

13th International Conference

Transportation Planning and Implementation Methodologies for Developing Countries

10 - 11 December 2020

Abstract Booklet



Transportation Systems Engineering
Department of Civil Engineering
Indian Institute of Technology Bombay
Powai, Mumbai – 400076, India





13th TPMDC
10-11 December 2020



**13th INTERNATIONAL CONFERENCE ON
TRANSPORTATION PLANNING AND IMPLEMENTATION
METHODOLOGIES FOR DEVELOPING COUNTRIES**

10 - 11 DECEMBER 2020

ABSTRACT BOOKLET

**ORGANIZED BY
TRANSPORTATION SYSTEMS ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY BOMBAY
POWAI, MUMBAI - 400076, INDIA**



PREFACE

The earliest roots of the Conference on Transportation Planning and Implementation Methodologies for Developing Countries (TPMDC) can be traced back to the International Workshop/Conference series started by The Transportation Systems Engineering (TSE) group of IIT Bombay about 26 years ago by making the first announcement in the WCTRS (World Conference on Transport Research Society) Newsletter. The first Workshop of the series was organized in December 1994 on “*Impact Evaluation and Analysis of Transportation Projects in Developing Countries,*” IEATP-94. Riding on the success of the workshop, the second of the series, Transportation Planning, and Implementation Methodologies for Developing Countries (TPMDC-96) was conducted in December 1996. Starting from year 1996, international conference on TPMDC are conducted biennially. Considering Covid-19 pandemic, the organizing committee had decided to organize the 13th edition of TPMDC in online mode on 10th and 11th December 2020.

The practical problems associated with transportation systems engineering in many developing countries including India are different and complex. Therefore, researchers and agencies have been working to analyze the challenges and to identify implementable solutions for various transportation engineering related problems as per prevailing conditions. The TSE group of IIT Bombay is actively involved in the national and local level transport planning, traffic operation and management, pavement design, materials characterization, highway safety, geometric design, intelligent transportation systems and freight transport activities in India. Likewise, many of the agencies in developing countries have gained lot of expertise in transportation planning and significant innovations have been made to address the current issues. TPMDC 2020 brings an ideal platform for researchers, practitioners, and agencies to share and exchange the experience among the transportation professionals of the developing and developed nations.

The two days of conference sessions are consisted of around 123 selected presentations by the delegates. The major themes of the conference are Activity and Transport Demand, Emerging Travel Technologies, Pavement Materials, Analysis and Design, Sustainable Land Use Transport Planning, Traffic Management, Operations and Safety, Transport and Mobility Networks, Transport Economics, Finance, Policy and Governance.

Organizing Committee

TPMDC 2020



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IIT BOMBAY

IIT Bombay, set up by an Act of the Parliament, was established in 1958, at Powai, a northern suburb of Mumbai. Today the institute is recognized as a leader in the field of engineering education and research. Reputed for the outstanding calibre of students graduating from its undergraduate and postgraduate programmes, the institute attracts the best students from the country for its bachelor's, master's and doctoral programmes. Research and academic programmes at IIT Bombay are driven by an outstanding faculty, many of whom are reputed for their research contributions internationally. The idea and ideals on which such institutes are built evolve and change with national aspirations, national perspectives, and trends worldwide.

CIVIL ENGINEERING DEPARTMENT

Indian Institute of Technology Bombay was established in 1958, and the Department of Civil Engineering has been an integral part of the institute since its inception. The department, with its multifaceted faculties, continues to maintain and cultivate its strong links with the building and construction industry and academic and research institutions, both within and outside the country. Beside high-quality teaching and instruction, the department is actively involved in the basic and applied research consultancy and provides high quality technological advisory support through various research and development projects and consultancies to various organizations.

The Department of Civil Engineering offers B. Tech., Dual Degree B. Tech., M. Tech. Ph.D. programmes in the following seven specializations: Transportation Systems Engineering, Geotechnical Engineering, Structural Engineering, Ocean Engineering, Construction Technology and Management, Water Resource Engineering and Remote Sensing Engineering.

TRANSPORTATION SYSTEMS ENGINEERING GROUP

Transportation Systems Engineering (TSE) group started its post graduate programme in 1988. Now it is one of the strongest groups of Civil Engineering Department with seven faculties working in various fields of transportation such as Transportation Planning, Traffic Engineering, Transportation Infrastructure Design, Intelligent Transportation Systems, Highway materials and design. The TSE group is actively involved in the national and local level transport planning activities in India and is now recognized as one of the major research entities in the country.



LABORATORY FACILITIES

The Transportation Systems Engineering laboratories hold many traditional and advanced types of equipment for testing drivers (Driver Testing Units) such as Fixed-Base Driving simulator and traffic studies instruments (Radar gun, VBOX, sound meter, pedal sensors, and GPS receiver). Further, we have been using drones and high-definition cameras for field traffic data collection.

Advanced Pavement Laboratory includes advanced research instruments to characterize, analyse and design pavement materials for road constructions. Some of the instruments are Dynamic Shear Rheometer, Bending Beam Rheometer, Aggregate Image Measurement System, Hamberg Wheel-Tracking Device, Universal Testing Machine (UTM) and Asphalt Mixture Performance Tester (AMPT).

The transportation studio lab features a wide range of software tools for transportation planning and traffic simulation (VISSIM, AIMSUN, VISUM, TransCAD, Paramics and CUBE), pavement analysis, design and management (IITPave, KENPAVE and HDM – IV), Highway geometric design (MX-Road) and GIS (ArcGIS) to analyse the various models related to traffic.



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CHIEF GUEST-TPMDC 2020



Shri R A Rajeev belongs to 1987 batch of Indian Administrative Service, Maharashtra cadre. In his thirty-three years' of career, he has mainly worked for eleven years in urban development, four years in environment and four years in finance in addition to other sectors at State as well as Central government levels. Before joining the present assignment of Metropolitan Commissioner, MMRDA, he was working as Principal Secretary in Finance department of Government of Maharashtra dealing with State Budget and expenditure management. He has also worked as Joint Secretary (Finance), Department of Atomic Energy, Government of India. During his long tenure in urban development sector as Joint Municipal Commissioner and Additional Municipal Commissioner in Mumbai and Municipal

Commissioner of Thane City, Shri Rajiv handled many critical urban issues. His experience in finance and Environment came handy in handling urban issues with more effectiveness and efficiency. Presently as head of MMRDA, Shri Rajeev is handling mega infrastructural projects, which include 340 kms of Metro and the longest sea bridge MTHL in Mumbai metropolitan region, costing USD 21.42 billion. He has displayed his immense leadership in mobilising financial resources through bilateral and multilateral funding agencies, and timely implementation of these projects. He has been able to raise financial resources of USD 4285 million from agencies like ADB, JICA, KFW, AIIB and NDB. Further negotiations are also on with ADB, NDB, AIIB and AFD. In MMRDA, Shri Rajeev has also created a new organisation, namely Maha Mumbai Metro Operation Corporation Limited, for operation and maintenance of the Metro services, which are being constructed now. Shri Rajeev's strength lies in public policy analysis and in implementing mega infrastructure projects of immense societal benefit.



KEYNOTE SPEAKERS

Topic: Transport Infrastructure for India's Economic Development

Dr. KE Seetha Ram, Senior Capacity Building and Training Specialist, Asian Development Bank Institute (ADBI), leads research and capacity development programs on transport policy, its spillover effect on economy and impacts on quality of life. He is also a visiting professor at the Center for Spatial Information Science, University of Tokyo, Japan, co-chair of special interest group on high-speed rail in the World Conference on Transport Society (WCTRS) and special advisor to East Japan Railways Company for India High Speed Rail. Dr. Seetha Ram has published 97 research articles and has more than 2900 citations with web of science h-index of 21. He is passionate about Philanthropy, Innovation, Diplomacy and Education in Human Values. He completed his Dr.Eng. from the University of Tokyo, Japan.



Dr. KE Seetha Ram
Asian Development Bank
Institute, Japan

Topic: Recent Technologies to Pave Roads to Zero Waste in Construction Works

Dr. Iswandaru Widyatmoko, Technical Director, Infrastructure and Transportation Materials R&D, Centre of Excellent for Asset Consultancy at AECOM, leads Pavement Materials Research team. He is a UK Chartered Engineer, Fellow of the Institute of Asphalt Technology, and Fellow of the Chartered Institution of Highways and Transportation. He has more than 25 years of experience in implementation of the latest development in road paving materials into industry practices in the UK and overseas. Dr. Iswandaru Widyatmoko work interest includes provision of mix design, laboratory and site assessments, technical specification, failure investigation, recycling options and remedial solutions. He is also involved in managing collaborative research programs with the UK industries.

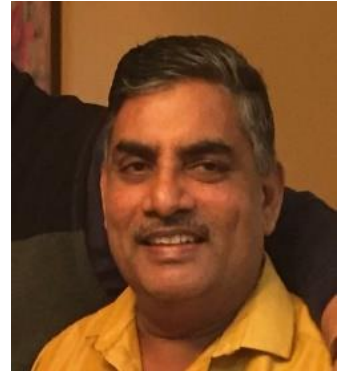


Dr. Iswandaru Widyatmoko
Technical Director, AECOM,
Nottingham, UK



Topic: Implementation of Mega Transportation Infrastructure in MMRDA Challenges and Perspectives

Shri PRK Murthy is Director (Projects) Metro, Metro Project Implementation Unit (PIU) at Mumbai Metropolitan Region Development Authority (MMRDA). He is on the Board of Mumbai Metro One Pvt. Ltd and serves as the Director of Mumbai Railway Vikas Corp., Ltd. He served as the Chief of Transport and Communications Division at MMRDA. He has 25 years of experience in the field of engineering, administration & project implementation relating to mega transportation infrastructure projects in MMRDA.



Shri PRK Murthy

Director (Projects) Metro,
MMRDA, India

Topic: Selection and Scheduling of Interrelated Improvements for Transportation System Development

Dr. Paul Schonfeld, is a Professor of Civil Engineering at the University of Maryland, where he served for 19 years as Director of its Transportation Engineering Program. He has experience in analyzing various transportation systems, including road networks and traffic management systems, public transportation systems, freight logistics, inland waterways and airports. He has over 500 publications, including 170 accepted for peer-reviewed journals with more than 5200 citations. He has served as Editor of the Journal of Advanced Transportation and of ASCE's Journal of Transportation Engineering. He is a Fellow of ASCE and ITE. Dr. Schonfeld received ASCE's 2018 James Laurie Prize for career achievements in transportation engineering. His work has been significantly implemented by U.S. Army Corps of Engineers, Federal Aviation Administration and Maryland Department of Transportation.



Dr. Paul Schonfeld

Professor, University of
Maryland, USA



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KEYNOTE ABSTRACT I

TRANSPORT INFRASTRUCTURE FOR INDIA'S ECONOMIC DEVELOPMENT

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Abstract

India is planning a large number of high-quality infrastructure development projects to catalyze the economy and improve the quality of life. Decision makers are seeking policy measures for attracting private sector investment in transport infrastructure. The impact of COVID-19 on cities and transportation systems requires new thinking on human mobility, supply chains, and logistics. First, transportation infrastructure generates long-term economic impacts that are often not directly attributable to a specific project. Second, many Indian cities are planning and implementing mass transit networks following the transit-oriented development principles. Third, large transport infrastructure development projects generate effects on different spatial scales viz. regional, local, corridors and stations. Fourth, human capital affects innovation, research and technology necessary successfully build and operate transport infrastructure. In this keynote, the speaker plans to share views relevant to India on these aspects, drawing inspiration from infrastructure the experiences of Asian countries, particularly, Japan in the last 50 years. The keynote will cover priorities, policies, and programs for planning, financing, constructing, operating and maintaining transport infrastructure, supported by data, scientific knowledge, and technology.



KEYNOTE ABSTRACT II

RECENT TECHNOLOGIES TO PAVE ROADS TO ZERO WASTE IN CONSTRUCTION WORKS

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Abstract

Raw materials and natural resources have been under far increasing pressure due to the recent boom in infrastructure construction. This activity has caused more severe environmental damage. The construction and demolition of infrastructure assets accounts for about 30% of global material consumption and waste generation. There are many benefits associated with recycling end of life materials and waste from this construction work. Recycling reduces waste costs and carbon emissions. It also helps comply with environmental laws and what restrictions can be sent to landfill. It is expected that reliable recycling methods in the future should efficiently use comprehensive catalogs and material databases currently used in construction. Furthermore, there has been increased usage of innovative “green” materials, which include non-bituminous, non-mineral and waste-derived products, in pavement construction. However, the impact from application of these materials on the pavement durability is not well understood. An inclusive process to assess and manage impacts to support all stakeholders at the various stages of technology development is required.

Greater challenges when dealing with end-of-life infrastructure assets are often associated with a lack of, or incomplete, records on materials used in the assets, such as since the design and construction phases, and throughout the lives of those whilst in service. The increasing use of recent technologies open ways to build banks of material digital database. This will provide detailed records of existing materials and their in-service history ahead of any future recycling, thus better informed during the design stage, and helps improving the effectiveness and quality of recycled products. The concept of digital ecosystem can be implemented to achieve zero waste landfill, by adopting holistic design, augmenting design practices, digital platform which leads to smart consumption of raw material resources. Use of these smart tools can facilitate site specific evidence-based design and help engineers gaining better confidence in incorporating end of life infrastructure assets in their rehabilitation projects while maintaining high quality and good efficiency with improved safety. This will also ultimately contribute to realizing zero waste in construction works.



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KEYNOTE ABSTRACT III

IMPLEMENTATION OF MEGA TRANSPORTATION INFRASTRUCTURE IN MMR: CHALLENGES AND PERSPECTIVES

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Abstract

Mumbai Metropolitan Region (MMR) is one of the fastest growing metropolises in India. With a population of about 22.8 million based on it is ranked as the sixth largest Metropolitan Region in the world. This accounts for approximately one-fifth of the Maharashtra state total population. Mumbai continues to be a significant engine of economic growth for the whole nation. The note presents the status of various infra projects under implementation, opportunities and challenges in implementation.



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KEYNOTE ABSTRACT IV

SELECTION AND SCHEDULING OF INTERRELATED IMPROVEMENTS FOR TRANSPORTATION SYSTEM DEVELOPMENT

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Abstract

The selection and scheduling of interrelated alternatives has pervasive applications in engineering, business management, operations research, public administration, financial analysis and other important fields. While generally accepted methods for analyzing mutually exclusive and independent alternatives can be found in standard textbooks, no such general methods are found for analyzing interrelated alternatives. Furthermore, even the methods that have been designed for analyzing interrelated alternatives in some specific applications have been deficient in their abilities to deal with complex interrelations, dissimilar types of alternatives, multiple uncertainties, scheduling decisions, realistic problem sizes and other important factors. Some practical methods will be presented for evaluating, selecting, sequencing and scheduling interrelated alternatives in the process of developing transportation systems, while dealing with uncertainties and financing considerations. Application-specific methods for evaluating various systems will be combined with general algorithms for selecting and scheduling improvements. Applications will be discussed for road network improvements (e.g., widened links, new links and expanded intersections), public transportation systems, freight railroad networks, inland waterways and airports.



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ABSTRACTS

TRACK 1: ACTIVITY AND TRANSPORT DEMAND



Paper ID: 32

ANALYSING MODE-CHOICE-BEHAVIOUR USING NESTED LOGIT MODEL: A CASE STUDY OF BENGALURU CITY

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Abstract

Bengaluru's massive economic growth and rapid urbanisation have led to a change in the travel behaviour of commuters. The high private-motorised-vehicle-rate points towards a decline in the mode share of bus transport. In this context, the study aims to evaluate the mode-choice-behaviour of commuters and assess the feasibility of introducing premium bus services (AC bus) in the city to improve the ridership. A discrete choice model (DCM) was developed to analyse the willingness to shift to the new AC bus services. Revealed preference (RP) and stated preference (SP) surveys were conducted for commuters travelling on the selected corridors, and a nested logit model was estimated. Further, value of time was computed under different models interacting the cost and income variable. From the results, it was concluded that commuters using intermediate public transport (IPT such as auto rickshaws) and two-wheelers display the greatest willingness to shift to AC buses.

Keywords: *Discrete Choice Model, Revealed Preference, Stated Preference, Nested Logit, Value of Time*

Paper ID: 36

VALUING THE ATTRIBUTES OF PLUG-IN HYBRID ELECTRIC VEHICLE IN URBAN INDIA: A STATED PREFERENCE APPROACH

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Abstract

The present study investigates consumers' willingness to pay (WTP) for the attributes of Plug-in Hybrid Electric Vehicle (PHEVs) in the capital city of Delhi, India. A Stated Preference (SP) survey was designed to develop Mixed Logit (ML) models for the overall sample. Additionally, in ML models, heterogeneity around the mean of random parameter was investigated with respect to monthly family income, availability of home-based parking facility, education and trip length to examine WTP differences, if any, across population sub-samples. The results indicate that for overall sample, charging time is perceived as the attribute of topmost priority influencing consumers' choice of PHEV, followed by battery warranty. Heterogeneity investigation reveals that consumers with high income, and those with absence of home-based parking facility have higher WTP for charging infrastructure and charging time. While consumers with higher education and higher trip length have higher WTP for emission and electric range respectively.

