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Plenary Session

Sustainable Transportation for Indian Cities
Problems, Issues, Challenges and Opportunities

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The vision for any city need to ensure easily
accessible, safe, affordable, quick, comfortable, reliable and sustainable mobility for all in our towns and cities .Thus the Components as well as Problems of Transportation system are examined and Sustainable Transportation Systems are explained through case studies. Sustainable Transportation for Indian Cities are planned in the light of

- Transit-Oriented Development
- Integrated Mass Transit Modes
- Transportation Fuels
- ITS

Development of Guidelines to Improve the Transport Infrastructure to Address the Mobility of Blind and Visually Impaired 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 after facing difficulties they encounter by going to various places by themselves. These difficulties are very often magnified in the absence of facilities for them in the society. By introducing facilities on road infrastructure and public transport can substantially transform the livelihoods of blind and visually impaired people and their families. Lack of accessibility and mobility will discourage this sector of society in finding employment, gain access to education and health services and also will limit their social and recreational activities. Therefore these people should be able to travel independently within their locality or in urban and suburban areas at least for their urgent needs using public transport. Therefore study of the need of blind and visually impaired people is an urgent requirement.

Initially local and international guidelines, publications and literature were reviewed. It was noticed that international guidelines cannot be directly applied to local environment, since the road infrastructure and transport systems are different from those in developed countries. There were situations where guidelines given in one country is different from the other. Those details and positive and negative outcomes of previous studies were taken for the case study. Based on the outcome of the case study, An opinion survey was done for sample of blind and visually impaired people to identify their issues and get their feedback and suggestions and clarify issues noticed during the case study. On the outcomes of opinion survey solution options were developed for questionnaire in order to identify their preferred option. Finally a mobility expert trainer was interviewed.

Outcome of the study revealed how barrier free environment can be created on road infrastructure, bus transport and by tactile tactile paving. It is very important to maintain the consistency everywhere. Therefore three guidelines; (1) road infrastructure, (2) bus transport and (3) tactile paving were developed as a part of this study to suite local road environment. The guideline for road infrastructure provides guidance for planning, dealing with obstructions on footwalk, kerb ramps safety measures, provision of resting facilities, information signs, colour contrasts etc. The guideline for bus transport provides information for bus stops, bus shelter, boarding area, seat reservations, payment methods, information signs, discipline of

driver and conductor etc. This guides places where tactile paving is necessary, warning and directional tiles, selection of colour contrast, background paving, paving at road crossings, bus stops etc. Guidelines developed under this project will create a barrier free environment and help blind and visually impaired people to be more independent.

Key words: Visually impaired, Tactile guideline

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Assessing the Appropriateness of Providing Separate Openings for U-Turns at Signalized Intersections

Nadika Jayasooriya[1], Loshaka Perera[2], Saman Bandara[3]

Generally the right turns along with the U turns is one of the main contributory factors for the delays at signalized intersections. If any intersection is experiencing a high amount of U turns, the effective time that can be allocated for the other phases and directions would get reduced. Therefore if time given for the U turns can be reduced at the intersection, sufficient amount of capacity improvement can be obtained and thus the congestion at the intersection can be reduced.

The concept of providing separate openings for U turns has been experienced in the world, with concepts like super street junctions or j junctions, but no significant research was conducted based on the applicability of such in the Sri Lankan context.

With respect to that, the objective of the research was to assess the appropriateness of providing separate openings for U turns at signalized intersections in the local context. Further it is needed to develop a guideline to be followed when introducing separate openings for U turns.

The Orugodawatta junction was considered as a case study, whereas high number of U turns are observed at the junction for North bound direction and a 12 hour traffic flow count was taken on an average week day along with a video recording.

Based on the basic analysis it was obtained that, 5% of the vehicles travelling North bound Direction are U turns which is quite high for a normal intersection. Further, it was found that out of all the vehicles traveling in North bound Direction, 17% of the vehicles can be considered as either right turns or U turns. On the other hand, out of all the right turns occurring from south to east direction, 25% of the right turns are actually U-turns, which is very significant. It is also observed that on average a right turn takes nearly 1 second and a U turn takes nearly 3 seconds.

