Functional Evaluation and Accidents Analysis of Selected Road Links of Meghraj Taluka

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Abstract- *The Present study focus on to understand rural roadway accidents causes and evaluate various functions of selected roads in Meghraj taluka, in order to help for reducing the frequency and severity of crashes on rural roadways. To achieve such a goal, traffic accident data, roadway geometric data, traffic volume data, surface condition data for the selected five road links of Meghraj Taluka will be collected and analyzed. A total of seven-year accident data (from 2011 to 2017) are collected from the Police Department, Meghraj Taluka. The data analysis reveals that on selected road links mainly fatal accidents happened with cars and two wheelers, whereas non- fatal accidents happened due to two wheelers and Light carriage vehicle. From the collected data of road inventory, Present serviceability index, priority index model will be developed. Accident rate models for the significant parameters will also be developed. Several suggestive measures will be given to reduce the accident rates on the selected road links and to improve the functional characteristics. The developed accident rate models reveal that significant parameters for accidents are road width rise and fall and no. of junctions of the selected road links. Several suggestive measures are given to reduce the accident rates on the selected road links. The priority ranking methodology is based on priority index concept, which makes use of overall traffic adjustment factors. It involves a process of expert opinion through a series of questionnaires and the derivation of weighted average condition measure. From the data analysis, Priority rank has been given to selected road link Moti mori to Varthali.*

Keywords- Road crash, Functional evaluation, Present Serviceability Index, Priority index.

I. INTRODUCTION

General

In India, Out of the total road length of 3.17 million km about 2.17 million km are categorized as rural roads. At the same time, the number of traffic accidents in rural areas is increasing year by year, according to Ministry of Road Transport & Highways (MORT&H) India, the analysis of road accident data 2016 reveals that about 1,374 accidents and 413 deaths take place every day on Indian roads which further translates into 55 accidents and 17 deaths on an average every hour in our country. and Table 1Shows that rural area significant part of road accidents, so there is requirement of analysis of accidents and functional evaluation of roads for safety measurement.

Table 1.Total Accidents, Persons Killed and Injured in Rural & Urban Areas during 2016 (@ MORTH 2016)

Category	Total Accidents	Fatal Accidents	Person Killed	Person Injured
Urban Area	2,16,813 (45.1)	53,487 (39.3)	57,840 (38.4)	2,12,346 (42.9)
Rural Area	2,63,839 (54.9)	82,584 (60.7)	92,945 (61.6)	2,82,278 (57.1)
Total	4,80,652	1,36,071	1,50,785	4,94,624

Problem Statement

In the road accidents the cost due to death, injury or property damage is much higher which directly affects the national economy. Rural area of country plays significant roll to reduce road accident. Accident analysis should be given priority for any road or existing road scheme to reduce the cost of maintenance and to reduce the accident cost. Fatal accidents are not only damage economically but affect more emotionally to humanity Road safety shall be given first priority at planning, design, construction, operation and maintenance i. e. at all stage.Very few studies have been conducted to develop the relationship between numbers of accidents with above mentioned parameters. Therefore, this study is aimed to develop a detailed report for the selected stretches of selected road link of Meghraj Taluka(Rural area). From the collected accident data and Functional evaluation a model can be developed to predict the probability of accident occurrences and developed road network in rural area.

Aim of study

The main aim of the study is to understand rural roadway accident causes and various functions of selected roads in Meghraj taluka, for reducing the frequency and severity of crashes on rural roadways. Develop models for accident rates and priority index. Determine Present

Serviceability Index It also aims to developed Maintenance Priority Index (MPI) for the road links of the Meghraj Taluka using functional parameters of for redesign of geometry of road to reduce fatal accidents and serious injury and to develop road accident model for rural road.

Objective of study

- To collect information of existing condition and past accidents data of selected road links.
- To get the overview of existing traffic flow, surface condition, geometry etc.
- To examine safety features adopted in the selected section of rural road and find out deficiencies in the road network which led to accident and safety hazards to road users.
- To develop a model/relationship for identification of safety influencing parameters in minimizing likelihood accident rate on selected section of rural road network.
- To develop a model for deciding priority for maintenance.

Scope of Study

- This study is limited to selected rural road links of Meghraj Taluka.
- This study will audit route network of selected study area for road safety.
- This study can give an idea to prepare a priority list according to consideration of the main factors with proper weightage.
- Improvement with respect to decided priority list, increase socio-economic development and proper utilization of fund and also reduces accident rates, fatalities, accidents injuries, rate of loss of property loss and improve the quality of rural road network.