Keywords: *Plug-in Hybrid Electric Vehicle, Mixed Logit (ML), Heterogeneity, Willingness to pay*



Paper ID: 38

EVALUATION OF YOUNGER AGE BICYCLE USER'S TRIP BEHAVIOUR

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Abstract

This study examines the student's response to their decision to use a bicycle as a commuter mode. To explore this, different age students were selected, and a questionnaire survey was carried in 2019 among the selected age groups along the selected corridors in Nagpur city. The collected data has been analyzed by using descriptive analysis and exploratory factor analysis (EFA). The model result shows that motivation, infrastructure barriers, parental norms, individual barriers and parental allowance significantly affect their decision to use bicycle as a commuter mode (viz., school commuting trips). Further, results show that socio-demographic characteristics (viz., gender, education, purpose, daily distance travelled) play a significant role in their decision to use bicycle. The findings of these study may be useful to encourage commuters (viz., younger age groups) to use non-motorized modes such as bicycles which may lead to more sustainable transportation.

Keywords: *Younger age, bicycle, commuter, trip behaviour, EFA*

Paper ID: 42

IMPACTS OF HEALTH- AND SERVICE-ORIENTED PRIORITIES ON COMMUTERS' MODE CHOICE BEHAVIOURS BEFORE AND DURING COVID-19 PANDEMIC IN A DEVELOPING COUNTRY

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Abstract

The outbreak of COVID-19 has compelled the people around the globe to change their travel behaviors in a matter of months. The public transit modes, which were once considered as the future of sustainable transport system seemed no longer to fulfil safe transit needs of travelers. In this study, a total of 671 responses from an online questionnaire were collected regarding Service-oriented Priorities (SOPs) and Health-oriented Priorities (HOPs) about different transport modes for before and during COVID-19 pandemic situations. The results suggested that commuters who preferred HOPs selected rickshaw and bicycle before COVID-19, whereas they selected private car and bicycle as transit modes during COVID-19. However, commuters concerning SOPs preferred walking, taxi and private car before COVID-19, and private car and motorcycle during COVID-19 pandemic. These findings can help policy makers to formulate guidelines for meeting individual's safe transit needs in the post COVID-19 world especially in the developing countries.

Keywords: *Travel Behaviours, Mode Choice, COVID-19, Pandemic and Pakistan*



Paper ID: 47

UNDERSTANDING THE IMPACTS OF ONLINE GROCERY SHOPPING (E-COMMERCE) ON TRAVEL DEMAND

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Abstract

COVID-19 pandemic has made many changes in our day to day life and encouraged us to adopt online shopping over in-store shopping. In the coming years, we might see more number of delivery vehicles plying on roads, to fulfill increased online shopping demand. This raises the concern for policymakers and transportation planners to understand the changes in trip making behaviour for shopping and the resultant change in vehicle kilometers travelled. To determine these changes in trip making behaviour for shopping and the impact of COVID-19 on the adoption of online shopping and the resultant change in vehicle kilometers travelled, studies are needed that measure and compare vehicle travel both before and after COVID-19 pandemic. This study will help in understanding the general changes in trip making behaviour of grocery shoppers and their adaptability of online shopping before and after pandemic and the resultant change in vehicle kilometers travelled.

Keywords: *E-commerce, Online shopping, COVID-19 and Travel demand*

Paper ID: 50

ACTIVITY DURATION MODEL FOR SOCIAL VISITS OF THE ELDERLY IN A TIER II CITY IN INDIA

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Abstract

The paper presents the activity duration model developed for the elderly engaging in social visits like visiting family members, attending marriage functions, etc. in a Tier II city in India. The residents of Kozhikode Municipal Corporation were chosen as sample for the study. The activity duration of social visits of the elderly was analyzed using non-parametric Kaplan-Meier survival analysis and parametric Weibull survival analysis. The non-parametric Kaplan-Meier analysis indicated that half of the elderly population is likely to engage in social visit, for more than three hours. Fully parametric Weibull analysis demonstrates the effect of various socio-demographic, personal, attitude and activity-travel behavior of the elderly on the selected model. The results would be useful in development of activity simulators for the population of Tier II cities in India.

Keywords: *Elderly population, Activity-duration, Social visit, Tier II city and India*



Paper ID: 56

ROLE OF E-RICKSHAW IN URBAN TRANSPORTATION

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Abstract

The transport scenario in many small and medium sized urban areas like Silchar varies considerably with increased population and urban activities. In this study, the role of E-Rickshaw was assessed in terms of percentage share of E-Rickshaw and percentage share of urban passengers carried by them at the city level. This was done using the traffic volume survey and vehicular occupancy survey. The utility function of E-Rickshaw for the city was estimated with the logit model using the maximum likelihood method using SPSS. A total of sixteen variables were considered, the data for which was collected using home interview survey. The sensitivity of the usage of E-Rickshaw against the significant variables was analyzed and a Multinomial Logit Model was used to predict the modal utilities. A utility map of E-Rickshaw is drawn to show its usage in different locations of the city.

Keywords: *Utility function, Logit model, Multinomial logit model, Sensitivity and Utility map*

Paper ID: 59

A STUDY ON THE USER SATISFACTION LEVEL OF KOCHI METRO

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Abstract

Cities in developing countries are implementing metro rail as a solution to the steep increase in travel demand, leading to road traffic congestion. Kochi metro was started in the city to attract commuters to public transport. However, a study to understand whether it has been successful in attracting the masses is important. This paper presents a study which examines the satisfaction level and concerns among the current users of Kochi metro. A questionnaire survey was conducted among the users of the newly operational metro. The data were analysed and the overall customer satisfaction was found to be good. The level of satisfaction was, in particular, low in the case of ticket prices and parking charges. The variation in the satisfaction levels and concerns regarding the various aspects of the metro with key demographic and trip characteristics were also examined. Certain improvements were recommended to increase the ridership of Kochi metro.

Keywords: *Metro rail, Travel demand, Public transport, Level of satisfaction and Ridership*



Paper ID: 73

ANALYSIS OF PASSENGER FLOW USING ELECTRONIC TICKET MACHINE DATA

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Abstract

Passenger flow is an important parameter for transit operators to improve the performance of public transit. The Electronic Ticket Machine (ETM) data can be used to analyse passenger flow effectively instead of other time-consuming conventional data collection procedures. This study utilised the ETM data of Mysore urban public transit system to visualise and predict the passenger flow of transit users. In this study, Seasonal Autoregressive Integrated Moving Average (SARIMA) model has been adopted to predict the passenger flow of transit users. The prediction accuracy of the developed SARIMA model has been discussed for different boarding-alighting stages. The results of the study show that ETM data can be used to understand the passenger flow effectively and SARIMA model can be used for prediction of passenger flow which requires only historical data.

Keywords: *Passenger Flow, Electronic Ticket Machine (ETM) Data, Time Series Models, SARIMA, Public Transport*

Paper ID: 105

TRAVEL PATTERNS OF URBAN INDIA-RELATIONSHIP BETWEEN SOCIO-ECONOMIC AND TRAVEL CHARACTERISTICS ACROSS CITY CATEGORIES

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Abstract

Understanding the travel behaviour of users is key to developing sustainable urban mobility systems. This article adds to the existing literature on travel behaviour by presenting a comprehensive analysis of socio-economic characteristics and travel behaviour of Indians living across cities of different sizes. Data from a primary survey of 3,682 respondents was used to compare categorized data for mode choice, travel time and trip length characteristics of users against their gender, age, occupation and city size. Chi-square test and Cramer's V test were used to establish the relationship and strength of association between variables. Trip length was the only variable that showed a strong association with mode choice, with longer trips having higher usage of private vehicles. Travel time and other socio-economic characteristics have a moderate association while city size has a weak relationship with mode choice. The findings can inform future policy and planning choices for Indian cities.

Keywords: *Urban mobility, Travel behaviour, Socio-economic characteristics, Mode choice*



Paper ID: 134

EVALUATION OF RIDERSHIP CHARACTERISTICS OF KOCHI METRO RAIL

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Abstract

Kochi metro is one of the biggest project undertaken in Kerala. The project was introduced in a densely populated area in order to meet the high traffic demands. Metro was implemented to reduce the traffic congestion and thereby increasing the economic development of the country. People are reluctant to use the metro services due to various reasons. Customer satisfaction is a concept of measuring the quality of services provided by a sector or organization for building and maintaining a long-term relationship with their customers. The study identified the various factors influencing customer satisfaction and other service-related considerations which in turn contributing to the successful and economical metro operations. The main focus is confined in analysing the problems of regular customers who are the potential pillars of the metro economy by analysing important factors like riding safety, metro facilities etc.

Keywords: *Traffic, Metro, Customer satisfaction, Regression analysis*

Paper ID: 150

MODE CHOICE MODELING AND ANALYSIS OF INFLUENCING FACTORS IN THE WAKE OF COVID-19

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Abstract

The global COVID-19 outbreak has changed our travel patterns dramatically as well as forcing various governments, including Indian government, to adopt different policies to ensure safe and improved public transport. This paper tries to analyze the mode choice model for public transport, ride hailing services and private transport in the wake of the pandemic. It integrates logit model along with creating a Machine Learning model that can predict future mode choices of people based on various influencing factors. The data collected through an online web-based questionnaire survey has been used for the present study. The analysis shows that 70% shift back to public transport can be possible by taking measures like sanitation drives, increased frequency of vehicles with decreased capacity and ensuring online transactions for payment of transportation fare.

Keywords: *Mode choice model, COVID-19, Public transportation, Machine learning*



Paper ID: 156

**APPLICATION OF RECURRENT NEURAL NETWORKS AND PROGRAMMING INTERFACES
FOR POST-PANDEMIC TRAVEL TIME PREDICTION**

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Abstract

This paper illustrates the usage of Recurrent Neural Network for time-series related prediction of travel time across major corridors in a post-pandemic world. Application programming interfaces are used to calculate travel time in 11 cities across the world which have surpassed the peak of COVID-19 pandemic in their region. Corridors are so chosen that they are arterials having several intersections with average travel times higher than half hour. Travel times are estimated considering daily and weekly post-pandemic trends using RNN as well as SARIMA and compared. It is observed that estimated travel time does not deviate significantly from actual timings. RMSE and MAPE comparisons are used to observe that RNN is better than SARIMA. The study is useful to predict travel time, reliability and assist in planning measures in a post-pandemic world.

Keywords: *Travel-Time Prediction, Neural-Network Modelling, SARIMA*

Paper ID: 167

**UNDERSTANDING USERS PERCEPTION TO RIDE MULTI-MODAL PUBLIC TRANSPORT
SYSTEM**

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Abstract

Travel using public transportation offers financial benefits to the people. However, reaching a destination by using a single mode of public transport seems to be difficult in metropolitan cities. Need to change more than one transportation mode by taking transfer at an interchange becomes necessary in such cases. As a result, the transfer facilities and their characteristics affect city dwellers' perception to ride using Public modes of transport. With this background, the present study aims to understand the factors influencing people's behavior to use public transport, including transfer for the Surat city. Based on 752 non-transit users' responses, the Structural Equation Model was developed using AMOS software. The Results revealed that factors like 'monthly income,' 'in-vehicle time,' 'crowding at the interchange,' 'frequency of others mode at the transfer station,' 'travel time reliability' and 'customer guidance at interchange' play a crucial role for attracting people to use public transport with transfers.

Keywords: *Structural Equation modelling, Non-transit users perception, Public transport system*



DEVELOPMENT OF MODE CHOICE MODEL FOR DOMESTIC TOURIST TRAVEL: A CASE STUDY OF HYDERABAD CITY

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Abstract

Transportation system plays a key role in tourism. Tourism involves the people travelling for entertainment, site visiting and recreational purposes. Unlike work and education related trips, travel analysis in domestic tourism context is challenging on account of the vast heterogeneity in preferences of tourists as well as variability in selecting the mode of travel and destination value. Data collected through onsite personal interviews in Hyderabad were used for analysis and building of the models. The variables considered for model development include household characteristics and socio-economic variables. The results obtained from the models would clarify and predict the individual decisions to forecast the tourist travel demand. Finally, the best fit model out of various trials based on Logsum parameter and Rho-Square values is developed. Understanding the travel behaviour and predicting the decisions of tourists would be helpful for tourism department to improve the existing mode choices and to allocate resources optimum.

Keywords: *Mode choice variables, travel analysis, tourism*



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TRACK II: EMERGING TRAVEL TECHNOLOGIES



Paper ID: 15

DRIVER BEHAVIOUR PROFILING USING NATURALISTIC DRIVING DATA - A SYSTEMATIC REVIEW

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Abstract

Road accidents and vehicular emissions are two significant issues related to road transportation, affecting both human life and the environment. Prior research suggests that driver behaviour is one of the crucial factors in the majority of road crashes and is a significant factor influencing fuel consumption. Significant improvement in driving behaviour can be achieved by providing feedback to drivers about their driving behaviour. With recent development in telematics devices, it is possible to collect the naturalistic driving behaviour data of drivers during their everyday trips. An increasing interest among researchers to identify risky and non-economical driving manoeuvres has led to the development of driver behaviour profiles, i.e. rating/categorising drivers into different categories based on how they drive. To get an insight into different parameters and methodology adopted by researchers for categorizing driver into different categories, this paper presents a systematic review of previous studies on driver behaviour profiling.

Keywords: *Driver Behaviour Profiling, Driver Rating, Driver Scoring, Crash Risk, Eco-driving*

Paper ID: 52

ANALYSIS OF USER PERCEPTION FOR ELECTRIC TWO-WHEELER ATTRIBUTE PRIORITIZATION AND MARKET SEGMENT EVALUATION IN INDIAN CONTEXT

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Abstract

The promotion of electric two-wheelers will have a positive impact on the environment by reducing the total pollution load emitted into the atmosphere by conventional two-wheelers. Therefore, in order to encourage the electric two-wheelers, it is most important to have a clear and better understanding of the perceptions of the users to provide a good insight into the actual requirements of the future generation Electric two-wheelers. This study has therefore uses the RIDIT technique and the Binary Logit model to obtain a clear understanding of the electric two-wheeler market segment. The study results revealed that Purchase cost, Operation cost and Maintenance cost are the key attributes among the Economy related attributes. Similarly, the key Vehicle related attributes are found to be Range, Top speed and Battery charging duration. Finally, the Binary Logit model calibrated for the respondents' socio-demographic characteristics has revealed valuable insights into the market segment for electric two-wheelers.

Keywords: *Electric two-wheelers, User perception, RIDIT and Binary Logit*



Paper ID: 82

TECHNOLOGY FEASIBILITY OF BATTERY-SWAPPING TECHNOLOGY FOR E-BUSES IN BENGALURU

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Abstract

Electric buses (e-buses) have gained prominence in recent years as a substitute for conventional buses to address the environmental issues raised by mass motorisation. The realisation of large-scale adoption of e-buses would require careful planning for charger technology and infrastructure elements. In this study, the characteristics of battery-swapping technology—an emerging charging technology in India—were investigated. A route analysis was carried out to identify feasible routes, and the details were input to a simulation model. The model analysed the performance characteristics of battery-swapping technology at a particular node in Bengaluru. The obtained results show that this technology is suitable for large-scale adoption because of low average waiting time and maximum technology utilisation. The results of this study would help service providers to determine the minimum number of batteries, chargers, and robots required for electrifying the routes emanating from a selected node.

Keywords: *Battery Swapping, Simulation Model, Power Demand and E-Bus*

Paper ID: 99

EFFECT OF TRAVEL TIME UNCERTAINTY ON PERFORMANCE OF TWO-FLUID MODEL

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Abstract

The present study attempts to investigate the effect of travel time uncertainty on the performance of two-fluid model. Traffic data for a period of four weeks was collected using Wi-Fi sensors for an urban arterial corridor in Chennai, India. Traffic flow variables mainly traffic volume, traffic density, speed were estimated at an aggregation interval of 15min. A nonlinear optimization problem was formulated, and the generalized reduced gradient method was used to calibrate the speed-density based two-fluid model. The effect of uncertainties on the performance of the two-fluid model was investigated using travel time uncertainty as a potential uncertainty measure. The results revealed that the uncertainties have a significant effect on the performance of two-fluid model.