Blink 2005 software, which is specifically designed for traffic signal designs is used for further analysis. A comparison is done based on the Cycle time between the two instances, with and without the separate opening and it was obtained that the cycle time at the present situation is 291 seconds and with the introduction of the Separate opening the cycle time can be reduced to 240 seconds.

Further, cycle time variation for different proportion of U turns are also calculated. Based on the results obtained it can be concluded that more than 10% of the cycle time reduction can be obtained when the U turns are more than 15% of the total right turns occurring at a signalized intersection, by eliminating the U turns and introducing separate openings for U turns.

Key words: Separate U-turn opening, Delay at signalized intersections, Intersection geometry

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Determination of Longitudinal and Lateral Friction Standards for Sri Lankan Roads

S.Thanenjeyan[1], H.R.Pasindu[2], W.K.Mampearachchi[3]

In recent years, Srilanka has an unprecedented scale of adding new roads and expressways through funding from various foreign agencies. During last few years, more than **4500 km** length of '**A**' and '**B**'class has already been improved and open to public. With the improvement of roads, the exposure to accidents appears to be significant. Though appropriate methods are adopted during the design stage to ensure the road safety and due considerations were taken during the construction stages, it is wondering some significant accidents are taking place and it may be purely because of the nature of the new road for road users. Pavement friction design is one of the key elements required for ensuring highway safety.

The longitudinal as well as lateral friction determines the functional performance of the roads. The geometric design is carried out in Srilanka is based on Austroads, AASHTO publications and the guideline of RDA publication in the year of 1998, which is also prepared based on Austroads and AASHTO publications. It is a timely decision in local context to test the applicability of these parameters and to find out any variations and to provide recommendations. The outcome from this research will be very useful in the geometric design of highway, Pavement Management and construction techniques. An extensive literature review was carried out and based on the methodology and guidelines cited and it is experimented in local roads for dry and critical wet conditions.

The information provided, will serve as the basis for many of the guidelines and recommendations. Most importantly, it presents information on **a)** Coefficient of longitudinal friction for asphalt **b)** the design of highway improvements with the longitudinal and lateral friction.

Keywords: Longitudinal and Lateral friction, Pavement management, Geometric design

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Development of Thermally Comfortable Paving Block Arrangement for Pedestrian Walkways

H.A.C.K Hettiarachchi[1] and Dr. W.K.Mampearachchi[2]

Interlocking concrete block pavements are used to pave walkways, parking lots, roadside pavements, open spaces, religious places etc. where people used to walk. The pavements are subjected to heavy thermal loads during day time in tropical countries like Sri Lanka. Surface temperature of these pavements rise up to more than 50 degrees of Celsius during daytime. Maintaining surface temperature at a comfortable level is one of the key challenges that modern block pavers are facing.

To reduce the effect of temperature rise and maintain the thermal comfort, the behavior of the ICBP under different conditions need to be analyzed. Thermal behavior of interlocking concrete block pavement is mainly governed by the solar radiation. When the pavement is exposed to solar radiation the block gets heated. Several factors such as heat capacity, convection film coefficient, heat conductivity directly affect the temperature of the ICBP.

A finite element model was developed to predict the thermal behavior of the ICBP and the model was validated using obtained experimental data. The verified model was used to predict the thermal behavior of different arrangements. Simulation was done changing the physic of the block and also changing the laying arrangement of the block.

When the simulation was done for different conditions it is observed that,

- Increasing the gap does not affect significantly in reducing temperature
- Leaving the gap with air can reduce the temperature
- Block with vertical holes can be effectively used to reduce the temperature of top surface on pedestrian pavements.
- Change in the block size can be used effectively to reduce the surface temperature

Combination of above mentioned parameters were also simulated and the temperature reduction of selected combination was observed.

Keywords: interlocking concrete block, Thermal behavior, finite element model

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Framework for Traffic Incident Management for Colombo Municipal Area

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Various locations of Colombo City are frequently affected by traffic congestion daily. This may be due to insufficient road capacity during peak hours. But other times it is due to various incidents that occur here and there. An incident that occurs during peak hours worsens the congestion.

Since congestion causes delays, wastage of human resources and fuel, increased rate of accidents, environmental pollution etc. improving the situation is utmost necessary.

