
MARKOV CHAIN AND AN EMPIRICAL EQUATION DEVELOPED FOR DELAY

Raveena A¹, Gnanedra Babu M², Govindaraju Anand³

¹Mtech Student (19S11D2206), Dept. of Civil Engineering, MRITS college, JNTUH University, India

²Assistant professor, Dept. of Civil Engineering, MRITS college, JNTUH University, India

³ Professor, Dept. of Civil Engineering, MRITS college, JNTUH University, India

ABSTRACT

Traffic is the major issue that facing the major developing cities. From the research it knows that the main cause of the delay is because of not following the actual design of the road width and length of the road and not following the signal rules. There are many factors which are leading to the congestion are taken in the study like road length, road width and traffic volume. Data is collected at Patny x road, Rasoolpura and secunderabad intersection concerning road width, road length using Q GIS and traffic volume manually. Markov chain is mathematical model which can be using any stream to find out percentage of possibility for an experiment to take part. Straight line equation is developed for delay forecast by considering the values from data gathered. Emergent the values into the stochastic probabilistic matrix and straight-line equations to calculate the factors influencing delay and calculating the delay errors.

KEY WORDS: *Vehicle congestion, Markov chain model, Stochastic probability matrix, Delay studies.*

1. INTRODUCTION

Transportation is the main source for everything in the world to communicate with the people and transport good and services and exchange the machines and new technologies based upon on the population, their need and their facilities to fulfill all the transportation need. Initially population less used transport facility is ok then after population increased rapidly billion in 100 years, later it next million within 50 years then after next billion in 18 years .it lead to more population further to fulfill their needs increase the transportation system. Now India is the 2nd largest transport system having in the world. it is paved one it captured more than the half of the 100%. Good transportation system indicated benefits to the economy and international relations and good way of life.

These days in major metropolitan cities facing congestion delay the following are the reasons

1. Urbanization due to migration of people.
2. Land acquiring increase
3. Consumption of goods and services increase
4. The using vehicles increases
5. No of vehicles using increased more
6. It leads to congestion
7. Then it leads to delay

1.1 CONGESTION:

There is no possibility of moving vehicles on the road. Mostly it occurs nearby junction. Due to road transportation occurring congestion. These are the following conditions such as less acquired area, less time and mostly in a single directed roadway (Orski 1987), mobility from one place to other place (Arsan 2012), urban

transportation, behaviour of the road user, road networks, excess use of road infrastructure, road capacity at saturation point, when road condition does not match the demand of road users, environmental conditions like rain causes floods, deformation failures in the payments, corrugations, depressions, rutting and shoving. Street vendors, bottle necks, huge traffic struck for longer duration, absence of lane discipline, rapid urbanization.

1.2 DELAY

Extra time taken by the passenger than actual time to reach the destination like When passenger started travelling from one location to reach its destination.

1.3 URBAN ROADS DESIGN BY IRC

CLASSIFICATION OF URBAN ROADS

For the purpose of geometric design, urban roads other than expressways are classified into four main categories by IRC 86-1983 These are:

Arterial: A general term denoting a street primarily for through traffic, usually on a continuous flow of vehicle.

Sub-arterial: A general term denoting a street primarily for through traffic usually on a continuous flow but offering somewhat lower level of traffic mobility than the arterial.

Collector Street: A Street for accumulation and dispersal of traffic from and to local streets and also for providing access to arterial streets.

Local Street: A street primarily for access to native place, industries or other abutting property

2. OBJECTIVES OF PROJECT

- Developing a straight line equation for delay prediction by considering various influencing factors like road length, road width, and traffic volume and observed delay at junction.
- Identifying other factors leading to delay.
- To determine the impact of various factors like carriage way, median and sidewalks.
- Generating the transition probabilistic matrix by using traffic volume by using Markov method then after execution in mat lab to get over time probability.
- Emergent the probability values and compared road length and road width values in equations to find out the functionality and delay.
- Identifying the errors in between observed and calculated.
- With the help of results conclusions and recommendations are given.

