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Problem

The use of bicycle is growing in Australia. The number of people cycling per day increased by 20.9% from 1985/86 to 2011. In the Greater Melbourne area, bike trips to work have increased from 12,124 in 1991 to 25,572 in 2011. Despite the growing interest in cycling, bike safety has remained a major concern. In order to provide adequate information for planning purposes, there is a need to better understand the various planning factors that influence cycling and its safety.

Methodology

Four sets of data are obtained; cycling crash data, socio-economic data, demographic data and land use data. These data are aggregated into the Australian Statistical area level 2 (SA2) defined by the Australian Bureau of Statistics and also into residential and non-residential crashes (as defined in the 1991 census). Spatial analyses of cycling crashes are done to show both residential and non-residential crashes. A negative binomial (NB) model is developed to understand how the various planning factors influence both residential and non-residential cycling crashes.

Results

The NB modelling results show that different planning factors influence the two different models; residential and non-residential crash models. In the residential model, some of the factors identified to have the potential of influencing traffic crashes include; those below the age of 19 years, income and land use mix. In the non-residential model, some of the planning variables that were seen to have a statistically significant influence include; residential land use and industry land use.

Importance of Study

The outcome of the study is very important for regional planning purposes. Variables identified to have the potential of increasing crashes especially in residential areas can be an indicator for planners to understand how our cities should be planned to avoid the risk of increasing cycling crashes.
Understanding Cycling Practices in Sydney
Nicole Mcnamara

Mobilities scholars are increasingly interested in challenging what it means to be mobile in contemporary cities; concentrating on the shifting temporalities, multiple identities, and joy which form part of how we experience everyday mobility. Cycling is one such mobility form that is gaining prevalence in planning Australian cities, due to its well-documented health, social, environmental, and economic benefits. Significant research effort has recognised this in exploring measures to promote and encourage cycling. However, research and policy has given much less attention to understanding cycling practices and experiences in detail. A deeper understanding of cycling practices and experiences can help inform alternative measures to promote and encourage cycling that considers the multiplicity of cycling.

This paper reports on the first 12 months of a three-year PhD project that examines cycling practices in Sydney. The project aims to gain a detailed understanding of cycling practices and challenge how researchers and policy makers view cycling and cyclists. By viewing this as more fluid, we can develop a different understanding of cycling and cyclists as dynamic. Practice theory offers a useful way to gain an in-depth understanding of how practitioners perform cycling, potentially highlighting the multiplicity of practice. However, practice approaches to cycling have been employed in a limited capacity by scholars.

This paper first describes how a ‘practice approach’ informed qualitative research methods, namely the use of semi-structured interviews with cyclists and practice diaries. This is followed by a discussion of preliminary findings, focusing on how the elements of practice are assembled for different cyclists (commuter, recreational and sports/fitness cyclists). This project aims to provide recommendations to encourage sustainable transport, and contribute to a new conceptualisation of autonomous mobility through analysis of freedom and independence as articulated by cyclists.
Electric or power assisted bicycles, known generically as e-bikes, are changing the way some Australians travel. Most significantly that shift is from private motor vehicles for frequently made trips. As in many western countries, cars are the primary mode of transport for most Australians and for many people there are real and perceived barriers to riding a conventional pedal bike including hilly terrain, lack of time, lack of fitness and lack of end of trip facilities. E-bikes can overcome these barriers.

Recent rationalisation of the regulations for e-bikes in Australia, to bring our regulations into line with European standards, has seen an expansion in the range and quality of e-bikes offered for sale in the Australian market. In Europe, e-bikes are one of the fastest growing segments of bicycle sales and the enhanced offerings here have served to stimulate demand. Consequently e-bikes are becoming more common on bicycle facilities in Australia.

While safety implications related to e-bike use have been addressed by international researchers there are often contextual differences which make that research less relevant in an Australian context. This research addresses the role of infrastructure and safety in relation to e-bikes in Australia.

The paper draws on a survey of riders of e-bikes and conventional bicycles conducted in 2015. The survey explored their:

• experience on a range of on and off-road cycling facilities,
• expectations of on and off-road cycling facilities,
• knowledge of e-bikes and attitudes towards e-bikes, and
• perceptions of safety related to cycling when riding both e-bikes and conventional bicycles as well as safety related incidents experienced by e-bike riders.
This poster provides a status on research into some practical methods for assessing sustainability associated with transport and urban form within our cities. Specifically this poster connects to a research discussion at the 12th WCTR in 2010 which introduced the concept of strategic scans of future scenarios to underpin the backcasting approach for trend breaking urban and transport planning. Further updates from discussions in Europe this year are also reported by the authors. These strategic scans are based on a sustainability framework, the elements of which provide evidenced based drivers of sustainability.

The framework culminates in metric visualisations for each of the three pillars of sustainability. The paper details some of the operational aspects of these metrics in the form of environmental sustainability - accessibility space, putting into practice measures of environmental stewardship, social equity and economic efficiency and the relationship between them.

In particular the poster presentation updates how these metrics are evolving and being applied to research on transport structure and urban form and moving towards becoming operational techniques for use in decisions on transport and land use planning on a city scale. Traditional transport and land use interaction modelling methods form the foundations of the required metrics methodology, enabling common land use and transport data to be used for building up a database and typologies of sustainability performance.

The poster concludes with a call for other researchers to participate in developing a typology of sustainability performance using the strategic scan methodology to extend the principles of the methodology into a useful tool for city governments and contribute to assembling a database of city forms & transport structures and their sustainability performance.
Motor vehicle emissions have increased the environmental and public health concerns. Vehicle emission models are an essential tool to conduct environmental impact assessment of transportation activities and traffic management policies. The complexity and stochasticity associated with dynamics of individual vehicles further complicate modelling emissions. Therefore, there is a need for fast and simple methods to model emissions based on aggregate traffic flow characteristics without requiring to describe the dynamics of individual vehicles in a traffic network.

This paper presents the macroscopic fundamental diagram model (MFD) for estimating the emissions of vehicle activity over a large scale network. We use a simulation model to study the relationship between vehicles emission and traffic flow parameters at a network level. The emissions model Enviver, which is based on the VERSIT+, has been used to estimate the traffic emissions of CO2, NOx and PM10 based on a second by second vehicle activity output from PTV VISSIM model.

Recently, macroscopic fundamental diagram (MFD) has been used to develop control strategies to manage congestion in urban traffic networks. Thus, this approach can help evaluate its emission impacts as well as potentially be used to develop control strategies to manage emissions.
Nowadays, visualization of transportation data outputs is widely accepted as a necessary tool to interpret the data and find the trends in such complex space and is now a vital part of the modelling process or project delivery. Nevertheless, one key issue in this regard is the time and skill required for data visualization that may cause unexpected delays in the modelling process and finalization. In addition, due to the lack of a standard publishing format as well as the licencing issues of transportation modelling software, delivery of the projects are still limited mainly to printed maps along with the reports. Consequently, having a tool that can ease the visualization process and publish them in a free interactive environment can be quite advantageous.

In this paper, a developed tool to convert the tabular transportation software outputs to schematic maps and to publish them as schematic three-dimensional maps is presented. The application is relying on Keyhole Markup Language (KML) as a well-known international standard of Open Geospatial Consortium (OGC) developed and supported by Google Earth browsers) and publish the raw data as exchangeable KML files. The basic version of this application is able to read basic GIS Shapefiles, EMME software outputs, tabular Excel files, and Public Transport Data Source (PTDS) data, and publish them as schematic maps enriched with tabular pop-up boxes in KML format. Basic mapping tools such as data clustering, filtering the confidential data, and embedding required pictures and graphs into the pop-up boxes are also developed in this application. Transportation modellers and managers can implement such tool for data interpretation as well as project delivery.
Transit signal priority (TSP) has proven to be a cost-effective solution for public transport vehicles at signalised intersections as it usually does not require substantial infrastructure upgrades, while improving bus travel time and reliability. Numerous studies have focused on the design and operation of TSP, while few have considered the optimum combination of TSP at a corridor and a network level.