Keywords: *Two-Fluid model, Wi-Fi sensor, Uncertainty, Travel time uncertainty (TTU)*



Paper ID: 104

**TRAFFIC EVENT DESCRIPTION BASED ON TWITTER DATA USING UNSUPERVISED
LEARNING METHODS FOR INDIAN ROAD CONDITIONS**

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Abstract

Non-recurrent and unpredictable traffic events directly influence road traffic conditions. There is a need for dynamic monitoring and prediction of these unpredictable events to improve road network management. The problem with the existing traditional methods (flow or speed studies) is that the coverage of many Indian roads is very sparse and reproducible methods to identify and describe the events are not available. Addition of some other form of data is essential to help with this problem. This could be real-time speed monitoring data like Google Maps, Waze, etc. or social data like Twitter, Facebook, etc. In this paper, an unsupervised learning model is used to perform effective tweet classification for enhancing Indian traffic data. The model uses word-embeddings to calculate semantic similarity and achieves a test score of 94.7%.

Keywords: *Intelligent Transportation Systems, Unsupervised Learning, Twitter Data*

Paper ID: 121

SKYTRAN: A CONVENIENT ALTERNATIVE TO PRIVATE TRANSPORTATION

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Abstract

Public transportation modes in developing countries fail to provide proper convenience to a segment of commuters, which forces them to use private transportation. An alternative mode SkyTran, which is a pod-based personal rapid transit system using magnetic levitation, offers greater convenience. The study tried to measure the convenience offered by this system to daily commuters in terms of travel time savings and estimated their willingness to pay for this new service. It was found that the service could be a viable alternative and can cause a possible mode shift from private transportation.

Keywords: *SkyTran, Public transportation, Convenience*



Paper ID: 157

HOW MUCH SUSTAINABLE ARE RIDE HAILING SERVICES? EXPLORING ITS IMPACT ON MODE CHOICE BEHAVIOUR

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Abstract

Recent developments in urban transportation services are rapidly transforming the way people plan their trips. Over the last decade, one of the most widely adopted, albeit controversial, products of such advancements is ride hailing services (RHS). The research presents an empirical investigation on mode choice behaviour in an Indian metropolitan city through the application of discrete choice modeling framework. The multinomial logistic regression model reveals a comprehensive set of socio-demographic and attitudinal factors which influences the adoption of RHS. The variables such as household size, vehicle ownership, and use of smartphone are observed to be important predictors of service adoption of RHS. The results can further be interpreted to aid in informed decision making and policy interventions for a sustainable urban transportation system.

Keywords: *Ride-hailing services, Mode choice, Multinomial logistic regression, Sustainable transport*

Paper ID: 175

TRAFFIC STATE ESTIMATION USING DSRC-BASED MOBILE SENSORS

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Abstract

This study proposes a methodology to estimate traffic conditions on urban arterials using DSRC-based mobile sensors. Corridor-level estimation of traffic state variables is carried out using the vehicle trajectories plot obtained from spatiotemporal data from integrated OBU-WiFi sensors. Edie's generalized definitions for flow, density, and speed are used for the estimation of traffic state variables using 2D trajectories. The results indicate that the speed and travel time values match very closely with the corresponding variables computed using GPS data.

Keywords: *Traffic state estimation, DSRC based mobile sensors, Vehicle trajectories*



ANALYSING THE ENVIRONMENTAL IMPACT OF AUTONOMOUS VEHICLES IN MUMBAI, INDIA

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Abstract

Due to fast economic development in India, light-duty vehicle transportation for personal use is experiencing radical growth causing recurrent congestion and environmental degradation. Among many anticipated benefits, connected and autonomous vehicles (CAVs) are thought to deliver significant environmental benefits from a comparatively smoother driving cycle than conventional vehicles and platooning. These potential environmental benefits include fuel saving and thus reduced greenhouse gas emissions, as well as other mobile source emissions. This study investigates the energy consumption and GHGs for the light-duty vehicles in the city of Mumbai, India. Necessary parameters of US Environmental Protection Agency (EPA)'s Motor Vehicle Emission Simulator (MOVES) are modified to represent a CAV's driving pattern in an all-CAV scenario. The results of the all-CAV scenario are compared with the baseline estimated for the City of Mumbai. The study found that CAVs lower emissions when applied on a hypothetical traffic network consisting of all CAVs.

Keywords: *Autonomous vehicles, Emissions, MOVES, Drive cycle*



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TRACK III: PAVEMENT MATERIALS, ANALYSIS AND DESIGN



Paper ID: 9

IMPACT OF WARM MIX ADDITIVE (WMA) ON PERFORMANCE OF HIGH RAP MIXTURES

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Abstract

The increasing cost of bitumen and anticipated abolition of natural resources such as aggregate and bitumen have steered highway agencies to maximize the use of reclaimed asphalt pavement (RAP) for pavement construction. The use of high percentage of RAP material in hot mix technology possesses challenges due to presence of aged and hardened bitumen in RAP material. This study investigated the feasibility of use of higher percentage RAP (60%) in binder layer using hot recycling technology with addition of warm mix additives (WMA). Chemical analysis of aged and rejuvenated binder has been conducted to see the feasibility of use of WMA as rejuvenator. Also, performance of 60% RAP mixtures with WMA as additive were compared with that of a control hot mix samples prepared with VG 40 bitumen and 30% RAP mixtures without addition of any rejuvenator.

Keywords: *RAP, Asphaltene, Warm mix additive*

Paper ID: 24

POTENTIAL USE OF RECYCLED CONCRETE AGGREGATE WITH FLY ASH FOR BASES IN LOW VOLUME ROADS

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Abstract

The waste generated from demolition and reconstruction site is more, and it is underutilization in India and major portions deposited in landfills. Quality quarry aggregates are becoming scarce and costly, the use of alternative materials, such as Recycled Concrete Aggregate (RCA) derived from demolition of buildings, concrete roads, in unbound and bound pavement base/subbase applications has gained interest in recent past. A laboratory evaluation of RCA and RCA-Fly ash (FA) mixture as pavement material is investigated. The physical, compaction and California Bearing Ratio (CBR) tests were conducted on RCA and compaction, CBR and compressive strength were conducted on RCA+FA mixture with FA content 3 to 12%. The results indicated that RCA could be an alternative to replace virgin aggregate for base/subbase courses in Low Volume Roads (LVRs).

Keywords: *Fly Ash, Stabilization, Low Volume Roads, RCA*



Paper ID: 25

A QUICK RESPONSE MODEL FOR PREDICTING PAVEMENT CONDITION INDEX

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Abstract

Pavement Condition Index (PCI) is a numerical value which represents the condition of a road surface based on which the strategies for maintenance of pavements are worked out. The service level of a road surface after a specific period can be obtained by the condition survey during that time. To obtain this index value with high accuracy, detailed pavement condition surveys are required which is time consuming as well as resource intensive. The presence of a model to predict the Pavement Condition Index can ease this task. The present paper describes development of a simple model which is established through non-linear regression. The proposed model requires knowledge of PCI of the road surface at any given time and number of commercial vehicles passing through the road at the time for which the PCI is to be predicted.

Keywords: *Pavement Condition Index, Distress, Quick Response Model, Traffic*

Paper ID: 28

AN EXPERIMENTAL STUDY ON THE COOL PAVEMENT MATERIALS

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Abstract

Built surroundings and human hobby make towns numerous tiers hotter than rural and suburban regions. The distinction is known as the urban heat island (UHI) impact and stems from exclusive warmness stability at building materials and at natural grounds. The present study focuses on reducing the temperature of the pavement surface using alternate materials like Fly ash and slag. Fly ash was replaced for cement for varying percentages of 5% to 25% and slag was replaced for fine aggregate for 10% to 50%. The results indicate the reduction of temperature around 1oC for specimens replaced with fly ash and slag and also there is a slight reduction in the strength of the specimens having replaced with the same.

Keywords: *Cool pavement, variance, albedo*



Paper ID: 34

**DESIGN AND ECONOMIC IMPACTS OF SOIL STABILIZATION USING RICE HUSK ASH:
QUANTITATIVE MATERIAL OPTIMIZATION**

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Abstract

The objective of this research was to evaluate the effect of soil stabilization using Rice Husk Ash (RHA) on flexible pavement design as per IRC 37: 2018 and determine its economic benefits. This study aimed at providing an easy estimation of RHA synergizing mechanistic improvement, design optimization, and related economic traits. The scope of this work included the evaluation of improved properties through proctor and CBR tests, pavement design as per IRC 37: 2018, and then economic analysis. The experimental results indicated that an addition of 10% RHA increased the CBR value by 92%. Further, an overall 38 and 42% reduction thickness was observed with the addition of 5 and 10% RHA with 5% lime to the soil, respectively. Economic analysis based on the construction cost of materials showed 42% and 51% reduction when 5% and 10% RHA used along with 5% lime as compared to untreated soil.

Keywords: *Subgrade Stabilization, Rice Husk Ash, Pavement design, Economic analysis*

Paper ID: 45

RUTTING RESISTANCE EVALUATION OF VG-30 MODIFIED WITH WARM MIX ADDITIVES

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Abstract

The present study appraised the effects of three WMA additives viz. Sasobit (wax based), Evotherm (chemical based) and Zycotherm (chemical based) on the rutting performance of asphalt binder. Three dosages of each WMA additive were blended with the neat binder VG-30. The dynamic mechanical analysis was done on all the binder combinations. For the evaluation and comparative study of rut resistance of total 10 binder combinations, criteria such as Superpave Rutting Parameter $G^*/\sin\delta$, Zero Shear Viscosity and Non-recoverable Creep Compliance (Jnr) were considered. The ranking of binders was made based on their performance. Out of the 10 combinations, VG-30 with 3% Sasobit dosage showed the best performance. Ranking of binders helped to establish optimum dosage of Sasobit, Evotherm and Zycotherm as 3%, 0.5% and 0.1% respectively, w.r.t. rutting resistance. Other considerations including cost, are to be considered while deciding effective additive dosage.

Keywords: *Warm Mix Additive, Rutting Resistance, Zero Shear Viscosity and Multiple Stress Creep and Recovery*



Paper ID: 68

DESIGN AND CHARACTERIZATION OF AGGREGATE GRADATIONS EMPLOYED IN OPEN GRADED FRICTION COURSE MIXES

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Abstract

Open-graded friction course (OGFC) is a surface course designed and constructed with high air voids through which surface rain water can be drained out. Gradation plays an important role to achieve the desired OGFC permeability and stone-on-stone contact condition. Bailey's concept has been used for the design and evaluation of aggregate gradations for dense-graded bituminous mixes, however, its use for OGFC mixes still needs to be studied. In this study, twelve different aggregate gradations for OGFC mixes were formulated using different combinations of Bailey ratios. The gradations were then evaluated for existence of stone-on-stone contact condition. A gradation parameter termed critical deviation value was computed for each gradation. OGFC mixes were also fabricated and evaluated for functional evaluation through permeability measurements. Results showed that OGFC mix properties could be also differentiated using the changes in Bailey ratios. All gradations achieved the stone-on-stone contact condition and met the desired permeability.

Keywords: OGFC, aggregate gradation, Bailey method, stone-on-stone contact, permeability

Paper ID: 69

INFLUENCE OF RECYCLED AGGREGATE AND CURING PERIOD ON CEMENT TREATED BASES

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Abstract

Utilization of Recycled Concrete Aggregates (RCA) and Reclaimed Asphalt Pavement (RAP) with stabilization found to be an alternative to Conventional Aggregates (CA). The current study deals with the strength properties of base layers made of CA and recycled material with the variation of the curing period at different cement contents. RCA and RAP were taken as a replacement of CA like 100%, 75%, and 50%. Cement contents were varied as 2%, 4% and 6%. It was observed that RCA mixes have higher Indirect Tensile Strength (ITS) than RAP mixes and ITS models showed the logarithmic variation with the curing period. Further, cement content, recycled aggregate content and curing period significantly influence the ITS of recycled cement-treated bases.

Keywords: Cement treated bases, Indirect tensile strength, Recycled concrete aggregate, Reclaimed asphalt pavement, Curing period



Paper ID: 74

PERFORMANCE EVALUATION AND COMPARATIVE ANALYSIS OF PERVIOUS CONCRETE PAVEMENT USING OVER BURNT BRICK AGGREGATE

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Abstract

The growing demand of infrastructure development has curbed the availability of pavement materials due to over consumption and continuous depletion of natural resources, which is now enforcing the developers to search for an alternate material. In this respect, over burnt brick aggregate (OBBA) can become a sustainable and cost-effective solution. In this study, over burnt bricks are used in pervious concrete pavement (PCP), and the performances of pervious concrete pavement are evaluated. This study mainly provides the comparative analyses of PCP using OBBA and natural stone aggregate (NSA). Laboratory tests are performed in pervious concrete specimens made with both brick and stone aggregates, and the results are then compared to check the feasibility of using OBBA in PCP. It is found that the average values of compressive, tensile and flexural strengths for PCP made with OBBA are about 3.2 times, 1.9 times and 1.2 times higher than their minimum requirements.

Keywords: *Pervious concrete pavement, pavement materials, over burnt brick aggregate*

Paper ID: 85

MIX DESIGN OF ASPHALT MIXES WITH STEEL SLAG AGGREGATES

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Abstract

It has been reported in the literature that the asphalt mixes containing high percentage of Steel Slag Aggregates (SSA) are susceptible to high air void space. This results in limited use of SSA by the road agencies. More void spaces in the asphalt mixes with SSA can be attributed to high specific gravity of the Coarse Aggregate (CA) of SSA and the adoption of weight-based gradation selection for mix design. This issue can be addressed by adopting the volume-based Bailey method. The present paper attempts to provide a framework to design asphalt mixes with a high proportion (up to 100%) of SSA by employing the Bailey method of gradation selection. The present study showed that by adopting the Bailey method for gradation selection, SSA mixes with VMA similar to Natural Aggregate (NA) mixes can be produced despite the significant differences in specific gravity between the fine and coarse aggregate fractions.

Keywords: *Steel Slag Aggregate, Bailey's Method, Volume-based gradation, VMA*



Paper ID: 88

EVALUATION OF FOURIER TRANSFORM INFRARED SPECTROSCOPY INDICES TO EXPLAIN THE RUTTING SUSCEPTIBILITY OF REJUVENATED RECYCLED BLENDS

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Abstract

Rejuvenators used in hot recycling of bituminous mixes increases the incorporation of recycled material in the mix. However, rutting susceptibility of the resulting blend/mix is a major concern. The present study evaluated the rutting susceptibility of rejuvenated recycled blends synthesised for the same target binder property. The study investigated the formation of additional functional groups in the recycled blends due to the doping of rejuvenators using Fourier Transform Infrared spectroscopy. It was found that Ester index (determined between wave number: 1725 cm⁻¹ to 1765 cm⁻¹) correlated well with binder rutting parameters evaluated for the recycled blends.

Keywords: Rejuvenators, RAP, Blending chart, MSCR, FTIR

Paper ID: 89

EVALUATION OF ADEQUACY OF PAVEMENT DESIGN PRACTICE OF USING CBR TO CAPTURE RESILIENT RESPONSES OF LATERITIC SUBGRADE SOIL

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Abstract

The paradigm shift in pavement design is by introducing the instantaneous response of the system in a particular environment. The resilient response of the soil in the subgrade layer under traffic loading is to be captured considering the influence of environmental factors like temperature, moisture and pressure regimes. The present study focuses on the resilient response of eight distinct lateritic subgrade soil at varying moisture conditions. The best constitutive resilient modulus, MR, model that could predict the non-linear stress-strain relationship of the laterite soils was statistically determined. MR at different moisture conditions were determined by multiplying the environmental adjustment factor (Fu) with MR determined at optimum moisture conditions. It was observed that the MR value obtained from MR –CBR empirical relationships does not complement with the experimentally determined MR at different moisture conditions for the selected laterite soils. Thus demanding conceptual modification to accommodate the lateritic soil behaviors.

Keywords: Laterite, Resilient modulus, CBR, Constitutive models, Environmental adjustment factor



Paper ID: 91

OPTIMAL INTERVENTION OF PREVENTIVE MAINTENANCE SELECTION

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Abstract

Preventive maintenance is proposed on pavements that are in structurally good condition. The structural condition could be evaluated from rebound deflection and the functional condition in terms of roughness of the pavement. For the present study, roughness is employed as a performance indicator. The analysis is performed for treatment options of thin Hot Mix Asphalt (HMA) overlay and Do-Nothing. The effectiveness of preventive maintenance is quantified in terms of extended service life and benefit area from the performance curve. It is proposed with mathematical programming using Mixed Integer Linear Programming (MILP) model for the optimal intervention of preventive maintenance and implemented in MS Excel using Excel solver. This will be a tool for the selection of appropriate selection of preventive maintenance strategy for pavement maintenance projects.

