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A STUDY ON GEOMETRIC ELEMENTS FOR CONTROL OF ACCIDENTS RATE IN HIGHWAYS.

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ABSTRACT

In India, the number of people killed in traffic accidents has risen steadily over the previous decade or so. As a result, scholars throughout the globe are debating traffic safety management. Because of this, a variety of elements must be considered while doing accident modelling. Modeling an accident allows us to identify the true culprits responsible for the incident. One reason may have a higher impact than the other. Accident modelling is the only way to discover these underlying causes. For the sake of this research, we have attempted to categorise these accident modelling approaches into two separate groups, one for urban roads and one for rural roads.It's been shown that accident investigation models vary widely, depending on the industry, domain, and investigative focus. Research on human variables is particularly susceptible to a broad range of approaches. The bulk of these theories may be traced back to the Rasmussen model of system hierarchy or the Swiss Cheese causality model developed by Reason.There are a lot of models that come from manufacturing and the energy sector in general. The use of these concepts in the aviation sector has shown their fundamental flaws. In reality, their intervention potential is confined to linear solutions because of their simplifications and lay interpretations. When designing for a multi-actor environment, a comprehensive systems engineering design approach should be employed. Three paradigm adjustments in investigative methods are required for such an approach. To begin, there must be a severance of ties between the fields of event modelling and systems modelling. There must be a distinction made between two distinct categories of design. Linear alterations to the current design envelope are distinguished from second-order alterations that aim to expand the design solution space. Third, building safe solutions in a multi-factor systems context needs prototyping, virtual system model simulation, and testing of limit state scenarios.. On the basis of these limitations, a framework for improving aviation safety is provided, which is based on actual experiences in the industry. As a result of new concerns about cost, safety, and the environment, undivided interurban road geometry has evolved throughout time. Initial design

Key words: Systems theory and sociological study of the socio-technical system; sociological theory; organisational theory; and systemic accident models are some of the terms used.

INTRODUCTION

The number of people killed or injured in car accidents has risen steadily over the last several decades. Research on this issue has prompted academics to look for plausible causes and preventative strategies to avoid accidents. Traffic safety and management is a sub-discipline of transportation engineering. Researchers have discovered new models for reliably forecasting traffic accidents after conducting these studies. This article outlines the theory behind the finding of a number of significant models. The models established by other researchers are also compared and contrasted..

Fig.: **Road Crash**

An accident is a quick, unexpected, and unwelcome incident or occurrence that results in an unwanted and unpleasant consequence that is directly or indirectly caused by human action rather than a natural phenomenon. Preventing accidents is the most fundamental safety management principle. There should be no incidents if safety management is successful. To put it another way, if there are accidents, then there is no effective safety management in place. It is essential to understand how accidents occur so that preventative measures may be devised.

Despite how it seems, accidents are seldom the consequence of a simple nexus.

Since the birth of the industrial revolution, it has been difficult to explain how accidents occur because of the complexity of a single failure. Over the years, writers have devised a slew of conceptual models in an effort to solve the enigma of accident causation. In the initial sight, they seem to be as different and dispersed as the accident issue they profess to assist address, but deeper examination shows that there are certain commonalities. There are linear and non-linear models, both of which hypothesise that a number of variables work together to cause an accident to occur. In theory, certain models are better at explaining how accidents occur than others. In addition, some are important in accident investigations, in order to acquire a thorough knowledge of the accident's root causes in order to implement effective remedial measures. How individuals perceive safety and how they identify and analyse risk elements are all influenced by accident models. Models that are founded on the principle of causation may be utilised in both reactive and proactive safety management.

As a general rule, countermeasures to avoid chain-of-event mishaps entail either eliminating or adding enough and gates (necessary simultaneous circumstances or events) to ensure that the chaining factors are not realised. Engineering design has mostly concentrated on avoiding component failures, i.e., enhancing component integrity, and on adding redundancy (and gates) to lower their risk of resulting to a loss since they are the most prevalent occurrences in event-based models. However, this emphasis on failures and the reliability engineering approaches used to avoid them does not take into consideration

Accidents may be attributed to a variety of reasons, including social and organisational ones.

Secondly, there are system failures and software faults.

(3) Errors of the human mind.