However, it is unclear whether the combination of TSP on an arterial or a network creates a multiplier effect on public transport benefits, i.e. benefits from providing TSP at multiple intersections are higher than the sum of benefits from providing TSP at each of those individual intersections. This paper investigates the effects of combinations of TSP measures on signalised arterials to establish if a multiplier effect exists. Results of a modelling test-bed reveal that combinations of TSP measures on signalised arterials can create a multiplier effect on bus delay savings when signal offsets are optimised to minimise bus delays. The existence of the multiplier effect suggests considerable impacts of TSP on a network-wide scale.
T4-8 An Agent-Based Simulation Model to Evaluate a Real-time Passenger Information System in a Bus Rapid Transit Station
Sanghyung Ahn, Jiwon Kim, Antonius Bekti, Stephanie Cipressi, Emma Clark, Lewis Jones, Dongho Kang, Kaci Karlsson and Roland Salita

A Bus Rapid Transit (BRT) station with multiple loading zones tends to have a longer passenger-bus interface and, thus, lead to longer passenger walking times and longer bus dwell times than ordinary bus stops. Previous studies suggest that the passenger-bus interface is further amplified when buses arrive together due to passengers’ increased uncertainty about the bus arrival sequence and the stopping location of their desired bus. As a way to reduce bus dwell times in a BRT station, this study focuses on eliminating delays in passengers’ reaction to their desired bus by designing an improved passenger information system (PIS) that can increase passengers’ certainty about the bus stopping location. In particular, this study considers the integration of a real-time loading zone assignment capability and a real-time PIS. The proposed system dynamically assigns the optimal loading area to an oncoming bus and provides the assigned loading zone information to both the bus driver and the passengers so that the passengers can proactively move toward their designated loading zone with certainty in advance. An agent-based simulation approach is used to model dynamic behaviours of heterogeneous passengers on a BRT station platform. This paper develops the agent-based simulation model based on observations from a BRT station in Brisbane, Australia, to reflect a real-world BRT operations and passenger flows. The input parameters (e.g., bus headway, dwell time, drivers’ reaction time during vehicle movement from stationary position, etc.) for the simulation model are calibrated with actual data including smart card records, field measurements, and video recordings. Various what-if scenarios representing different PIS settings were constructed and analysed. The findings from the simulation analysis suggest that the loading zone notification strategies can increase BRT station bus capacity as well as improve service time and rate.
Lane change models are one of the basic driver behaviour interactions in microscopic traffic simulations of traffic, safety and transportation system analysis. However, many of the present traffic simulations mostly pay attention to the lane changing decision process, while the lane change execution process is often simplified or even ignored. This paper presents a study of mandatory lane change (MLC) execution and proposes a surrounding traffic impact model on MLC. It studies lane changing behaviours on an arterial road where there is a block occurring on the curb-side lane to investigate the execution process. When the mandatory lane-changing vehicle shifts from the current lane to the target lane, the driver adjusts its lane-changing execution behaviour to complete lane change safely by evaluating the conflict with the direct surrounding vehicles. It is assumed that the driver will adjust its execution if a surrounding conflict is detected and will continue the lane change if there is no conflict around. A probability model is proposed to interpret the surrounding traffic impact to driver’s choice during the period of lane change execution. The surrounding traffic impact model associated with conflicts was estimated in this paper. In the conclusion, the paper provides a framework for future work in lane change execution models of traffic simulation to assess the traffic safety and road efficiency.
With the growing technological influences mobile phone use while driving has increased dramatically across the world over the past few decades. As a result, drivers are getting distracted and therefore, crash likelihood increases. This study explored the factors influencing drivers’ beliefs about mobile phone use while driving. Participants were 218 Australian drivers aged 17 to 76 years who owned mobile phones and held a valid Australian or overseas driver’s license from 1-60 years. A self-reported survey captured drivers’ demographics (e.g., age, gender etc.), information related to mobile phone usage while driving (e.g., calling and text messaging frequency, purpose of using phone etc.) and driver’s belief about phone use. Seventy percent of drivers reported using phone while driving. A probit model showed that young drivers are more likely to use mobile phone while driving. This study also explored drivers’ behavioral, normative, and control beliefs with regards to mobile phone use while driving. A multiple group Confirmatory Factor Analysis (CFA) was used to explore the effects of driving experience on the beliefs of mobile phone use. Initially, proposed model was not a good fit to the data. Numerous iterations were conducted to achieve and good-fit and internally consistent measurement model. Results of CFA suggests that novice drivers are more influenced to use their mobile phone while driving based on their attitudes towards that behavior not by the influence of their referent’s approval. These findings are significant for insurance companies to determine their risk premium and for road safety practitioners to identify the disutility of mobile phone use in a transport network.
Some models divide road sections into equally sized cells and assume the conditions to be homogeneous within each cell. These models stem from the well known Cell Transmission Model (Daganzo, 1995). More recent models only require tracking the situation on link boundaries to reconstruct a link state, examples of such a, arguably more elegant, model are the (Generalised) Link Transmission Model (Yperman, 2007; Gentile, 2011). In any case, virtually all models adopt a time discretised approach where in each time step the situation on the network is updated, before moving on to the next time interval. In some cases however, time discretised approaches are distinctly inefficient. Consider for example networks where large parts of the network exhibit relatively stable flows. In such cases recomputing the same situation over and over is a waste of computation time. Note that in practice often only small parts of the networks experience (many) perturbations regarding flow, making alternative solution algorithms a viable option.

This research proposes an event based solution algorithm to solve simplified first order dynamic network loading problems. Since the solution algorithm is event based rather than time discretised, it only requires updating when something actually changes on a link. This makes the procedure extremely efficient under relatively stable flow conditions. Various case studies show the correctness of the algorithm as well as demonstrating its suitability for applying it on a large scale networks.
As Bluetooth and navigation devices are widely used on latest produced vehicles, vehicle infrastructure integration (VII) system in Intelligent Transport System (ITS) has been given flourishing expectation because of its detection accuracy and multiple-information collecting capability. This paper suggests an ideal ITS environment where all vehicles are equipped with certain VII device and all vehicles can be recognized by ITS which is capable of memorizing all vehicles’ route choices. This paper proposed an innovative hypothetical theory and algorithm of coordinated ramp metering which takes the advantage of VII system. This algorithm integrates vehicle routing information with coordinated ramp metering by reading and processing the vehicles’ average travel distance along the freeway. Comparison between new coordinated ramp metering algorithm and traditional local ramp metering strategy has been made and travel time saving is observed in new ramp metering algorithm.
Autonomous vehicles (AVs), which are currently in testing on public roads, admit new behaviors that may improve network efficiency. One such behavior is dynamic lane reversal (DLR) on a fine time-scale. Lane reversal has previously been attempted to allocate more lanes to high-demand directions for peak hours. However, the protocols required to ensure safety with human drivers make it too inefficient to switch directions rapidly. AVs may be able to respond appropriately to DLR at smaller intervals through wireless digital communication. Hausknecht et al. (2011) consider DLR in a micro-simulation on entire links. However, alternate configurations, such as a link having different numbers of lanes at different points, are conceivable and might aid in reducing queues or increasing flow. We model DLR on a cell transmission model (CTM), where the number of lanes is constant per cell per timestep. We model this as a mixed integer program when demand is known, which may be useful for small lookahead times when demand can be accurately predicted from vehicles on adjacent links. For larger time intervals, demand may be more stochastic, and to address this we study DLR in the context of Markov Decision Processes (MDPs). Since the number of potential states for even a single link is large, we propose a saturation-based heuristic for DLR on CTM. Results on a city network show significant improvement from implementing DLR.
Number of vehicles on signalised links is a fundamental indicator of the intersection performance and an essential input for the control of traffic signal timing. Traffic signals naturally accumulate vehicle queues for the length of red interval. The green interval must be long enough at least to clear the queued vehicles to avoid a cycle failure. Adaptive traffic signal control requires the number of vehicles on the approach links to estimate the degree of saturation for the real-time optimisation of cycle length and green intervals. This is perhaps one of the most extensively studied topics in the literature. Various types of methods have been proposed based on different concepts such as input and output counts, shockwaves, gap and headway, loop detector occupancy and speed, and so on. Most of existing methods have limitations under specific traffic conditions depending on the estimation principles and associated traffic sensor requirements.

This study proposes a new approach for the real-time estimation of number of vehicles on signalised links through a weighted merge of loop detector time occupancies aggregated in various intervals. The linear relationship between time occupancy and space occupancy has been used for motorway density estimation in the past. This concept is applied to signalised intersections in this paper with necessary modifications and enhancements of the theory. We first demonstrate the implications of using time occupancies aggregated in various intervals for the purpose of number of vehicles estimation. A simple weighted merge technique is proposed together with some early test results under varying traffic conditions. The preliminary test revealed two limitations including: lagging and underestimation in the low traffic volume conditions. Some technical solutions are proposed to these barriers with discussions.
The conventional way of estimating the origin-destination matrix through conducting surveys is generally too complex and expensive. Therefore, many researchers have focused on developing models to estimate the O-D matrix from traffic counts. More recently, with the availability of online traffic counts in large volumes, the practical applications of these models have gained more interest among academics and practitioners. One such data set of traffic counts is available for South East Queensland (SEQ), known as PTDS (Public Traffic Data Interface Specification). This data set is available as part of the “STREAMS Integrated Intelligent Transport System” which is a traffic management system developed for the state of Queensland, Australia. PTDS provides traffic counts for over 20,000 links across South East Queensland, every three minutes. The availability of such a massive data makes the application of O-D estimation models very promising. However, the O-D estimation from this data has one major challenge. The challenge is that the O-D estimation models require knowledge of the network and specific properties of the links such as the Volume Delay Function (VDF) and capacity, whereas the network generated from PTDS data set is neither connected, nor provides all the required information about the links.