Keywords: preventive maintenance, deflection, roughness, optimal intervention, mixed-integer linear programming, service life extension, benefit area

Paper ID: 96

A REVIEW ON IMPROVING PAVEMENT DEFICIENCY METHODS USING ARTIFICIAL INTELLIGENCE

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Abstract

Road pavements usually experience different types of distress because of regular traffic loads, harsh environment, building materials, underscore soil quality, and construction process. Examples of such distresses include longitudinal and transverse cracking, potholes, rutting, and bleeding. These pavement distresses are one of the primary reasons for road accidents. Hence, it is necessary to detect these pavement deficiencies and correct them. Monitoring the pavement condition is mostly carried out manually. Traditional methods for detecting and assessing distress are laborious, time-consuming, and subject to the staff involved in injuries. A system for the automatic identification and evaluation of potholes, cracks, and patches is proposed in this paper. The proposed system automatically detects and quantifies the holes in the road, gaps, and defects using artificial intelligence and various image processing techniques.

Keywords: Pavement distress, Artificial intelligence, Image processing, Cracking, Potholes



Paper ID: 129

EFFECT OF BITUMEN VISCOSITY, SOURCE AND TEMPERATURE ON BITUMEN FOAM CHARACTERISTICS

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Abstract

This paper explores the impact of bitumen viscosity, source and temperature on bitumen foam characteristics. Three types of bitumen, sourced from two different refineries were investigated. The foam characteristics such as Maximum Expansion Ratio (ER_m), Half-Life (HL) and Foam Index (FI) were determined using an automated ultrasonic sensors system. It was noted that the source of the bitumen has more impact on the foam characteristics than the physical properties (viscosity and softening point) of bitumen. However, in general higher viscosity grade bitumen was found to have higher ER_m but less HL than that of the lower viscosity grade bitumen, when they belong to the same source. Study results also indicate that for every bitumen type, there exists an ideal temperature, at which the bitumen gives the optimal quality foam. It was noted that the foam characteristics of softer bitumen are more sensitive to foaming temperature compared to harder bitumen.

Keywords: *Foam characteristics, Physical properties of bitumen, Bitumen viscosity, Source, Temperature*

Paper ID: 131

PAVEMENT OPTIMISATION WITH HEXAGONAL STABILISATION GEOGRIDS – RESEARCH AND CASE STUDIES

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Abstract

This paper presents the research confirming beneficial influence of stabilisation of aggregate base with hexagonal geogrids on pavement life. This leads to possibility of optimising the pavements structure, by reducing its thickness or extending its life. Case studies of projects utilising this concept are presented.

Keywords: *Geogrid, Pavement design, APT*



Paper ID: 135

A REVIEW OF REMOTE SENSING METHODOLOGIES FOR THE PAVEMENT SURFACE ANALYSIS

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Abstract

The condition of road pavement reflects the infrastructure of society. It also has severe impacts on driving comfort and road safety. Thus, pavement conditions must be monitored regularly to detect damaged segments to minimize road hazards. Remote sensing required quick and efficient data collection. It delivers non-destructive methods with a broad spatial range for evaluating road conditions and distress classification. The images collected from satellite, high-resolution cameras, sensors should be analysed for the correlation of surface distress. High multispectral radar images outperformed in terms of accurately detecting surface textures better. The results also reveal that the defects are detected very well with paved and unpaved surfaces separately. The results have been used to mitigate the bad pavement conditions and also unbaled road users to use good road infrastructure with safety and comfort.

Keywords: *Remote Sensing, Road Surface Monitoring, Flexible Pavement, SAR*

Paper ID: 140

CHARACTERIZATION OF RECLAIMED ASPHALT PAVEMENT (RAP) MATERIAL

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Abstract

The aim of the present study is to estimate the Reclaimed Asphalt Pavement (RAP) characteristics with conventional apparatus available at most field laboratories. For this purpose, two tests, namely, the Fragmentation test and Cohesion test proposed by the RILEM TC237-SIB committee for RAP classification for cold mix design, were evaluated. Based on test results, it was observed that the indices derived from the fragmentation test correlated well with bitumen type and difference in percentage (%) of fines in black and white curves. It was also observed that indices derived from the cohesion test correlated well with bitumen content and bitumen type.

Keywords: *Recycling, RAP, Fragmentation test, Cohesion test*



Paper ID: 143

USE OF LOCALLY AVAILABLE OIL TYPE REJUVENATORS FOR ASPHALT RECYCLING

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Abstract

Effective reuse of (reclaimed asphalt pavement) RAP material to produce new hot mix asphalt mixtures, which leads to saving natural resources and reduce the cost of construction. As the incorporation of a higher quantity of the RAP in the bituminous mix prone to fatigue and thermal cracking, it has been a challenge so far. Rejuvenators can restore properties of the original binder. Various research has been undertaken to evaluate the performance of rejuvenators in RAP. Here, two rejuvenators, i.e., Pongamia oil and Polanga oil, have been explored as potential rejuvenators for higher RAP utilization. Rheological properties and Thermal properties were studied by Dynamic Shear Rheometer (DSR) and Thermogravimetric analysis (TGA). It was observed that the addition of these oils considerably increases the workability. Also, these oils not only restored the rheological properties of the RAP binder but also improved the thermal properties of rejuvenated binders.

Keywords: *RAP, Recycling agent, Rheology, TGA*

Paper ID: 145

AN EXPERIMENTAL APPROACH TOWARDS POLYSTYRENE MODIFIED BITUMEN

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Abstract

Waste polystyrene (PS) is a primary part of metropolitan and ocean junk. To dispose this garbage with a conventional method has become a serious matter. The present study investigates the fair use of the waste PS to modify the bitumen as a modifier. The modified bitumen was prepared by adding 2 % waste PS in VG 10 and VG 30 bitumen. The physical properties and storage stability of the modified bitumen was determined and compared with the conventional bitumen. The laboratory results shows that the penetration values reduced by 11% and 20% of modified bitumen and increase in the softening point values shows an improvement in the properties of the modified bitumen with no significant difference in the phase separation even after storage. The application of waste PS merely not improves the performance of bitumen but additionally developed an eco-friendly pavement by recycling the waste.

Keywords: *Waste polystyrene, modified bitumen, storage stability, eco-friendly pavement*



Paper ID: 147

PERFORMANCE CHARACTERISTICS AND EFFECT OF GRADATION ON HOT MIX ASPHALT AND COLD MIX ASPHALT

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Abstract

Hot mix asphalt design is a conventional method for pavement construction. The procedure includes heating of aggregates and bitumen, mixing and compaction. This has satisfied required performance characteristics but since all processes are performed in high temperature which is negatively impacting our environment, high amount of CO₂ emission (increasing carbon footprints). Thus, emulsion based cold mix technology is gaining popularity since it uses bitumen in the form of emulsion. Thus, no heating of bitumen and aggregate is required which will have less energy consumption as well as it will be environment friendly. Aggregates are major constituents of asphalt pavement. Gradation is one of the important characteristics of aggregates affecting the performance of hot mix asphalt and cold mix asphalt. Thus, the objective of this study is to evaluate the impact of aggregate gradation variations on the performance of Cold mix asphalt and Hot mix asphalt in terms of Marshall parameters.

Keywords: *Hot mix design, Cold mix design, Bitumen, Bitumen emulsion, Marshall stability*

Paper ID: 151

INVESTIGATIONS ON INFRARED LIGHT-INDUCED HEALING OF BITUMINOUS MIXTURES

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Abstract

Healing of fatigue damage in asphalt pavements is of considerable research importance as it is expected to increase the serviceable life of the pavement. Efforts have been made by a few researchers to increase the temperature of the mix by heating and studying the healing ability of bituminous mixes. Taking this idea, present research was taken up to study the Infrared light induced healing ability of the hot mix asphalt (HMA) and warm mix asphalt (WMA) mixes by considering the factors such as power of radiation, clear distance, and time of heating. The healing ability of mixes was evaluated by conducting an indirect tensile strength test before and after healing. Results indicated the prominent effect of the factors in designing the infrared heating system and also the healing ability of WMA is significantly higher than the HMA.

Keywords: *Warm Mix Asphalt, Sasobit, Indirect Tensile Strength Test, Infrared Heating and Healing*



DEEP NEURAL NETWORK BASED ROAD ROUGHNESS PREDICTION MODEL

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Abstract

Performance prediction is one of the crucial processes in decision making on pavement maintenance activities using historical data. Roughness has been widely used for performance prediction as it is a measure of ride comfort. The objective of this research study was to develop a prediction model for roughness using regression analysis and deep learning techniques for the data obtained from the USA-based long-term pavement performance database, which was further used to apply for pavement sections in India. Data related to age, maintenance, climate, traffic and pavement distress, profile, and deflection for the State of Illinois (USA) were used to develop the distress prediction models. Models developed using neural-network techniques were found to be more robust, accurate, and all the extrinsic and intrinsic parameters affecting a pavement were used so the model could also be used for pavements at locations other than the ones used in this study.

Keywords: *Road Roughness, Prediction Model, Deep Learning, Pavement Asset Management System*



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TRACK IV: SUSTAINABLE LAND USE **TRANSPORT PLANNING**



Paper ID: 8

**CONTINUITY AND CHANGE IN URBAN TRANSPORT DEVELOPMENT ARENA
- A CASE OF INDORE**

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Abstract

The existing city's structure and transportation conditions are directly linked to past transport policies and decisions of policymakers. Indore, rapidly urbanizing most populous city of Central India is struggling with an increase in the demand for mobility, leading to collateral issues like accidents, pollution, congestion, and delays. It has been observed that the continuity in the emergence of national policies and continued efforts for improving public transport played an important role in pushing the transport development trajectory towards sustainability. But the dynamics of sustainability is multi-layered and is affected by the decisions and perceptions of actors-policy makers, administrators, NGOs, media, citizens, institutions, and politicians. This research intends to provide a conceptual theoretical model that explain the role of policies, institutions, and actors in influencing change and continuity in transport development trajectories and analyse the direction of change with respect to sustainable transportation by taking a case of Indore.

Keywords: *Transport development trajectory, Path dependency, Coalitions, Window of opportunity, Sustainable transportation*

Paper ID: 54

**TRANSPORT DISADVANTAGE: UNDERSTANDING AGEING AND MOBILITY IN THE
PERIPHERAL BENGALURU**

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Abstract

Older adults in cities of developing countries such as India suffer from inaccessible and unaffordable transport systems. Transport disadvantages emerge from multiple socio-economic inequities and exclusionary transport infrastructure. This paper uses a mixed-methods approach to use geo-spatial mapping of physical infrastructure and ethnographic detailing of user-experience. The knowledge emerging from this synthesis is used to build stronger evidence of transport barriers experienced by older adults. The study's findings show that older adults' mobility suffers due to the unaffordability of intermediary transport, inaccessibility of public transport and inability to own and use private transport. The lack of a support system and poor implementation of universal design has devoid them of safe and accessible transportation. The paper provides context-specific research-based evidence for streamlining urban transport planning and eventuating into an inclusive city.

Keywords: *Mobility, Urban transport, Ageing, Transport disadvantage and India*



Paper ID: 109

EVALUATION OF USER PERCEIVED PUBLIC BUS SERVICE RELIABILITY BASED ON HEADWAY DEVIATION APPROACH: A CASE STUDY

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Abstract

The city public buses in a developing country is one of the most utilized forms of public transport for daily work trips. The punctuality of the bus users is mostly dependent on their perception and judgment of the service reliability. So, the present study aims to incorporate the bus users' perception in terms of expected waiting time (EWT) in evaluating the service reliability of buses based on the headway deviation approach. This approach is applied along a bus service route in Kolkata, India during the morning peak hours and the stop level reliability along the route is evaluated. It was found that the perceived reliability of the daily passengers depends on their trip length and trip importance. The variation of the trip reliability in the two directions is found to be statistically significantly different. This variation is dependent on the speed and link characteristics between two successive bus stops.

Keywords: *Public Bus Reliability, Headway Deviation, User Perception, Waiting Time*

Paper ID: 127

THE FACTORS AFFECTING INDIAN ROAD USER PREFERENCES FOR ADOPTING THE ELECTRIC TWO-WHEELER

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Abstract

Electric vehicles (EVs) can be the best alternative to fossil fuel-based vehicles because of its significant environmental benefits and use of renewable energy sources. A questionnaire survey-based study was conducted among the Indian road users to identify the significant factors for choosing two-wheeler and user willingness for mode shift from fuel-based two-wheeler (F-TW) to electric two-wheelers (E-TW). Binary logit and two machine learning models, namely the k-Nearest Neighbor (kNN) and Random Forest (RF) was developed to predict mode shift behaviour. The study result shows that easy to ride nature of TW, low maintenance cost, fast commuting are the major, and fuel efficiency is the minor significant factor for selecting two-wheeler as travel mode. Also, RF model gives better predictive accuracy than the other two models, and the result is consistent with the other researchers.

Keywords: *Electric vehicle, Mode shift, Random forest, Logit model, Questionnaire survey*



Paper ID: 137

HOUSING TENURE AND VEHICLE OWNERSHIP: A CASE STUDY OF HUBLI-DHARWAD TWIN CITIES

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Abstract

Housing tenure is long-term decision and affects both short-and long-term mobility choices. The correlation among housing tenure, socio-demographic, built environment characteristics and vehicle ownership is of interest to transportation planners. Quasi-longitudinal data collected in Hubli-Dharwad (twin cities), and the application of multinomial logit model to investigate the changes in housing tenure choices and vehicle ownership levels as a function of changes in socio-demographics, built environment and travel attitudes is discussed. The interaction between housing tenure choices and vehicle ownership decisions is observed by incorporating changes in vehicle ownership level as the independent variable in housing tenure choice model and vice-versa. It is expected that changes in socio-demographic characteristics like household income, number of married individuals and children are important factors associated in the estimated models. The change in household head's job status is found to have significant impacts on the decision regarding changes in vehicle ownership level and housing tenure.

Keywords: *Twin Cities, Vehicle Ownership, Housing Tenure*

Paper ID: 171

ASSESSING LAST-MILE CONNECTIVITY AROUND METRO STATIONS: A CASE OF MUMBAI

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Abstract

Mumbai, the financial capital of India, faces congestion issues and decline in public transport share, despite a robust public transportation network of many modes. One way of attracting the users of private modes to mass transit is to improve the last-mile connectivity. However, this aspect has not received much attention in Indian cities. In this research, MNL model is developed to predict the choice of access mode of the commuters residing in the transit catchment area of the upcoming Metro stations in Mumbai. For this study, a survey of 450 commuters was conducted and data was collected through a Revealed Preference and Stated Preference survey. Results implies that after the introduction of metro, the probability to use IPT modes for access increases by 18% and that of private vehicle increases by 11%. There was no significant impact of access cost and quality of infrastructure on access mode choice.

Keywords: *Last mile connectivity, Access mode choice, Multinomial logit model, Commuter behavior*



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TRACK V: TRAFFIC MANAGEMENT, OPERATIONS, AND SAFETY



Paper ID: 7

INTEGRATION OF METRO WITH OTHER MODES OF TRANSPORT - CUSTOMER SATISFACTION: A CASE OF DELHI

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Abstract

Urban transportation planning has been a complex problem due to its interdependences between the service and user behaviour. Despite of having multiple public transport modes, the lack of coordination among services has increased difficulties for modes to provide adequate transfer facility for the commuters. This paper is directed to identify the factors that influence user satisfaction in Delhi. For assessing user's perceptions, Importance Satisfaction Analysis and Structural Equation Modelling are used to identify the factors that have significant impact on user's satisfaction and areas which needs to be improved for enhancing the quality of service. The result shows that Safety/Security, Services and Accessibility are the most important areas which needs to be improved as Reliability have significant impact on user's satisfaction. In conclusion, the paper identifies integration as important tool for increasing patronage of public transports in Delhi. Due to inadequate transfers facility, the impact of integration remains less effective.

Keywords: *Delhi Public Transport, User Perception, User Satisfaction, Importance Satisfaction Analysis, Structural Equation Modelling*

Paper ID: 16

EVALUATION OF DRIVING ATTITUDES OF UNIVERSITY BUS DRIVERS IN OMAN

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Abstract

The safety of students in Oman has remained a big concern for the parents as every year many students died and injured in road accidents. Sometimes the students sustain major injuries that result in their disability. These accidents are mainly happened due to poor driving behavior and vehicle conditions. This paper attempts to explore the attitudes of bus drivers of educational institutes with the help of a questionnaire survey. The secondary data was also collected related to accidents of educational transport. Descriptive statistics were prepared in terms of qualitative and quantitative data. Common factors of causing accidents included a collision with other vehicles, driver's inattention, and mental stress, vehicle physical condition, and wrong overtaking. Driver's speeding attitudes and cell-phone addiction and safety aspects of bus service are underlying factors of driver's propensity to be involved in an accident. Some safety policies were derived from significant factors.

