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Abstracts

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Integration of Road Accident and Hospital Patient Data for Development of Road Casualty Information System in Hong Kong

William H.K. Lam[1]

Road safety has become an important issue in every country. Official statistics show that in 2010, road traffic injuries around the world took the lives of 1.3 million people; i.e. on average 148 lives per hour. The World Health Organization (WHO) forecasts that without preventive actions, the trend would lead to the loss of around 1.9 million lives on the roads each year by 2020 and road traffic injury will become the fifth leading cause of death by 2030. In addition, road traffic injury has considerable impact on the economy of a country. It was estimated that the global losses per year due to road traffic injuries are 1-3% of their gross national product. The devastating scale of road traffic injuries has attracted growing awareness and global concern. In view of this, many developed countries have integrated the road accident data with the hospital patient data to form a combined database for better understanding of the injuries of the road accidents. Recently, a research study has been carried out in Hong Kong to investigate the feasibility of development of a road casualty information system. In this road casualty information system, road accident data from Hong Kong traffic police will be integrated with the hospital data of road casualties. In this presentation, the integrated systems or combine databases for road casualties in selected overseas countries are reviewed and compared. A questionnaire survey has been conducted to understand better how these integrated systems are developed in overseas countries. Furthermore, in order to investigate the local requirements and expectations of the integrated system, views from the relevant parties in Hong Kong have been collected by opinion surveys. The key findings of these two surveys are presented and would provide useful information for development of the road casualty information system in Hong Kong.

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Prof. William H.K. Lam

Professor William H.K. Lam is a Chair Professor of Civil and Transportation Engineering and Associate Head of the Department of Civil and Environmental Engineering (CEE) at The Hong Kong Polytechnic University (PolyU), P.R. China. He joined the PolyU as lecturer in 1983 and has been promoted to Chair Professor in 2003 and has also been appointed as the Associate Head of CEE in 2007. Prof. Lam is currently the President of the Hong Kong Society for Transportation Studies (HKSTS) and the Chairman of Logistics and Transportation Discipline Advisory Panel of the Hong Kong Institution of Engineers (HKIE). He is also the past chairman of HKIE Civil Division in 2003 and Chairman of HKIE Civil Discipline Advisory Panel from 2008-2011). Prof. Lam is the Co-Editor-in-Chief of the SCI Journal of Advanced Transportation and the Editor-in-Chief of the SCI Journal – Transportmetrica. He is also a member of the International Advisory Committee of the International Symposium on Transportation and Traffic Theory (ISTTT) and of the International Scientific Committee of the International Symposium on Transportation Network Reliability (INSTR). He has been appointed as Chiang Jiang Chair Professor at the Beijing Jiaotong University for the period from 2010 to 2013. Recently, Prof. Lam and his colleagues from Beijing Jiaotong University, Beihang University, and the Hong Kong University of Science and Technology were granted with the National Natural Science Award in 2011, the highest honour in China. Prof. Lam has over 30 years professional experience and is the author of over 400 international journal and conference papers together with consultancy reports. In the past 5-year and 10-year periods, Prof. Lam was ranked within the top 10 in the world in terms of the research publications in the ISI Web of Science categories (Transportation Science Technology OR Transportation).

Total Highway Management System

T. F. Fwa[1]

Highway network development is one of the largest infrastructure investments of a country. Like any large infrastructure development or investment, it deserves major effort in planning, and efficient operational and cost-effective maintenance management to ensure the best return from the investment. Management of a highway network is a major challenge to any highway agency. This is because a highway network comprises various facilities that are very different in their physical and operational characteristics. These infrastructure facilities include pavement, bridges, drainage system, traffic signal and control devices, and roadside appurtenances. Their service and maintenance requirements differ significantly. In addition, since these highway facilities are installed with specific functions to serve the general road users and ensure smooth and safe operations, there are more than one goal that must be met. Examples of such goals are safe and smooth operations, high level of services, high cost effectiveness, low maintenance expenditures, low adverse environmental impacts, and little disruption to traffic operations and social activities. Some of these are conflicting in requirements, and some are qualitative or subjective in nature. This paper highlights the need for a total highway management system, provides a review of the current practices in managing highway networks, highlights the limitations of current practices, and proposes ways to overcome the limitations.