3. METHODOLOGY

- Depends on transportation many factors influence in the society like economy, development of the nation, goods supply and demand and other factors.
- Transportation of more vehicles on the road makes congestion, accidents, delay etc. To find out it I considered Markov chain method in that by using vehicles volume to find out present traffic in the field by that I can estimate how much congestion farmed.
- Following is the process to find out delay.
 1. Identification of study area.
 2. Data collection by using vehicle count.
 3. By using Q GIS calculating road length and carriage way, sidewalks and median.

4. Stochastic matrix used to find out congestion.
5. for delay straight line equation.
6. Validation
7. Results, conclusion, and discussions

3.1 LOCATION IDENTIFICATION

Patny x road: This is a four-legged intersection at the Patny road. The quality of the road surface in the study approaches is very excellent. Traffic flows from four directions i.e., towards paradise, clock tower, Bata Showroom and SBI Bank, were recorded from the intersection. The traffic in this intersection includes motor bike, auto, car, bus and truck. The dedicated left turn is available for the traffic approaching from the west direction.

Secundrabad: This is the two-legged intersection at the secundrabad. The quality of the road surface in the study approach is very excellent. Traffic flow from two directions i.e., towards paradise, Patny x road and CTO were recorded from the intersection. The traffic in this intersection includes motor bike, auto, car, bus, and truck. It is the major traffic generating area.

Rasoolpura: It is the T-junction traffic flow from the Rasoolpura to Panty, paradise and secundrabad and minister road and cto. These are major traffic flow generating areas.

3.2 DATA COLLECTION

Q-GIS First open the application of Q-GIS then go to browser panel click on xyz tiles it shows then i open street map where the GIS databases of the study area can be studied. From that select the location by using hand curser. Then after create layer as new shape file layer then create point or line or poly line layers by using virtual line layers or by digitizing.

In the study area the process is used is the Q-GIS Map virtually to calculate *Road Density and Road Geometry* involves following steps:

3.2.1 CREATING A PROJECT IN Q-GIS

1. Select new project then click on save button.
2. Go to layer and click on create layer then after go to new shape file layer.
3. Give name to that layer as point or line or poly line.
4. Then after go to browser panel then click on xyz tiles it show the open street map then select that then after it shows on the layer panels.
5. Select what location u want from open street map by using hand curser.
6. Then after go to point layer give right click on it and then go to attribution table then after go to add field option.
7. Add how many points i need in location by using add field option.
8. Similar manner create line and polygon.
9. Then after if you want digitization or geo referencing first select layer.
10. Go to vector layer then after geo referencing then after give buffer it shows one box first select the layer then after how much distance u want then after which type of buffer like round then finally click on run. When It shows the message successfully runned the program. Automatically it shows the buffer layer in panel.
11. If u want geometric details for the same layer go to vector layer then select geometry tool then after select the add geometric table then after select layer and then click on run button. it automatically gives the values in meters.

12. If you want digitization, here it having advance digitizing options are there for line, point and poly line in tool bar. By using that by free hand we can digitize.

13. If you want finds any width of the road by clicking add geometry than after select the first point and second point it gives the value.

15. If you want any editing's in the saved layer in which layer u want changes give right click on it. It shows the option toggle editing.

16. If you want to change any colour, band width etc. First go to which layer u want change give right click on it. it shows the properties option by clicking on it we can change.

Figure 1 Digitization at Rasoolpura

17. After finishing all the layers created click on save option.

18. It saves the all layers as one project.

Figure 1 showing the digitization at rasoolpura and Figure 2 shows the digitization at Patny x road and Figure 3 showing the digitization at secunderabad below respectively.



