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Transportation Network and Road accident analysis: A case study of Khandwa city

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***Keywords*— Accident severity Index, Black spot, Transportation models, Trip, Impact Factor.**

***Abstract*—** *The design and construction of any road section would remain incomplete without proper transportation planning process. With the case study of Khandwa through transportation model it became possible in identifying need, advantages, disadvantages and challenges while designing future Transportation infrastructure. The study was done taking transportation system of Khandwa. In which four transportation models: Trip generation, Trip distribution, Modal split, Trip assignment was generated for all 6 zones. After the assessment network diagram depicting traffic population of selected three modes of vehicles was obtained. Also the Road accident analysis was carried out in the same region using QGIS software.*

I. INTRODUCTION

Travel forecasting models are used to forecast changes in travel patterns and transportation system utilization as a result of changes in regional development, demographics, and transportation supply. Transportation network modeling involves four step procedures: Trip generation, Trip distribution, Modal Split and Trip Assignment. The goal of the study is to analyze transportation network modeling of Khandwa city.

According to the United Nations, one death occurs every four minutes on Indian streets, making it the world's most accident-prone country. Increasing population density leads to higher risks in road accidents. The studies have been conducted to analyze road accidents occurring in Khandwa city, location of black spots using QGIS software.

II. OBJECTIVES

This research paper aims to create transportation network model and Road accident analysis of Khandwa city of Madhya Pradesh. Through this study traffic population have been forecasted for next decade for 3 modes of transport i.e. cars, 2-wheelers and Rickshaw. While accidental analysis is done to find out black spots and accident severity index.

III. METHODOLOGY ADOPTED

The broad methodologies adopted for this complete research study have been shown through a flow chart given in Fig. 1.

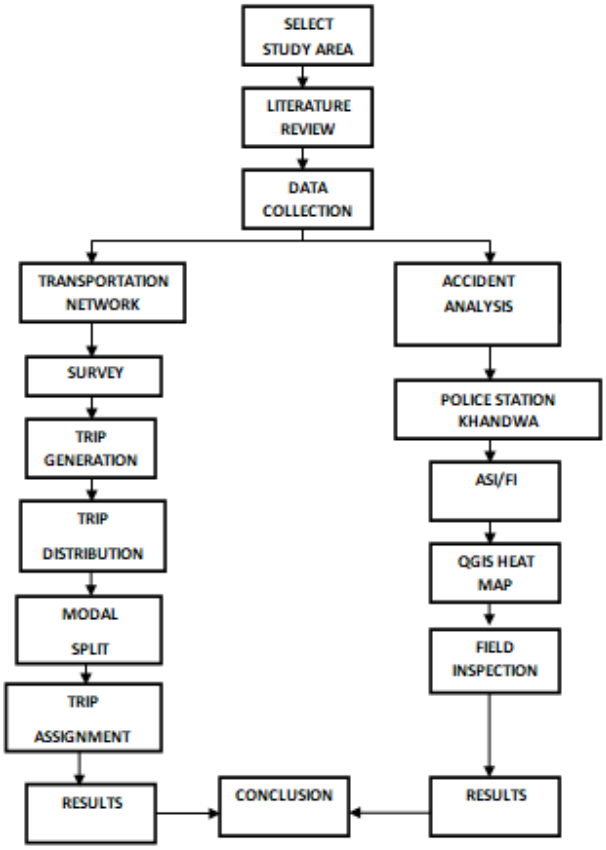


Fig. 1: Methodology Adopted

IV. SURVEYS PERFORMED

The methodology for survey adopted was home based survey and Road side survey in which questionnaire form was provided to people. For transportation network modeling vehicular count was done at peak hours. For accidental analysis data's were collected from various governmental departments such as Nagar Nigam, RTO office, statistics department Khandwa and field inspection was also done.

V. TRANSPORTATION NETWORK MODELING AND ANALYSIS

Transportation network modeling involves four stages i) Trip generation ii) Trip distribution iii) Modal split iv) Trip assignment. The study area selected for transportation network analysis is located in Nimar region Khandwa City of Madhya Pradesh. It is divided in 6 zones and 50 wards. The four transportation models are briefly discussed below:

5.1 Trip Generation: It forecasts the number of journeys that originate or end in a specific traffic analysis zone. Population of Khandwa city sourced from Nagar nigam Khandwa is 200681 and growth rate adopted for the study is 11.04%. Data have been collected from various government departments and their websites. Following results have been obtained for trip generation model which is shown in Table 1.