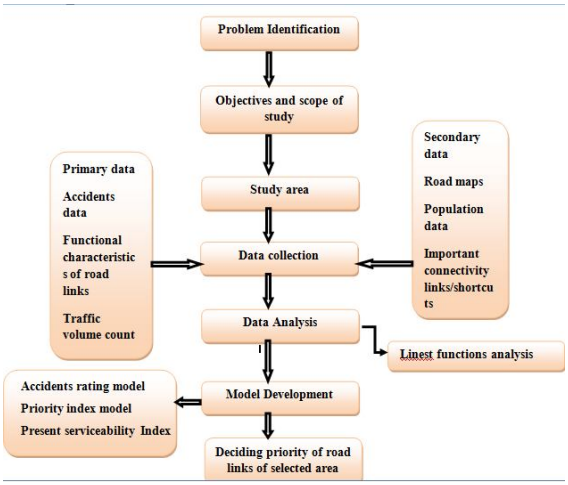
II. REVIEW OF LITERATURE

Roshina Babu (2014) This study present a development in Maintenance Priority Index (MPI) for the sections of the State Highway (SH-1) using certain factors affecting pavement maintenance. The factors considered in this study were pavement condition, riding quality, traffic characteristics, land use characteristics and characteristic deflection of the pavement. A relationship between pavement roughness and distress parameters like area of raveling, cracked area etc. also developed.Detailed pavement evaluation surveys were conducted. The main distresses identified on the roads were ravelling, potholes and cracking

Khaled A. Abbas (2004) paper present conceptualization of indicators, criteria and accidents causes that can be used to describe traffic safety. The paper provides an assessment of traffic safety conditions for rural roads in Egypt. This is done through a three-step procedure. In the course of conducting the above traffic safety assessment of rural roads in Egypt, it became evident that there is a lack of past sustainable and detailed accident data collection programs as well as a lack of accident prediction models. Time series data of traffic and accidents, over a 10 years period for the considered roads, was utilized in the calibration of these predictive models..The paper moves on to develop a number of statistical models that can be used in the prediction of the expected number of accidents, injuries, fatalities and casualties on the rural roads in Egypt.

Matthew G. Karlaftis (2002) present the relationship between rural road geometric characteristics, accident rates and their prediction, using a rigorous non-parametric statistical methodology known as hierarchical tree-based regression. The goal of this paper is to develops a methodology that quantitatively assesses the effects of various highway geometric characteristics on accident rates and,it provides a straightforward, yet fundamentally and mathematically sound way of predicting accident rates on rural roads. The results show that although the importance of isolated variables differs between two-lane and multilane roads, 'geometric design' variables and 'pavement condition' variables are the two most important factors affecting accident rates. As previously mentioned, NB regression has accounted.

III. METHODOLOGY



[Figure 1 : Methodology chart]

Methodology for the RSA and the basic requirement of data collection and analysis method are covered in this chapter. For RSA methodology IRC – SP: 88 (2010) is used as

guide line for different stages of road safety and also carried out the checklist required for the study. Different survey reconnaissance survey, Condition survey, Traffic survey, ADT. AWT, Road inventory, Checklists had been carried out for data collection. Data was analyzed through namely data management, road condition analysis, Traffic surveys, Treatment Recommendation, Prioritization and Ranking surface ranking and evaluation Project Implementation. For regression analysis to develop model/ relationship SPSS software and LINEST function will use. Figure 1 Shows the detailed Methodology chart

IV. STUDY AREA AND DATA COLLECTION

General : Meghraj is a Taluka in Arvalli District of Gujarat State, India. It is located 22 km towards west from District headquarters Modasa. 108 km from State capital Gandhinagar towards west . Meghraj is located at 23.5°N 73.5°E. It has an average elevation of 178 metres (583 feet)Meghraj consist of 279 Villages and 43 Panchayats. It is in the 149 m elevation(altitude).