Figure 1: Digitization at Rasoolpura



Figure 2: Digitization at Patny x road

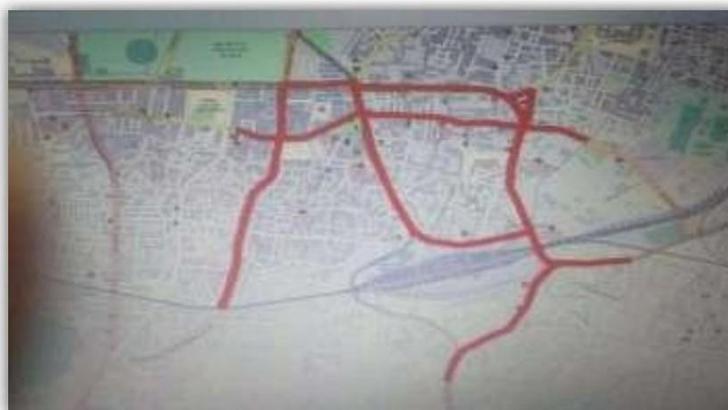


Figure 3: Digitization at secunderabad

ROAD DENSITY

It means length of the road. From selected stretch of the area center to up to 1 km² I am calculating road density values by using Q GIS by using digitization. the total length of the road provides at least as per IRC 106: 1998 Specifications 18m Road Density will be provided for 1 Km² Length. Road density values of three areas as shown in

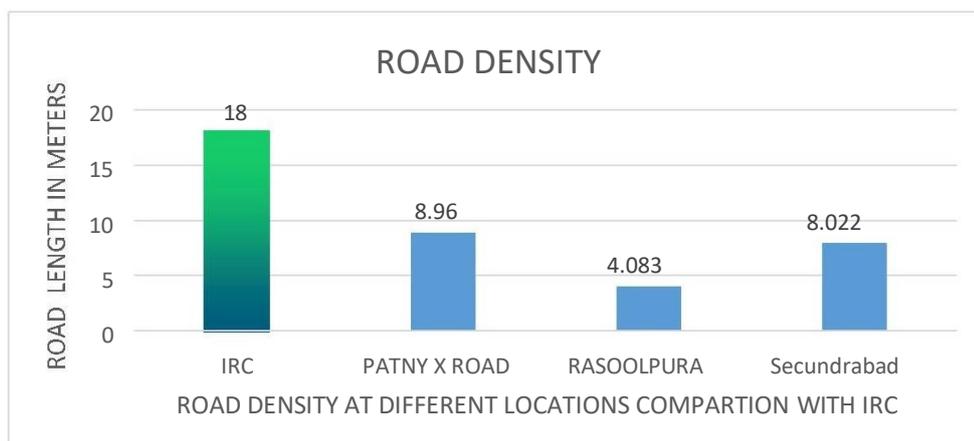


Figure 4: Comparison of Road density values with IRC

ROAD GEOMETRIC DETAILS

Geometry means carriage way width, median and sidewalks. These are calculated by using Q-GIS. Like this I got these values as shown in Table 1 below values at Patny x road.

Table 1: Road Geometric Details at Patny x road

Carriage way	Median	Sidewalk	Total width In meters
7.5 (2 LANE)	1.5	2.5	34

Geometric details of the secunderabad is calculated in Q GIS by using tool add geometry values will get as shown in Table 2 below

Table 2: Road geometric details at Secunderabad

Carriage way	Median	Sidewalk	Total width In meters
7.5 (2 LANE)	1.0	1.5	32.5

Geometric details (carriage way, median and sidewalks) of the Rasoolpura is calculated in Q-GIS by using the tool add geometry we will get values as shown in Table 3 below