Table 1: Forecasted trips for production and attraction after 10 years

After 10 years		
Zone	**Productions**	**Attractions**
	Trips/per person/day	Trips/person/day
Zone 1	1033332	3047837
Zone 2	1311068	3292729
Zone 3	1175390	5695087
Zone 4	1221385	6812596
Zone 5	1003443	3828164
Zone 6	933588	2703251

5.2 Trip distribution: Generated trips from first stage are distributed in all 6 respective zones. Growth factor method has been adopted for distribution. Impedance factor involves the resistance in flow of transportation. It is given by the following equation -

Impedance factor = $e^{-\beta Cij}$ ..... (1)

Where,

β = dispersion parameter = 0.1

Cij = cost incurred while travelling from zone i to zone j

The following trip distribution model has been obtained after adjustment which is shown in Table-2.

Table 2: Adjusted trip distribution after 10 years for different zones

O/D	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	∑O
Zone 1	476690	187862	121691	108233	81595	57261	1033332
Zone 2	188709	477536	158173	297702	122538	66410	1311068
Zone 3	136041	171678	491041	202188	117585	56857	1175390
Zone 4	93590	282213	173196	462048	143437	66901	1221385

Zone 5	71672	111768	93310	148158	466767	111768	1003443
Zone 6	71982	80285	57232	96265	136412	491412	933588
∑D	801974	866417	1498553	1792593	1007356	711313	6678206
∑D'corrected	1038684	1311342	1094643	1314594	1068334	850609	

5.3 Modal split

Mode choices allow the modeler to determine what mode of transportation will be used. It is decided by utility and disutility functions. For this study 3 modes of transportation have been taken: car, Rickshaw, 2-wheeler. After the utility matrix of these 3 modes have been found out from equations (cited) probability of three modes is found out by using the following equations

$$Probability(car) = \frac{e^{Ucar}}{e^{Ucar} + e^{U2-wheeler} + e^{Urickshaw}} \quad (2)$$

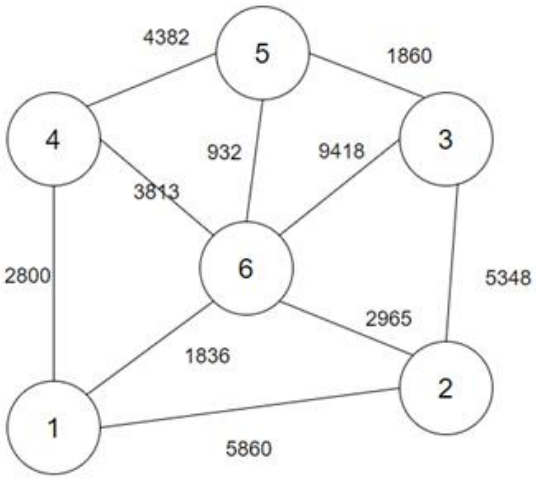
$$Probability(2-wheeler) = \frac{e^{U2-wheeler}}{e^{Ucar} + e^{U2-wheeler} + e^{Urickshaw}} \quad (3)$$

$$Probability(Rickshaw) = \frac{e^{Rickshaw}}{e^{Ucar} + e^{U2-wheeler} + e^{Urickshaw}} \quad (4)$$

Then using the above formulas modal share matrix for car, 2-wheeler and Rickshaws have been found out.

5.4 Trip Assignment

Here first the traffic at peak hour period have been found out. Then a network is assumed and by using generalized travel cost (GTC) for each mode of transport a matrix is prepared. Occupancy for car,2-wheeler and Rickshaw have been assumed from IRC 106: 1990 as 1,0.5 and 1.2. The final network is shown below:



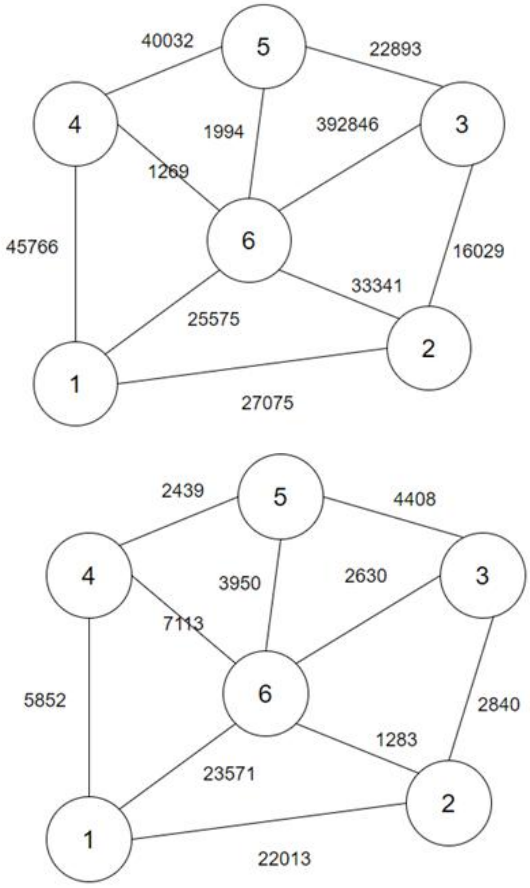


Fig. 2: Total number of cars, 2-wheeler and Rickshaw in each link

VI. ROAD ACCIDENT RESULTS AND ANALYSIS

Khandwa city has an area of 6206 square km. The roads in the city are highly congested and encroached by various activities. It is estimated that population of city will rise by 11.04% over next decade. Infrastructures have to cope up with growing population and economic activities; otherwise chances of accidental risks increases. In this study Black spot analysis of Khandwa city using QGIS software have been done. Also field inspection of those areas having higher probability of accidents have been performed.

The data has been collected from various governmental departments such as Yatayat police station, statistics departments, RTO office Khandwa.

Collected data is segregated as per weather conditions, age and type of mode of transport. The study has been grouped into 2 parts:

6.1 Black spot calculation

According to MoRTH (ministry of road transport and highways) black spot is a stretch of 500 m in length in which either 5 road accidents in all three years put together involving fatalities/ grievous injury took place during last 3 calendar years or 10 fatalities in all. Heat map using QGIS software have been found after putting the values of accidental spots obtained from Yatayat police station Khandwa and latitude and longitude of that region.

6.2 Accident severity Index (ASI)

It measures the seriousness of accidents and availability of medical facilities in the city. Based on black spot analysis ASI has been calculated as per the following equation:

$$ASI = NfWf + NsWs + NmWm \quad \ldots\ldots\ldots \quad (5)$$

Nf = Number of fatal accidents at the spot in last three years

Wf = weight assigned to fatal accidents = 6

Ns = number of serious accidents at the spot in last 3 years

Ws =weight assigned to serious accidents = 3

Nm =number of minor accidents at the spot in last 3 years

Wm = weight assigned to minor accident = 1

Table 3: Accident Severity Index

PLACE OF ACCIDENT	ASI
Rameshwar	20
Mansingh chawk	14
Main hospital	15
Girls hostel	14
SN college	11
Mata chawk	4
Awasthi chawk	6
Civil line chawk	6
Medical chawk	1
Dadaji dhuniwale	11
Sindhi colony	1

VII. CONCLUSION

1. The 4 step model processes have been illustrated for Khandwa city of Madhya Pradesh.
2. Errors in Trip generation, Trip distribution, Modal Split and Trip Assignment have been minimized through various mathematical models.
3. Transportation network model for 2031 for Cars, 2-Wheelers and Rickshaws have been calculated.
4. Since the population of Khandwa is predicted to rise by 11.04% Road accident analysis done through QGIS will be useful in taking the corrective measures.

VIII. FUTURE SCOPE

1. Improved accuracy in data collection will make transportation models more realistic and accurate. This can also be ensured by usage of artificial intelligence and machine learning tools.

2. The above transportation networks shall ensure the guidelines as prescribed. Emphasis on transportation planning at immediate stage should be given importance as much as it is provided in pre planning phase.

3. In Road accident analysis of Khandwa city black spot analysis have been performed. Accidents cause administrative, economical as well as humanitarian crisis hence while designing transportation infrastructure accidental analysis plays a key role.

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