Changes that occur throughout time.

I. LITERATURE REVIEW

When looking at the impact of accident-related variables on road mortality in Bali Province, Indonesia, Wedagama and Dissanayake (2010) conducted research. Data from Bali, Indonesia, was used to create different logistic regression models for fatal incidents involving motorcycles and all vehicles, including motorcycles. The created models used seven predictor variables. Female motorists and motorcycle riders both had a 79% chance of being killed in a collision, according to the findings of the research. Males are responsible for a higher percentage of deadly motorbike and automobile accidents. In addition, the average age of those killed in motor vehicle accidents was a major factor. About half of all car deaths were the result of old age.

Motorcycle accidents and severity collisions were studied in depth by Hauque et al. (2010). The study's primary goal was to determine which motorcycle riders were more at danger of being involved in a collision due to variables related to their own behaviour. A questionnaire encompassing 61 questions of impulsive sensation-seeking, aggressiveness, and risk-taking behaviours was created. The medoid portioning approach was used to create a log linear model that correlated rider behaviour to the accident score/number. Risky and aggressive motorcyclists are more likely to be in the high-vulnerable category, although impulsive sensation-seeking behaviour is not observed to be a factor.

Motorcycle accidents in the Philippines were examined by Seva et al. (2012), who looked at both individual and societal variables. In their research, they looked at factors such as age, lighting conditions, traffic flow, road character, junction type, day, surface conditions, and driving behaviour as variables. A logit model was built using logistic regression to estimate the chance of an accident based on the data analysed. When it comes to motorcycle accidents, the researchers discovered that three factors stood out as important indicators. Age, driving style, and kind of intersection were all factors. They employed Wald's and Hosmer-logistic Lemeshow's regression tests to check for fit. Overall, this research showed that young drivers had a higher accident rate than older ones.

Researchers Obaidat and Ramadan (2012) conducted an investigation into traffic accidents at 28 dangerous areas of urban roadways in Amman and Jordan that were analysed. When it comes to predicting the link between accident features as a determinant variable and the other factors analysed as independent variables, the researchers discovered that logarithmic and linear models were the most significant and realistic options.

IV **THEORY AND PRACTICE**

The impact of various roadway geometry components on the accident rate have been studied via accident analysis. The horizontal radius, deflection angle, horizontal arc length, Super elevation, rate of change of Super elevation, vertical gradient, vertical curve length, K-value, and visibility/sight distance are all geometric factors. As a last step, the statistical analysis of these geometric components is completed.Statistically important data are taken into account while building a model.

NUMBER OF INJURIES

When calculating an accident rate, one must divide the number of accidents that occurred in a particular year by the total number of cars that travelled that year. Crash rates per million vehicles are the most used unit of measurement. Number of Miles Traveled

To put it another way:

AR is equal to

365 N L

Here are the variables that make up this equation.

Accident Rate (AR) is the number of collisions per 100 million km of driving (100 Mvkm) In the study period, C is the total number of crashes. V = Annual Average Daily Traffic Volumes (AADT)

N is the number of years in the data set, and L is the kilometres of road.

Models of systemic accidentsCognitive Systems Engineering and the Systems Theoretic Approach

Modern technology has transformed the nature of human employment from mostly manual to primarily knowledge-intensive and cognitive pursuits. Human operator performance and overall human-machine system failure modes have been adversely affected by new technology-driven methods to automation, which have resulted in several tragic mishaps in the aviation, nuclear power, and military command and control industries (Parasuraman 1997).

Human performance and error modelling, as well as accident analysis of integrated human-machine systems, have benefited from this. To simulate the behaviour of human-machine systems in the context of the work environment, cognitive systems engineering (Hollnagel 1983) has arisen. "Human mistakes" are traditionally thought of as post-hoc explanations (Woods et al., 1994) based on the idea of "if there is an effect, then there must be a cause" (inverse causality).

Fig.: FRAM describing the essential functions to fly in RVSM

IV **DESIGN ELEMENTS ON TRAFFIC ACCIDENTS**

When considering cross-section effects, lane width and number of lanes are important.

• Shoulder Type and Width Dimensions

• Width and Type of Material

• Climbing the Lanes.