Table 3: Road geometric details at Rasoolpura

Carriage way	Median	Sidewalk	Total width In meters
7.2 (2 LANE)	1	2.5	30.5

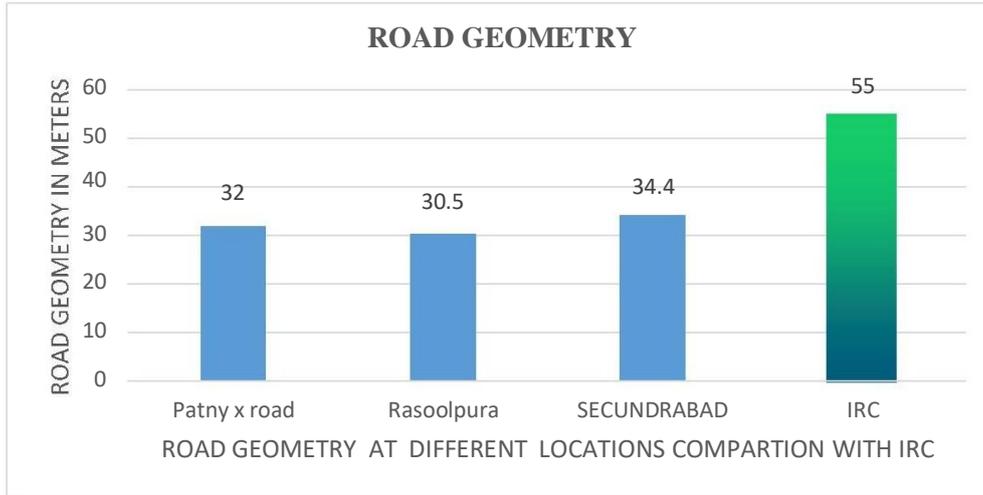


Figure 5: Comparison of geometric values with IRC

VOLUME COUNT

Volume count means no of vehicles passing through at one junction like enter at one stretch and leaving at other stretch such as two wheelers, three wheelers, car, buses, and others in PCU at peak hours timing morning and evening.

Volume count of bike, auto, cars, buses and others taken by Automatic count of vehicles data.

Volume count taken from 1 February to 7 th February at three location morning peak hours and evening peak hours.

1-week average volume count Of vehicles at Patny x road from four directions is 7259 and at Rasoolpura from three directions is 9408 and at Rasoolpura from three directions is 9706.

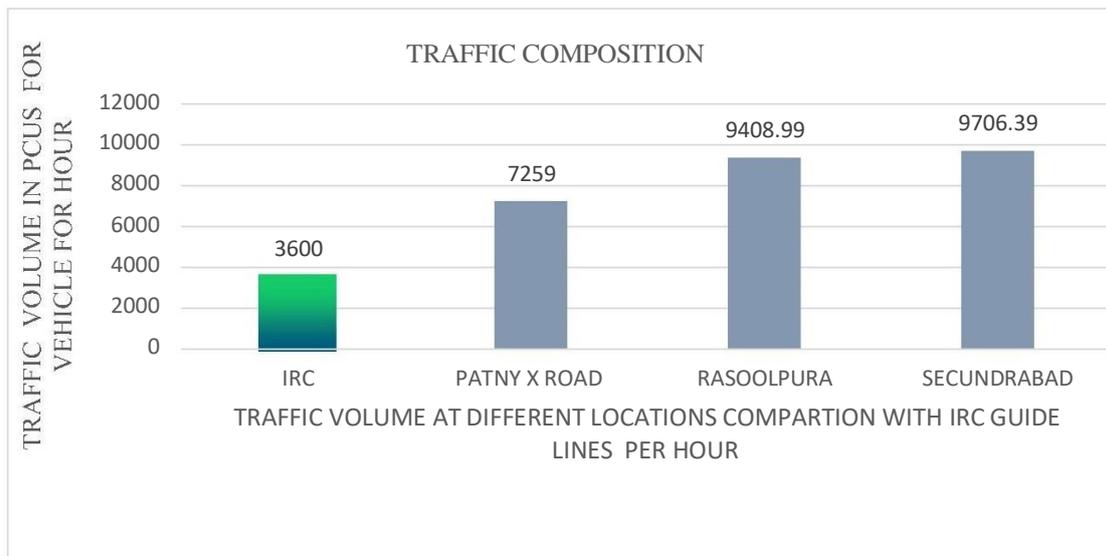


Figure 6: Comparison of traffic composition value with IRC

3.3 MARKOV CHAIN MODELLING

1. It is a random experiment.
2. It is having defined states.
3. It is having set of sample spaces
3. Markov chain is the probability, depends on present state future state can predict.
4. Possibility of moving vehicles from one state to another state over a time period is considered.
5. By this can estimate congestion

Markov analysis is random process in which the occurrence of future state depends on immediately preceding state and only on it.