Keywords: *Traffic safety, Accident, Oman, Drivers behaviour*



Paper ID: 20

CAPACITY ANALYSIS OF UNSIGNALIZED INTERSECTION BY DIFFERENT METHODS

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Abstract

Intersection is an important component of a traffic network. It is a place where two or more roads meet. Traffic conflicts occur when two or more roads cross each other due to competition for right of way by vehicles for the same area at the same time. To prevent these conflicts, the intersection should have enough capacity and proper geometry along with traffic control. An unsignalized intersection is an intersection without signal or manual control. Unsignalized intersections are used when there is a low volume traffic flow. Due to weak enforcement of traffic regulations and lack of understanding of lane discipline among road users in India, traffic congestion, reduction in speed and accidents occur. In the present study a four arm unsignalized intersection was taken in Bangalore city and was analyzed using three different standards (IRC SP 41, Indo-HCM and HCM) to evaluate the operational conditions.

Keywords: *Intersection, Capacity, Delay, Level of Service*

Paper ID: 21

AN APPROACH TO FIND DRIVER BEHAVIOUR OF AUTO RICKSHAW THROUGH PSYCHOLOGICAL TESTS

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Abstract

A driver behaviour is the set of actions that a person performs while driving. It is the main factor influencing accidents. In this project attempt was made to investigate the psychological factors such as, Driver vengeance questionnaire, Narcissistic personality inventory, Impulsivity questionnaire, Reaction time test and memory test. To carry out the study on psychological analysis, the data has been collected by questionnaire survey. A sample of 400 drivers, face to face surveys were taken in this study. From the results it has been found that, vengeance, narcissism and impulsiveness of young age drivers are more than middle age and old age drivers. Young age drivers react more quickly than middle age & old age drivers and memory of young age drivers are more than middle age and old age drivers. The average reaction time of young drivers was found to be 0.30s, middle aged 0.38s and old aged 0.58s.

Keywords: *Vengeance, Impulsivity, Narcissism, Reaction time, Memory test*



Paper ID: 23

**PROACTIVE EVALUATION OF TRAFFIC SAFETY IN UNSIGNALIZED INTERSECTION
USING SURROGATE SAFETY MEASURES**

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Abstract

Road safety has become a major concern for developing countries like India. Due to the rising population, its infrastructure is becoming unable to cope up with the increasing traffic volume. The analyses have been carried out with the help of Surrogate Safety Measures (SSM) instead of accident data. Further, unsignalized intersections pose more danger due to unruly driving behaviour. In this study, Post Encroachment Time (PET) was chosen as the indicator for the evaluation. Unsignalized intersections were studied and found that average PET values were lower which denotes a higher probability of accidents to occur. Critical conflicts were found by comparing the velocity of the following vehicle with a threshold velocity. The percentage of critical conflicts was found to be high which makes the intersections unsafe.

Keywords: *Traffic Safety Evaluation, Surrogate Safety Measures, PET, Unsignalized Intersection*

Paper ID: 26

**AUTOMOBILE LEVEL OF SERVICE ANALYSIS OF HETEROGENEOUS URBAN CORRIDORS
USING AN ANDROID APPLICATION**

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Abstract

Level of Service (LOS) is a performance measure which describes the quality of traffic operations on a transportation facility with specified traffic, road and control conditions. Highway Capacity Manual 2010 has introduced the Multimodal LOS analysis for homogeneous urban roads. However, the developing countries like India do not have a specified methodology to analyse the ALOS (Automobile Level of Service). Hence, this study focuses on the development of ALOS criteria for heterogeneous urban corridors. Motorised Two-wheelers, Three-wheelers, and Cars were the three different modes of automobiles considered for this study. The criteria was developed for two-lane two-way and four-lane divided urban corridors with un-signalised intersections. The threshold values were estimated using K-means clustering technique. An android application was developed using the open-source mobile development framework 'Apache Cordova', with the Speed Ratio models and criterion values. This application will help the government officials to analyse the quality of existing urban corridors.

Keywords: *Android application, Automobile Level of Service, K-means clustering*



Paper ID: 30

**PSYCHOLOGICAL PROFILE OF TWO – WHEELER DRIVERS IN MIXED TRAFFIC
CONDITIONS**

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Abstract

The frightening increase in the death rate of two – wheeler drivers has been a great concern globally. This study is undertaken to find the psychological profile of two - wheeler drivers by carrying out questionnaire survey. Questionnaire survey includes, Driver vengeance questionnaire, Narcissistic personality inventory, Impulsivity questionnaire, Reaction time test and memory test. A sample of 400 drivers, face to face surveys were taken in this study. From the results it has been found that, vengeance and narcissism of young drivers is more than middle and old age drivers. Male young age drivers are more impulsive than middle and old age drivers & female middle age drivers are more impulsive than young and old age drivers. Both male and female young age drivers react more quickly than middle & old age drivers. Memory of both male & female young age drivers are more than middle and old age drivers.

Keywords: *Psychological profile, Impulsiveness, Narcissistic, Reaction time, Memory test*

Paper ID: 33

MODELLING OF ACCELERATION NOISE BASED ON ROAD GEOMETRICS

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Abstract

Acceleration noise is a measure of traffic turbulence, defined as the standard deviations of accelerations of a vehicle calculated under nominally uniform operating conditions. Acceleration noise is characterized by traffic congestion, road alignment, road side friction and pavement surface conditions. Total acceleration noise is the sum of acceleration noise due to traffic congestion and the acceleration noise due to the remaining factors, which is termed as natural acceleration noise. In this paper, modelling of acceleration noise is carried out. Two lane roads are considered for the study, as the effect of opposing vehicles can be seen only in two lane undivided carriageways. The model developed proved to be effective in determining acceleration noise provided, the values of independent variables are known.

Keywords: *Acceleration Noise, Horizontal Curves, Two Lane Roads*



Paper ID: 39

IDENTIFICATION OF ACCIDENT BLACKSPOTS AT HORIZONTAL CURVES BASED ON JERKS

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Abstract

Blackspot is the location on the road where the crashes occur frequently. Crash is not a 'random event' and occur due to various factors. This study presents the various factors that influence the crashes and various pro-active methods for identification of blackspots. The study is done by analysing the collected data from the field (horizontal curves) for identifying the jerks. The curves with linear jerk value more than 9.9 m/s³ in magnitude is considered as critical curve. For selected set of critical curves, site reconnaissance survey and geometric survey has been done to get essential details from which existing factors can be evaluated. The collected data is analysed to identify the possible blackspots. Cost effective improvement techniques and enforcement policies like speed control measures are proposed. From the study it has been inferred that curves with less radius are more prone to crashes in terms of both crash-frequency and crash-severity.

Keywords: *Pro-active technique, Blackspot, Lateral and Linear Jerk, Critical Curve*

Paper ID: 41

A SURROGATE SAFETY FRAMEWORK INCORPORATING THE SURROUNDING VEHICLES

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Abstract

The study aimed to understand the vehicle safety of heterogeneous (mixed) and homogenous traffic flow over road midblock. In addressing the limitations of existing safety frameworks, the paper proposes a new safety framework that includes the collision instincts caused by the surrounding vehicles using the conventional time-to-collision (TTC) measure. An automated trajectory data tool is developed using advanced image processing concepts to generate trajectory data over the study sections. In the proposed framework, the lateral movement of vehicles is accurately modeled using deep learning. Further, the proposed framework is tested using the developed trajectory datasets. The results show that, in mixed traffic, the collision points occur over the entire study section. In the case of homogeneous traffic, the collision instincts are clustered toward the median lanes. With advanced technologies, trajectory data can be implemented in real-time within the proposed safety framework.

Keywords: *Traffic safety, Trajectory data, Time-to-collision, Mixed traffic and Homogeneous traffic*



Paper ID: 44

**DEVELOPMENT OF AUTOMOBILE LEVEL OF SERVICE CRITERIA FOR THE
URBAN CORRIDORS WITH HETEROGENEOUS TRAFFIC**

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Abstract

This paper focuses on the development of the Automobile Level of Service (ALOS) criteria for the heterogeneous four-lane divided urban corridors in Bangalore, India, considering the maneuverability of automobiles. The speed profiles of the motorised two-wheelers were collected from the study corridors using the GPS based mobile application. From speed profile data, speed and time variation characteristics were studied in detail. Microscopic parameters influencing the quality of travel were identified as speed ratio (SR), coefficient of variation of speed (CV) and, congestion index (CI). Many cluster analyses were performed to define the threshold values of ALOS classes, and K-means clustering technique gave the best result. Six specific classes were identified and validated with silhouette coefficient values. The criterion values predicted for heterogeneous traffic conditions were significantly different from the values given in HCM 2016 and Indo-HCM 2017.

Keywords: *Automobile level of service, Urban corridor, K-means clustering and Silhouette measure*

Paper ID: 46

SAFETY IMPACT ANALYSIS OF LANE CONVERSION ON SELECTED HIGHWAY CORRIDOR

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Abstract

In this study the safety impact analysis of a widened corridor stretch of NH 66 is carried out. A before and after black spot analysis was carried out using ARC MAP 10.6 to identify significant hotspots using spatial joining and Getis Ord analysis. The actual method of proposed before and after Empirical Bayes analysis was not fully able to proceed with since due to lack of over dispersed data and lack of control section dataset. In that context two separate Poisson regression models were formulated for weighted sum of fatal and grievous accidents for both pre lane widening as well as post lane widening conditions. Weighted sum of accidents showed significant relationship with AADT value and black spot segment length in both models. A 40 to 50 % reduction of crash estimate was found from the lane conversion at a selected AADT range.

Keywords: *Black Spot Analysis, Empirical Bayes Analysis, Lane Conversion, Post Lane Widening Model, Pre Lane Widening Model*



Paper ID: 49

PASSENGER CAR UNITS (PCUS) OF VEHICLES ON TWO-LANE HIGHWAY SECTIONS WITH HORIZONTAL CURVES AND TANGENT GRADES

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Abstract

Traffic flow behaviour under heterogeneous traffic conditions is a complex phenomenon where vehicles of different static and dynamic characteristics ply on the same road without following lane discipline. Therefore, traffic volume expressed as vehicle per hour will not give an accurate estimation. This problem can be addressed by finding the equivalent value of the vehicle types in terms of the passenger car called as Passenger Car Unit (PCU). Although, PCU is deemed sensitive to roadway and traffic characteristics, advancement in study of its dynamic characteristics is predominantly on straight and plain terrain. The present study aimed to study the effect of geometric design elements like radius of horizontal curve, gradient, shoulder width and traffic volume on PCU to establish relations for determining PCU of various vehicle types on two-lane roads using regression analysis. It is found that PCU value increases significantly with increase in gradient and radius of horizontal curve.

Keywords: *Passenger Car Unit, Geometric Design Elements and Two-lane roads*

Paper ID: 60

DOES THE CROSSING TIME OF PEDESTRIAN IS SAME FOR ALL ROAD CROSSING PATTERNS? – A STUDY AT MID-BLOCK

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Abstract

This paper attempt to study the road crossing time of pedestrians due to change in road crossing pattern. The crossing distance is different from the actual road width, while the pedestrian follows an irregular crossing pattern. So, the speed calculated by fixed road width results in reporting a false speed because of varying crossing distance of pedestrians. To overcome the issue a crossing speed of 1.2m/s is assumed and the crossing time is calculated for given road width. This crossing time is considered to be a base reference crossing time, and the actual crossing time of each pedestrian is compared with the base crossing time (High/Low). The crossing time "High/Low" has been estimated using a binary logit model with a prediction accuracy of 69.7%. The increase in path change and number of stages result in higher crossing time resulting in more traffic exposure.

Keywords: *Pedestrian, Midblock, Road crossing pattern and Crossing time*



Paper ID: 64

EVALUATION OF THE EFFECTIVENESS OF TRAFFIC CALMING MEASURES

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Abstract

The main objective of this research is to evaluate the effectiveness of various traffic calming measures on achieving their predetermined objectives. The first stage focused on the influence of measures like Speed table, Rumble strips, Road studs and Lane narrowing implemented in isolation under same conditions, on the speed of unimpeded vehicles has been investigated by evaluating differences in speed profiles of individual vehicles. Their effect on safety was assessed by comparing the accident data before and after installation of these measures. The second stage measured the operating speeds of vehicles passing through successive measures using a GPS based mobile application, Speedometer in 2 seconds interval to have an insight on the relationship between spacing and speed. The raw speed data were analyzed and formed significant relationships which formed the basis of a multiple linear regression model for the speed profile of unimpeded vehicles in a given traffic calmed link.

Keywords: *Unimpeded vehicles, Speed profiles, GPS Speedometer, Traffic calmed link*

Paper ID: 65

COMPARATIVE ASSESSMENT OF JOURNEY TIME, SPEED AND DELAY CHARACTERISTICS OF HDBRTS AND HETEROGENEOUS TRAFFIC: CASE STUDY ON SPEED AND DELAY METHOD

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Abstract

BRTS advantages are manifolds by saving travel time, good speed, comfort, and cost-effectiveness. Meanwhile, its operation will get disturbed, mainly when there is interference with heterogeneous traffic even though small stretch and delays caused at the stations. The study comprises, analysis of the actual travel time, free-flow speed, running and journey speed, and various delays caused to the operation of the Hubli-Dharwad Bus Rapid Transit System (hybrid system) in comparison with moving car on the heterogeneous traffic lane. For the purpose speed and delay study by moving car method was considered. The study observed that there is a positive effect of the dedicated corridor on the BRTS operation as running speed is very near to the free-flow speed. Station and congestion delays on the non-dedicated lane are the primary cause for total delays happening for BRTS operation.

Keywords: *Bus Rapid Transit System, Journey Speed, Running Speed, Travel Time*



Paper ID: 66

IDENTIFYING ZONE OF INFLUENCE USING DRIVING CYCLES AT TOLL PLAZAS UNDER MIXED TRAFFIC CONDITIONS

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Abstract

Zone of influence (ZOI) is the region in the close proximity of any facility such as intersections, toll plazas etc. in which the speed-profile/driving-cycle gets affected. This ZOI is an important parameter for studying traffic operations, safety and emission estimation. Hence, the present study is undertaken to give a proper methodology for estimation of ZOI using driving cycle from real field data at toll plazas. The instantaneous data of driving cycle for seven categories of vehicles are taken with the help of performance-box instrument. Moreover, Manual Toll Collection (MTC) and now implementation of Electronic Toll Collection (ETC) system also called FASTag, are two common methods of toll collection in India. The results showed that the vehicle starts decelerating from its mainstream speed, before the minimum distance of 50m and maximum of 240m for MTC lane and a minimum of 111.03m and maximum of 201.50m for ETC lane.

Keywords: Toll plaza, Zone of Influence, Driving cycle, Mixed traffic

Paper ID: 75

MODELLING AGGRESSIVE CLEARING BEHAVIOUR OF RIGHT TURNING DRIVERS AT UNSIGNALIZED INTERSECTIONS

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Abstract

Aggressive behaviour of drivers at unsignalized intersections makes vehicular movements very complex and compromises the safety. This study attempts to understand the aggressive clearing behaviour of drivers and the reason for behaviour. Four unsignalized intersections have been considered in this study, and the results show that speed of the major road vehicles is the only factor which influences the aggressive clearing of right turning vehicles. 'Critical speed' has been proposed in this study which is the minimum speed major road vehicles should maintain, so that the right turning vehicles will not risk clearing the intersection aggressively.

Keywords: unsignalized intersections, aggressive clearing behaviour, mixed traffic



Paper ID: 77

EXAMINING INDUCED FUZZINESS IN DRIVERS' PERCEPTION TO DETERMINE URBAN STREET LEVEL OF SERVICE

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Abstract

The conventional methods of determining level of service states that, for any decision a discrete output should be given. Nevertheless, transportation facilities and the problems form a complex system need to be more subjective, descriptive, and deductive. Therefore, this paves a way for fuzzy logic to be fit here as an overcoming of the above limitations. This study is focused on identifying primary factors influencing automobile users and predict LOS of investigated road segments from drivers' perspective. The proposed model development process also emphasized on the determination of Automobile level of service (ALOS) with the application of a suitable Fuzzy inference system. It was concluded that most of the segments have ALOS belonging to category B, C, D or below, which have vital issues related to the provided service quality. This study can be helpful for the transportation administrators to design a sustainable transportation infrastructure in Indian mixed traffic conditions.