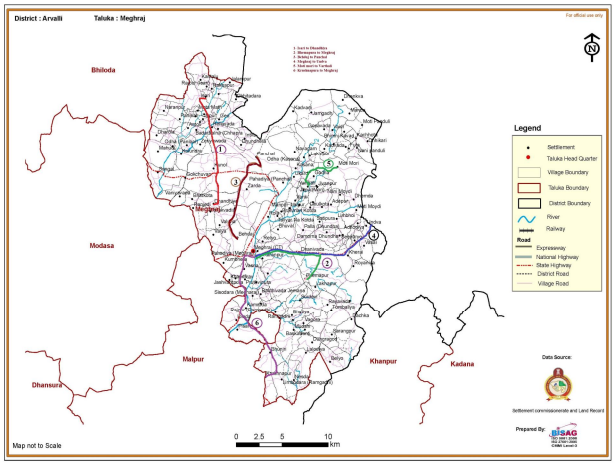
Reason to selected study area

Meghraj Taluka which is having more than 10 schools, colleges of graduation courses, and also agricultural market and GIDC. Also Selected road links have unevenness so there is more chances to accidents. Improper management of road network. Improper sign board, lighting, curvature, other geometry parameters etc In 2015 there were 80767 fatal accidents in rural area in India, it shows that rural road links is significant parameter of accidents.

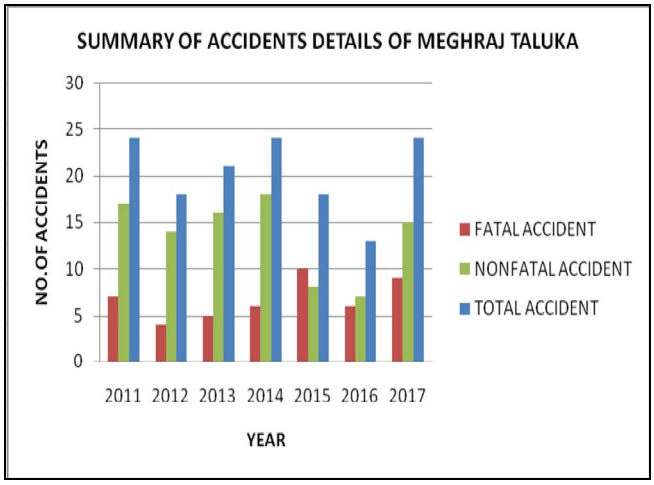
Very few research are carried out for both functional evaluation and accident analysis of rural road links so I have selected Meghraj Taluka rural road links as study area. Table 4.1 shows details of selected road links.

Table 2 Summary of Data collection of selected Roads in Meghraj Taluka:

Name of Approach	Pavement type	l (m)	w (m)	Area (m2)	Road type	No. of Accidents.	Crack Area(m2)	Potholes area(m2)	Rut area(m2)	Avg.ADT (PCU/ DAY)
Isari to Dhandhiya	Flexible (Bitumen road)	11.4	3.5	39900	ODR	18	12.96	404.74	370.08	392.75
Behdaj to Panchal	Flexible (Bitumen road)	12	3.5	42000	ODR	16	11.67	422.93	381.34	349
Bhemapur to Meghraj	Flexible (Bitumen road)	9.6	7.75	74400	SH	18	9.71	210.63	216	397.25
Meghraj to Undva	Flexible (Bitumen road)	14.5	7.5	108750	SH	14	7.41	204.68	240.3	491
Moti mori to Varthali	Flexible (Bitumen road)	7.81	3.5	27335	ODR	12	4.22	430.98	162.41	364.5



[Figure : 2 Map of Study area]



[Figure : 3 Summary of accidentd details of Meghraj Taluka]