To overcome this problem, this study relies on another network, provided by the “Brisbane Strategic Transport Model (BSTM)”. BSTM is a four-step transport model, delivering details on the road network in Brisbane. To perform the O-D matrix estimation, the traffic counts initially are needed to be assigned to BSTM network’s links. However, making this connection is not trivial as the network generated from PTDS data is not an exact match to the network provided by BSTM. Therefore, a heuristic approach is developed to create this connection. This study is aimed to carry out a relaxation of the network matching (conflation) problem as there is no requirement to find the exact match of all the links and nodes of one network to another one. This method will be useful to develop heuristics that perform faster and benefit from particular information available in two sources of data, namely: PTDS and BSTM.
Major construction projects undergo transport analysis to understand trip generation impacts on the network. The results are used to support plans for infrastructure improvements including intersection redesign, public transit investment or bike and pedestrian facilities. Trip generation values are often based on average or peak values, which makes it difficult to account for benefits that might distribute demand over the day or week. Queuing analysis provides a method for coherently analysing traffic demand with the distinct temporal patterns associated with stadium attendance, public transit service, parking facilities and signalized intersections.

This work addresses the construction of a new 60,000-spectator stadium in Perth, WA. Due to open in 2017, the stadium project includes plans to upgrade Victoria Park Drive, improved bus and rail service, bicycle facilities and a new pedestrian bridge from the CBD. Using queuing diagrams, we analyse the capacity of the proposed facilities and their success under different assumptions for spectator arrivals. Queuing analysis estimates the delay in the system and allows us to distinguish delay for stadium users from delay for other network users.

A queuing analysis reveals that, despite high capacity, delay will occur in the system due to highly peaked arrivals. The proposed plans attempt to minimize this delay, but high fixed costs of infrastructure (particularly for rail) reduce the value of some aspects. This approach also reveals the benefits of distributing demand through pre- and post-event activities and off-peak/mid-week scheduled events.
Traffic Flow Prediction Using ARIMAX: A Case Study from M4 Motorway in Sydney, Australia
Milad Ghasri, Emily Moylan and S. Travis Waller

Short-term prediction of traffic flow is an essential tool for real-time forecasting of highway performance. Building on traffic flow theory and fluid dynamics, flows represent the fundamental variable that influences speed and travel time in a given traffic state. Previous work used machine learning techniques (Castro-Neto et al., 2009; Vlahogianni, Karlaftis & Golas, 2005; Vlahogianni & Karlaftis, 2013), statistical modelling (Ishak & Al-Deek, 2002; Chandra & Al-Deek, 2009) and hybrid approaches (van der Voort et al., 1996; Yu & Zhang, 2004) to forecast travel time and traffic volume. Within the range of statistical approaches, time series analysis builds on information about the current and recent states of the system to predict flows in the near future.

The Sydney-Blue Mountains M4 Motorway in Sydney, Australia is considered in this study. Traffic volume measurements are taken at 92 loop-detectors sites in each direction. The model is trained on 30s-average flows from the month of February 2013.

While most of the previous studies focus on prediction at one location or over one distance, and spatial relationships are generally introduced as an external covariate (Chandra & Al-Deek, 2009; Ding, 2011), this study aims to take into consideration spatial cross-correlation in flow prediction. To this end, in the first method, it removes seasonality from the data. Robust, typical values for each time of week are computed from the dataset and subtracted from recent observations to create a time series of the deviations from usual conditions. The resulting time series is stationary and eligible for ARIMAX modelling. The second method creates ARIMAX models for each monitor site location on the M4 corridor taking into consideration spatial cross-correlation, local effects and consistency in the parameters between consecutive locations. The final method is to create a metamodel of the ARIMAX parameters illustrating the variation in the time-series components as well as the external covariates along the corridor.
Traffic congestion and the issues associated with it have had ascending trends in many metropolitan areas during the recent years. Among all contributors to this increasing congestion, traffic crashes both on freeways and arterial roads have been widely acknowledged to account for a considerable proportion of the aforementioned congestion and travel delays.

Crash duration (the time elapsed between the start and the clearance of an incident), as a major decisive factor in the estimation of total crash-incurred delay, has been extensively investigated for freeway crashes in the available literature; whereas the identification of the critical determinants of this elapsed time for arterial crashes still requires further research.

Accordingly, this research will address this gap and investigate the determinants of arterial crash duration such as the crash-specific, temporal and infrastructural characteristics as well as the extent and form of impact these determinants have on the duration, using one year of arterial crash data in Brisbane, Australia.

In many recent duration studies, hazard-based duration models generally and Accelerated Failure Time (AFT) models specifically, have been proven to provide in-depth insight into how the aforementioned determinants affect the duration. More precisely, AFT models allow for the explicit study of the impact of external covariates on the crash survival probabilities at each point of time. Taking advantage of this property of AFT models, this study will investigate the individual and simultaneous impact of the relevant covariates on the survival probabilities of arterial crashes. To serve this purpose, AFT models with both fixed and random parameters will be calibrated on one year of arterial crash records from Brisbane, South East Queensland and the differential effects of determinants on crash survival functions will be comprehensively studied.
Simulation-based Dynamic Traffic Assignment (DTA) models provide a more realistic representation of network traffic compared to static traffic assignment. They could be used to evaluate the effects of different traffic management strategies, infrastructure improvement, and ITS technologies. This paper presents development and calibration of a regional simulation-based DTA model of Melbourne. To improve traffic estimation and prediction accuracy of the model, we present a calibration process for both supply and demand using traffic loop detector data, floating car data, and SCATS data.
T4-20 Regional Dynamic Traffic Assignment Model for Sydney: Lessons Learnt in Developing Input Data

Sai Chand, Neeraj Saxena, Nima Amini, Melissa Duell, Hanna Grzybowska and S. Travis Waller

It is a colloquial truth among modellers that the data you get out is only as good as the data you put in. This is also true in the case of dynamic traffic assignment model that is increasingly being deployed in major metropolitan areas and with the potential to be expanded to many more. The project team explored the deployment of the Metropolitan Area Dynamic Assignment Model (MADAM) for the Greater Sydney Metropolitan Area. This paper describes the process of developing the input data and hopes to offer practical insight from an Australian perspective.

The five input datasets explored in this paper are network geometry, demand, departure-time profiles, signals, and transit data. The majority of the data was obtained from the Sydney Strategic Travel Model (STM3), and supplemented with the Household Travel Survey (HTS), Public Transport Information and Priority System (PTIPS). This article provides insight into the various techniques the team developed in response to data challenges and examines the impact of different sources of data on the model output. This work may provide guidance for future large-scale deployments of dynamic traffic assignment, particularly in Australia. Finally, this paper concludes with a discussion of future model improvements and challenges that may be faced.
The Macroscopic Fundamental Diagram (MFD) remains a common tool of choice for evaluating and controlling urban traffic networks. In particular, the MFD provides a consistent and reliable method to develop algorithms that improve traffic conditions. Similar to congestion, safety is an important externality of traffic. However, there is a limited understanding and theoretical underpinnings for the relationship between MFD and safety. Based on previous studies, generally, traffic flow and speed have been found to significantly influence traffic safety. The theory and relationship with MFD will provide insight into analysing the correlation of crashes and traffic flow, and develop dynamic control measures to improve safety. This is achieved via the assessment of influence areas making use of conflict analysis technique. The results obtained from this analysis are identified via the observation of the simulated traffic patterns, at first, and then a test performed using Surrogate Safety Assessment Model (SSAM) conflict analysis software. The final results provide promising results with regards to the relationship among accident and MFD.
Managing traffic congestion requires accurate knowledge of the causes of congestion on a given road network as well as their relative significance and respective solutions. Previous research has focused on estimating the relative impact of different causes of congestion, which include incidents, weather, work-zone, and special event, using statistical analysis such as linear regression methods. Traditional statistical methods, however, have limitations in capturing complex dependencies and uncertainties in external events and traffic states in urban networks. This study proposes a Bayesian Network (BN) analysis approach to modelling the probabilistic dependency structure among causes of congestion on a particular road segment and analysing the probability of traffic congestion given various roadway condition scenarios. A BN is used to encode the joint probability distribution over a set of random variables that describe scenario variables, which represent factors affecting the congestion level of a target segment such as time-of-day, incident, weather, and traffic states on adjacent links, and output variables, which represent traffic performance measures of the target segment such as flow, density, and speed. A properly configured BN model can be used to (i) quantify the contribution of each cause or the combination of multiple causes to traffic congestion, thereby allowing the identification of leading causes for the purpose of congestion diagnosis, (ii) predict future congestion levels based on the current network situations, and (iii) analyse the likely scenarios (combinations of causes) that produce worst traffic congestion in a study network and their occurrence probabilities. This study develops a methodology to build a BN model based on historical traffic and event data, and demonstrates the BN-based traffic analysis using a study network in Queensland, Australia. The study discusses applications of the proposed BN model in urban traffic congestion management, focusing on its capability to provide a comprehensive data-driven and probabilistic analysis platform for congestion diagnosis and prediction.
The transport sector from conventional Internal Combustion Engine (ICE) vehicles is one of the largest contributors to greenhouse gas and carbon emissions. Due to growing environmental concerns, there is an increasing governmental interest in evaluating policies that can increase the uptake of Electric Vehicles (EV).