Keywords: *Drivers' perception, Automobile mode, Level of service, Fuzzy inference system, Mixed traffic flow condition*

Paper ID: 81

ANALYSIS OF TIME HEADWAY DISTRIBUTIONS ON MULTI-LANE HIGHWAYS CONSIDERING PASSENGER CAR-HEAVY VEHICLE INTERACTION

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Abstract

The time headway of vehicles is crucial for rural infrastructure design, traffic control, and management. It varies by different leading and following vehicle types on multi-lane highways under mixed traffic conditions. This paper attempts to analyze the theoretical time headway distributions for different patterns of vehicle leader-follower interaction on a multi-lane highway in India. The time headway of the traffic is collected using infra-red sensor-based technology. The best-fitted probability distribution function for different leader-follower vehicle patterns, which include a passenger car (PC) and a heavy vehicle (HV), was estimated by using the maximum-likelihood estimation, Kolmogorov-Smirnov (K-S) test. The results showed that the time headway for PC-PC, HV-HV, PC-HV, and HV-PC are significantly different from each other. The results from this study can be useful in many traffic analytical and microscopic simulation models as an input to generate more accurate and reliable traffic models.

Keywords: *Time Headway, Multi-lane Highways, Passenger Car, Heavy Vehicle and Infra-Red Sensor*



Paper ID: 84

EVALUATION OF URBAN UNCONTROLLED INTERSECTIONS THROUGH CAPACITY AND LEVEL OF SERVICE ASSESSMENT

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Abstract

Ten uncontrolled intersections with four-lane divided major roads (5 nos. three-legged and 5 nos. four-legged) from urban regions of India were chosen for this purpose, thus, having a total of 24 movement/potential capacities (5 nos. three-legged = 5 X 6 = 30 & 5 no. four-legged = 5 X 12 = 60). EMCAP model was created using SPSS and then validated after training adjustment factors in the adaptive neuro-fuzzy inference (ANFIS) tool keeping GAP capacities as base values. The difference in normalized mean absolute normalized errors (MANE) for volume to capacity (v/c) ratios for all ten intersections during comparison of ACF and EMCAP with respect to GAP indicates that ACF (i.e. MANEGAP-ACF = 3.13% < MANEGAP-EMCAP=4.85%) is more appropriate in estimating capacity appropriately whereas EMCAP is more relevant in predicting the level of service (with v/c ratios being >0.80 operating under LOS E) than GAP.

Keywords: Capacity, Level of service, Evaluation and Uncontrolled intersections

Paper ID: 86

FACTORS INFLUENCING PEDESTRIAN WALKING SPEED AND SAFETY MARGIN AT SIGNALIZED INTERSECTION CROSSWALKS

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Abstract

The present study investigated factors associated with pedestrian crossing speed and safety margin at intersection crosswalks. Two ordinary least square regression model were estimated, one for crossing speed and another for safety margin. Crossing speed model estimates highlighted that pedestrian gender, age, group size and luggage significantly influence crossing speed at signalised crosswalks. Additionally, investigation on safety margin showed that group size, approaching vehicle's direction, and vehicle size influence the gap selection decision process of the pedestrian. Frequent traffic glance behaviour associated with reduced crossing speed and adopted gap size as well. The results could provide vital information for planners and traffic engineers.

Keywords: Road Crossing, Safety Margin, Crossing Speed, Risk-Taking, Glance



Paper ID: 92

URBAN ARTERIALS VS FREEWAYS: A COMPARATIVE EVALUATION USING TRAVEL TIME RELIABILITY MEASURES

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Abstract

This research compares travel time reliability (TTR) between urban arterials and freeways in the central business district (CBD) and urban areas of the city of Charlotte, North Carolina. Based on the comparison at similar levels of congestion, a significant difference in TTR between urban arterials and freeways was noted. Therefore, TTR measures at similar levels of congestion were grouped to signify different levels of reliability (LOR). The developed LOR facilitated a comparison of TTR between urban arterials and freeways at similar levels of congestion. The observations revealed that for weekdays during peak hours, the urban arterials in both CBD and urban areas are more reliable compared to the freeways. However, both, the urban arterials and freeways are reliable during morning peak and off-peak hours during the weekends.

Keywords: Travel time reliability (TTR), Urban arterials, Freeways, Level of reliability (LOR)

Paper ID: 93

BEHAVIOUR OF DRIVERS TOWARDS VEHICLE IDLING AT SIGNALIZED INTERSECTIONS

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Abstract

Vehicle idling is very common at controlled traffic intersections, thus resulting in unnecessary fuel consumption and increase in exhaust emissions. On encountering a traffic signal, drivers are in dilemma for turning-off the engine or keeping it on while waiting for the signal to turn green. The present study analyses the heterogeneity in the idling behaviour at signalized intersections for Indian traffic conditions and identify the factors for drivers' ignorance, lack of motivation to reduce/stop idling. An estimate of fuel wasted per person per trip is also provided to demonstrate the extent of the problem. The results indicate that position of the vehicle in the queue and level of congestion are primary reasons which are impacting the decision of turning-off the engine. A large number of respondents (74%) are willing to use an app/ system which assist in providing a dynamic, vehicle-specific threshold value for turning-off the engine.

Keywords: Vehicle Idling, Fuel Consumption, Emissions, Idling Behaviour, Intersections



Paper ID: 102

SURROGATE SAFETY ASSESSMENT OF VEHICULAR CONFLICTS AT LANE DROPS

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Abstract

Safety analysis using conventional method is based on several years of crash data to understand the trend of the road crashes and factors affecting it. However, in a developing country like India, reliability and accuracy of the available accident data are highly questionable. Hence Surrogate safety measures (SSMs) can be used which serves as near-crash indicators to measure spatial and temporal proximity of road users. As an alternative to crash risk estimation based on limited crash data, SSMs can be used as a measure of severity and frequency of traffic conflict events. In this study Deceleration Rate to Avoid Crash (DRAC) was used to evaluate how spatially and temporally close the vehicle-vehicle conflict is to a collision. This study investigates the scope of application of Deceleration based SSMs in the analysis of vehicle – vehicle conflicts at lane drop locations.

Keywords: *Deceleration rate to avoid crash, surrogate safety measure, conflicts*

Paper ID: 103

ASSESSMENT OF PROTECTED AND UNPROTECTED CROSSWALKS USING SURROGATE SAFETY MEASURES

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Abstract

Pedestrians are the most vulnerable road users and they are more susceptible to conflicts at midblock crosswalk locations. They exhibit higher risk-taking behaviour while crossing the road and the decision making behaviour of pedestrians at unprotected crosswalks are more crucial than that at protected crosswalks. In this study, data were collected from four different locations of Trivandrum city which includes both protected and unprotected crossings. Crossing behaviour of pedestrians for both crosswalks are compared by analysing different characteristics such as gap acceptance , surrogate safety measure in terms of post encroachment time (PET), waiting time, crossing time, walking speed of pedestrians, critical gap value etc. Multiple linear regression technique was used to develop gap acceptance models. The study also proposes new pedestrian level of safety (PLS) criteria for crossings based on PET value which describes how the pedestrian is safe at crosswalks.

Keywords: *Crosswalks, surrogate safety, post encroachment time, pedestrian level of safety*



Paper ID: 107

REVIEW OF STUDIES ON CRASH MITIGATION MEASURES AT SIGNALIZED INTERSECTIONS

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Abstract

Worldwide, Road traffic accidents are taking the lives of millions of people annually. Improper design of signalized intersections without considering the safety factors increase the probability of crashes. This study endeavors to provide an in-depth look into identifying those factors, emphasizing area objectives and strategies, selecting the most precise methodology in identifying and ranking the hazardous locations in developed and developing countries by considering budget constraints and preventing the wrong identification of sites for improvements. Literature reviews show that these roadway locations' complexity and potential safety problems are due to plenty of factors such as signal design, junction's geometry, operation, vehicle, human factors, etc. The limited research throughout low-income countries made us focus on those regions, as the frequency and severity of collisions are more than in developed countries. Furthermore, along with many suggested solutions from different researchers, gaps for future research in developing countries are listed.

Keywords: *Safety Issues, Signalized Intersection, PSI, Empirical Bayes, Benefit-Cost ratio*

Paper ID: 108

ASSESSING THE PREVALENCE RATE OF SELF REPORTED HELMET USAGE IN CALICUT

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Abstract

India has a high burden of fatal Road Traffic Injuries (RTI). A large proportion of fatal RTIs in India is among Motorised Two-Wheelers (MTW). MTW crashes result from a variety of behavioral factors such as driving experience, speed at which riders travel, etc. To reduce the number of fatalities, motor vehicle laws are mandating the use of helmet across many countries. To understand the user's perception and opinion of helmet use, many surveys are being conducted, including questionnaire surveys. In the earlier studies, it is reported that there is self-bias in the questionnaire survey, which leads to over-reporting, which distorts the result. A question asking "Do you always wear a helmet?" helps us in identifying the over reporters. The objectives of this study are to assess helmet usage by comparing observed and self-reported use through videographic and questionnaire surveys, and to identify factors influencing helmet usage in Calicut, Kerala, India.

Keywords: *Motorised Two-Wheeler, Questionnaire survey, Helmet, Self-bias, Over-reporters*



Paper ID: 110

A CRITICAL REVIEW ON GLOBAL WARRANTS OF GRADE SEPARATED PEDESTRIAN CROSSING FACILITIES

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Abstract

Vehicle-Pedestrians crashes are one of the frequent road accident types. Despite many At-grade facilities like zebra crossings and separate pedestrian phase signal, accident rate is uncontrollable. Grade Separated Pedestrian Crossing Facilities (GSPCF) includes Foot Over Bridge (FOB), Subway & Hump Subway. These facilities not only minimize the accident rate but also the delays of both the users (vehicle & Pedestrian). But globally, the warrants of GSPCF are hardly considered. This paper examines the literature on GSPCF around the world. The discussion highlights the limitations associated with existing guidelines and the need to develop the new warrants of GSPCF.

Keywords: *Pedestrian crossing Warrants (PCW), Grade Separated Pedestrian Crossing Facilities, Global practices*

Paper ID: 111

INVESTIGATING THE EFFECT OF CONSTRUCTION WORK-ZONE ON REAR-END CONFLICTS BY VEHICLE TYPE FOR VARYING TRAFFIC FLOW CONDITIONS

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Abstract

The present study investigates the effect of construction work-zone on the rear conflicts. Data is collected on Western Expressway for work zone (2-lane closure) and without work zone sections. Vehicular trajectories for three flow levels (free-flow, near capacity, and congested conditions) are extracted using a semi-automated tool. Using the trajectory data, leader-follower pairs are identified. The rear end conflicts for both work and without work zone section are analysed by vehicle type and volume level and compared. Observations revealed a higher conflict probability for without work-zone section compared to work zone section. Investigations revealed that smaller size vehicles (motorized two-wheeler and motorized three wheelers) have significant implication on safety of traffic stream.

Keywords: *Work-Zone, Rear-end conflicts, Time to Collision (TTC), Deceleration Rate to Avoid Collision (DRAC)*



Paper ID: 112

APPLICATION OF EXISTING PEDESTRIAN AND VEHICLE DELAY MODELS AT CONTROLLED MID-BLOCK CROSSWALKS IN INDIAN CONDITIONS: A CASE STUDY OF HYDERABAD CITY

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Abstract

In the field of transportation engineering, one of the most concerned factors by the planners and users (pedestrian and vehicle) is the delay which governs the LOS of a facility. Literature shows various delay models like HCM and Webster which were modeled as per the homogeneous traffic conditions. Very limited studies were done on the heterogeneous traffic conditions like in India and in other developing countries. Apart from that, all the models were developed and validated at signal intersection and not many studies were conducted at controlled midblock sections except Austroads model. The present study aims to compare pedestrian and vehicle observed field delay at controlled mid-block sections with the existing models. Field delay was calculated using Simpsons one third rule. The superior model was suggested based on MAPE (Mean Absolute Percentage Error) analytical tool. Results can be used in the evaluation and design of mid-block pedestrian crossing facilities.

Keywords: *Controlled mid-block crossings, Pedestrian delay, Vehicular delay, MAPE*

Paper ID: 113

DESIGN OF TRAFFIC SIGNAL CONSIDERING SAFETY AND SUSTAINABILITY PARAMETERS

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Abstract

Signal timing optimization is used to reduce traffic delay and stops and thus enhance traffic characteristic efficiency. The concept of optimizing signal timings to reduce fuel consumption and emissions was addressed decades ago, but with the advent of efficient microsimulation tools, this has become more effective. This study aims to optimize signal timings considering safety and sustainability parameters. Microsimulation tool VISSIM is used to simulate vehicle trajectories which will be the input for SSAM and emission models. Results obtained from the emission model and surrogate safety model are used to optimize the signals. In this study, we consider unconventional performance measures such as the number of conflicts and emission to optimize signal cycle time along with conventional measures like delay and throughput. The resulting signal cycle plan shows that safety and environmental matrices somewhat coincides but at the cost of a decrease in mobility.

Keywords: *VISSIM microsimulation, Surrogate Safety measures, Optimization of signal timing*



Paper ID: 117

PUBLIC TRANSPORT SYSTEM IN NAGPUR

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Abstract

Public Transport for a city is not only government run transport services but also other IPT modes which are not usually regularized and are not included in the policy making decisions usually. Nagpur has similar modes of public transport available which are being integrated in the planning stages with the Nagpur Metro. Nagpur Municipal Corporation plans to integrate different modes of transport together. The planners understand that in a city not very big and having very different travel demands needs all the public transport systems to be integrated in order to compete with the private transport. This paper attempts to throw light on the measures undertaken by the authorities to integrate different public transport modes being operated by different authorities and manage these modes such as metro, feeder buses to metro, city bus service, public bike sharing system, IPT modes, private bus service and walking.

Keywords: *Public Transport, Traffic, Private Transport*

Paper ID: 120

MICROSIMULATION APPROACH FOR TOLL PLAZA OPERATIONS - A CASE STUDY

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Abstract

Mixed traffic conditions in the same toll lane at the toll plazas and also use of manual toll collection(MTC) gives birth to the serious problem of congestion and thus delay at toll plazas. To overcome this, electronic toll collection(ETC) system, commonly called as FASTag is recently implemented in India, which allows the fast movement of vehicles creating less delay and pollution. This new technology thus crafting new challenges for designers to optimizes the system. To address these issues VISSIM micro-simulation model is developed for the toll plaza in India. The VISSIM model is thus calibrated with the driving behavior and validated with the queue length and delay obtained from field data collected at Ghoti Toll-Plaza(GTP), near Nashik, India. The results show that the full implementation of ETC system decrease the queue delay by 95% and lane base traffic decrease delay by 24.62% in MTC method while in ETC by 48.35%.

Keywords: *Toll Plaza, FASTag, Mixed Traffic*



Paper ID: 122

EVALUATION OF EFFECTIVENESS OF RFID SENSORS FOR DELAY ESTIMATION UNDER MIXED TRAFFIC CONDITIONS

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Abstract

Intersections are the most common places in a road network where vehicles face significant delay while traveling. Traffic in developing nations such as India is highly heterogeneous in nature with poor lane discipline. As a consequence, conventional delay estimation approaches developed for homogeneous counterpart tend to provide erroneous results. This paper evaluates the delays determined by using Radio Frequency Identifier (RFID) sensors and compares the same with actual delay at a pre-timed signalized intersection under mixed traffic conditions. Based on the results, it was observed that the delays determined from RFID sensors best replicates the actual delay with a Mean Absolute Percentage Errors (MAPE) of 10.4%. A simulated traffic network of the study site was made in VISSIM to determine the optimum percentage of RFID cars in traffic stream and was found to be 40% to 60% to represent the actual traffic delay with minimum error.

Keywords: *Intersection Delay, Mixed traffic conditions, RFID sensor, Simulation, VISSIM*

Paper ID: 123

DELAY ESTIMATION MODEL FOR A PRE-TIMED SIGNALIZED INTERSECTION UNDER MIXED TRAFFIC CONDITIONS

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Abstract

Estimation of delay at intersection plays an important role in evaluating the performance of a traffic network. The heterogeneous nature of traffic with poor lane discipline in developing nations, referred to as mixed traffic, poses more challenge in estimating delay at intersections. As a consequence, conventional delay estimation approaches developed for homogeneous counterpart tend to provide erroneous results. This study compares the delays estimated by Indian Highway Capacity Manual (Indo-HCM, 2017) with the delays estimated using the model proposed in this study. A multiple linear regression model which utilized flow (V), Percentage vehicle green (PVG), Capacity (c) and effective green (geff) was employed to develop delay estimation model. Based on the results, it was observed that delay estimated from the model proposed in this study replicates the actual delay with a Mean Absolute Percentage Error (MAPE) of 18% indicating a good estimation of delay by this method.

Keywords: *Delay, Indo-HCM method, Multiple Linear Regression analysis*



Paper ID: 128

**EFFECT OF TWO-WHEELERS AND CARS ON SATURATION FLOW AND CAPACITY AT
SIGNALISED INTERSECTIONS IN HETEROGENEOUS TRAFFIC CONDITIONS**

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Abstract

In developing countries like India with heterogeneous traffic conditions, a major proportion of the urban traffic is constituted by Two-wheelers and Cars. In this paper, an attempt was made to analyse the effect of vehicle types like two-wheelers and car on saturation flow and capacity at signalised intersections.