Even though the importance of minimizing the congestion has been realized by relevant authorities, they are reluctant to implement any plans considering possibility of high cost involvement.

This study proposes a framework for managing traffic incidents with the available resources and existing institutional setup.

CCTV Cameras and Variable Message Signs

It is proposed to establish CCTV cameras at main junctions and Variable Message Signs just before and after the junctions along the main corridors, based on a criteria of selecting only main junctions, which provide another alternative route for the main corridor considered. As majority of the main junctions have already been equipped with CCTV cameras installed, only a few remaining junctions are to be fixed with cameras to cover the entire area. Vicinity of the city limits also taken into consideration for the incidents near to city limits.

Message sign boards proposed to be fixed are having three different sections to show permanent direction markings, variable messages displayed and indicator lights. Variable messages and indicator lights are controlled by the Traffic Operations Centre. These indicator lights gives approximate traffic condition of the proposed alternative routes.

Traffic Operations Centre

The Traffic Operations Centre gets the messages, analyzes it and displayed suitably in the display panel. The centre is already in operation for monitoring activities, even though the cost of establishing is not there, necessary expansion of the centre will be required. Since it is necessary to display fairly accurate details in the signboard, well trained officers with sufficient

traffic knowledge should be employed for this center. CCTV cameras will help to obtain real time updates.

The Traffic Police who is currently involving with incident management, with the coordination of the Colombo Municipal Council and other stake holders and with a minimum improvements or modifications to their institution, could undertake this in an efficient way. Initial investment for Variable Message Signs, CCTV cameras and modifications to Traffic Operations Centre and for other improvements would be required but small when compare with the losses due to congestion.

The system could be integrated with the agencies operating public car parks and an efficient parking management done. Parking also another main reason for the congestion. Gradually, private car park owners also could be entertained to display for the convenience for their customers.

Funds for Maintenance

Following Possible ways proposed 1. Fines imposed with the help of cameras. 2. Advertisements related to parking availability and other commercial activities.

Keywords: Congestion, Incidents, CCTV camera, Traffic, Variable Message Signs

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Review of Roundabout Design Parameters and Development of a Roundabout Design Guideline for Sri Lanka

E.M.C.B.Ekanayake[1] and W.K.Mampearachchi[2]

Sri Lanka has been thriving through rapid development process with the ending of the civil conflict. Currently people of Sri Lanka are experiencing a local industrial revolution especially in highway and transportation sector. Increase of accessibility and mobility has led to more trip generation and attraction. Adequate traffic control measures are a timely need in Sri Lanka to develop effective transportation system.

Roundabouts are frequently used in urban areas in Sri Lanka where considerable amount of traffic move across a junction to function the traffic controlling effectively. However there is no proper guideline to design roundabouts in Sri Lanka. Increasing traffic and use of long vehicles resulted in malfunctioning some of the roundabouts. Geometry of roundabout has great influence on operation of the roundabouts.

Main objectives of the study are to review the roundabout design guidelines and identify the issues in existing roundabouts. The other objective of this study is to formulate a roundabout design guideline for Sri Lanka.

Five major design guidelines were considered to compare the design parameters of roundabout geometry. Twenty three number of roundabouts spread over major cities were considered for study. Main geometric parameters of each roundabouts were collected using Satellite images calibrated and validated using field measurements. Parameters of local roundabouts have been analysed with the standards of international Roundabout guidelines. Swept path analysis was carried out on selected roundabout layout for single unit truck to determine the adequacy of entry width, circulation width, exit width and operational speed.

Design parameters that need to be improved on existing roundabout will be identified and suitable values for selected design parameters will be proposed.