This study develops a framework to evaluate the impact of policies for EV uptake. Using the city of Sydney, Australia, as a case, the framework utilizes can calibrates a system dynamic model that explicitly incorporates the life cycle of vehicles, consumer preferences, impact of infrastructure on choice, positive cascading effect on choice due to increased penetration of EVs as well as feedback effects of advertising. And a cost benefit analysis was conducted to evaluate the economic impacts of policies. Five policies were identified that could affect these variables. It was found that improving the station availability and providing subsidy in electricity charge is the best approach to promote the uptake of EV. Though this framework was used in Sydney, this methodology provides planners a tool through which they can evaluate policies related to uptake of new vehicle technologies.
Material transportation within a construction site comprises a large proportion of the activities being undertaken throughout the development of the project. Managing traffic during the various construction phases is a challenging task due to the dynamic nature of the work that is involved in construction activities. A practical way of approaching the organisation of a construction site across the different stages of the project is to adopt a site layout which accounts for the transport routes based on the travel demand amongst the facilities. Previous works address the site layout planning problem using optimisation models that allocate facilities with the aim of minimising an objective function which captures the transportation costs. Specifically, the sum of pairwise distances amongst facilities, weighted by estimated travel frequencies is minimised subject to layout design constraints. The distance metric between facilities is generally assumed to be either rectilinear or Euclidean, and the construction site is often represented as a 2-dimensional region with polyhedral-shaped barriers, representing the building under construction or facilities. However, most existing formulations do not account for the presence of obstacles within the path planning model, hence potentially resulting in non-optimistic layouts. This work introduces a Mixed Integer Programming site layout planning model that tackles the issue of travel impedance due to the presence of barriers on a 2-dimensional plane. We propose a novel heuristic algorithm to solve this problem using an Allocation-Location Heuristic. Results demonstrate that the algorithm is able of finding competitive site layouts when tested on challenging benchmark instances.
Rescuing unspoiled food that would have otherwise disposed into landfill and redirecting it to people in need is a large scale collection, distribution and inventory management problem which deals with simultaneous problems of food waste and hunger. The planning, management and optimisation of such large scale food recovery and distribution networks are problems of critical importance to society, but also represent an exceptionally complex combination of numerous domains and methodologies. The problem described in this study is motivated by the food rescue operations in Sydney, Australia. The data collected from the food rescue organisation shows that the food recovery network is characterized by high volume collection and distribution of surplus food which is uncertain and shows variation with time and space. The network consists of around 500 donors (all types of food providers) and more than 250 recipients (welfare agencies who support different forms of food relief) distributed over an area of 12,000 square kilometres. The number of donors and recipients visited per day is restricted due to the fact that they operate with limited transport resources and the truck has to return back to the depot at the end of the day travelling a long distance. They rescue and redistribute more than 10 categories of food. Not all the categories of food are donated by all the donors. The recipients have their own preference with the different types of food delivered. Also, there is a significant gap between the food rescued and the requirement of the recipients with different types of food which makes the decision making process difficult. The rescue and the delivery of surplus food should meet several criteria such as minimising routing costs and waste as well as ensuring an equitable distribution of the resources collected among welfare agencies. In this paper, we propose bi-objective models to promote their social interest, fair and equitable resource allocation within the food rescue program: maximize the total satisfaction of delivery customers (welfare agencies) and maximize the satisfaction of the least satisfied delivery customer. Both objectives are combined with the traditional transportation cost minimization to provide balanced solutions.
Over the period from 1993 to 2014, Gross Domestic Product (GDP) in Australia increased by more than 90 percent while container traffic through sea port terminals continuously grew by more than 270 percent. Considering the substantial growth in container transportation for the past decade, it is important to investigate what challenges exist in sea port operations and how to create a more efficient and sustainable system of container terminal lifecycle. To this end, this study aims to identify challenges in Brisbane port operations by focusing on reviewing container ships’ waiting time in anchorage and wharf utilisation for the last three years from 2012 through 2014. The percentages of the number of container ships waited for longer than 2 hours for port entry clearance were 15.4 percent in 2013 (Jan-Jun) and 9.5 percent in 2014 (Jan-Jun), respectively. Moreover, the average waiting times in anchorage were 22.2 hours in 2013 and 11.7 hours in 2014 under the order of 40 percentage of wharf utilisation. We thus recreate daily arrivals/departures (i.e., entrance/exit) of container vessels into/from channel and port including tidal changes as animations to analyse delays before entering the port. The animation enables going back to any point in time and space to observe the vessels’ activities as they took place. Waiting times in anchorage that exceed prescribed threshold (e.g., 2 hours) can be automatically identified and flagged for further investigation.

Additionally, a realistic discrete-event simulation (DES) model is prepared based on the historical data to perform what-if analyses as well as to autonomously acquire performance measurements such as each wharf’s utilisation and each vessel’s waiting time. Due to its modular design, the simulation model can be used “as is” to model any other terminals.
A Conceptual Framework toward Integrating Traffic and Construction Simulation in Road Development Projects
Alireza Ahmadian Fard Fini, Taha Hossein Rashidi, Ali Akbarnezhad and S. Travis Waller

Developing roads is a challenging construction operation for both constructors and citizens. Although researchers of transport and construction industry have intensively used simulation software for their own discipline-specific purposes, little have been done to enhance advantage of concurrent application of both simulation environments. To fill this gap, this study proposes a conceptual framework that can be utilized into analyzing interactions between traffic flow and road construction (or rehabilitation) projects. The developed framework is built through a succinct review of relevant literature on both construction and transport. It details flow of information between two applications and consists of input, processing, and output sections. Applicability of the proposed method is demonstrated through a hypothetical example. The results helps transport department to improve their temporary decisions on traffic assignment at vicinity of project area based on changed flow traffic. Also, road construction schedule is adjusted through reliable information on truck and machinery arrivals. Moreover, a common decision making platform can be provided for both parties to assess location and length of new development segments.
As Australia’s road freight task continues to improve, the increased demand is expected to lead to greater freight vehicle payloads and prevalence of higher productivity vehicles on the current road network. It is forecast that the total road freight task in Australia will increase from 203.6 billion tonne kilometres in 2012 to 342.0 billion tonne kilometres in 2030. This represents an average annual growth rate of 3% per annum.

The expected increase in higher productivity vehicle payloads and corresponding pavement wear to road infrastructure assets is an issue that most state and local government road agencies must consider at the forefront of their agenda. Currently, a set of parameter values does not exist to quantify the marginal cost of road wear on rural and urban arterial roads and motorways in New South Wales. The marginal cost is defined as the impact of an additional load increment made by a vehicle on road wear costs. The paper estimates the marginal cost of road wear for rural and urban arterials and urban motorways in New South Wales.
The Emotive Aspect of Road Rage: How Do People Feel and How Would they Like to Respond?
Matthew Beck and Stephen Greaves