Assumptions of Markov chain

1. Intersections must be defined and finite
2. Set of sample spaces available at junctions should be determined.
3. Junctions are mutually exclusive
4. Probability of moving vehicles from one junction to other junction is constant over particular time.

4. MARKOV CHAIN OVERTIME PROBABILITY

Markov chain over time probability consider when one junction to another junction in how much time period vehicles are moving can be calculated. Depending on quality of parameters the possibility of probability can be obtained to reach its destination from its starting location how much possibility is there. It gives the percentage values. then it incorporates in mat lab to get after computation of certain iterations the value become neutral which denotes that after travelling of n no of times the road user will end with a decision that chances of using any facility would be of certain percentage the values are very much dependable. Figure 4 represents the transition diagram as shown below.

Table 4: After 6 iterations the values

0.314	0.389	0.293
0.314	0.389	0.293
0.314	0.389	0.293

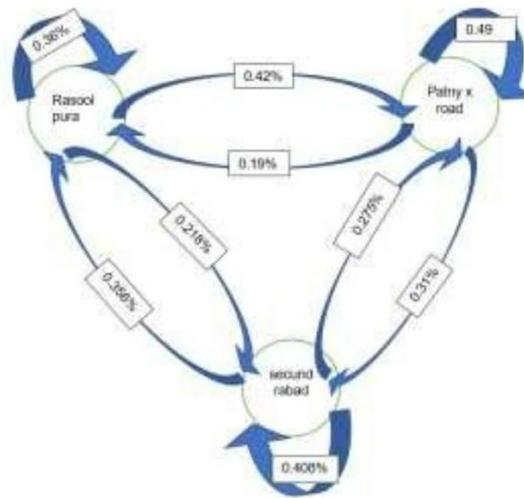


Figure 7: Transition Diagram at 3 locations

MAT LAB

Here this tool is used to calculate the iterations and to get the graphs. The mathematical model used in this is a transition probabilistic model which will contain the values in a matrix form. So, the Iterations are made easy and the required graphs are obtained at the same time. Even for solving the empirical equation to find out the coefficients this tool made it simple. it gives more accurate values and no of iterations it will give. The following values are given below.

MONTE CARLO SIMULATION METHOD

Is a method for exploring the sensitivity of a complex system by varying parameters within statistical constrains this system can include financial, physical and mathematical models that are simulated in a loop, with statistical uncertainty between simulations? The results from the simulation are analyzed to determine the characteristics of the system. Let say we have a linear model for peak annual load forecast that has been fitted using historical data for both the dependent (response) variable (y) and the independent variable(x).

Keeping other values of independent variable (x) constant (we make prediction about those values), the Monte Carlo simulation process is used for simulating the Uncertainty in weather variables.

This given us an ability to describe somewhat probabilistically, what future peak load will be (i.e., Median, 70 th and 90 th % etc.).

LINEAR EQUATION

After creating all the needed calculations in the Markov chain process for each parameter i.e., traffic characteristics, road density, road geometrics. Based on our objectives, a linear model created and different variables defined and the data was consequently measured.

From the transition probability matrix, the value obtained keeping into linear equation modeling to find out the that are taking place in each intersection, Whether the functionality of the road is good or not. The general form of the model is:

$$Y=a Z0+b Z1+c Z2$$

Where,

Y is the observed Delay,

Z0 is road density,

Z1 is the road geometrics,

Z2 is the traffic volume

a, b, c are coefficients.

Linear equations, coefficients, and constants:

here Table showing the observed delay and over time probability by using traffic composition values at three areas and road geometry and density values at three locations by using Q GIS.

$$Y = a Z_0 + b Z_1 + c Z_2$$

$$a * 0.49 + b * 0.581 + c * 0.293 = 120$$

$$a * 0.45 + b * 0.625 + c * 0.314 = 100$$

$$a * 0.23 + b * 0.554 + c * 0.389 = 80$$

Coefficients are, a = 205

b= 115

c= 105

Table 5: Observed Delays and Overtime Probabilities at Patny X road, secunderabad and Rasoolpura