Key words: Design Parameters, Guidelines

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Animal Collision Induced Road Accidents in the Southern Expressway

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Declaring open the Southern expressway in November 2011 marks a major milestone of the future road network development in Sri Lanka. Ensuring road safety is one of the key considerations during the operational phase of an expressway as vehicles travel at a much faster rate, which will increase the probability of road accidents. During the period, November 2011 to December 2013, 1023 road accidents have taken place in the Southern Expressway. Out of these, 20% have resulted due to animal-vehicle collision. Animal-vehicle collisions could result in property damage, personal injury or fatalities to the commuter. This study was undertaken to analyze temporal and spatial patterns of animal induced road accidents reported in the southern expressway that would inform development of mitigation measures to reduce the incidence of road accidents caused by animal collision. Accident reports available for animal collision related road accidents during the period, December 2011 to December 2013 was collected and analyzed to identify animal collision patterns. During this period 173 road accidents have taken place. Out of these 172 accidents only involved only a single vehicle while one of the incidents involved two vehicles. Further, 98% of the incidents (169) resulted only property damages while the remaining four incidents have resulted in injury to the 10 commuters. During the study period no fatalities have resulted due to accidents due to animal collisions. There was no significant difference between the incidence of road accidents resulting due to animal collisions reported in the Galle bound section (87 incidents) compared to Colombo bound section (86 incidents) of the highway. The rate of accidents resulting due to animal collisions has reduced by 11% during the second year of operation compared to the first year. Animal collision rates fluctuated over time with highs in April and July and lows during March and May. The highest number of incidents was reported in the stretch between 80 and 90 km followed by 21 to 30 km stretch. Out of the 173 accidents recorded, 70% (121 incidents) have resulted due to collision with dogs followed by pigs (20 incidents), birds (20 incidents) monkeys (7 incidents). Out of the 20 accidents reported due to bird collision 13 have resulted due to Peacocks. Other animals that have resulted in accidents include land monitors, buffaloes, goats, porcupines and foxes which have all contributed less than 5% of the incidents. The road accidents resulting due to collision with dogs have undergone a 33% reduction during the second year of operation compared to the first year. Out of the 173 animal collision related road accidents reported 74% involved motor cars followed by vans (11%), jeeps (8%), cabs (5%), busses (1%) and lorries (1%), indicating

smaller vehicles are more susceptible for animal collision related road accidents. Out of the reported animal related road accidents 58% have occurred during day time and 87% of these accidents have occurred on sunny days while the rest on rainy days. Further 83% of the animal related road accidents have taken place on clear days compared to 13% that have occurred during rainy days. Therefore, lack of visibility or whether condition may have not contributed to animal related road accidents. This study indicates that animal related road accidents show clear spatial and temporal patterns that can be used to develop mitigation measures in the future.

Keywords: Animal-vehicle Collisions, Southern Expressway, Road Accidents

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Development of a System for Rating of Hazardous Locations along National Highways

Tharmini.K[1], W.K.Mampearachchi[2], J.M.S.J. Bandara[3]

In highway safety plan; identification of hazardous locations on highways is one of the most important factors. In this study the geometric of road is considered to identify the hazardous locations with the concern of design standards of Road Development Authority, Sri Lanka.

Availability of accident data is a significant requirement for identifying hazardous location of roads. However, for roads with poor accident data sets or no accident records, a method is needed to find and rank road segments with respect to road geometry independent of the accident records. In this study, initially hazardous locations or section of roads were identified based on ***Geometric Design Standards of Roads*** published by Road Development Authority on 1998. Then major parameters of road geometry such as horizontal alignment, vertical profile and road side activities and combination of these; are considered as main influence elements and identified the venerable factors of the each element. After that the relative contribution of the elements to the safety of critical location or road sections was determined by using the Analytical Hierarchy Process (AHP) with a system of scores which were suggested by an expert panel. Subject to a consistency test of the expert responses, AHP determines the weight of the elements. On which the horizontal radius is identified as most critical parameter of the geometry element, to induce accident prone hazardous location followed by long straight section or series of curves with small straight section with influence of the site condition.

Key Wards: Hazardous road location, Geometry elements of hazardous on road and Road Safety

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Identify Possible Reasons For Accident Occurred In Southern Expressway

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Southern Expressway, the first ever access controlled expressway in Sri Lanka was started to function in year 2011.Total road length from Kottawa to Pinnaduwa is 126 km and there are eleven interchanges within that length. Government of Sri Lanka is expecting lots of benefits through this expressway. Safety consideration is essential in any of the road project. Even though there is several safety precautions are provided, about 1100 number of accidents have been reported up to now. Since “expressways“ is a new topic for Sri Lanka , perception about it will be bad due to this and discourage the road users. Therefore identifying possible reasons for the accidents and accident prone locations is essential to provide immediate safety improvements.