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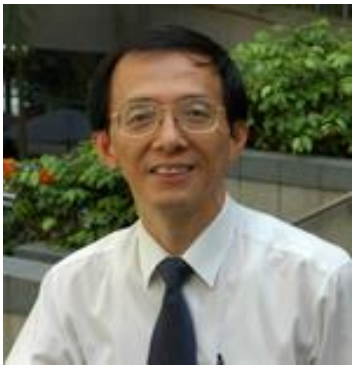

Dr. Fwa's research in the last 25 years covers all aspects of highway engineering, with special emphasis in the areas of pavement design, maintenance and management, and pavement performance evaluation and testing. He is the editor of the recently published Handbook of Highway Engineering by CRC Press. Dr. T. F. Fwa is Professor in the Department of Civil Engineering and Director of the Centre for Transportation Research, National University of Singapore. He received his BEng (First Class Hons) from the then University of Singapore (now known as the National University of Singapore), MEng from the University of Waterloo, Canada, and PhD from Purdue University, USA. He has received a number of awards for his academic and research contributions, including the 1985 Eldon J. Yoder Memorial Award by Purdue University, USA, the 1992 Katahira Award by the Road Engineering Association of Asia and Australasia, the 1992 Arthur M. Wellington Prize by the American Society of Civil Engineers, the 1995 Katahira Award by the Road Engineering Association of Asia and Australasia, the 2000 Engineering Achievement Award by the Institution of Engineers, Singapore, the Enterprise Challenge (TEC) Award 2002, Singapore, and the Frank M. Masters Transportation Engineering Award 2005 by the American Society of Civil Engineers, USA. Professor Fwa serves the international community in various capacities. He is the Asia Region Editor for the ASCE Journal of Transportation Engineering. He also serves on the editorial board of three other international journals: the International Journal of Pavement Engineering, the International Journal of Road Materials and Pavement Design, and the International Journal of Pavements. He is currently Vice President of the International Society for Maintenance and Rehabilitation of Transport Infrastructure, Board Member of the Eastern Asia Society for Transportation Studies, and Special Advisor to the International Association of Traffic and Safety Sciences. Locally, he has been chairing the Transportation Engineering Technical Committee since 1993. He is the founding President of the Pavement Engineering Society (Singapore).

Towards a Safer and Effective Bicycle Lane Implementation in Sri Lankan Highways

S.A.S.T Salawavidana[1]

Bicycle lanes are in cooperated into the new road projects carried out by the Road Development Authority. This is a step to encourage the non-motorized transport of this country. But it is observed that these bicycle lanes are not used for its intended purpose. Especially in Colombo area, there are very few bicyclists on the roads and bicycle lanes are always empty. So it is seen that the bicycle lanes are used to overtake vehicles in wrong side, for illegal roadside parking etc. While the situation is such, Road Development Authority is planning to extend its new policy to all the roads in Hambanthota hub development projects by in cooperating bicycle lanes. A natural question any highway and traffic engineer would have in this situation is; have the bicycle lanes failed in these projects around Colombo? If so, what are the recommendations that can be drawn to avoid such an ill fate to fall in the proposed bicycle lane facilities in Hambanthota hub development projects? In this research, many design guidelines in various countries were studied. Then the drawbacks experienced in local projects were analyzed. So it was learnt that the reason for failure of bicycle facilities in our country must be due to the non-adherence to such a guideline and also the local climate, social stigma etc. Recommendations are therefore made to avoid these problems in the future projects.

