University of Southern Queensland

The Application of Variable Speed Limits to Arterial Roads for Improved Traffic Flow

A dissertation submitted by

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ABSTRACT

Traffic congestion problems continue to increase in large cities due to rapidly increasing travel demand and a lack of transport infrastructure. Congestion causes mobility and efficiency loss, safety reduction, increased fuel consumption and excessive air pollution. A number of traffic management strategies have been proposed and some are applied in cities, such as diverting traffic from peak periods to off-peak periods using congestion pricing, reduced speed limits, coordinated traffic signals along major arterial roads, or adding additional lanes where network expansion is feasible. Among the many solutions to traffic congestion, operational treatments for existing road networks provide more cost efficient traffic operation due to their relatively low cost. This research looks to improve efficiency through the application of Variable Speed Limits (VSLs). While VSLs have been used to improve traffic conditions on congested motorways in terms of mobility, safety and travel time, they are largely untested on signalized urban arterial roads.

Griffith Arterial Road (GAR) U20 was selected as the case study for the research. GAR is part of the Brisbane Urban Corridor (BUC), and is approximately 11.5 km long and lies between the Gateway Motorway and the Ipswich Motorway. The average daily traffic volume (ADT) is between 18,000 vehicles to 24,000 vehicles. The number of lanes at approaches to signalised intersection varies from 1 to 4.

In the context of this research, the study used STREAMS data and real world data collected using six high definition (HD) video cameras to develop a VISSIM model and to discern the effectiveness of applying VSL control. VISSIM is a time step and a psycho-physical car following model developed to model urban traffic and public transit operations. The VISSIM model was extensively calibrated and validated with the empirical data collected regarding measure of effectiveness such as traffic volumes, volume distribution, and saturated headway along the west bound (WB) and eastbound (EB) directions. The simulated model allowed the testing of different control strategies for VSL and Integrated Traffic Control System (ITCS) under different scenarios and circumstances. It helped to contrast the traffic flow parameters of invariant (no controlled speed) and VSL (controlled speed) conditions. Multiple simulation runs were considered in the calibration and evaluation process.

The measures of effectiveness used to characterise the operational quality of signalized intersections were delay, queue length, and number of stops. In addition, flow, speed and density parameters were used to characterise the changes in traffic performance for the arterial road.

This thesis investigates the application of VSLs for control of upstream traffic as a proposed traffic control strategy on the GAR. The objective was to investigate how dynamic VSL and signal control systems could be used in an integrated approach to traffic management to improve the traffic efficiency, safety, and mobility of a congested urban arterial road. The research indicates that the application of VSL could improve the traffic performance and safety during the peak period. It helped to maintain a planned continuous flow through coordinated intersections to avoid congestion. Integrating VSL with other traffic congestion management (changing the signal timings for the congested traffic) appeared effective in improving traffic conditions and reducing total travel time on the GAR. The research highlighted some important elements that could be used for the design and implementation of VSL systems using intelligent transport systems.

Certification of Dissertation

I certify that the thoughts, experimental work, numerical outcomes and conclusions reported in this dissertation are entirely my own efforts, except where otherwise acknowledged. To the best of my knowledge, I also certify that the work presented in this thesis is original, except where due references are made.

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Associated Publication

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Al-Nuaimi, H, Ayers, R & Somasundaraswaran, K (2012), 'The effectiveness of using variable speed limit on the performance of an interrupted flow', proceeding paper presented to IASTED International Conference on Engineering and Applied Science (EAS 2012): Applications for the 21st Century, 27-29 Dec 2012, Colombo, Sri Lanka.

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List of Abbreviations

ABS	Australian Bureau of Statistics
AD	Australian Dollar
AIMSUN	Advanced Interactive Microscopic Simulation for Urban and Non-urban Networks
ALINEA	Asservissement Lineaire d'Entree Autoroutiere
AMOC	Advanced Motorway Optimal Control
ARE	Absolute Relative Error
ATC	Area Traffic Control
BMA	Brisbane Metropolitan Area
BTRE	Bureau of Transport and Regional Economics
CORSIM	CORridor SIMulation
DTMR	Department of Transport and Main Roads
EMME	Equilibre Multimodal, Multimodal Equilibrium
EP	Evening Period
FMS	Freeway Management Systems
GAR	Griffith Arterial Road
GEH	Geoffrey E. Havers
HCM	Highway capacity manual
HDC	High Definition Cameras
HV	Heavy Vehicle
ITCS	Integrated traffic control system
LOS	Level of Service
METANET	Modèle d'Ecoulement du Trafic Autoroutier: NETwork
MFD	Macroscopic Fundamental Diagram
MOE	Measures of Effectiveness
MP	Morning Period
MPC	Model Predictive Control
MTFC	Mainstream Traffic Flow Control
PARAMICS	PARAllel MICroscopic Simulation
QDTMR	Queensland Department of Transport and Main Roads QDTMR
QLD	Queensland
RLC	Red-Light Camera
RLR	Red-Light Running
SATURN	Simulation and Assignment of Traffic to Urban Road Networks
SCL	Speed Control Limit
STREAMS	Synergised Transport Resources Ensuring an Advance Management System
TDM	Travel Demand Management
TFL	Transport for London
TH, RT, LT	Through, Right turn, Left turn
TRANSYT	TRAffic Network StudY Tool
TRB	Transportation Research Board
TTT	Total Travel Time
TU, WE, THU	Tuesday, Wednesday, Thursday
VISSIM	Verkehr In Städten-SIMulationsmodel
VMS	Variable Message Sign
VSL	Variable Speed Limit
VSMs	Variable Speed Message signs