• Density of Access

• The Median Barrier

Effects on Alignment

• Radius of Curvature

RATE OF CHANGE IN CURVATURE

It has been shown in several studies that the curvature rate (CCR) of successive components is associated with important safety-related variables. Although the radius indicates just a single element, the CCR describes a collection of sequential items. When it comes to driving behaviour, equal radii might lead to a variety of outcomes [4]. Consequently, the CCR is a better number to characterise the geometric qualities of various components. They studied the correlation between the number of curves and the frequency of accidents. According to their findings, roadways with more bends had fewer accidents.

Elevation of the highest order

Because of the centrifugal force that is exerted upon vehicles when they are on a curve, pavement traverse slopes are often constructed to be steeper outside and lower inside. This is known as "super elevation." Depending on how much centrifugal force is being countered, this might increase both the stability and comfort of a ride. The formula for traversing. Vehicles moving on a horizontal curve may determine the vehicle's super elevation value (I) by observing the balancing force acting on the vehicle.

The following is an example of acceptable grammar: (1)

Crash Rates at Different Roadway Conditions

Roadway Condition	Accident Rate (personal injuries per million vehicle kilometers)
Dry are roadway, winter	0.12
Wet bare roadway, winter	0.16
Slush	0.18
Loose snow	0.30
Ice	0.53
Hoarfrost	0.53
Packed snow	0.31
Bare ruts	0.12
Black ice in ruts	0.30
Dry bare roadway, summer	0.14
Wet bare roadway, summer	0.18

General Characteristics of RTA in Guntur-Ongole- Amaravathi Road Section

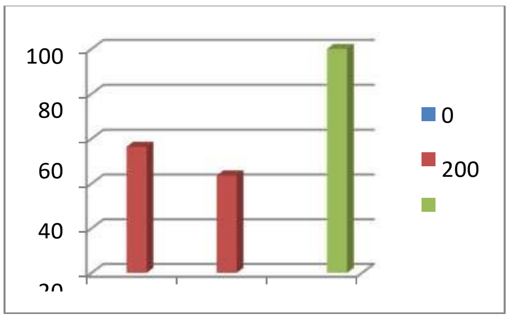
There has been a dramatic rise in the number of fatal and serious RTAs in the region under investigation. From 2010 to 2015, Guntur-Ongole saw an unequal distribution of geographically identifiable road traffic accidents across the rural and suburban area administration, according to a study from the Region Traffic Police.

Table: Variations of Road Traffic Accident Frequency

District	Road Traffic Accident per Year						Total	(%)
	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15		Share
Guntur	35	36	51	45	28	62	257	27
Ongole	47	49	65	49	43	61	314	33
Amaravathi	51	54	67	70	45	87	374	40
Total	133	139	183	164	116	210	945	100

Variations of RTA by Severity Classes in Guntur-Ongole - Amaravathi Road Section

This system required that each accident at a location be categorised into one of the following severity levels: fatal accident, serious injury, minor injury, or property damage (PD). According to the 2010-215 road traffic accident police report, the severity class percentage distribution included around 22.8% of fatal



accidents, 18.6% severe injuries, 13.8% minor injuries, and 44.6% property damage (Table 5.2)). Tab
Severi

Severity Class	Total Road Traffic Accidents						Total	(%) Share
	2010	2011	2012	2013	2014	2015		
Fatal Accident	16	22	36	31	45	75	225	22.8
Serious Injury	28	10	29	32	30	55	184	18.6
Slight Injury	62	17	16	8	23	10	136	13.8
Property Damage	62	68	46	52	55	157	440	44.6
Total	168	117	127	123	153	297	985	100

In Guntur, Ongole, and Amaravathi Districts, RTA and property damage

Direct and indirect financial repercussions from traffic accidents may be seen on a property, as well as the impact on pedestrians, animals and other drivers travelling through the area.

Road Traffic Accident Spatial Variation Even in locations where traffic accidents occur on a regular basis, the distribution of crashes in urban and rural areas is unpredictable. There was a strong link between the types of accidents and the types of routes taken and the kinds of activities taken by passengers.