Key Words: Cycling**,** non-motorized transport

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Motorcycle Safety Usage Rates and Motorcycle Injury Severity in Sri Lanka

Samith Amarasinghe[1] and Prof Saman Bandara[2]

Involvement of motorcycle crashes as a motorcycle occupant is the most common cause of serious head injuries among children. Use of motorcycle safety helmets has been found to be effective in reducing injuries in crashes. Beginning from 2011, wearing safety helmets for all types of motorcycles are mandatory in Sri Lanka. The objectives of this study are to investigate motorcycle safety helmet use rates and the motorcycle crashes.

The data were collected using the mobile observation covering all A-, B-, C-, and D-class roads throughout Sri Lanka during 2011 and 2012. While traveling inside vehicle head-on motorcycles were observed and recorded which included number of persons in the motorcycle and the helmet usage of all the occupants. The crash severity data were obtained from the Police headquarters, Baduraliya and Homagama Police Station while injury severity data were obtained from the, Baduraliya and Homagama Hospital.

According to observation data, the average motorcycle helmet use rate was 80.81%. Motorcycle operators and pillions in town areas travelling on A-class roads were more likely to wear safety helmets. While the safety helmet usage was low among operators and pillions traveling in rural areas on C- & D-class roadways. The helmet usage rate among children was as low as 20%, while adult helmet usage rate was 86%.

Approximately 35.2% of fatal crashes out of all fatal crashes were reported for motorcycles during 2010 and 2011. Also, motorcycles represented 41% of grievous injury crashes, 38.9% of non-grievous crashes, and 9.6% of Damage Only crashes. The comparisons between helmet use rates and injury severity in both rural and urban setting were carried out using selected A- B-, and C-class roadways. As compared to low safety helmet use in rural areas, the numbers of fatal and grievous injuries in these areas were higher.

Key words: Motorcycle crashes, Safety helmet, Crash data analysis, Observation studies

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Use of GIS as an Integrated Tool, on Selecting Minimum Hazard Traces for New Railways & Highways

Kelum Wickramarathne[1] and Saman Bandara[2]

Natural hazards, such as landslides, floods, cyclones, storms, coastal erosion & tsunami etc; bring catastrophic outcome on transportation infra-structure. Inundation, embankment damages, washed off, structure damages, debris fallen are the major problems on current highway and railway sector. Reconstruction of these damaged infrastructures is a burden to economy of a country. A well planned, road, railway or its infrastructures that avoids possible disaster prone areas may not subject to severe damages by the natural or manmade disasters. However, integrated modern technological strategies, such as GIS, RS etc. are not used sufficiently for disaster resilience in developing countries during the planning & design stages of roads and railways. Often, traditional strategies, such as field visits and surveys, maps and library surveys, etc. are used for this purpose.

This paper is an attempt to develop a methodology to realize suitable traces for road and rail developments, against disasters, using GIS spatial analysis tool. Superimposing feature layers and its attributes, such as geomorphology, terrain, land use, areas vulnerable to inundation, landslides, cyclones etc., a GIS data base is developed. Then, by using a systematic strategy, those features and attributes are weighted accordingly its significance and estimated magnitude, using published information about disaster risk. Using these weighted, value added data; less vulnerable traces can be developed with the help of GIS spatial analysis tool. By using a VB interface this tool can be made user friendly such a way that different disaster scenarios could be evaluated.

A case study of a new railway development is presented to illustrate the application of the proposed methodology

Key words: Transportation Infrastructure Development, Spatial Analyses, Disaster Resilience

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A GIS Based Tool to Estimate Transport Demand Associated with Land Use Changes Expected at an Expressway Interchange Township Development

P.C.P. De Silva[1], M. Aseem[2], J.M.S.J. Bandara[3]

The first ever expressway in Sri Lanka has already been declared open at the end of 2012 and authorities are planning for township developments at three of the expressway interchanges closer to the City of Colombo. A number of different land use and transport infrastructure proposals have been put forward but there is no tool to evaluate the effectiveness of transportation infrastructure proposals or to identify the traffic impacts due to land use developments. Models available for intercity travel demand cannot be used for this macro and micro level planning and not having sufficient traffic and travel related information is another serious issue faced by the planners.