Keywords: *Signalized Intersection, Saturation flow, Capacity, Heterogeneous traffic*

Paper ID: 130

**ACCELERATION AND DECELERATION BEHAVIOR OF TWO WHEELER ON FLYOVERS
USING GPS**

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Abstract

In past decades many improved acceleration/deceleration models have been developed but most of them are limited to homogeneous lane based traffic. Indian traffic streams are weak lane disciplined and heterogeneous in nature. Moreover previous studies are limited to traditional methods of data collection which are relatively less accurate. The presence of different vehicle types including heavy vehicles like trucks motorized three wheeler and passenger cars. Present study is based on modeling acceleration/deceleration models of motorized two wheeler on grade separated infrastructures based on using modern sensors based technology like Global Positioning Systems (GPS) mounted on vehicle including maximum acceleration/deceleration envelop. Present study proposes new models which overcomes the limitations of previously existing models. The proposed models are calibrated and validated using statistical tools.

Keywords: *Acceleration/deceleration models, Heterogeneous traffic, GPS, Motorized two wheeler, Dual regime mode*



Paper ID: 136

ESTIMATION OF PEDESTRIAN WALKING SPEED OVER ELEVATED FACILITIES USING DEEP NEURAL NETWORK

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Abstract

Estimation of pedestrian walking speed using fundamental diagrams is quite popular among researchers. However, to predict the walking speed based on the different microscopic parameters and geometric conditions requires the use of machine learning techniques. In the present study, an attempt is made to estimate the walking speed over elevated walkways using Deep Neural Network (DNN). Initially, XGBoost was used to tune the hyper-parameters of the model and derive the top five variables impacting the walking speed. The model was trained and tested using DNN, and the evaluation metric (MAE) showed that the model was able to predict the walking speed accurately. The outcome of the study would be helpful to planners and designers to increase the usability of the elevated walkways.

Keywords: *Walking speed, Overpass, Deep Neural Network*

Paper ID: 138

CONFLICT RISK ASSESSMENT AT SIGNALIZED INTERSECTION USING EMPIRICAL AND SIMULATED VEHICLE TRAJECTORIES

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Abstract

In this study, vehicle trajectories at a signalized intersection are extracted and used to estimate various safety surrogate measures (SSMs) for assessing safety. Trajectories are extracted from the field-collected data of a signalized intersection in Delhi and are then further used for developing a microsimulation model. The well calibrated and validated microsimulation model is then extended to analyzed conflicts and risks probabilities for various scenario. The results are then compared to draw critical conclusions about the applicability of an SSM for the heterogeneous traffic conditions in developing countries like India. Investigation revealed Deceleration Rate to Avoid Collision (DRAC) as the best-suited SSM amongst the tested scenarios.

Keywords: *Safety Surrogate Measures (SSMs), Microsimulation, Vehicle Trajectory, Crash Risk Probability, Signalized Intersection*



Paper ID: 139

ANALYSIS OF STABILITY AND FUNDAMENTAL DIAGRAMS UNDER MIXED TRAFFIC FLOW USING VEHICULAR TRAJECTORY DATA

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Abstract

Traffic safety and efficiency are the two critical factors in traffic engineering studies that are known to be inversely related to each other. Stability is a concept that affects the efficiency of the traffic, but safety in terms of collision cannot be analyzed or measured. However, stability acts as a pivot in balancing safety and efficiency. In this work, seven car-following equations are used to derive and analyze stability and fundamental diagrams of mixed traffic consisting of six vehicle types. These models are calibrated using vehicular trajectory data of Western Expressway, India. Sensitivity analysis for different penetration rates of various vehicle categories on both stability and fundamental diagrams is made. The impact of parameters in car-following models is interpreted based on derived stability equations. Microscopic and macroscopic comparisons between car-following models and between vehicle categories are made.

Keywords: *Mixed traffic, Car-following model (CFM), Optimum velocity (OV) functions, Sensitivity analysis, Stability, Penetration rates*

Paper ID: 146

ANALYSIS OF PEDESTRIAN GAP-ACCEPTANCE BEHAVIOUR UNDER DIFFERENT TRAFFIC CHARACTERISTICS: A CASE STUDY OF UNCONTROLLED MID-BLOCK ROAD SECTION

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Abstract

Gap acceptance is one of the most important pedestrian road-crossing behaviours. Pedestrians' perception towards the traffic condition is crucial in deciding how to cross the road. The objective of this research is to explore the impact of traffic characteristics i.e. vehicle type and vehicle speed on pedestrian gap acceptance behaviour. To model this correlation, a Pearson Type III distribution was developed by using the data collected from an uncontrolled mid-block pedestrian crossing. Results of the developed model clearly demonstrates that the vehicle type is an important factor along with the vehicle speed to understand the pedestrian gap acceptance behaviour. The study can simulate pedestrian gap acceptance for different vehicle type and speed, which can be beneficial to take appropriate decisions while formulating the polices.

Keywords: *Gap acceptance, Mid-block road, Pearson Type III distribution*



Paper ID: 152

RELIABILITY BASED CONSISTENCY EVALUATION OF HORIZONTAL CURVES

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Abstract

The difference in operating speed is extensively considered in consistency evaluation of road geometry. But, horizontal curve of identical geometry with same operating speed may have different speed distribution leading to incorrect consistency evaluation. This study develops a reliability-based framework to evaluate consistency of horizontal curves considering speed distribution at curve with respect to speed distribution at long tangent. Speed data of long tangent and five horizontal curves have been obtained from National Highway-3. Result shows that reliability at horizontal curve with 90m radius is 0.13 and with 430m radius is 0.39. Reliability value increases with increase in radius of the curve. Difference in 85th percentile speed is higher at horizontal curve with low reliability. However, this trend of difference in 85th percentile with reliability does not follow for all sites.

Keywords: *Horizontal curve, Geometric design consistency, Reliability, Road safety*

Paper ID: 153

ANALYSIS OF OVERTAKING SIGHT DISTANCE CONSIDERING ROAD AND VEHICLE PARAMETERS

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Abstract

Overtaking Sight Distance (OSD) is crucial in the design of undivided two-lane highways. It has major implications on the safety and operational efficiency of roads. Existing OSD standards and models are based on simplistic assumptions and incorporate minimal road and vehicle characteristics. This research evaluates the adequacy of OSD standards in practice by comparing them with more realistic values from IPG CarMaker®, a commercial vehicle and traffic simulation software. Similar test variables are chosen to ensure an identical comparison between the simulation and standards. Additionally, the effect of the road gradient and tyre-road friction on OSD is also analyzed by configuring the parameters in the simulation. High deviations of up to 28% are observed in the OSD values when compared to existing standards under different road conditions.

Keywords: *Overtaking Sight Distance, Two-lane highways, Vehicle dynamics simulation*



Paper ID: 158

IMPACT OF THE ODD EVEN POLICY IMPLEMENTATION ON CAR OCCUPANCY

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Abstract

The Odd Even policy was implemented in New Delhi from 4th November to 15th November, 2019 for twelve hours starting 8 AM onwards, with a motive to reduce the pollution and ease the congestion. The policy was also expected to impact the car ridership of people and encourage shift to car-pooling. The objective of this paper is to study the impact of this policy on the car occupancy of commuters and see its variations between before and during the policy period. Eight locations were selected for collecting data. The results were analysed based on different scenarios - comparing direction wise rates, before and during policy rates, hourly basis rates and comparison of Phase III results with I and II. The Phase-III results depicted that car occupancy was found to reduce in 6 out of 8 locations, thus making the policy ineffective and people not resorting to car sharing.

Keywords: *Odd Even Policy, Car occupancy, Comparative analysis*

Paper ID: 159

ESTIMATION OF CONGESTION PRICING LEVELS, DURATION AND BENEFITS TO AN URBAN CORRIDOR

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Abstract

This paper considers application of congestion pricing to an urban corridor in Kolkata, by estimating duration and the benefit (in terms of traffic volume reduction). Traffic flow data (extracted from videography) and travel time data (using Google Maps) is used to find (i) Temporal variations of travel time and flow, and (ii) A quadratic relationship between flow and travel time. Preference study is made using questionnaire survey to find the probability and willingness to pay, if congestion pricing is introduced in a corridor. Using Multinomial regression techniques, users' willingness to pay or shift has been calculated, and is used to estimate the traffic shift, (either to public transport or a different time) as well as pricing levels. Optimal pricing duration (maximum reduction in flow) is observed from 9-11 am and 4-7 pm during both peaks, with flow reductions around 18% and 30% respectively and a pricing level of ₹ 15.

Keywords: *Congestion pricing, temporal variation, multinomial regression technique*



Paper ID: 160

ASSOCIATION OF MANEUVERABILITY AND SAFETY OF VEHICLES IN A CONGESTED URBAN ROAD WITH WEAK LANE-DISCIPLINE AND VEHICLE HETEROGENEITY

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Abstract

Traffic congestion at urban centers elicits potential crash situations, which would be more problematic when the traffic is composed of vehicles with different maneuverability. The present study investigates how the crash potential of a vehicle type is associated with its maneuverability. The maneuverability of a vehicle class was defined as the standard deviation of the cumulative lateral shift of the vehicle during the forward movement. The analyses were performed using the trajectory data collected using the imaging technique from urban midblock sections. The crash risk was estimated using the surrogate safety indicator, the time to collision (TTC), which was extended to consider the crash risk during the different driving configurations of the vehicles. The result from this study indicates that, as the maneuverability of a vehicle type increases, the crash risk increases in a congested urban road.

Keywords: *Maneuverability, Mixed traffic, Weak lane discipline, Time-To-Collision, Trajectory data*

Paper ID: 161

INFLUENCE OF TRUCKS ON THE SAFETY OF PASSENGER CARS ON RURAL HIGHWAYS

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Abstract

The truck composition has a significant impact on the mobility and safety of passenger cars on high-speed highways. The present paper addresses the effect of truck composition on the safety of passenger cars. Data were collected from a multilane rural highway section using an infrared traffic logging system. The car-following interactions for car-car and car-truck pairs were identified based on the relative speed, longitudinal gap, and lateral overlap between the two interacting vehicles. Time-to-collision (TTC) was used as the surrogate safety measure to identify the potential crash events corresponding to different levels of truck flow rates. It was found that the number of potential crash events depends significantly on the truck flow rates. Contrary to the common belief that more trucks will cause more safety concerns for cars, potential crash events are low at high flow rates of trucks.

Keywords: *No-lane discipline, Car-following, Time-to-collision, Rural Highways*



Paper ID: 162

EVALUATION OF STRATEGIES TO IMPROVE OPERATIONAL CHARACTERISTICS OF MULTI-LEGGED INTERSECTION USING VISSIM

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Abstract

Intersection is a critical component of a road network where traffic from different approaches merges and diverges. These merging and diverging movements have significant impacts on traffic operations and safety at the intersection. Different demand management measures and control strategies are necessary to optimize traffic operation at the intersection. In this study, a micro simulation-based evaluation of different alternatives to optimize traffic operations for a real-world case is carried out. Kamrej intersection, Surat, is taken as a case study. Field data obtained through the various survey is used in the calibration of the base model in VISSIM to simulate field conditions. Validation against travel time for each approach and vehicular flow during peak hours is done. Average delay is used to evaluate different demand management alternatives. It is found that with different alternatives, delays for straight and right movements can be reduced by 20-80 %.

Keywords: *Traffic simulation, Intersection improvement, heterogeneous traffic*

Paper ID: 163

GIS BASED SPATIAL ANALYSIS OF URBAN TRAFFIC ACCIDENTS: A CASE STUDY IN BANGALORE CITY

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Abstract

According to the Comprehensive Mobility Plan report 2019, vehicle ownership in Bangalore City has increased from 32.4 lakh vehicles in 2001 to 74.06 lakh vehicles in 2018. The accident data of past 4 years 2015-2018 collected, and it provides information that the accident rate has decreased about 26.66% from 2015-2016 and 8.69 % decrease for the year 2016-2017 but there is an increase of 30.02% accident rate from 2017-2018. The primary data reveals that the 19-35 age group people involved in the accident of two-wheeler causality involvement is more. The seriousness of an accident, analyzed using the Accident Severity Index (ASI) using Geographic Information System (GIS) for the hotspots and cold spots. The point Kernel Density Estimation function is used for the assessment of spatial densities and spatial clustering for different years.

Keywords: *Accident Severity Index, Geographic Information System, Kernel Density Estimation, Spatial Densities, Spatial Clustering*



Paper ID: 165

UNDERSTANDING THE DRIVERS' PERCEPTION OF TRAFFIC SIGNAL COUNTDOWN TIMERS

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Abstract

Signal Countdown timer (SCT) works as an advance time warning device by providing information to drivers on remaining signal time. Its presence may affect drivers' psychologies and behaviours while approaching an intersection or waiting at the red light. An opinion survey containing 15 questions is conducted on 300 drivers in Delhi to assess the perceptions of drivers as they relate to countdown signal timers. 72-94% of the drivers felt that SCTs are beneficial to make better decisions of switching off the engine and relieving frustration during the wait at a red light, reduced honking and early start when the signal turns green, providing confidence for stopping/crossing the intersections during change interval. Although half of the drivers think that red light violations increase in the presence of timer, 85-89% of the drivers opined that these timers do not distract them, improve safety, and should be installed at more number of places.

Keywords: *Signal countdown timer, Opinion survey, Driver Frustration, Red-light Violations, Safety*

Paper ID: 170

MODELLING WAITING DURATION OF PEDESTRIANS AT SIGNALIZED INTERSECTION: A HAZARD BASED DURATION APPROACH

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Abstract

With the development of urban roads all over the world, traffic fatalities have increased, which is a major concern for most of the nations. India experiences a huge number of crashes every year with remarkable percentage of pedestrian fatalities. The current study focusses on pedestrian violation behavior while crossing with main focus on waiting duration at the curb. The process involved the videography of pedestrian crossing behavior at four signalized intersections in Nagpur City, Maharashtra. The Hazard based duration model has been utilized to analyze the waiting duration of pedestrians during the violation crossings. The results from non-parametric hazard model (Kaplan-Meier Curve) and parametric hazard model (Weibull AFT) were utilized (i) to identify the relation of survival probability with waiting time of pedestrian and, (ii) to understand the association of various internal and external factors with the risk associated to violation crossings, respectively.

Keywords: *Pedestrians, Waiting duration, Violation crossings, Survival analysis, Hazard based duration model*



Paper ID: 172

TRAVEL TIME VARIABILITY ANALYSIS OF PUBLIC TRANSIT BUSES USING GPS DATA

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Abstract

Travel Time Reliability (TTR) is an important measure to quantify the variation in travel times. Despite the importance of TTR for both the passengers and operators, limited research has been done to model the same. The present study aim to model TTR by considering planning time as dependant variable. From results, it was observed that the presence of divider, number of intersections, day of the week and time of the day had maximum effect on TT variability and eventually on reliability of public transit. For the purpose of analysis, both static and dynamic data were collected from three different routes in the National Capital Region of Delhi using GPS devices fitted in Delhi Transport Corporation (DTC) buses.

Keywords: *Travel time reliability, travel time variability, planning time, GPS data*

Paper ID: 176

COMPARATIVE STUDY OF CRITICAL GAP AT ROUNDABOUTS: HETEROGENEOUS TRAFFIC CONDITION

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Abstract

A comparative analysis of probabilistic models (logit and probit methods) and fuzzy logic models for critical gap at roundabouts are presented in the study. Hence, different roundabouts site are chosen in Odisha state and data are collected through videography method. From the comparative analysis, it is found that fuzzy logic model can better represent critical gap in roundabout under heterogeneous traffic conditions. It is observed that critical gap is minimum for two wheeler motorized vehicles in case of both short and long waiting time, while for bus or truck it is found to be more in case of longer waiting time. The performance of fuzzy model is esteemed using Receiver Operating Curve (ROC). The values of Area under ROC curve (AUR), True Positive Rate (TPR) and True Negative Rate (TNR) are found to be .879, .819 and .889 respectively.

Keywords: *Fuzzy logic, Logit, Probit, ROC curve*



Paper ID: 177

APPLICABILITY OF VARIABLE SPEED LIMITS USING SUPERVISED MACHINE LEARNING AND TRAVEL TIME DATA

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Abstract

With increasing congestion and associated challenges to manage the transportation network, intelligent transportation systems (ITS) have gained popularity due to their data-driven approach and application of advanced technologies. Variable speed limits (VSLs) is a popular ITS-based solution which uses a dynamic speed limit to promote harmonization in the transportation network. A cluster analysis was first used to identify potential road links susceptible to speed variation for the implementation of VSLs. A supervised machine learning algorithm, forest-based classification and regression, was then used to model and examine the influence of the average annual daily traffic (AADT), historical speed of the road link, and the speed of upstream and downstream road links on the average speed of the road link. Modelling and validation were performed using data for Mecklenburg County, North Carolina, USA, for all the road links as well as for road links with low- and high-speed variation.