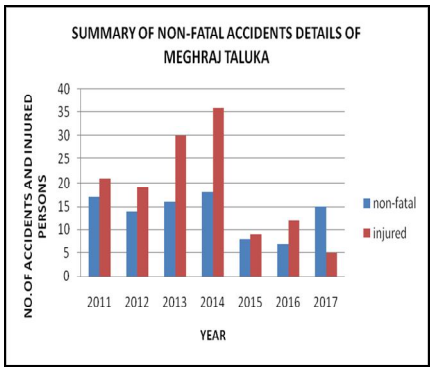


Figure:4 Summary of non-fatal accidents details of Meghraj Taluka

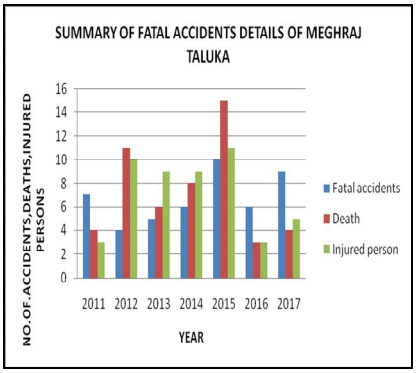


Figure:5 Summary of fatal accidents details of Meghraj Taluka

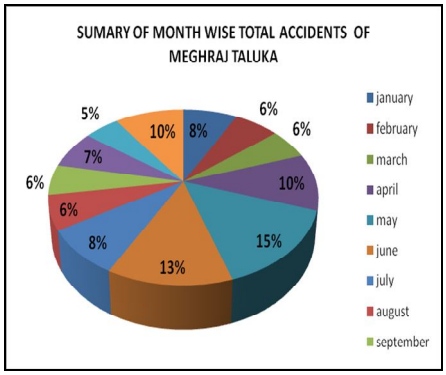


Figure:6Summary of month wise accidents details of Meghraj Taluka

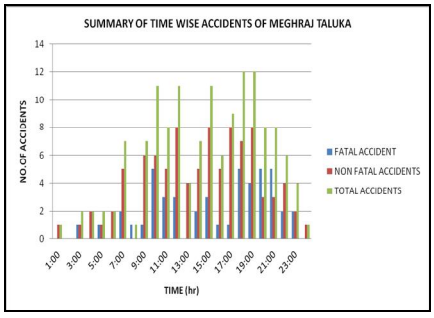


Figure:7Summary of Time wise accidents details of Meghraj Taluka

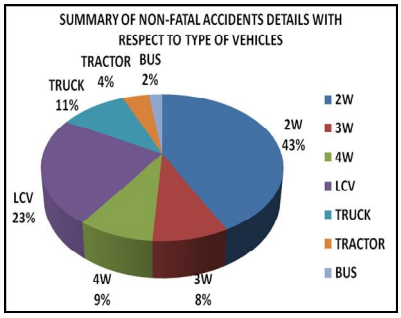


Figure:8 Summary of non-fatal accidents details w.r.t types of vehicle

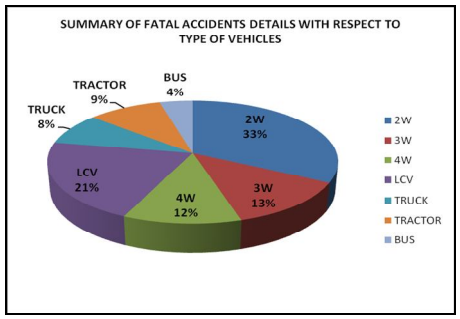


Figure:9 Summary of fatal accidents details w.r.t types of vehicle

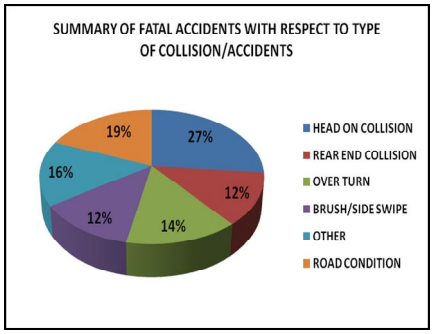


Figure:10 Summary of fatal accidents details w.r.t type of collision/accidents

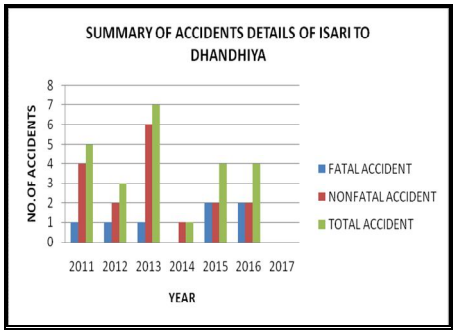