The objective of this paper is to present a tool developed based on GIS to facilitate the travel demand estimation within the township development area. This tool make use of the outputs of an intercity demand model (TransPlan) and distribute the trip ends within the study area using land use and local area transport network using GIS tools. This tool is based on Arc GIS software and Visual Basic has been used for different tool developments.

Demographic information available on smallest level administrative divisions (Grama Niladhari Divisions) and traffic counts carried out at strategic locations are used for the traffic flow distributions. GIS tools developed to find out link and node independent paths, trip generations and trip attractions based on land use information are used to evaluate different alternatives. This tool is transferable to any geographic area and can be customize depending on the level of data availability. A case study representing one of the townships (Kottawa, at the end of Sothern Expressway) is presented to demonstrate the application of this tool.

Key words: Traffic Demand Estimation, Land Use Planning, GIS Applications, Models

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Automatic Road Extraction form High Resolution Satellite Images

R.M.P.N.S. Bandara[1], P.C.P. De Silva[2], J.M.S.J. Bandara[3]

The presence of high resolution satellite images and their potentials to be used in many fields such as urban planning, transportation engineering etc ,especially in the meaning of preparing and updating maps, have made the automatic extraction of objects, a new challenge in remote sensing. Automatic road extraction, one of major uses of preparing and updating maps, provides means for creating, maintaining, and updating transportation network, which subsequently offers databases for all means of traffic management. Moreover, automatic road extraction is a critical feature for an efficient use of remote sensing imagery in most contexts, which has been an active research area in computer vision and digital photogrammetric for over past decades.

Further, the pixel-oriented analysis of satellite data has a main limit: the acknowledgement of semantic low level information, as the amount of energy emitted from the pixel, where the context does not assume any role. Conversely, the application of object-oriented image analysis on very high resolution data allows obtaining, by an automatic or semi-automatic analysis – with a minimal manual participation – a good classification also in presence of high and very high resolution data of small cities, where higher is an error possibility. Object-oriented image classification involves identification of image objects, or segments, that are spatially contiguous pixels of similar texture, color, and tone.

A simplified methodology using the object oriented image analysis for automatic road extraction for the Colombo City Area is presented in this paper. The proposed object-oriented image classification method comprises few fundamental and important steps towards content analysis and image understanding for instant image segmentation and classification. Few algorithms and techniques for the segmentation and classification in order to identify road features from satellite images were also supported to the proposed method.

Key words: Object-Oriented Methods, Image Segmentation, Road Network, Algorithms

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Finding AADT Thresholds for Upgrading Low Volume Roads in Sri Lanka (Using HDM-4 Model)

Y.P.S.R.Piyasena[1] and W.K. Mampearachchi[2]

The Highway Development and Management Tool (HDM-4) is a powerful system for the analysis of road management and investment alternatives and it is used to prepare road investment programmes and to analyze road network strategies.

In this study, the HDM-4 tool is used to find the AADT thresholds based on traffic, subgrade and climate for upgrading low volume roads to maximize economic benefits in Sri Lanka.

Several road sections were defined based on different possible traffic, subgrade and climatic conditions for Gravel, Penetration Macadam (PM), Surface Dressed (SD), Portland Cement Concrete (PCC) and Asphaltic Concrete (AC) pavement types. Altogether more than 120 sections were modeled in HDM-4. Level-1 calibration was done in HDM-4 to harmonize with the Sri Lankan condition. Using HDM-4 strategy analysis, different rehabilitation and improvement alternatives were analyzed. Maintaining existing pavement considered as the base case. Analysis was done for a 20-year period and optimized for maximum NPV.

The outcomes of the analysis EIRR was compared in tabular and graphical forms in order to identify the AADT thresholds for traffic, subgrade and climate for upgrading each pavement type. This shows that traffic volume and growth rate are significantly affected and whereas the effect of climate and of sub grade condition are negligible.