As roads become increasingly more congested the probability that a driver finds themselves in a situation that causes stress and frustration is similarly increased. We know that driving behaviour is linked to the personality and psychological profile of the driver with traits such as irresponsibility, impulsiveness, risk-taking, hostility, anxiety all contributing to different driving patterns. Some of this behaviour translates to driving that is rude, aggressive or dangerous which in turn can prompt other road users to experience negative emotions. When these negative emotions are strong they can trigger emotive, angered, aggressive and at times violent responses in drivers. While there is a strong stream of literature on the antecedents of road rage, there relatively little research on how road rage makes drivers feel. In this study we qualitatively explore a sample of Australian drivers to understand what types of behaviours make them prone to “road rage”, but more importantly we examine the emotive response that drivers have to these incidents. It is hoped that through a better understanding of how our driving behaviours affect other road users, policy makers can better develop campaigns aimed at creating greater self-awareness in the driving community.
By 2050, United Nation projections indicate, the urban population will reach 6.5 billion that means every two from three people will call a city home. Sydney, as well as many other cities, is expanding at a faster rate than we have ever experienced, due to natural increase; overseas and interstate immigrants in search of opportunities. Hence, to develop an understanding of how a city will evolve is crucial for policy makers and planners, for that reason the land use modelling comes in. In this research, an agent-based model is developed, using Netlogo framework, to simulate the residential mobility of households in Metropolitan Sydney. Agent-based modelling is known for its ability to replicate a complex system from the bottom-up, therefore it is selected to model actions and interactions between and within the households and housing market which recreate real world behaviour. The whole framework of the model consists of five sub-models; population synthesis model, population dynamics model, housing market model, relocation choice model and location choice model. Using Household, Income and Labour Dynamics in Australia survey (HILDA) and Census Population and Housing survey data to synthesise the population and develop rule-based models in the decision making processes of the households. It has been found that about 18.4% of the households in Metropolitan Sydney relocate each year, mostly renters with young age.
T5-5 Did Car Travel Reach a Peak in Australia? An Analysis of the Factors Driving a Decline in Per Capita Kilometres Travelled
Ines Österle

There has been a reversal in the upward trend of car travel in a range of industrialised countries with declining or stagnating car travel per capita. The observation of these trends has led to the hypothesis that car use may have reached a plateau in these countries and that it may stabilise, or even decrease in the foreseeable future. This study aims to explore the main factors of declining per capita car travel in Australia where it started to decline in 2003. The importance of identifying the main causes for the current decline in private motorised travel in Australia cannot be understated as it allows a better projection of future car use. This in turn is not only important for purposeful infrastructure planning, but private motorised transport also has wide-reaching repercussions on other sectors such as the environment and energy. In addition, the identification of causes for the recent declines may provide generalizable implications regarding effective transport policies to limit car travel.

This study uses a generalised least squares (GLS) model to estimate a model of car travel. The model includes a number of variables that have been noted in the literature as being influencing factors of car travel such as socio-economic factors and the cost of different transport modes (e.g., retail petrol prices). Pooled data for 29 years (1982-2010) across eight Australian capital cities has been used to estimate the regressions. The main data sources are the Australian Bureau of Statistics and the Australian Government Bureau of Infrastructure and Regional Economics. The study focuses on capital cities rather than on country level so as to concentrate on a relatively disaggregated dataset (compared to the national or state level). Initial findings suggest that car travel per capita in Australia declined in recent years due to a dramatic increase in household expenditure and an increase in petrol prices.
With increased awareness of aging infrastructure, attention has focused on the need to maintain physical infrastructure in a state of good repair. This focus is justified by the threatened disruption, impacts on the economy, loss of life, and costly repairs incurred as a result of infrastructure failure. In reality, such failures rarely occur and it is difficult to estimate the cost of possible failures.

In June 2014, a major bridge carrying I-495 across the Christina River in Delaware was closed due to tilting of the pillars. The southbound lanes of the bridge were closed for two months and the northbound lanes were closed for almost three months while Delaware Department of Transportation (DelDOT) expedited repairs. Approximately, 80,000 vehicles per day were impacted.

Using data from traffic counters and signals throughout the region and models of alternative routes, this analysis reviews the impacts on both those diverted to alternative routes and the existing users of the alternative routes who experience heavier traffic during the closure. Furthermore, I-495 provides access to the Port of Wilmington that serves as the port of entry for much of the imported produce to the Mid-Atlantic region. The economic impact on truck traffic is also considered.

We assess the cost of the closure using our estimates of the number of vehicles delayed and detoured, the length of the delay and the detour, and the typical unit costs for delays and detours, added to the cost of repair as estimated by DelDOT. We also discuss the impacts on neighborhoods disrupted by the construction and detours. We conclude with a discussion of the relevance of this analysis to infrastructure renewal decisions.
Best-worst choice data provides additional information on respondents' behavioural preference, as well as alleviates cognitive burden for respondents (Louviere et al., 2013, Finn and Louviere, 1992; Flynn et al., 2007). The majority of best-worst research is on the basis of the assumption that respondents choose best option, followed by the worst one. However, recent research suggested that scale and error variation are inconsistent across different choice sequence (Collins and Rose, 2011; Scarpa et al., 2008). Recognising respondent's decision procedure provides us the insight into the correlations between best-worst choices. This paper concentrates on understanding respondents’ decision processes when completing a stated mode-choice best-worst survey.

A stated preference survey was conducted in April 2014 within the catchment areas of seven train stations with park-and-ride (PnR) facilities in Perth, WA. An efficient design (Rose et al., 2008; Rose and Bliemer, 2008) was developed and optimised using genetic algorithm (Olaru et al., 2011). Each respondent was asked to provide best and worst options in six choice tasks without any indication of the choice order. In total, 171 commuters completed the entire survey.

Multinomial logit model, nested logit model and mixed logit model are mainly exploited in current research to compare best-worst sequential process, worst-best sequential process, as well as choosing best and worst choice simultaneously in terms of scale estimation and model improvement.

With the normalisation of scale associated with the first choice data to 1.0, the mean of scale estimate of second choice data is less than one, which implies more error variation, probably due to individual’s lack of engagement in the survey. Empirical results indicate that respondents are more likely to exploit the best-worst sequential choice process when facing best-worst choice task.
In the field of transportation engineering, Network Design Problem (NDP) is a complex and challenging research problem which aims to optimize a transportation network in order to maximize overall system performance through capacity expansion and link addition. Most NDPs are based on minimizing travel cost and rarely account for equity. Recently, equity-oriented NDPs have received an increasing attention since they are consistent with sustainable development principles. The objective of this study is to propose a novel approach to integrate multiple equity measures into a discrete NDP, including link-based equity, spatial equity, and environmental equity. We first analyse and compare each equity criteria considered. Secondly, we propose bi-level programming models with for these three equity measures. In each model, the upper level is a multi-objective program, which aims at optimizing the total system travel cost and an equity-oriented criteria under a given budget and the lower level is the traffic assignment problem under user equilibrium conditions. Thirdly, an exact solution methodology is developed to find Pareto-optimal solutions for each equity-oriented NDP. Namely, we use the ε-constraint method to transform the bi-objective models into single-objective models and the tailored branch and bound algorithms (upper level) and convex programming algorithms (lower level). The proposed methodology is able to find globally optimal solutions to the proposed equity-oriented NDP models. Finally, the implications of adopting each equity measure and the trade-offs among these equity measures and total system travel cost are demonstrated through experiments over benchmark networks. As a result, the research outcomes highlight the compromises inherent to the integration of alternatives equity measures into transportation planning and show that the proposed approach can be used to identify balanced solutions with respect to system efficiency and equity.
Travel demand management (TDM) is a key policy strategy for the mitigation of urban traffic congestion in Australasian cities. Managing travel demand can improve the efficiency of existing road, public transport, cycling and walking infrastructure. TDM is defined as any instrument or set of instruments aimed at reducing congestion by means of influencing behaviour change, without having to supply additional road or public transport infrastructure. Travel demand can be managed by policy intervention to change when the timing of travel, the mode of travel or by reducing the need for travel. Travel demand varies across different transport systems in cities, for example the factors influencing demand for travel to work differ from the factors that influence travel for shopping. For policy makers appraising the utility and performance of TDM instruments, an understanding of the benefits and costs associated with appropriate TDM instruments is important.

This poster presents the range of TDM instruments available to policy makers, organised according to a TDM matrix. The instruments are categorised according to three characteristics: the relevant transport system or ‘market’ they operate within, the intended TDM objective, and whether the instrument uses a ‘push’ or ‘pull’ demand management mechanism. TDM instruments were identified through a comprehensive review of over one hundred international and national transport research papers, conference proceedings and policy reports. Nine categories were identified to organise seventy-one TDM instruments. The poster illustrates each category, outlining associated sub-categories and providing case studies to demonstrate TDM instrument characteristics.

The poster reports on the first stage of a research project by the Planning and Transport Research Centre (PATREC), Congestion Abatement Through Travel Demand Management.
The paper offers an overview of the appraisal tools and evaluation procedures that may be used as the basis for selecting, implementing and reviewing travel demand management (TDM) initiatives.

The first part of the paper is an international review of the tools used to appraise the potential effectiveness of employing a particular TDM instrument (or suite of instruments) to a specified market, route or area. In addition, the report examines a number of evaluation cases where the actual performance of a TDM instrument was reviewed after its implementation. Based on the review, the second part of the paper provides a top down decision framework that starts with policy creation and the setting transport performance indicators. The outcomes of the first stage inform TDM project appraisals through the use of a sketch model. Sketch models import behavioural response parameters and monetary valuations without collecting primary data for each project. Sensitivity of the decision to the parameters values should be undertaken when using a sketch model.