Figure:11 Summary of accidents details of Isari to Dhandhiya

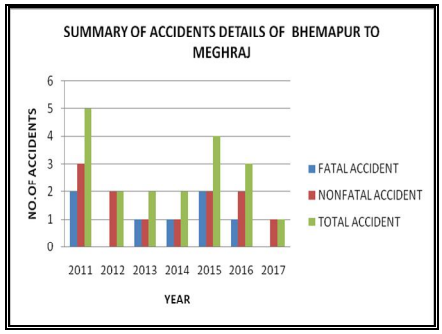


Figure:12 Summary of accidents details of Bhemapur to Meghraj

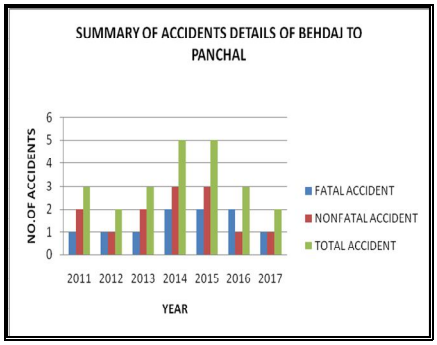


Figure:13 Summary of accidents details of Behdaj to Panchal

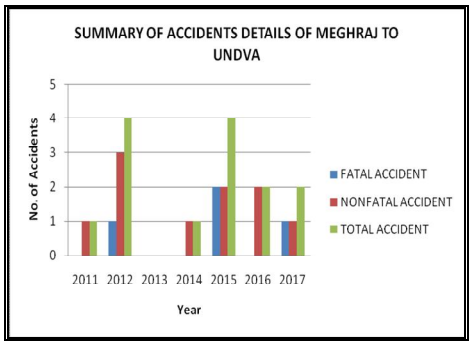


Figure:14 Summary of accidents details of Meghraj to Undva

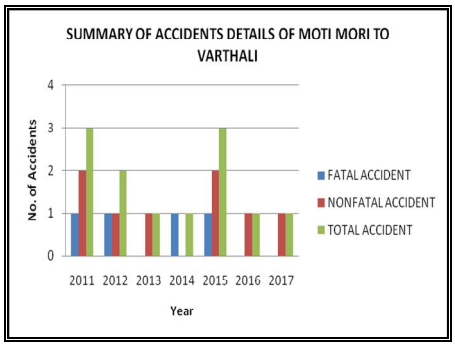


Figure:15 Summary of accidents details of Moti mori to Varthali

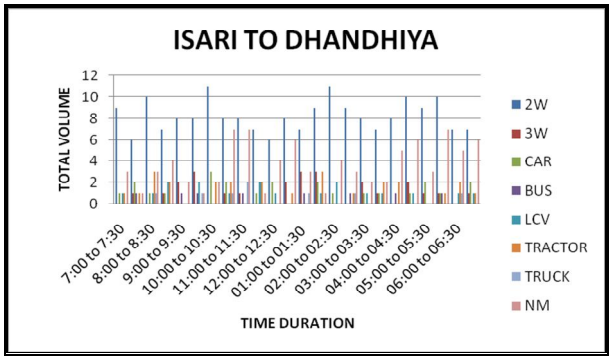


Figure:16 Summary of Classified traffic volume count of Isari to Dhandhiya

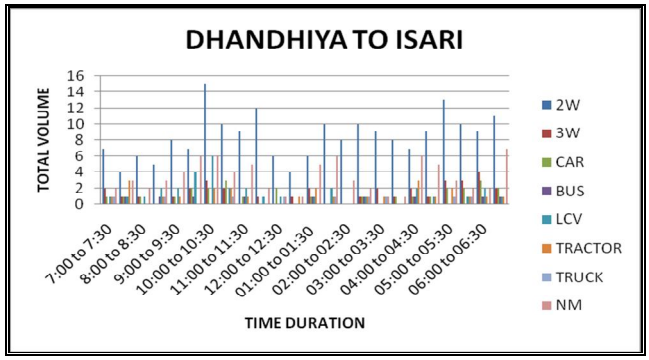


Figure:17 Summary of Classified traffic volume count of Dhandhiya to Isari

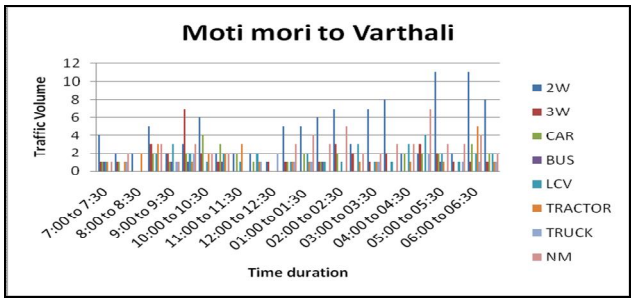


Figure:18 Summary of Classified traffic volume count of Moti mori to Varthali.