Upgrading threshold of low volume road can be decided based on traffic volume in AADT with a fair assessment of the number of heavy vehicles, traffic growth rate and climate condition. According to the study, AADT ranges were defined to get maximum economic benefit for different pavement types of low volume roads in Sri Lanka.

Furthermore it can be concluded that low volume roads (AADT less than 1000) in Sri Lanka can use Gravel, PM or SD pavement type with proper maintenance and it is more economical than upgrading to AC or PCC.

Keywords: HDM-4, Low volume roads, Pavement upgrading, Road maintenance

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Analysis of the Flexible Pavement Sections Using Mechanistic - Empirical Method

W.K. Mampearachchi[1] and N.P. Dulwala[2]

Pavement design procedures used in road design is either empirical or mechanistic. In Sri-Lanka most of the road pavements have been designed based on the empirical design methodologies. A guide to the structural design of roads under Sri Lankan conditions issued by Road Development Authority (RDA) is used as the reference for the local road pavement designs. Overseas Road Note 31 and American Association of State Highway Transportation official's method (AASHTO) are the other references used in the pavement designs.

Pavement layer compositions given for the same road section by the different references are not in the same. In the other hand due to the non- availability of the materials and different cost constraints in the projects might subjected to change the pavement compositions rather given by the design references.

So the different layer compositions are needed to be analyzed against their performances and developing improving method for analyzing is required.

The quality of material properties in different layer composition can be evaluated through the mechanistic- empirical methods. KENLAYER is the mechanistic- empirical tool widely used in the pavement analysis. The output results of the KENLAYER gives the vertical stresses and strains, horizontal stresses and strains, and displacements at the specified locations.

For the selected road stretch, traffic data has collected .The same section has designed using different design references and some sections are subjected to changes as available material properties. Some pavement compositions are designed with the same structural adequacy, matching with the structural Number by the varying material property which gives economic benefits. These different pavement compositions are used in analysis.

Design life has analyzed for the each pavement composition using Mechanical – Empirical method. The critical layers are identified at early stage of the failure. The study concludes by identifying the best suitable pavement composition by the evaluating of the pavement performance.

Key Words: Flexible Pavement, Mechanistic Method, Empirical Method

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Evaluation of Temperature Susceptibility Measures in Penetration Grade Bitumen Used In Sri Lanka

J.N.Meegahage[1] and W.K.Mampearachchi[2]

In the recent years Sri Lanka has experienced a massive evocation in highway construction than any other period in the history. This leads to enhance the quality of ride and minimize the cost and time incur with transportation industry. Most of these highways are being constructed with Hot Mix Asphalt (HMA) where bitumen is a major constitution. The increase in demand for bitumen has lead the way to increase bitumen production and import significant amount of bitumen. In order to have good quality long lasting pavements one should ensure the usage of bitumen with desired properties. In Sri Lanka 60/70 penetration grade bitumen is used for HMA. One of the major problems in penetration grade bitumen is the absence of temperature susceptibility measures within the grading system. In this study the bitumen used in Sri Lankan roads are evaluated using several temperature susceptibility measures. They are Penetration Index (PI), Viscosity Temperature Susceptibility (VTS) and Pen-Vis Number (PVN). Bitumen samples collected from various highway projects around the country was evaluated using the above temperature susceptibility measures. The result of these measures has been analyzed for the correlation and with the limits specified in literature. It was found that there no good correlation between penetration and softening point of bitumen samples. About 50% of the samples tested showed lower penetration than the required penetration and similar behavior was obtained with their consistency. Penetration Index related to softening point showed that many samples tested were in highly temperature susceptibility region. VTS values for the test samples were scattered throughout and out of the VTS limits. PVN values obtained for the test samples were scattered closely at the temperature susceptibility region. Using the findings of the literature the behavior of PVN was approximated to PI which shows further evidence of temperature susceptibility nature of Sri Lankan bitumen. The results of temperature susceptibility measures of PI, PVN and VTS highly vary among the samples.