Location	Y(Delay)Observed	Road length Z ₀	Road Geometrics Z ₁	Traffic volume Z ₂
Patny X road	120	0.49	0.581	0.388
Secunderabad	100	0.445	0.625	0.314
Rasoolpura	80	0.227	0.554	0.293

Table 6: Calculated Delay and Delay Errors

Location	Y (Delay in Sec) Observed	Road length Z ₀	Road Geometrics Z ₁	Traffic volume Z ₂	Delay Calculated	Delay Error
Patny x road	100	0.49	0.581	0.388	115	15
Secundrabad	100	0.445	0.625	0.314	205	105
Rasoolpura	80	0.227	0.554	0.293	105	25

Calculated delay values are higher than the observed delay because influence factors such as inadequate length of the road and carriageway, sidewalks and medians and other factors.

VALIDATION

For the project is to be acceptable in the limits or not know by observed values minus calculated values should be less than 15%. R-square is a statistical measure of how close the data are to the fitted linear model and it shows the chi squared goodness of fit test. Generally, the higher the R^2 value, the better the model fits the data. The difference between the observed value of dependent variable(Y) and calculated value(Y') is called the residual (e) that it should be have normal.

Table represents the goodness of fit test for both of the above-mentioned models by R^2 .

Table 7: Residuals and R-Square for the Model

S no.	Place	Delay Observed(Y)	Delay Calculated(y)	Residuals(R)	$R^2=Y-y/y$
1	Secunderabad	120	205	85	35.24
2	Patny x road	100	115	15	1.95
3	Rasoolpura	80	105	25	5.95

Chi square values and probability takes depends on degree of freedom.

Degree of freedom means depends on independent parameters we will measure the number of parameters each other take the probability values.

$$\text{Degree of freedom} = n-1$$

Where,

$$n = \text{number of parameters}$$

Here parameters are three. So degree of freedom is 2.

By considering the degree of freedom two we are checking the error values in that. It gives the probability values at Patny x road probability value is 0.50 it means 50 percent acceptable. at Rasoolpura probability value is 0.05 .it means 5 percent acceptable.

5. CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

1. An empirical model developed to find out delay.
2. Road density and road geometric are calculated by using Q GIS.
3. Road density and road geometrics are compared with IRC values to know how much less field values are provided calculated.
4. Markov chain method used to calculate transition matrix at three junctions that are Patny X road, secundrabad and Rasoolpura.
5. Then after transition probability matrix executed in mat lab to get iterations.

6. Then after traffic composition iteration values and field and IRC values of road density and road geometry are incorporated in linear equation and calculated delay at three junctions.
7. Footpaths occupied by vendors and sellers.
8. Improper crossing of road.
9. Less provided geometric values than IRC.
10. Not following the signal crossing rules.

5.2 RECOMMENDATIONS

These commendations are detailed based on the observations of the urban traffic.

- By comparison of field and IRC guide we conclude that provided field values are less than actual provide values.
- It created more congestion than normal.
- It further leads to poo level of service. It creates the problem of saturation flow of traffic. It effects to economy and all other sectors.
- It is further advised to create a monitoring system in GIS enhancement while issuing the permission for change of land use or placing
- The road near activities can be minimized by well-design system in a town. The street beggars can be moved to separate area at every one or two km area. The vertical occupancy decreases the land use.
- The transport metros should be interlinked so that no public could get down and come on to roads interchanging vehicles or routes.
- The Geographical Information System and Global Positioning System integration system is to be made to get traffic data at congestive junction.
- The ITS concepts suggest developed detecting systems to detect the traffic order.
- The satellite interaction method should be promoted for linear interaction with vehicle user problems.
- Automatic alter signals should be providing in the city. This gives decrease of accidents, delay.

6. FUTURE SCOPE

A straight-line equation is developed by using three parameters such as road length, geometry and traffic volume to delay done in this study. For more accurate values the delay function can be extended by using the effecting factors and keen observation on the influencing factors. Markov chain modeling obtained for traffic composition probability and Monte carol simulation method is used to combine all the parameters in the study to find delay. By using these different independent variables used to find the delay.

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