Main objectives of this research are identifying accident prone locations, identifying possible reasons for the accidents and calculate the accident rate based on the vehicle travel kilometre.

It could be identified the nine number of most critical accident prone locations and by detail analysis of those prone locations found out the possible reasons for the accidents. In addition to that since the traffic data is reported daily it could be find out the accident rate based on the accident travel kilometre which is more accurate than other methods to calculate accident rate. Road user and the road environment are the two key factors contributed for the accidents based on the accident data of the Southern Expressway collected from the Road Development Authority and Sri Lanka Police. Since it is very difficult to carryout accurate analysis for the contribution of road user with the recoded accident data, this study was mainly targeted on the second important factor, road Environment to the accidents.

According to the analysis it could be concluded as there is a higher possibility to occur accidents during rainy weather under the slippery road condition. In addition, driver fatigue was identified as a contributory factor for accidents of long distance travellers (travelling distance is more than 40 km).

Key words: Road Accident, Accident Analysis, Southern Expressway

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Valuation of Road Accidents (Damage Only Accidents)

B.A.Sampath[1] and H.R.Pasindu[2]

Road crashes impose large human and financial costs on society. Each accident consist economic cost and social cost of pain, grief, and suffering of families of the victims. It also has an adverse impact on the resources of the government. The main objective of the study is to develop a detail and comprehensive methodology for the estimation of unit accident cost for damage only accidents and secondary objective is to determine the accident unit cost figure for damage only accident in Sri Lanka. The Human Capital (HC) approach, specifically the Gross Output methodology, is adopted for estimation. The results indicate an estimated cost of damage only accidents in Sri Lanka of Rs. 838.4 million for the year 2013 and cost per unit accident as Rs. 104,576.72. This study has shown that it is necessary to update the annual traffic accident costs regularly, as the figures vary with the number of accidents which change with time.

Keywords: accident cost, human capital approach, gross output methodology

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Effectiveness of Resettlement Approach of Road Development Authority to ensure Social justification for Affected People: Case Study on Colombo - Katunayake Expressway

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The development of roads improve the connectivity, reduce regional disparity, open up new markets, generate employment opportunities and thereby bring benefits to majority of the population reducing poverty. However, some people are becoming affected by the negative consequences of these projects. With the introduction of expressways, the population affected by road development has increased during the last decade. The main responsibility of resettling these affected people lies with the executing agency of the project as per the legal framework of Sri Lanka.

Road Development Authority (RDA) has carried out resettlement planning for projects during last decade. In carrying out resettlement RDA has taken initiative for many projects like Baseline Project, Outer Circular Highway (OCH) and Southern Transport Development Project (STDP). This study mainly focused on the Colombo Katunayake Expressway (CKE). The study involved household survey, case studies and key informant interviews as primary data collection methods along with secondary data. The land acquisition for the project was started in 1999. Two resettlement sites namely Wanawasala and Meegahawatta were developed for affected people in the Kelaniya Divisional Secretary area by the project.

The findings of the case study reveal that housing conditions of the affected people have a positive increase over the past years. However, the re-settlers claim that they have not received title deeds for the land plots in resettlement sites and they have issues in finding schools for children.

keywords: Land Acquisition, Resettlement, Colombo Katunayake Expressway

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Trends in Heavy Vehicle Crashes in Sri Lanka

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Around 2,250 number of people die annually in Sri Lanka from road accidents. In 2013, the heavy vehicle percentage of the country is 8% but its involvement in fatal crashes is 21%. Therefore it is evident that heavy vehicles are playing a major role in fatal crashes. Finding the causes for these accidents and finding proper engineering and other solutions to minimize them have become of great importance. In order to find out the critical conditions and contributory factors for the severity of heavy vehicle crashes, a logistic regression analysis was carried out using accident details of heavy vehicles for the year 2013 extracted from Sri Lankan Police Accident Database. In the analysis, accident severity was considered as the dependent variable and crash factor for severity, vehicle ownership, validity of license, weather condition, road surface condition, location type, time of accident, urban\rural condition, light condition, road surface condition were considered as independent variables. Accidents occurrence at 'Y' junctions, SLTB bus involvement, drivers with probationary driving license, hitting a fixed object were found to be as having a significant effect on the severity of heavy vehicle crashes.