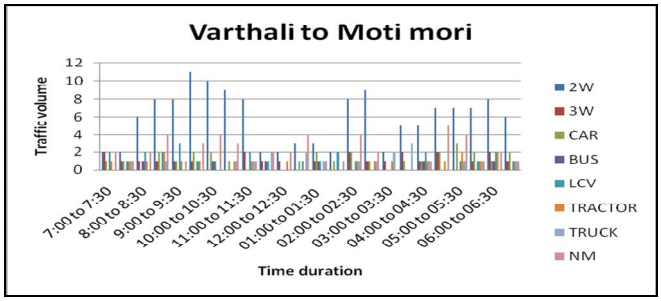


Figure:19 Summary of Classified traffic volume count of Varthali to Moti mori

V. DATA ANALYSIS

PSI is determine for every section of selected rural road links of Meghraj Taluka by following equation.

Present Serviceability Index (PSI) = 5.03 - 1.91 log (1+SV) – $1.38RD^2 – 0.01(C+P)^{½}$

Where, SV is slope variance measured in square inches

RD is the rut depth in inches (both wheel tracks) measured with 4ft. Straight-edge,

C is cracking ($ft^2/1000ft^2$) and

P is patching in square feet ($ft^2/1000ft^2$)

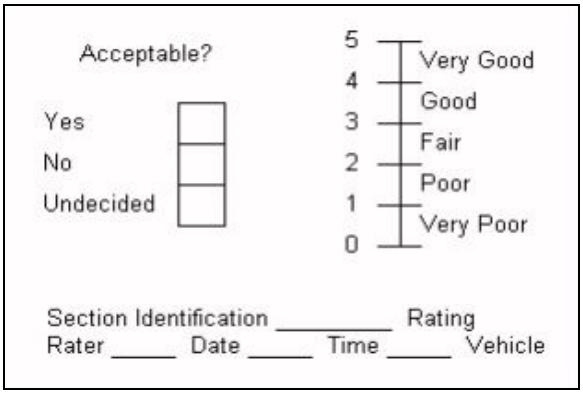


Figure 20 :Present Serviceability Index rate using pavement condition @AASHTO (1993)]

Calculation:

Section 1: Isari to Dhandhiya

$PSI = 5.03 - 1.91 \log (1+SV) - 1.38RD^2 - 0.01(C+P)^{1/2}$

where,

SV=0 (assumed)

RD= 1.50

C= 1.25 sq m = 13.45 sq. ft/(1000*4*10.76)=0.57 ft²/1000ft²

P= 75.6 sq m = 813.75 sq. ft/(1000*4*10.76)=35.02 ft²/1000ft²

$PSI = 5.03 - 1.91 \log(1+0) - 1.38(1.50)^2 - 0.01 (0.57+35.02)^{1/2}$

$= 5.03 - 0 - 3.105 - 0.05$

PSI (Section1) = 1.88

[Note :Section is divided as road length of 1.2 km]

Name of Approach	length(m)	width(m)	Area(m2)	Road type	No.of Accidents	Crack Area(m2)	Potholes area(m2)	Rut area(m2)	Avg.ADT(PCU/Day)	Avg. PSI
Isari to Dhandhiya	11.4	3.5	39900	ODR	18	12.96	404.74	370.08	392.75	2.01
Behdaj to Panchal	12	3.5	42000	ODR	16	11.67	422.93	381.34	349	2.26
Bhemapur to Meghraj	9.6	7.75	74400	SH	18	9.71	210.63	216	397.25	2.15
Meghraj to Undva	14.5	7.5	108750	SH	14	7.41	204.68	240.3	491	2.39
Moti mori to Varthali	7.81	3.5	27335	ODR	12	4.22	430.98	162.41	364.5	2.71

[Figure:21 Summary of Present Serviceability Index of Selected road links]

Accidents Rate Models/Relationship

[Table 3: Accidents Rate Models/Relationship of selected road links]

Name of Approach	Accidents Rate Model/Relationship	R^2
Isari to Dhandhiya	AR= -6.57573 + 0.068988 RF + 0.002866 CV + 1.905514 AW +0.074759 J	0.54
Behdaj to Panchal	AR= -0.22418 + 0.60345 RF + 0.05930 CV + 0.395349 AW +0.030005 J	0.88
Bhemapur to Meghraj	AR= -1.049455 + 0.829447 RF + 0.019301 CV + 0.454861 AW +0.35062 J	0.87
Meghraj to Undva	AR= -0.43091 + 0.04615 RF + 0.00423 CV + 0.08578 AW +0.496042 J	0.64
Moti mori to Varthali	AR= 2.38253 + 0.284272 RF + 0.006372 CV + 0.70321 AW +0.08496 J	0.79