The case is made for investing in a monitoring program and undertaking periodic evaluations of each initiative. These activities provide feedback into the policy setting stage. In a sense monitoring and evaluating projects is an evidence based approach to challenging any assumptions that were made in the first round of policy setting. The second use of the TDM evaluation is that this provides primary evidence on the parameters used in the sketch model and overtime the model can be calibrated to the city for which the model is being deployed.

The paper marks the end of Phase 1 of the Planning and Transport Research Centre’s (PATREC) investigation into congestion abatement through the use of Travel Demand Management.
Car dependency in Australian cities is one of the fundamental challenges for sustainability. Public transport in these cities requires government funding for both capital investment and ongoing operations. Public transport projects compete with other public projects for funding at all levels of government, and therefore, political support for public transport is critical. Recent research has identified a number of potential sources of dedicated funds for public transport such as land value capture. However, the political awareness and support for this funding scheme is not yet sufficient for implementation. This paper reviews research publications on implementing land value capture in the developed world. It aims to construct an understanding of the institutional requirements for such a funding scheme to apply in the Australian context.
The conventional four-step approach, which includes trip generation, trip distribution, mode choice and traffic assignment, has several drawbacks that are addressed in modern travel demand estimation models such as activity-based models while accepting the significant increase in the computational cost. Furthermore, the conventional four-step model lacks a behavioural foundation. More specifically, trip distribution step in the best situation is based on the gravitational rules (if the fraternity technique is not used) which has no behavioural basis compared to the other three steps. To break through the limitations of the traditional aggregate models like the four-step model while not imposing a high computational load, an innovative disaggregate system of models was introduced by the authors in their previous work. Nonetheless, the destination choice and integration with a traffic assignment was left for future work, which are addressed, in the current study. The previous work attempted to predict daily trips of individuals using the concepts of decision tree (DT) and random forest (RF). However, the developed models only modeled destination attributes while the exact locations are yet to be randomly selected. The previous work, developed models for commute distance and land use attributes of the destination. To improve the precision of the destination choice model, the universal choice set is first filtered using the commute distance and land use attribute models. Then, using data mining techniques and learning algorithms the final destination is selected in a more systematic way. Once the destination choice model is finalized, the entire system of models is integrated with the traffic assignment algorithm.

The dataset used in this research is the Victorian Integrated Survey of Travel and Activity (VISTA) of the year 2007. VISTA consists of three main aspects: household data (each row represents a household), individuals (each row represents an individual of one household) and trips (each row illustrates the information of one trip of individuals). The data is improved firstly by adding the travel time from one section to another by private cars or public transits. This supplemental information is obtained from the websites of public transit and digital maps for private cars. The travel time data will be updated when the integrated model is developed. Using the synthesized population, the full network is loaded with daily trips. The results of the modelling exercise are compared against the link flows observation for validation purposes.
The conventional methodology for estimating economic impacts of urban transport projects has two key weaknesses: (1) prices in markets external to transport are taken as static and (2) the distribution of impacts cannot be described. In particular, the static price assumption is only valid where there are no technological externalities and markets are in perfect competition, which might not be appropriate for large projects with wider economic impacts. Computable general equilibrium (CGE) models are able to relax this assumption by simulating all agents in an economy reacting to price and quantity signals. When applied to transport, a CGE model measures welfare at the household level, rather than from the transport market, providing a comprehensive framework that facilitates comparisons with potential investments in sectors other than transport.

Spatial CGE models for urban transport projects typically incorporate transport costs between regions, usually with static travel times or distances. Variability in transport costs requires iteration between a CGE model and a transport model to assign flows to networks. However, using a mixed complementarity form of the traffic assignment problem, it is possible to integrate the two models within the one formulation that can be solved with off-the-shelf optimisation software. One such example of a fully integrated model was used to study congestion charging for commuting flows, but few of these models exist as it requires the modeller to span two separate fields of enquiry.

We propose two extensions to existing integrated transport CGE models in mixed complementarity form, to be solved in GAMS. The first extension is to add other household trip generators (‘discretionary trips’) to the existing representation of commuting flows, to provide a complete evaluation tool. The second extension is to include land use as a production and household input, to model substitutions and impacts to regions.
Historically, transport and land use planning decisions have been largely based on typical travel time values within the network. A growing interest on system reliability and resilience has emphasized the value of higher-order approaches to travel time distributions. In particular, travel time is influenced by the activities accessible in the transport network, and the relationship between land use characteristics (intensity, zoning, activities, demographics) and the higher-order attributes of the travel time distribution is an underexplored area of research.

This work examines distributions of travel times on freeways in California in conjunction with local land use characteristics taken from the United States Census and the Longitudinal Employer-Household Dynamics dataset. Using linear regression, the moments of the travel time distribution (mean, variance, skewness, kurtosis) are described by the type and intensity of the surrounding activities.

Special attention is given to endogeneity in the transport-land use system. We expect to find strong correlations between mean travel time and land use with ambiguous directionality. Higher order moments of the travel time distribution are more rarely sensitive to land use variables, which reflects intuitive behaviors regarding location choice and willingness to pay.
Comprehensive, current and reliable O-D matrices are required to plan for urban public transport infrastructure and services. The use of smart card fare data has become one of the most popular and reliable techniques for public transport O-D estimation. The unique set of data from Brisbane, Queensland, gives the opportunity for better understanding and evaluation the parameters affecting the estimated matrices. Different assumptions have been applied in the past to overcome the lack of information regarding the alighting stop. Transfer walking distance and allowable transfer time are some examples of these assumptions. The paper investigates the effect of different assumptions on the reliability of the estimated O-D matrices and provides sensitivity analysis for different parameters. The results show that these parameters have different impact on the estimated matrices. The allowable transfer time has a small impact, where the maximum difference in the total number of O-D trips is around 9 percent, as the allowable transfer time changes from 15 to 90 minutes. At all allowable transfer times, most of passengers would not walk more than 800m when transferring between bus stops. Transfer walking time designates the majority of the shorter transfer times. As the transfer time increases, waiting and short activity time tend to make up the majority of the transfer time.
Movements of containers from the seaport to destination areas in the hinterland are largely carried out by road and rail. The flexibility and efficiency of trucks and the economies of scale associated with the rail mode motivated the introduction of a third of mode of transport called intermodal transport. This mode of transport involves the use of at least two distinct modes of transport and a special facility where the loading units (e.g., Containers) can be transferred from one mode to another. This special facility or place of transfer between modes (e.g., from rail to truck or vice versa) is called an intermodal terminal (IMT). Decisions on the location of these IMTs in practice are largely ad hoc and often lead to unsuitable and unsustainable intermodal terminals or having too many terminals in a particular region which often threatens the sustainability of all terminals in that area. Thus the location choice of intermodal terminals is critical for not just its viability but also the sustainability of the existing terminals. In this paper, we present mathematical models for determining the optimal locations of new intermodal terminals given existing terminals. We also propose a Lagrangian relaxation technique for solving these models as they are NP-hard problems. The solution technique was tested through experimental studies with thousands of generated instances to ensure that it works well in practice.
Exploring Tram Stop-Level Spacing for Different Land Use Types in Melbourne
Jingxu Chen, Graham Currie, Zhiyuan Liu and Wei Wang

Transit stops and stations provide accessibility to the public transit services, whereas they also act to increase in-vehicle ride time due to dwell time at stops. Deciding how many stops to put on a transit route is a trade-off between transit attractiveness and operational costs. At the same time, the spacing of stops and stations should differ for different land use types since they imply differential coverage for variation in the scale of activity.

Melbourne trams are amongst the slowest in the world. As a legacy of the historical development of the system, stop spacing is very short by international standards (250m) whereas internationally values in Europe are 3 times larger than this. While reducing the number of stops is effective in speeding up trams it also increases passenger walk access distance and service coverage; reducing stops is not a popular measure with the ridership community. There are clearly operator vs passenger perspectives on what is best for stop spacing.

This study aims to develop an analytical approach to optimising tram stop spacing balancing the concerns of all parties. It includes an overview of the key issues about transit stop spacing. Then, a mathematical modelling approach to transit stop spacing is developed which includes two parts: (1) the service area of a transit line is classified into several catchments, using a clustering method associated with transit demand and land use types; and (2) a bi-level optimization model is used to analyse the optimal stop-spacing for these catchments with different land use types. The upper-level problem is formulated as a mixed integer non-linear program with the objective of minimizing the total cost of passengers and also the costs to operators, and the lower-level problem is the transit assignment problem with demand constraints. Due to the complexity of the model a heuristic algorithm is used to solve the model. Finally, a case study with two tram lines in Melbourne is conducted to explore the practical implication of the proposed model and algorithm.