Key words: Bitumen, Temperature susceptibility, Penetration grading

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Analysis of Factors Affecting Pedestrian Route Choice

Chamali Hewawasam[1], Saman Bandara[2] and S.C. Wirasinghe[3]

Walking is considered as a most efficient mode of transport for shorter distances as it is environmentally friendly, requires minimal energy, costs nothing and is accessible to all irrespective of the age, gender and ability if facilities are provided appropriately. Pedestrian facilities in an urban area have a significant influence on the traffic flow and socio-economic environment. Communities with good pedestrian facilities will enhance the quality of life. Pedestrians enjoy a high degree of freedom of movement even in a highly congested area as opposed to vehicles. Accordingly, more alternative paths are available for pedestrians between any origin-destination (O-D) pair. This paper describes a study carried out in Panadura city center in Sri Lanka to estimate the relative importance given by pedestrians to various factors such as travel time and visual attractions in their route choice. The first part of the questionnaire that was used in the study was on their current journey and the second part was based on stated preference using a series of hypothetical route choice questions. Here respondents were presented with choices between hypothetical yet realistic alternatives, with each alternative being described in terms of their attributes. The results were obtained by conjoint analysis and highlighted that travel time is the most significant factor in route choice for less than 1000m trips and travel distance got priority for longer distance trips. Further, it is apparent that congestion and visual attractions were secondary factors their route choice.

Key words: Panadura city center, Origin-destination, Stated preference, Conjoint analysis

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Methodology to Identify the Optimum Number of Locations that Minimized Double Counting Errors for Origin – Destination Surveys

P.C.P. De Silva[1], J.M.S.J. Bandara[2]

An origin – destination matrix is a spatially disaggregated measure of the traffic demand within a defined study area. Further, results of origin – destination (OD) surveys, which primarily comprise information about the spatial and temporal distribution of activities between different traffic zones, are of vital importance for transportation systems operation, design, analysis, and planning. However, in the OD estimation process, the quality of the estimated OD data is highly dependent on accuracy of the input data, which is a subsequent factor of the selection of perfect number and locations of observation. Further, although scholars argue the importance of selecting the correct sample sizes at each location in order to produce accurate data while minimizing the cost and disturbance to the traffic and etc, still it seems this factor has not been incorporated for the studies.

This paper presents a new approach for establishing permanent locations for OD surveys, which enclose entire study area travel movements, by having taken divisional secretariat divisions as the traffic analyzing zones. The main argument considered here is the selection of minimum number and keeping no room for the double counting. Further, the paper evaluates sample sizes required for each counting location for OD surveys.

Key words: Origin Destination Surveys, Optimum, Counting Locations, Sample Sizes

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Study of Bus Crew Behavior and User Complaints

M.P.P.S. Pathirana[1], J.M.S.J. Bandara[2]

Efficiency, public acceptance and user satisfaction of bus service is largely dependent on the behavior of bus crew. Hence, it is the responsibility of the authorities to identify deficiencies and take necessary action to improve the situation. This study focus on analyzing data collected by National Transport Commission on bus crew behavior by Monitoring and Enforcement, Investigation and public complaint handling units. Information available was divided into two categories as violations and complaints. Violations are the detection taken by the flying squads of National transport Commission and provincial authorities. Complaints are made by the general public about the crew behavior and bus operation.

It is identified violations can be categorized into 31 different offences and there are 08 different categories of complaints. It is found that on average long distance buses (route lengths over 50 km) are more responsible for violations as well as complaints as compared to short distance (route length less than 50 km). Employing unregistered crew is the most frequent violation that amount to nearly 30% of the total. Discourtesy towards passengers and charging higher fair are the two main complaints received that contribute to nearly 86% of the complaints.

It is also found that majority of the detected buses have less than 2 violations during a given year but there are few buses that have received over 5 violations during a given year. Violations and complaints are also analyses according to the service type, bus route and corridor of operation. It is found that more detections are from Northern corridor while more complaints are from Southern corridor.