Key words: Heavy vehicle crashes, Logistic regression

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Criterion for Selecting Appropriate Rapid Transit Technology for Colombo

G.G.S.Geethanga[1] and Prof. J.M.S.J. Bandara[2]

Traffic congestion is a condition on road networks that occurs as use increases and is characterized by slower speeds, longer trip times, and increased vehicular queuing. As demand approaches the capacity of a road (or of the intersections along the road), extreme traffic congestion sets in. Traffic congestion contributes to waste of time and money every second. Many developed/developing countries find solution for the traffic congestion at roads with the help of rapid transit systems.

Rapid transit systems that are widely in use can be dividing in to four major categories; Mass rapid transit (MRT), Light rapid transit (LRT), Monorails, Bus rapid transit. (BRT)

The main objective of this research is to find a criterion for selecting most suitable rapid transit system for Colombo Metropolitan Region from among the above four types. The study consists of collecting user preference based on a questionnaire survey, evaluating different systems based on considering land availability, passenger demand, road network system, passenger transfer from other modes & environmental issues, and calculating costs & benefits for each rapid transit system. A case study for Battaramulla corridor is presented.

The questionnaire collects from the passenger who travels the Battaramulla-Fort corridor. This road section is highly congested at peak time and it will be increase at future due to administration city will become Sri Jayawadanapura Kotte. Hence it is essential to give proper solution for the increasing traffic in this corridor.

In addition to user preferences the questionnaire focuses on the drawbacks in existing systems, user expectations for a new system. These were used to identify the user related issues in existing systems and to find whether a rapid transit can address those issues.

According to the survey results, more than 50% respondents of indicated that BRT may be the better option for Colombo. Most of the passenger who travel daily for the work and low income (less than Rs: 50,000 per month) prefer BRT over others.

According to the cost for install of new rapid transit system, MRT is more expensive than LRT system. Source of power can be use as Electrical power system because we have limited power supply for usage .Alternative other solution of energy we can think of renewable energy. BRT system need to more space than improving the current system and Monorail system is

consume less space and required the mode of power to operate. The land value is going up day by day it will take considerable cost for land acquisition. According to the cost calculation for the selected road trace of Battarmulla -Fort, It is considerable cost reduction for the BRT system than the installation of Monorail system.

It is required to establish criteria based on the cost /benefits, passenger's preference, accessibility, connectivity with other modes, future expansion possibility, incentives for the land use development along with new system and emission levels of vehicles.

According to the research, passenger preference for the BRT system, with the connectivity with other modes monorail systems is better than BRT. Possibility of future expansion of the system, there is a difficult with BRT system due to problem of Land acquisition. That can create significant social issues due to resettlement of people. From the environment point of view, more missions are expected from BRT system as compared to Monorail. Incentive for land use development along with BRT is restricted due to limited access to other vehicles considering all of the above monorail seems to have an edge over BRT.

Key words: Rapid Transit Systems, selection criterion

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Identification of Possible Reasons That Affect Departure Flight Punctuality

S. A. N. Sarojanie[1] and J.M.S.J. Bandara [2]

A flight is said to be delayed when an airline flight takes off and/or lands later than its scheduled time. The Federal Aviation Administration (FAA) considers a flight to be delayed when it is 15 minutes later than its scheduled time. Punctuality is one of the key performance indicators in the airline industry and an important service differentiator especially for valuable high-yield customers. In addition, improved on-time performance can help achieve significant cost savings.

This is a critical issue in the air transportation industry since it generates lot of problems to the operation and the inconvenience for the passengers. Once a delay is occurred, it is totally affect to the entire airline network and it will then effect to the passengers. Flight delays are an inconvenience to passengers. A delayed flight can be costly to passengers by making them late to their personal scheduled events. A passenger who is delayed on a multi-plane trip could miss a connecting flight. Anger and frustration can occur in delayed passengers. Hence airlines are always interested in making delays a minimum.