Fig.: Showed that the rural area composed of about 56.40% road traffic accident

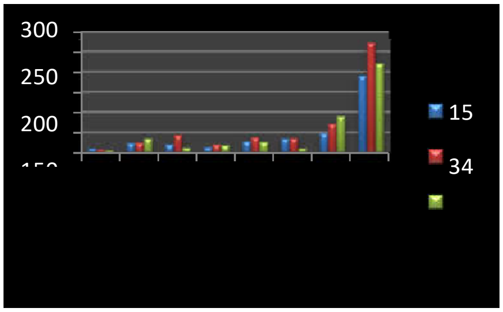
The metropolitan area was only a little bit higher than where the accident took place. Some of the causes of this collision were the short right-of-way, inadequate lane width, eroding shoulder, lack of visibility of pavement markings, excessive speed, and overloading. 43.6 percent of urban traffic accidents are caused by limited lanes, missing road signs like zebras, neglecting pedestrians and animals, as well as improperly located highway medians.

Number of road traffic accident V/s Area of accident

Fig: Number of RTA within rural & urban areas

Temporal variation of Road Traffic Accidents (RTA)

RTAs may occur at any time of day or night, with varying frequency. Numerous elements, including geometry, light availability, road surface markings and signage, topography features of a roadway and human and animal traffic, have been shown to have a significant effect on the daytime variability of RTA distribution. In three areas, 38 percent of all RTA occurrences occurred between the hours of 12:00 PM and 6:00 PM during a three-year period. RTAs occurred at an alarmingly higher rate throughout the same time period. According to the figures from the three districts, the time period from 12:00 AM to 6:00 AM contributed just 22% of all road traffic accidents. Guntur, Ongole, and Amaravathi had more nighttime traffic accidents than daytime



ones (12 p.m. to 6 p.m. and 12 a.m. to 6 a.m.). This phenomena is particularly noticeable at night because of the terrain's escarpment, abrupt bends, steep slopes, and short visibility distances.

The Indian traffic police were in charge of compiling the accident statistics for the Guntur-Ongole-Amaravathi Road Section. An accident code has been established that includes 30 probable causes of accidents, including drivers, pedestrians, vehicles, and road issues. It depicts the main causes of all road defects-related accidents, including alignment effect, cross-sectional effect, and building of roads in the figure shown below In the three districts, 47.3 percent of the accidents were attributed to these road defects.

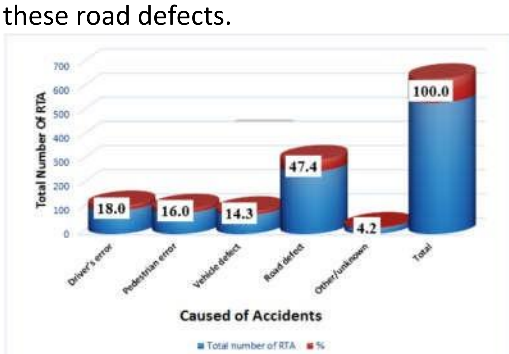


Fig.: Main causes of accidents Source: District Traffic Offices (2015)

Table: Detailed

Accident Reason	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	Total	%
Missing	15	34	26	35	54	23	187	12.6
Break Failure	10	7	5	15	3	34	74	5.0
Failing To Give Way To a pedestrian	23	24	34	12	23	23	139	9.3
Speeding	20	43	12	54	43	25	197	13.2
Unsafe Loading	13	20	18	14	23	15	103	6.9
Failure to respect the right-hand rule	27	37	25	34	35	10	168	11.3
Lack of experience	34	35	10	8	11	19	117	7.9
Road defect	47	70	89	101	97	101	505	33.9
Total	189	270	219	273	289	250	1490	100.0

Causes of Traffic Acciden

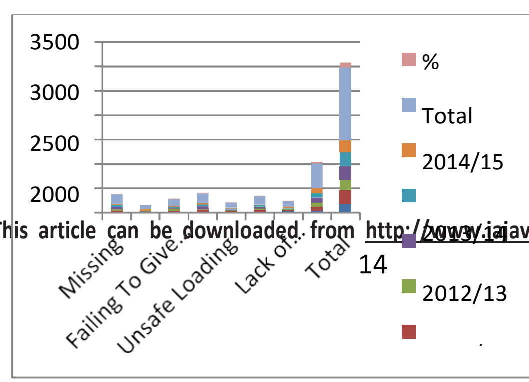
Fig.: Causes of Traffic Accident

Effects of existing road geometric design element of the path traffic accident

Many of the incidents in the studied region may be attributed to existing road geometric design components that increase the risk of an accident, such as abrupt curves, layered circumstances, and pavement that does not satisfy minimal criteria (i.e. too slippery surface).