Key words:

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Development of Guidelines to Improve the Infrastructure to Address the Mobility of Blind and Visually Impaired Self Employed People of Sri Lanka

R. A. M. C Ranasinghe[1] and W. K. Mampearachchi[2]

Sight loss can affect a person's independence more than any disability. Unsurprisingly many people who lose their sight never go out unaccompanied again. Those that do overcome enormous difficulties to do so. These difficulties are very often magnified by undeveloped road infrastructure and public transport facilities. Encouraging greater access to transport and public transport can substantially transform the livelihoods of blind and visually impaired people and their family. Lack of Accessibility and mobility can make these people to find employment, to gain an education; access to health services and also this limit their social and recreational activities. Therefore these people should be able to travel independently within locally or within urban and suburban areas at least for their needs using public transport. Though Sri Lanka has developed specifications for road infrastructure and public transport, those are not adequately address the requirements of blind and visually impaired people. The number of blind and visually impaired people has considerably increased due to thirty years civil war.

Therefore study the need of blind and visually impaired people is an urgent requirement. Once the requirements of blind and visually impaired people are identified it is necessary to provide solutions for them. The development of tactile paving guideline and road infrastructure development guidelines will address these issues. Mainly four different methodologies were used for this research. Initially literature was reviewed. Standard guidelines of developed countries, laws and regulations in our country, previous research papers, websites related to this and relevant publications referred .After that a case study was done on the tactile guide way to identify the practical issues of existing tactile guide way and to study response by blind and visually impaired people. Three blind persons were used for this study. Then a questionnaire survey was done for selected blind and visually impaired people to identify their issues and get their suggestions and clarify issues noticed during the case study. Then the second questionnaire survey was done by giving options which were identified in first questionnaire survey. Therefore second questionnaire survey done after the analysis of data collected from first questionnaire survey.

Finally I interviewed an expert who has experience on this subject. Based on results and decisions made by all these methodologies, our own guidelines and specifications have been developed.

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Determination of Vehicle Kilometers Travelled and to Find Methodology for Calculating VKT in Future Years

D.A.S.Jayasekera[1] and W.K.Mampearachchi[2]

Vehicle kilometers traveled is the total kilometers traveled by motor vehicles on the highway system during a given period of time. Vehicle kilometers traveled by passenger automobile is an important variable in the analysis of fuel efficiency, fuel consumption, environmental quality, and highway safety. Changing patterns of future vehicle kilometers traveled have significant applications for energy conservation and economic stability. This report evaluates fuel pumped data for vehicle kilometers traveled and fuel consumption. Collection, reporting, consolidation, and estimation procedures are addressed. Since direct measurement of vehicle kilometers traveled has never been made, the surveyed information consists of indirect estimates based on various sets of assumptions. The type of assumptions and the reliability of the data determine the models that can be meaningfully tested. Historically, the importance of vehicle kilometers traveled accumulation has been directed toward highway planning and included such areas as traffic density, highway safety, and other non-energy-related areas. For these non-energy endeavors, the traffic-counting methodology has been the procedure used most widely by the individual states to estimate vehicle kilometers traveled. However in Sri Lanka, Estimation of Annual kms by vehicle type from Interviews is done in 1992 by Prof. Amal S. Kumarage but this estimation is carried out for determination of vehicle kilometers traveled based on volume of fuel pumped, average fuel volume utilized for different vehicle classifications.

Key Words: Fuel Consumption, Vehicle Kilometer Travelled (VKT), Passenger Automobile, Fuel Efficiency

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Road Maintenance Management System

P.J.B.Lenadora[1]

Road Maintenance Management System (RMMS) was implemented to assist the decision making of the Eastern and North Central Provincial Road Management Agencies of Sri Lanka with funding from the ADB.

The road network of Eastern and North Central and Eastern Province comprised of 1100 kms and 2000 kms of Class C and D roads respectively which comes under the purview of the respective Provincial Road Management Agencies. These Class C and D roads provides the connectivity to the rural populations and facilitate the transportation of their agricultural and other produces to the Class A and B National road network maintained by the Road Development Authority.

