison of OD and Link Travel Times for Existing and Signal Priority Policy

The punctuality index has also drastically fall down in case of signal priority policy for buses and it can be seen in Figure 19. About 4 minutes reduction in punctuality index for the bus stop 8 (link 67) can be observed from this policy as shown in the figure.

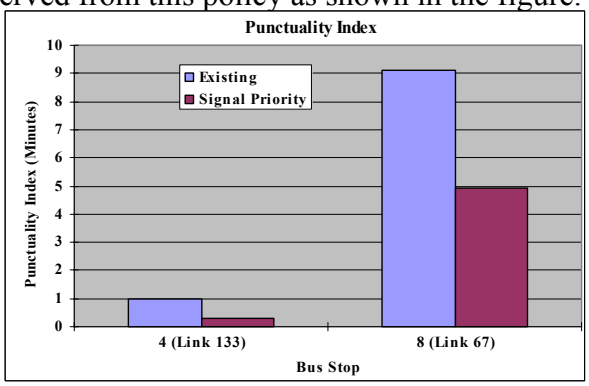


Figure 19. Comparison of Punctuality Index for Existing and Signal Priority Policy

The congestion level before and after PTPS policy on these links have been calculated and presented in Figure 20. As the volume of buses is very small compared to other vehicles, the priority for buses has a little impact on existing congestion though it has improved level of service of buses. At the same time the level of congestion has increased on the crossing streets which is also representing the fact that the less signal priority has been given to this direction of traffic. This can be very clearly observed from the Figure 20.

Figure 20. Comparison of Congested Blocks for Before and After Signal Priority Policy

4. CONCLUDING REMARKS

The absence of sophisticated model to evaluate different public transport policy measures has necessitated the starting of this study. Several uncertainties are involved in route choice behaviour which is not addressed in the conventional models led to use fuzzy logic approach. So in this study, a microscopic simulation model has been formulated by considering car-following, lane changing models and tried to evaluate different public transport policies particularly public transport priority systems (PTPS). The main conclusions from this study can be summarized as given below:

- A microscopic simulation model has been developed to evaluate the public transport policies such as public transport priority systems (PTPS).
- Fuzzy logic reasoning has been incorporated in choosing the route by the drivers.
- The developed simulation model has been applied on the part of Gifu city network and it is able to predict the vehicular movements with a fair amount of accuracy.
- Two types of public transport policies have been considered for evaluation and they are: bus lanes and bus priority at traffic signal
- The priority at traffic signal policy is able to achieve the maximum reduction in travel time of buses about 29% and 58% where as bus lane policy about 53% and 88% for travel time of OD and individual links respectively.
- The punctuality has also increased in case of both the policies.
- About 7.5% of the vehicles have changed their route because of the implementation of bus lane in one hour i.e. from 7:00 am to 8:00 am.

From this study, it can be concluded that the developed microscopic simulation model can be applied to evaluate public transport polices particularly bus lane and PTPS at intersections with fair amount of accuracy.

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