Note: Yellow colour shows significant parameter for causes of road

Maintenance priority Ranking

Maintenance priority ranking means priorities the road links based on importance and urgency of repair to that links the composite maintenance priority value was selected for road links maintenance priority ranking procedure.MPV is calculated by multiplying each priority factor value by its weightage and summing the products as follows:

$$MPV = \sum_{i=1}^{n} Vi * Wi$$

Where, Vi = priority factor value

Wi = priority factor weightage of importance to priority ranking

Calculation : For, Moti mori to Varthali road link,

(1) For, Traffic

(a). Total area of road link = 27335 sq. m.

(b). Measured Traffic Volume

ADT = 364.

©. Traffic Volume PCU per 1000 sq.m.

27335 1000 ⇒

364.5 ? ⇒

=13.33

(d). Weightage factor for Traffic = 10.82

MPV for Traffic = 10.82 * 9.84 = 144.27

(2) For, Crack

(a). Total area of road link = 27335 sq.m. (b). Measured Crack Area = 4.22 sq.m.

(c). Crack in Percentage (%) 27335(area) 100

4.22 (area) ?

=0.015

(d). Weightage factor for Crack = 15.21

MPV for Crack = 15.21 * 0.015 = 0.234

(3) For, Rut

(a). Total area of road link = 27335 sq.m.

(b). Measured Rut Area = 162.41 sq.m.

©. Rut in Percentage (%)

27335 (area) 100

162.41 (area) ?

=0.59

d. Weightage factor for Rut = 17.14

MPV for Roughness = 17.14 * 0.59= 10.18

(4) For, Potholes

(a). Total area of road link = 27335 sq.m.

(b). Measured Potholes Area = 430.96 sq.m.

(c). Potholes in Percentage (%)
27335 (area) 100
430.96 (area) ?
=1.57
(d). Weightage factor for Potholes = 17.76
MPV for Potholes = 17.76 * 1.57 = 28.00

(5) For, Benefited Village on Road,

(a). Total Length of road link = 11.4 Km (b). No. of Village connected Road link = 13
©. Benefited village on road link per Km
7.81 (Km) 13
1 (Km) ?
=1.66
(d). Weightage factor for connected benefited Village = 11.56

MPV for Potholes = 11.56* 1.14
= 19.24
Total MPV = 144.27 + 0.234 + 10.18 + 28 + 19.24
= 201.9

[Table 4: Priority rank of selected road links]

SR. NO.	APPROACHNAME	TRAFFIC(PCU/DAY)	CRACK	RUT	POTHOLES	BENEFITED VILLAGE	MPV	PRIORITY RANK
		WEIGHTAGE 10.82	WEIGHTAGE 15.21	WEIGHTAGE 17.14	WEIGHTAGE 17.76	WEIGTAGE 11.56		
1	Isari to Dhandhiya	106.51	0.49	15.89	18.02	9.13	150.04	2
2	Behdaj to Panchal	89.91	0.42	15.56	17.88	11.56	135.34	3
3	Bhemapur to Meghraj	57.77	0.20	4.98	5.03	13.25	81.22	4
4	Meghraj to Undva	48.85	0.10	3.79	3.34	11.16	67.25	5
5	Moti mori to Varthali	144.28	0.23	10.18	28.00	19.24	201.94	1