The system was developed with HDM-4 as the core decision support engine, A simple to operate Geographical Information System with query facilities, Road Information Database, Road Structure database and the software framework to provide the inter-communication between the modules and the other common applications such as MSWord, MSExcel etc. MSAccess was used as back end database and MSSqlServer was used to support spatial queries in the GIS module. The aims of the endeavor were to develop a highly user friendly "one stop shop" style application for the agencies which was considered important for the sustainability of the system itself. The system provided the tools for optimum road maintenance planning and road prioritizing methodology considering social benefits and equity in geographical distribution.

The outcomes of the projects were the development of complete inventories of the C and D class roads and road structures, maps of the entire road network, tools for systematic road maintenance management and a road information system that provides all the day-to -day information for all levels of staff of the respective provincial road agencies. The development of detailed database can also be considered as a good foundation for further studies and researches such as pavement behavior and the significance of social factors in road development prioritization.

Key Words: Road Maintenance Management System, HDM-4

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Passenger Arrival and Waiting Patterns at Terminal Service Centers at Bandaranaike International Airport

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Optimizing passenger movements through an airport terminal is one of the important accomplishments to reach in efficient functioning of an airport. Minimizing delays at critical service centers within terminal such as ticket counters, immigration, baggage claim and security checks could improve the passenger throughput.

Arrival pattern of passengers at different service centers could vary depending on the airport location and the operating strategy of the terminal. Knowledge on arrival and waiting patterns at the key service centers will help modeling the passenger flow through a terminal. This paper presents passenger arrival and waiting patterns at selected terminal service centers at Bandaranaike International Airport, Katunayake, based on surveys carried out over twelve weeks period.

Data collection was done by observing the various terminal service centers such as ticket counters, immigration, baggage claim, and security checks over around three months period. Based on the flight schedule in each month at BIA, data on rush hours (night shift) and non-rush hours (day shift) of rush days and non-rush days were collected.

It can be seen that arrival pattern at ticket counters follows normal distribution and the passengers' average waiting time at the ticket counters is around 120 seconds with standard deviation of 67.8 seconds. The service time at the check-in-counters follows lognormal distribution with mean 191.7 seconds and standard deviation of 131.3 seconds and the passengers' waiting time at the check-in-counters follows lognormal distribution with mean 1101.7 seconds and standard deviation 1087.3 seconds. A lognormal distribution is a continuous probability distribution of a random variable whose logarithm is normally distributed.

Key words: Normal distribution, lognormal distribution, continuous probability distribution

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Study of Airport Curbside and Parking Area Operations at Bandaranaike International Airport

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Airport Curbside, where travelers and their baggage enter exit the terminal, and parking area are important components in airport land-side facilities. Passengers expect safe and efficient roadway operations even as volumes increase, but the design and capacity of the curbside are often constrained by the terminal building and the proximity of on-airport land-side infrastructure. The operating characteristics of airport terminal curbside differ significantly from those of most other roadways due to several reasons such as vehicle dwell time, maneuvering of vehicles to and from adjacent lane, variation in demand etc. The capacity of a curbside roadway is defined both by the number of vehicles that can be accommodated while stopping to pick up or drop off passengers and the number that can be accommodated while traveling past the curbside in the through lanes. Therefore a study of operations at curbside and parking area is important to identify issues that will occur based to existing and future demand levels.

The main focus of the research is on the evaluation of vehicle operations and passenger behavior at the airport terminal access roadway, weaving segment, arrival and departure curbside roadways and terminal car park. Analysis of vehicular traffic, travel mode choices, and curbside roadway vehicle queues, vehicle dwelling times, passenger occupancy time at curbs and passenger processing and walking times will provide useful information for developing plans for operational improvements as well as for future expansions. Using the available data, the demand and capacity at these facilities are evaluated to estimate the existing level of service. In addition, measures were identified to improve the operational efficiency of these facilities and design improvements are proposed to ensure good operational efficiency for the forecast future demand.

Key words: Curbside, Weaving Segment, Terminal, Dwelling Time

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