This study focuses on identification of possible reasons for departure flight punctuality and a case study carried out on the National Carrier of Sri Lanka is presented. Attention was given to identification of departure flight delays, identifying critical delay types and finding their reasons based on Srilankan Airlines monthly delay reports.

The findings of the analysis represents that there are 6% of Technical delays, 9% of Unavoidable delays, and 8% of Airport delays and 5% of Air Traffic Control delays out of average departure delays per day. The average delay time due to technical delays is 1.22hrs and average delay due to uncontrollable delays such as weather, late reporting of crew due to road traffic ant etc. is 0.34 hrs. Airport facility delays contribute on average 0.16hrs and average delay due to and of Air Traffic Control is 0.10 hrs per departure flight.

Keywords: Departure flight delays, Aircraft Punctuality, Policy and Regulations

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Lessons Learnt From Humanitarian Logistics of the Short Term Tsunami Reactions in Sri Lanka In 2004

P.T.Ranil Shanaka Sugathadasa

In 2004, short-term humanitarian logistics and supply chain for the tsunami relief operations were carried out mainly by the Sri Lankan government's formal leadership with the integrated support of community, NGOs, military and private sector. However, the informal relief operation activities taken by the community, private sector and NGOs also complemented the government's formal relief operation. In the remote areas, all the relief operations were handled by the military with its infrastructure and expertise. Sri Lankan humanitarian logistics comprised flow of people, food, shelter, clothing, heavy machinery, and medical supplies together with financial and information flows.

Supply chains and logistics have a vital role to play at a time of crisis in order to save lives and minimize suffering. Efficiency and effectiveness of supply chain and logistics process will decide the effectiveness of short-term reactions such as relief operation and medium term reactions such as restoring infrastructure facilities such as health, transport as well as rebuilding the disaster affected infrastructure and buildings

The key findings of the short-term humanitarian logistics and supply chain for the relief operation may be summarized in the following key findings.

- The Sri Lankan government led the process with the integration of community, military, NGOs and private sector to rescue the affected people and to supply the essentials to the affected people.
- The informal and adhoc initiatives taken by the community, private sector and NGOs was encouraged in the short-term relief operation alongside the planned interventions by the government. This ensured that the synergy of the governmental macro plan and the micro plans of communities, NGOs and private sector for a common goal.
- Support of the military was fully incorporated into relief plan because they had the equipments, infrastructure and training to be an effective facilitator. This is specifically important in remote areas having poor infrastructure. Cohesion and coordination of the teams were encouraged to have an effective team integration to minimize the effort duplication.

- Communication is a vital part of short-term relief operation. As such, formal communication should be encouraged. It will ensure the effective financial flows, which is an important part of the relief supply and logistics operation.

Keywords: humanitarian logistics, restoring infrastructure facilities

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Space Syntax and Mobile GIS Application: Investigation of Relationship between Human Walking Pattern and Spatial Configuration

A.B.Jayasinghe[1] and R.M.P.N.S.Bandara[2]

The process of how people recognize spatial configurations and use them is an important subject for understanding of human walking pattern. Understanding of human walking pattern play a vital role in pedestrian pathway design and city street network design. In this context this study is to investigate the relationship between Mobile GIS is a newly introduced method that facilitate to collect much reliable and accurate data instead of conventional methods and space syntax enables the advance analysis in relation to space.

In this study first actual human walking pattern were captured by using Mobile GIS application. Then spatial configuration and visibility of the study area were analyzed by using UCL Depth map software.

Then visual analysis and spatial correlation were employed to identify the relationship between human walking pattern and spatial configuration. Results indicates that human walking pattern has significant correlation with spatial configuration (78%) and visibility of the space (62%).