The paper concludes with a discussion of implications for planning practice and identifies areas for future research.
This study presents a method that can be used to estimate the traffic congestion relief associated with urban public transport (PT). In order to calculate the impact of PT, it is assumed that a proportion of PT riders shift to car if PT service were to cease. As a result, the level of congestion on the highway network will increase because of the increase in the number of car trips. In this research, variation in the share of PT users switching to car based on the traffic characteristics in each of Melbourne’s Local Government Areas (LGAs) is explored. Four predictor factors affecting this parameter are presented in this paper. These are the share of: (1) Park and Ride, (2) long-distance PT trips, (3) car available and (4) driving license. The major finding is that the share of mode shift to car when PT is removed is lower in inner areas and higher for regions further from the CBD. Further, by using the Victoria Integrated Transport Model (VITM), the level of congestion relief in Melbourne is compared for the “base” and “without PT” scenarios. The result shows that when all modes of PT are removed, the diversion to private cars generates more than an additional about 1500 congested road links and increases the number of links congested by over 100%. The results of the new methodology are compared to previous research which used a fixed share of mode shift (32.4%). It is found that the congestion relief is significantly different in the inner and outer areas according to the new approach used. Mapping using ArcGIS illustrates these findings. The new approach offers a more precise model for assessing the impact of PT on traffic congestion. The paper closes with suggestions for further methodology development.
Urban congestion in cities is one of the most expensive and fastest growing global problems. Together with increasing world population, and urbanisation, it is exacerbating transport performance problems in world cities.

The operational performance of public transport is currently facing challenges due to patronage growth, limited capacity and the impacts of traffic congestion on on-road service reliability. The majority of public transport takes place on road and giving it priority has been seen as a logical next step in service development. However, despite the benefits of public transport priority, studies have shown that it is problematic to effectively determine where priority should be located. Current ways of evaluating urban transport congestion have been found limiting and obsolete. There is an urgent need to find new ways to understand the distribution and preferences for transit priority in order to improve the performance on on-road public transport.

Lorenz Curves, and the associated Gini Coefficient parameter, have been developed in social science as a powerful tool to study income inequality. This research explores if, and how, these metrics can be re-interpreted to help with targeting improvements for on-road public transport and priority mitigations. A new concept is presented where the Lorenz Curve and Gini Coefficient are adopted as a new and original measure of public transport operational performance. The results of preliminary research applied on Melbourne’s tram network show that these metrics have the potential to better demonstrate the operational performance of road based public transport routes and networks, and specify the distribution and locations of links for targeted attention through approaches like on-road priority. Implications for future research and policy are discussed.
This paper presents a lot choice model for park-and-ride (PNR) trips using multinomial logit (MNL). Our study area is Brisbane. The dataset is taken from a public transport origin destination (PTOD) survey and from a PNR number plate survey conducted in a large number of PNR lots. There are over 170 formal PNR facilities across SEQ providing around 27,000 parking spaces.

Each individual trip observed from the PTOD survey faces different alternative lots. Only those PNR lots that can be reached from the origin in less time than it takes to drive to the destination are considered. Among these retained lots, 20 PNR lots are randomly sampled in such a way that the actual observed PNR lot is also within the sample.

This model uses a wide range of variables to address travellers’ sensitivity to changes in lot characteristics, accessibility and availability, such as the shortest travel time from origin to lots and lots to destinations, the capacity of the PNR lot, the type of PNR lot (formal or informal) and total public transport fare. Travel times are further divided into in-vehicle travel time, walk time and wait time. Also, dummy variables indicating whether a PNR lot is located within the central business district (CBD), serves train routes (vs. only bus routes), and lies near to a freeway, are tested.

This model gives a clear understanding of how travel time in the auto network and in the transit network affects a traveller’s choice of a PNR lot. It sheds some light on the attractiveness of PNR lots based on their attributes. Knowledge of these attributes affecting a user’s choice of PNR lots will help improve transport planners’ understanding of factors to consider in the design of PNR lots and associated transit services.
Crime on public transport is a major concern for society and authorities; and many security measures have been adopted in public transport facilities like stations to reduce crime and improve the perception of safety of passengers. However a scale to measure the design quality of the public transport facilities Crime Prevention Through Environmental Design (CPTED) principles has not yet been developed. This presents preliminary results of a research program to develop a unified measure of the overall design quality of train stations in terms of surveillance, access control/target hardening, maintenance, territoriality and activity support, which are the main underlying elements of CPTED. In this study a preliminary scale has been developed and applied to 4 stations in suburban Melbourne. The scores illustrate the overall station design quality and highlight elements of the stations to address to enhancing safety in future. Areas for future research and implications for practice are explored.
Safety is an overriding concern in design, operation and development of light rail systems including trams or streetcars as they impose crash risks on road users in terms of crash frequency and severity. The aim of this study is to identify the key traffic, transit and route factors that influence tram-involved crash frequencies along tram route sections in Melbourne. A random effects negative binomial (RENB) regression model was developed to analyze crash frequency data obtained from Yarra Trams, the tram operator in Melbourne tram network. The RENB modelling approach can account for spatial and temporal variations within observation groups in panel count data structures by assuming that the group specific effects are randomly distributed across locations. The results identify many significant factors affecting crash frequency. They are, in order of affect; tram stop spacing (-0.43), tram route section length (0.31), tram signal priority (-0.263), general traffic volume (0.17) and tram lane priority (-0.148). Platform stops (-0.09) and service frequency (0.004) also influence crash frequency. Findings provide useful insights on route section level tram-involved crashes in an urban tram or streetcar operating environment. The method described represents a useful planning tool for transit agencies hoping to improve safety performance.
New Approach to Calculation of Transfer Matrix in a Transit Network
Elnaz Irannezhad, Mark Hickman and Seyed Hossein Mousavi

Transfer rate is considered a tool for getting feedback and efficiency evaluation of current or designed transit networks. So, being organized around transfer is very important approach in redesign process which needs a simple method for calculation transfer rather than regarding as a limitation in modelling process. With having transfer information, lack of a possibility of using transit system with reasonable transfer rate, provide necessity of redesign.

In most of cases, especially in developing and under-developed countries, these automatic fare collection systems are not developed massively and there are not valuable data for analysis, so as transport engineers move into planning, the limitations of using complicated models begin to become more and more apparent. While, most of policies regarding to urban transportation systems are dependent to managers and policy makers, and might not be going to extend in future by another manager, so they usually do not wait to complete a time consuming modelling process and detailed data. Thus, going through the sketch planning approaches would be valuable in these cases.

The objective of this research is to develop a simple model without need to detailed data for transfer calculation that can assist with transit network design by using Graph Theory. Question to be answered in the first step is that with how many transfer rates every person can travel from every location with transit lines to another location in the city with explores potential of improvement in transit network and in the second step is that how many trips are done by how many transfer rate in the transit network system. Results of model were validated with real data obtained from south east Queensland (SEQ) transit system which is planned and delivered by Translink.
The architectural design of doors, gates and corridors can significantly contribute to crowd safety. However, the literature has yet to articulate our knowledge in crowd mobility. One potential approach is to look at the similarities between pedestrian and vehicle route choice behaviors while utilizing the theories and knowledge accumulated in vehicle route choice research. To this end, a Cellular Automata model, consisting of a grid network of nodes/links to represent pedestrian movements, was developed and hybridized with principles consolidated in transportation. The behavior of pedestrians was modeled as a movement function associated with the corresponding link or direction. A pedestrian assignment model (similar to traffic assignment) was then carried out. In order to evaluate the model, a case study of pedestrians evacuating via a narrow corridor and an exit door was introduced and studied numerically. Using the concept of the Braess Paradox, different architectural configurations for the corridor were analyzed to test their ability to facilitate greater rates of egress. Results were consistent with previous studies reported in the literature in which a funnel-shaped corridor can process a higher rate of pedestrians under crowded conditions. The proposed methodology has the advantage of being easily integrated and implemented into transport planning applications.
Variation in the Walking Time to Bus Stop by the Degree of Transit Captivity
Jason Chin Shin Chia and Jinwoo Brian Lee

One primary concern for public transit sector is to adequately assess the access to transit system. Measures of transit accessibility are important in evaluating transit services, planning for future services and investment and making decision on land use development. Existing tools measure transit accessibility using averaged walking distance or walking time to public transit. Although the mode captivity may have significant implications on one’s willingness to walk to use public transit, this has not been addressed in the literature to date. Failed to distinguish transit captive users may lead to overestimated ridership and spatial coverage of transit services. The aim of this research is to integrate the concept of transit captivity into the analysis of walking access to public transit.