Keywords: *Intelligent transportation systems, Variable speed limit, Supervised machine learning, Travel time*

Paper ID: 178

STUDY OF PEDESTRIAN STREAM BEHAVIOUR AT MASS GATHERING

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Abstract

Crowd-gathering mass religious events are common in India, causing unfortunate incidences due to mismanagement. This paper highlights the pedestrian parameters in mass gatherings across India on pedestrian-dedicated sections. Four pedestrian-dedicated sections are examined for their speed, flow and density relationships during mass religious events in India. The capacity of sections varies from 2262.6 ped/m/hr. to 4039.2 ped/m/hr. Linear and exponential speed-density relationships are observed having a better goodness of fit in these scenarios. Optimum speeds are comparable to the literature, however uncongested regimes vary from section to section and depend a lot on pedestrian behavioural dynamics. Therefore, further study in this regard may consider pedestrian behavioural dynamics while policy-making in mass gathering events.

Keywords: *Pedestrian density, Pedestrian capacity, Mass gatherings, Pedestrian dynamics*



**ASSESSMENT OF IMPROVEMENT IN ROAD SAFETY THROUGH MARKINGS: A
SURROGATE SAFETY MEASURE BASED APPROACH**

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Abstract

Road markings are highly essential in preventing head on collisions and vehicle off tracking on roads. They are also essential to highlight key movements and pedestrian crossings. Presence of road markings affect overtaking behavior of vehicles too. It is important that the road markings are re-applied at regular interval to ensure its functionality is not lost. However unfortunately this does not happen in Indian conditions due to budgetary constraints and hence many roads are left without legible road markings.

This study performs an analysis of safety impact of road markings, particularly longitudinal markings along center line and edge markings on the overtaking manoeuver in two lane roads. Surrogate Safety Measures, which are promising non-crash-based indicators are used in the study.

Keywords: *road markings, overtaking, surrogate safety, conflicts*



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TRACK VI: TRANSPORT AND MOBILITY **NETWORKS**



Paper ID: 27

SUBURBAN RAIL IN INDIA: ISSUES, OPPORTUNITIES AND WAY FORWARD: A CASE STUDY OF CHENNAI SUBURBAN RAIL

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Abstract

Suburban Rail in India is acting as a back bone of public transport in few cities and playing an important supporting role in several other cities. Institutional strengthening, multi-modal integration and funding are the three critical elements for development and optimal utilization of suburban rail capacity. In this context, the paper discusses the issues, opportunities and the way forward for suburban railway in India with a case study of Chennai suburban railway.

Keywords: *Suburban Rail, Multi-modal Integration, Institutional strengthening*

Paper ID: 35

STUDY ON THE IMPACT OF METRO ON THE MODE SHIFT BEHAVIOUR OF COMMUTERS IN KOCHI CITY

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Abstract

A steep rise in the travel demand of the commuters due to rapid urbanization and intense commercial developments have adversely affected the traffic and transportation scenario in Kochi city. The metro system was developed to mitigate traffic congestion while providing safe and rapid transportation to commuters by reducing pollution and noise levels. This paper investigated the impact of metro on the mode choice behaviour of commuters in Kochi city by developing logit models. Revealed Preference Survey and Stated Preference Survey were the data collection techniques adopted for the present study. Mode choice models were developed separately for bus, two-wheeler and car and was analysed to determine the major factors influencing mode choice decision of commuters. The findings from the study revealed that the increase in probability of choosing metro was 4.25% among car users and 13.64 % among two wheeler users with a reduction in metro fare by about 25%.

Keywords: *Mode choice, Metro ridership, Public transport*



Paper ID: 67

ESTIMATION OF WEEKLY FREIGHT TRIPS GENERATION IN CENTRAL BUSINESS DISTRICT OF THE CITY – A CASE STUDY OF TIRUCHIRAPPALLI

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Abstract

Freight Trip Generation (FTG) modeling is one of the efficient techniques for assessing freight flow operation in an urban area. This study deals with conducting an Establishment Based Freight Survey (EBFS) and developing the FTG model for Central Business District (CBD) areas in the Tiruchirappalli city. In this paper, a hundred and nine samples are collected, and an outlier test is performed to finalize the sample. Using the establishment characteristics data, the FTG model is developed by adopting a stepwise linear regression method, and the model is established at 95% confidence interval. The FTG model is validated with field data for identifying the predicting accuracy. The model results showed that the performance of the developed FTG model is good and reasonable in considering the establishment characteristics. Finally, this paper will assist the policymakers in understanding the condition that the establishment characteristics itself play a vital role in urban freight movement.

Keywords: *Urban freight, FTG, EBFS, Establishment characteristics*

Paper ID: 70

ASSESSING THE RELATIONSHIP BETWEEN REGIONAL ACCESSIBILITY AND DISTRIBUTION OF SERVICES ACROSS PERI URBAN AREAS – CASE STUDY OF INDORE

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Abstract

Peri urban areas (PUA) are defined as those settlements which are present just outside the city limits having rural-urban characteristics. Post 1991 economic reform PUAs developed due to increased connectivity, availability of employment opportunities and services outside city limits. People tends to settle in those areas which have either availability of services or higher accessibility to reach them. The movement of the people in a particular area is due to the attractions present there but the road network configuration determines the movement and attractions distribution in the region. This paper tries to evaluate integral accessibility by computing the closeness centrality index of the settlements using network analysis and examines its relationship in describing the distribution of services and amenities across region using centrality functional index. The research would help planners and policy makers to take decisions for planned development of the road network and PUAs.

Keywords: *Regional accessibility, closeness centrality, centrality functional index, network analysis, peri-urban areas*



BUS TRANSIT NETWORK ANALYSIS USING GENETIC ALGORITHM BASED APPROACH

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Abstract

Network design is the process of identifying the best set of routes, their associated frequencies, and schedule with an objective to minimize travel time, bus kilometre travel, and environmental hazards, and maximize the demand coverage and accessibility, etc. It can be considered as the combinatorial optimization problem to optimize all performance parameters. In this study, a Genetic Algorithm (GA) based routing procedure is proposed to minimize the overall cost of transport, including user's cost (governed by user's travel time) and operator's cost (governed by bus kilometre travel). GAs are the evolutionary algorithms that work on the natural principle of genetics. The algorithm is then applied to the study network consist of 8 nodes, and 11 links and results are discussed.

Keywords: *Genetic Algorithm, Routing, Scheduling, Overall cost of transport*



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TRACK VII: TRANSPORT ECONOMICS, FINANCE, POLICY AND GOVERNANCE



Paper ID: 12

IDENTIFYING THE CRITICAL AREAS OF IMPROVEMENTS FOR THE EFFICIENT OPERATION OF ELECTRIC RICKSHAW SERVICES: A CASE STUDY OF NEW DELHI, INDIA

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Abstract

The aim of the study is to identify the critical areas of improvement in electric rickshaw (ER) services in India. Such a study is necessary to improve the overall performance of any public transport services that would eventually provide users with a better service and help in achieving broader sustainability goals. In this study, an interviewer-administered face-to-face questionnaire survey was conducted in New Delhi, India, to obtain data from 200 ER drivers. Principal component analysis of sixteen statements related to operational issues of ER services revealed four latent constructs, infrastructure and regulations related issues, financial issues of drivers, safety issues, and performance issues. Out of these constructs, infrastructure and regulations related issues have the most significant impact on the performance, followed by financial issues of drivers and safety issues. The study provides several policy implications for the efficient operation of ER services.

Keywords: *Electric Rickshaws, Principal Component Analysis, Drivers*

Paper ID: 19

ECONOMIC ASSESSMENT OF TRAFFIC CONGESTION RELIEF MEASURES AT SIGNALISED INTERSECTION – EVIDENCES FROM AN INDIAN CITY

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Abstract

This study focuses on the economic assessment of traffic congestion relief measures at signalised intersection under heterogeneous traffic condition. Economic evaluation of relief measures such as road widening and mode shift from private to public transport is considered in this study. The mode shift namely two wheeler to bus and car to bus is considered as the demand management strategy for this research work. For this a unit change in the quantity is adopted and changes in the congestion cost are estimated. It was found that the percentage congestion reduction cost due to widening process is 14.92, percentage reduction cost with the mode shift of two wheeler to bus and that of car to bus is 27.74 and 27.92 respectively. Therefore, this study proposes mode shift to public transport than road widening process to the Indian city to alleviate congestion at signalised Intersection.

Keywords: *Delay cost, value of travel time, road widening, signalised intersection, mode shift*



Paper ID: 29

**RANKING OF ROAD TRAFFIC ACCIDENT BLACKSPOTS BASED ON ECONOMIC CRITERIA:
A STUDY FROM INDIAN CITIES**

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Abstract

Road safety improvement measures imposing a significant financial burden certainly explain the need of a tool for the prioritization of expenditure on improvement works at crash prone areas to channelize the limited financial resources effectively; especially in developing countries like India. In this study the cost of road crashes is used as a key parameter in ranking the blackspots for improvement. Stated Choice Method (SCM) is adopted here to find out people's Willingness to Pay (WTP) to reduce the probability of involvement in a crash and this value is used to evaluate the total cost of crashes in different blackspot areas; based on which, the blackspots can be ranked for improvement. It is expected that this study will fill the gaps in the traditional criterion followed in blackspot ranking, which are based on dominant pattern of crashes characterized by an over-representation of particular type of crashes.

Keywords: *Stated Choice Method (SCM), Willingness to Pay (WTP), crash costs, ranking of blackspots*

Paper ID: 43

ADOPTION OF ELECTRIC VEHICLES: A SYSTEMATIC REVIEW

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Abstract

Electric vehicle concept, however, is not a new terminology but one of the highlighted technologies being adopted by several countries to reduce pollution due to transportation. It is very much essential to understand the several root causes of the influencing parameter to lay down the conceptual framework for a particular country. This study aims to provide a deep insight into different dimensions of the factors influencing the adoption of EV. It is found that there are several theories for the diffusion of new technologies, but few are well suited to the electric vehicle's adoption, such as TAM, TRA, TPB, and DIT. The dimensions of the factors were found to lie within: demographics, economic factors, infrastructure readiness, consumers' perspective, government interventions, technological factors, environmental concern, and marketing perspective. The developing countries with less GDP rate should work on public charging infrastructure along with subsidy and tax relaxation to boost EV market.

Keywords: *Electric vehicle, EV adoption, Green vehicle and Diffusion of EV.*



Paper ID: 53

CONSEQUENCES TO FREIGHTS TRANSPORT DEMAND ON ACCOUNT OF COVID-19 AND ROBUST RESPONSE POLICIES: A REVIEW

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Abstract

The pandemic, termed by the WHO as COVID-19 has its base in December 2019 in China and spread to almost the whole world very quickly. Respective government authorities need to put strict rules of confinement in a region, state, or whole country as a measure to contain the spread of contagious disease as no treatment or vaccine has been found to date. Each sector has been hit by the interruption due to lockdown measures among which the transport sector is perhaps the most quickly, critically, and directly affected one. Coronavirus has hit freight transport the hardest and so the sector will necessarily have to lead the way in the post-COVID-19 situation as it is the lifeline of the global supply chain. This research aims to analyze the impact of the novel SARS-COV-2 on the goods transport demand suggesting robust response policies for post-pandemic recovery.

Keywords: COVID-19, Goods Transport Demand, Carriage and Response Policies

Paper ID: 87

TRUCKING INDUSTRY GETTING BENEFITS FROM IMPROVED ROAD INFRASTRUCTURE IN INDIA- REALITY OF MYTH?

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Abstract

The aim of this paper is to analyze the impact of developed road infrastructure on operation of trucking industry in India. The study also attempted to look at impact of road network, freight handled, GDP growth rate, public spending for road infrastructure development on truck population/growth. Despite of various efforts undertaken by concerned authorities so far, the trucking industry still facing certain impediments as far as operation is concerned and hence having viability issue especially for small operators. Thus, in current study attempt has been made to find out those impediments and how they are affecting the trucking operations, and lastly, possible solution to it through policy recommendations.

Keywords: Transport, Infrastructure, Roads, Policy, Operational Efficiency



Paper ID: 100

A REVIEW OF FACTORS AFFECTING CYCLONE EVACUATION

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Abstract

Evacuation of the vulnerable population to safety is an obvious solution in the face of an imminent cyclonic disturbance. Various studies have been carried out to evaluate the behavioral aspect of the population at risk during a storm. Numerous factors which impact the evacuation of those at risk due to a storm include household characteristics like income, education status, age group of the various individuals in the house, presence of pets in household; shelter characteristics like the facilities available at the shelter, its distance from the household; source of information of the evacuation and individuals' past experience to storms, etc. Findings suggest that the evacuation behaviour is found to be affected largely by the socio-cultural background of the individuals at risk of that specific area.

Keywords: *evacuation, storms, behavioral aspect*

Paper ID: 101

TRANSPORT PLANNING AND IMPLEMENTATION METHODOLOGIES FOR DEVELOPING COUNTRIES

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Abstract

This paper gives an overview of the subject-what all is involved here, how crucial it is for the decision maker as transport projects are usually big and expensive, are essentially long time-horizon works, take time to throw up benefits that are invariably multi-dimensional. Transport Economics also includes an array of social benefits which one can see clearly but are sometimes difficult to quantify.

Keywords: *Transport Planning, Economics, Social*



PUBLIC-PRIVATE PARTNERSHIP (PPP) ARRANGEMENTS IN DELIVERY OF URBAN BUS TRANSPORT SERVICES

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Abstract

The provision of public bus transport services has always been a subject of public control i.e. State Transport Undertakings (STU)/ or City Authorities (ULBs), who have not been able to keep pace with increasing passenger demand due to the high cost involved in bus procurement, infrastructure, operations & maintenance. This leads to the privatization of urban bus services. Private players bring investment along with high managerial capabilities on lower operational costs. The bus operations are shifting from Net- Cost Contract (NCC) to Gross-Cost Contract (GCC), as the risks are fairly shared between parties, and have significantly contributed to the reduction of operational costs than NCC. An assessment of Ahmedabad city bus (both AMTS and BRTS) contract reforms from the year 2005-2019 is documented as a research methodology. The outcomes suggest strategies to improve public-private partnerships for efficient public bus services.

Keywords: *Public Bus Transport Services, Public-Private Partnership, Bus Contract Models, Gross-Cost Contract*

PROJECT FINANCE ARRANGEMENT IN MASS TRANSIT SYSTEMS: A CRITICAL ANALYSIS OF THREE METRO RAIL PROJECTS IN INDIA

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Abstract

Financing constraints to develop capital intensive public transport infrastructure continues to be a primary challenge for improving urban mobility in India. Given the limitations of traditional public funding, innovation in financial arrangements becomes crucial for sustainable development and to meet growing expectations of stakeholders. This research paper conducts a comparative analysis of financing for urban metro rail systems at Bangalore, Delhi and Hyderabad. The various funding mechanisms that have been used in the three projects have been scored based on the relative innovativeness. The findings indicate that that metros' have been majorly public funded and project's finance is unique. Few innovative finance tools utilised are property development, bonds, debt raised by SPV, commercial loans. It is concluded that scope for utilisation of innovative financing mechanisms is high for upcoming projects of metro rails or MRTS.

Keywords: *Project finance, Financing arrangement, Elements of innovation, MRTS projects*



A STUDY OF USER'S PERCEPTION TOWARDS SHIFT TO ELECTRIC VEHICLE - A CASE OF RESIDENTIAL EDUCATIONAL CAMPUS

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Abstract

The growing concern for the environment, and in-keeping with the anti-pollution and de-carbonization policy trends by major economies of the world, the Government of India has demonstrated a strong commitment in introducing electric mobility in India. An individual's decision on whether EVs can be adopted largely depends on the consumers' perception of the relative advantage of EVs over conventional-vehicles. In this study, users' perception towards the aforementioned attributes of EVs were captured through a questionnaire survey in a residential academic campus, of approximately 20,000 residents, to identify likelihood of an individual shifting to electric vehicle. The study shows that there are few encouraging factors like style, performance, cheaper road-tax and insurance and discouraging factors like power delivery, lack of trust on new technologies and unwillingness to change lifestyle, which have significant relation in developed ordinal logit-model. The results helped us ascertain the drivers and barriers to the EV-market in India.

Keywords: *Electric vehicle demand, Consumer perception survey, Ordinal logistic regression*



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