Keywords: Human Walking Pattern, Spatial Configuration, Visibility, Mobile GIS

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Study of Critical Success Factors and Impact of ERP Implementations for Warehouses in Sri Lankan Context

G C Dampahalage [1] and P.T. R.S. Sugathadasa [2]

Enterprise Resource Planning (ERP) concept is new to Sri Lanka and considered as a powerful tool for supply chain integration. Most of the third party logistics companies tend to implement various expensive ERP systems without any proper study of their impact and success factors which finally results the implementation an utter failure. This research is a study of the impact of ERP systems and their critical implementation success factors specifically done for the area of warehouse management and has two main objectives. First objective is studying the impact of an ERP system for the warehouse operation performance. This study is done by comparing the warehouse KPIs of after and before the ERP implementation. Second objective is to determine the critical factors that will distinguish between a successful and unsuccessful ERP implementation in a warehouse. The results that are obtained by the second objective can be directly used by the warehouse operators as a best practice for new ERP implementation projects and this information is commercially more valuable in the industry. Data collection was done using selected 15 warehouses for this research using two questionnaires which were answered by the managers, end-users of the system and the consultants of them. With the research the warehouse functions improved as a result of ERP implementation and 19 critical success factors for them were found out. This is the first successful research in Sri Lanka conducted in the areas of warehousing and ERP.

Keywords: Enterprise Resource Planning, warehouse operation performance

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Study of Public Sector Medicine Supply Chain in Sri Lanka, With Particular Emphasis in Medicine Stock Outs

K.D.N.L. Dissanayake [1] and P.T. R.S. Sugathadasa [2]

Sri Lanka as middle income earning country, delivers health care facilities to the general public on free of charge, through government hospitals network. The main aim of the government is to provide superior public health care service to ensure healthy nation. The government medicine supply chain plays a major role in public health sector and currently public hospitals are suffering with major issues like frequent medicine stock outs, quality fail medicines etc. According to recent research findings the availability of medicine in public health care institution is around 50%, while it is over 90% percent in most of private institutions.

The main objective of the research is to identify the main root causes and other supply chain related issues in the public sector medicine supply chain in Sri Lanka, which results above mentioned hospital level issues. The secondary data were collected through literature survey while primary data were collected through questioners and interviews. Both Hospital level and institutional level problems are focused separately and collecting data on those was also done separately. To rank issues based on its' criticalness, descriptive analysis were used for both hospital and institutional levels.

As the final output of the research, critical issues in both hospital level and institutional level were identified. Finally, in the latter part of the research possible solutions to overcome those issues were discussed base on interviewees' ideas in public health sector. The overall research findings and suggestions will paves the way towards excellent public sector health care delivery in Sri Lanka.

Keywords: public health care, medicines

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An Approach to Estimate the Vehicle Travel Time on Un-signalized Two Lane Roads

Gayani S. Galappaththi[1], Loshaka Perera[2], Saman Bandara[3]

Reliable travel time estimation for a given route is important in transport planning. Even though the developed countries in the world have different methods of forecasting travel time from a simple road network to a complex transport network, local availability of such methods are lacking mainly due to the inadequacy of data or investments for the implementation.

Several qualitative factors such as geography, weather, time of travel etc. and quantitative factors such as road geometry, traffic flow etc. affects the time taken to travel. But the fluctuations in these factors cause significant changes in the travel time. There are no any travel time estimation models currently used in the country during the planning stage or in the monitoring stage to check the efficiencies or enhance the current conditions of the road network. The objective of this study is to develop a relationship using different land use patterns to estimate the travel time on three leg intersections accurately for road links in order to build a model for travel time estimation on un-signalized two lane roads.

Trip attraction and trip generation in regions depends on the land use pattern of that area and cause the differences in vehicle travel. Due to this reason this study focus to develop a travel time estimation technique that can be implemented by considering different land use types such as residential, commercial, industrial, accessibility, agricultural/forest coverage etc.

Two lane road sections of three national highways in Sri Lanka; Peliyagoda-Puttalam road (A03), Colombo-Kandy road (A01), Ambepussa-Trincomalee road (A06) were considered for this study to associate the different land use types, different vertical and horizontal alignments and its correlation with vehicle travel times. For this study, travel time data along the roads was collected during peak hours of the day using a GPS (Global Positioning System) data logger. Time taken to travel, Travel length, presence of commercial length, additional number of access roads (access roads present other than intersection connection roads) and number of schools or temples in the intersection were collected for each intersections. Multivariate regression analysis is used to develop the relationship between the land use pattern and the travel time. The model showed a significant positive correlation with Travel length and Commercial length present.

Key words: Three Leg Intersections, Travel Time Estimation, Land Use Pattern, Transport Planning

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