Dimensionality and Road Traffic Accidents: Geometric Design Elements

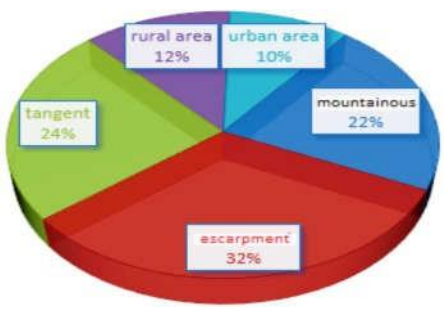
Figure 5.4 depicted the prevalence of vehicle collisions according to highway type. At 32 percent of the escarpment parts and 24 percent of the tangent, 22 percent of the steep terrain, 12 percent of rural areas and 10 percent of urban areas there were crashes. This occurrence demonstrated that the escarpment and tangent segment had the greatest collision rates. Many bends and gradients were present in the mountain areas, making it difficult to maintain a sufficient right-of-way for a road and



to reduce the slope to the appropriate level. It has also influenced the steep bends, which tend to limit viewing distances and the amount of Super height necessary. T

Fig: Vehicle collision by roadway alignment Observed effects of existing geometric design parameters on Road Traffic Accidents

Surveys were undertaken in the research region with the objective of assessing traffic accident patterns and verifying that road geometric design features had an impact. A complete list of all defects and dangers identified by the checklist. The list is broken down into two sections. In contrast, one was a



roadside issue risk, while the other was a road design problem, hazard. When completing the road safety audit, the faults were divided into these two major categories and documented in accordance with the corresponding section of the checklist.

Table: Road Design Problem

A. Road Design Problem	
S.No.	Observed (Hazard)
1	Shoulder missing
2	Carriageway too narrow
3	Narrow road right of way
4	Shoulder too narrow
5	Improper median opening
6	Limited sight distance
7	Improper pedestrian crossing
8	Too small radius of horizontal curve (Sharp curve)
9	Asphalt defects
10	Improper drain
11	Missing Road Marking
12	Dismantling road signs, No inventory of speed control

Table: Roadside problem checklist during site visit

B Roadside Hazard	
S.No.	Observed roadside problem
1	Temporary narrow bridge
2	Missing guardrails
3	Improper culvert design on the roadside
4	Improper bus stop location
5	Missing sign boards

V. CONCLUSIONS

Researchers have built a slew of models throughout the years to better understand how accidents happen, what causes them, how severe they are, and other factors, as well as prophylactic measures. Although regression models are the most frequent, researchers have utilised a variety of alternative strategies in their modelling. These include: 'Genetic mining' Multinomial and binomial Logit models are both available.

Linear, non-linear, and logistic regression models are all examples of regression models.

Bayesian-cohort model, for example.

The models of traffic safety that will be examined in this research are separated primarily into two sections. They're as follows:

Road accident investigation in cities

a study of accidents on country roads

The following may be deduced from a survey of several research on the subject of cross-section and alignment element safety:Accidents involving head-on collisions are less likely when there is a median. Accidents are less severe when medians are used in conjunction with barriers.

In order to reduce the number of accidents, cameras should be installed around the city, and the police's response should be similar to that.

in high-traffic regions, offering subterranean transit facilities reduces wait times and travel times. Increases in lane and shoulder width reduce ROR and OD accident rates. However, if the baseline lane width or shoulder width grows, the marginal impact of lane and shoulder width adjustments is minimised.

The lower the accident rate on multilane roadways, the more lanes there are available.

Shoulder widths more than 2.5m don't provide much protection. Accidents rise in proportion to the median shoulder width.

Using climbing lanes seems to considerably lower accident rates, based on the little data available.

In terms of accident rates, lane width is more important than shoulder width.

The combination of horizontal curves and gradients, as well as surfaces with minimal surface roughness, might be problematic.

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