Brisbane is used as the case study as walking access to public transit is the most important component of travel. The conventional way of defining “captive” and “choice” transit users showed no significant difference in their walking times according to a preliminary analysis. A cluster analysis technique is used to further divide “choice” users by three main factors, namely age group, labour force status and personal income. After eliminating “true captive” users, defined as those without driver’s licence or without a car in respective household, “choice” users were classified into a total of eight groups having similar socio-economic characteristics. The analysis revealed significant differences in the walking times and patterns by their level of captivity to public transit.

This paper challenges the rule-of-thumb of 400m walking distance to bus stops. In average, people’s willingness to walk dropped drastically at 268m and continued to drop constantly until it reached the mark of 670m, where there was another drastic drop of 17%, which left with only 10% of the total bus riders willing to walk 670m or more. This research found that part-time mothers were the ones with lowest transit captivity and thus most sensitive to the walking time, followed by high-income earners and the elderly. The level of captivity increases when public transit users earned lesser income, such as students and part-time students. The results are applied to produce a better representation of walking time in different suburbs having
different socio-economic characteristics in overall so that appropriate policies and plans could be implemented.

T5-26 Park-and-Ride Network Design in a Bi-Modal Transport Network Optimising Network Reliability
Shahi Islam, Zhiyuan Liu and Majid Sarvi

Modern cities suffer immensely from traffic congestion caused mainly by the proliferation of private vehicles on the road network. Park-and-Ride (P&R), an already established critical infrastructure system, encourages commuters to drive from their trip origin to train stations or bus terminals, where they park and ride public transport (bus, train or tram) to their destination with the objective of mitigating traffic congestion. Traffic congestion adversely affects the roadway capacity thus making the traffic condition on the network uncertain. Therefore, the need for reliable transport system is an increasing demand for transport network users. Reliability of network is one of the key indicators for the evaluation of transport network performance. Optimisation of network reliability for P&R network has not been studied yet. Consequently, the P&R network design in a bi-modal transportation system considering the network reliability is a novel area in transport research. Commuters manifest different types of behaviour when tackling unstable traffic condition in transportation network. This behaviour can be known as risk-aversion, risk-neutral and risk-seeking. Travel time disutility associated with the aforementioned behaviours is taken as reliability measurement for the evaluation of network performance. A Bi-level programming model is developed to determine the optimal P&R scheme in a bi-modal transport network with the objective of optimising network reliability. Optimal P&R scheme includes optimal parking location and size which are determined considering real life commuters behaviour. The objective of the upper level is to minimize the total expected travel disutility in the whole network. The lower level is the commuters’ route choice problem and travellers are assumed to choose the path/route with minimal expected travel disutility. This disutility-related multiclass user equilibrium is formulated as nonlinear complimentary problem which is a non-additive path cost problem. A Genetic Algorithm (GA) is implemented to solve the bi-level model and verified by a numerical example considering a P&R network.
T5-27 Foundation Technology for Developing an Autonomous Complex Dwell-Time Diagnostics (CDD) Tool
Julien Collart, Nathan Kirchner, Alen Alempijevic and Michelle Zeibots

As the demand for rail services grows, intense pressure is placed on stations at the centre of rail networks where large crowds of rail passengers alight and board trains during peak periods. The time it takes for this to occur — the dwell-time — can become extended when high numbers of people congest and cross paths. Where a track section is operating at short headways, extended dwell-times can cause delays to scheduled services that can in turn cause a cascade of delays that eventually affect entire networks. Where networks are operating at close to their ceiling capacity, dwell-time management is essential and in most cases requires the introduction of special operating procedures.

This paper details our work towards developing an autonomous Complex Dwell-time Diagnostics (CDD) Tool — a low cost technology, capable of providing information on multiple dwell events in real time. At present, rail operators are not able to access reliable and detailed enough data on train dwell operations and passenger behaviour. This is because much of the necessary data has to be collected manually. The lack of rich data means train crews and platform staff are not empowered to do all they could to potentially stabilise and reduce dwell-times. By better supporting service providers with high quality data analysis, the number of viable train paths can be increased, potentially delaying the need to invest in high cost hard infrastructures such as additional tracks.

The foundation technology needed to create CDD discussed in this paper comprises a 3D image data based autonomous system capable of detecting dwell events during operations and then create business information that can be accessed by service providers in real time during rail operations. Initial tests of the technology have been carried out at Brisbane Central rail station. A discussion of the results to date is provided and their implications for next steps.
Towards More Train Paths Through Early Passenger Intention Inference
Peter Colborne-Veel, Nathan Kirchner and Alen Alempijevic

In public train stations, the designed wayfinding tends to induce individuals to conform to specific egress patterns. Whilst this is desirable for a number of reasons, it can cumulate into congestion at specific points in the station. Which, in turn, can increase dwell time; for example, loading and unloading time increases with concentrations of people trying to load/unload onto the same carriage. Clearly, a [n influence] strategy that is more responsive to the current station situation could be advantageous.

Our prior research studies in Perth Station demonstrated the feasibility of reliably and predictably influencing passengers egress patterns in real time during operations. This capability suggests the possibility of active counterbalancing of the egress-alternatives while maintaining wayfinding. However, the prerequisite for such capability is the availability of knowledge of passenger's intention/destination at a point in their journey where viable egress-alternatives to their destination exist.

This paper details an approach towards an early (in the passenger journey) passenger intention/destination inference system necessary to enable active egress-alternative influencing. Our contextually grounded approach infers intention/destination through reasoning upon observed system and passenger cues in conjunction with a-priori knowledge of how train stations are used. The empirical validation of our intention/destination inference system, which was conducted with data acquired during operations on a platform in Brisbane’s Central train station in Queensland, is presented and discussed. The findings from this study are then employed to argue the feasibility of an influencing system to reduce passenger congestion and the potential service impacts.
Understanding pedestrian crowd behaviour during emergency evacuations or during normal egress situations under extreme levels of congestion has become of researchers’ growing interest in transport discipline. Public transport facilities and public places which serve pedestrians need to be able to handle such situations efficiently to ensure safety of their users. The rarity of such events and as a result, the scarcity of the explanatory data has made modelling pedestrian wayfinding in crowded places a challenge for researchers. This study aims to investigate pedestrians’ exit choice behaviour during egress situations. Data sets of people’s stated responses to hypothetical egress scenarios have been collected in public places based upon which a discrete-choice analysis has been conducted. Of particular interest, in this study has been investigating evacuees’ tendency to follow other peoples’ choice when evacuating a place. Our Random-utility modelling identifies in a quantitative way the priority people give to following other peoples’ decision in contrast with other factors such as choosing closer exits, less congested exits and visible exits. Our model estimation results suggest that people mostly do not tend to follow others’ choices when exiting a place, at least when familiar with the egress environment. Also our findings indicate that the tendency towards following other pedestrians is less unlikely when all the exits are not visible to pedestrians at the same time due to the geometric design of the evacuation environment. For the verification purpose, we have also provided some empirical evidence based upon the evacuation experiments with humans which substantiates our findings from the stated choice analysis. Incorporation of such behavioural findings in crowd simulation computer programs can enhance the level of accuracy that planners can practice to identify potential hazards and examine different scenarios of demand level prior to arranging large public events.
Investigating pedestrian crowd behaviour has recently gained a lot of attention in a wide variety of disciplines. It has been acknowledged that capturing and forecasting human behaviour, which is becoming an inevitable task to ensure crowd's safety before arranging mass public events, requires advance modelling and simulation tools. Computational tools are now available for simulation and design of emergency evacuation and egress. However, these tools heavily rely on oversimplified and inconsistent assumptions regarding human individual and social behaviour.

In order to address the challenges involved in replicating pedestrian crowd movement, extensive research has been undertaken. According to the literature, however, most of the research has centred on the simple geometry under normal walking conditions. In contrast, there is a little knowledge as to the understanding of complex geometries which can be expected in quite a few of public infrastructures.

Merging and crossing of streams of pedestrians can be considered as unavoidable features of mass gathering areas in which the dynamics of pedestrian streams are complicated. However up to now they have not been studied meticulously. Understanding of merging and crossing movements is of crucial importance to guarantee the safety of buildings and mass event places. To acquire knowledge about impacts of these environmental configurations on macroscopic and microscopic pedestrians' characteristics, this article attempts to describe different proposed approaches for analysing and modelling of human behaviour in these physical features based on previous researches.

It can be concluded from the review that existing studies on merging areas are limited to staircases and T-junctions. Furthermore, conducted experiments on crossing layouts are right angle in most of researches.