SR. NO.	APPROACH NAME	LENGTH (KM)	WIDTH (M)	AREA (SQU. MET.)	CRACK AREA (SQ.M.)	CRACK IN %	WEIGHTAGE 15.21 (MPV)	RUT AREA	RUT IN %	WEIGHTAGE 17.14 (MPV)	POTHOLES AREA	POTHOLES IN %	WEIGHTAGE 17.76 (MPV)	NO. OF CONNECTED VILLAGE	ADT	TRAFFIC VOLUME (adt/100 sq.m.)(%)	WEIGHTAGE 10.82 (MPV)	BENIFITED VILLAGE ON ROAD LINK PER km	WEIGHTAGE 11.56 (MPV)	TOTAL MPV	PRIORITY RANK
1	Isari to Dhandhiya	11.4	3.5	39900	12.96	0.0325	0.494	370	0.9273	15.894	404.74	1.0144	18.015	9	392.75	9.8434	106.51	0.7895	9.1263	150.04	2
2	Behdaj to Panchal	12	3.5	42000	11.67	0.0278	0.423	381.3	0.908	15.562	422.93	1.007	17.884	12	349	8.3095	89.909	1	11.56	135.34	3
3	Bhemapur to Meghraj	9.6	7.75	74400	9.71	0.0131	0.199	216	0.2903	4.9761	210.63	0.2831	5.0279	11	397.25	5.3394	57.772	1.1458	13.246	81.221	4
4	Meghraj to Undva	14.5	7.5	108750	7.41	0.0068	0.104	240.3	0.221	3.7873	204.68	0.1882	3.3426	14	491	4.5149	48.852	0.9655	11.161	67.247	5
5	Moti mori to Varthali	7.81	3.5	27335	4.22	0.0154	0.235	162.4	0.5941	10.184	430.96	1.5766	28	13	364.5	13.335	144.28	1.6645	19.242	201.94	1

[Figure 22: Summary of weightage and MPV of selected road links]

V. CONCLUSION

Data analysis shows that overall average PSI of all selected road links are between 2 to 3 . From Figure 20 [Present Serviceability Index rate using pavement condition@ AASHTO (1993)]it realize that all road links are fair and all links are need to an improvement or maintenance. Accidents rate models/relationship realize that average width and rise & fall are significant parameters for causing of road accidents whereas No. of junctions, curvature/km are dominant parameters for causing of road accidents. Improvement in the gradients are necessary to minimize the accident occurrences, as the regression equations of accident rates reflect the significant effect of rise fall for the causing more accidents. Proper sign boards, lighting, flashing amber signals shall be provided on the rising/ falling gradients. Periodic maintenance is required for patch work on all the selected road links to improve the pavement surface condition. Also This study realize that the MPV value of selected road links deciding the priority based on their priority index. For finding MPV value the selected parameter like traffic volume, crack ,rut,potholes, no. of villages connected gives proper weightage by expert opinion survey. priority is depends on MPV value thus, MPV value is more than improvement of road link is must prior.

REFERENCES

[1] AASHTO (1993), "AASHTO Guide for design of pavement structures", American Association of State Highway & Transportation Officials, Washington, D C.
[2] MORT&H, IRC 2001, “Report of the committee on norms for maintenance of roads in India”,New Delhi.”
[3] Minu P K (2014). “Development of pavement roughness model and maintenance priority index for kerala state highway I” (IJERT), ISSN:2278-0181.
[4] IRC: SP: 88-2010. “Manual on Road Safety Audit”. Indian Road Congress, New Delhi, India.
[5] Aggarwal, S. (2003). “Development of pavement Management system for Indian National Highway Network”, PhD. Thesis, Indian institute of technology Roorkee, Roorkee.

[6] Francesca Russo(2016), "Mariarosaria Busiello Safety performance functions for crash severity on undivided rural road Accident Analysis and Prevention"
[7] Khaled A. Abbas (2004), "Traffic safety assessment and development of predictive models for accidents on rural roads in Egypt Accident Analysis and Prevention"
[8] Karlaftis Matthew G. (2002) , "Effects of road geometry and traffic volumes on rural roadway accident rates." February 2001. Accident Analysis and Prevention
[9] Sitao HU , Qiaojun XIANG (2012), "Characteristic Analysis of Traffic Accidents on Rural Roads." ASCE 2012, 2506.
[10] Essam, A., Sharaf and Fathy, M., Mandeel (1998). “An analysis of the impact of different priority setting Techniques on network pavement condition” ,4th International Conference on Managing Pavements.

[11] Laird James (2010), "Accidents on rural roads – for better or worse PTRC and Contributors", 2010 Roshina Babu., (2014), "Development of Pavement Roughness Model and Maintenance Priority Index for Kerala State" HighwayInternational Journal of Engineering Research & Technology (IJERT) IJERT ISSN: 2278-0181 IJERTV3IS110683

[12] Sathyakumar,M.,and Vijayakumar, V.N.(2004). "Development of methodology for priority ranking of highway pavements for maintenance based on composite criteria" Highway Research Bulletin, 31-49

[13] Reddy, B.B, Veeraragavan, A. (2001). "Priority ranking model for managing flexible pavements at network level." J. Indian Roads Congress, Vol.62 (2), 379