DEVELOPMENT OF A MODEL TO EVALUATE CAPACITY OF URBAN MULTI-LANE ROADS UNDER HETEROGENEOUS TRAFFIC CONDITIONS

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Degree of Master of Philosophy

Department of Civil Engineering

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DECLARATION OF THE CANDIDATE & SUPERVISOR

I declare that this is my own work and this dissertation does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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Signature of the supervisor: …………………………… Date: …10.5.2020……

DEDICATION

I dedicate this dissertation to Dr. H. R. Pasindu, my supervisor and mentor who encouraged me to complete this study successfully, and my parents who supported me throughout.

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10.05.2020

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ABSTRACT

Road capacity is defined as the maximum sustainable hourly flow rate at which vehicles can reasonably be expected to traverse a point or uniform section of a lane during a given time period under prevailing roadway and traffic conditions in the US Highway Capacity Manual. The knowledge of capacity of a given section of a road is an important input parameter for transport planning and traffic management studies. Presently, there aren't any up-to-date guidelines for road capacity estimation in Sri Lanka. The use of foreign guidelines is not recommended as each country has unique factors that influence capacity. Since urban multi-lane roads are typically the busiest roads, this research study focuses on developing a capacity estimation model for urban multi-lane roads in Sri Lanka.

Flow and speed data were collected using manual counting methods and Google Distance Matrix API (Application Program Interface) method respectively. The heterogeneous traffic flows were converted to Passenger Car Units (PCUs) using Chandra's method. Greenshields' traffic flow model was used to calibrate the empirical data. Capacity values were established from the developed flow-speed model. Using this method, the capacity values of all study locations were established. The average observed lane capacity was 1829 pcu/h/l.

Regression models were developed to estimate capacity of four-lane and six-lane roads. It was observed that the four-lane road capacity was influenced by the effective lane width, access point density, built environment and median type whereas the six-lane capacity was influenced by the effective lane width and access point density. The four-lane capacity model had an R-squared value of 0.81 and the six-lane capacity model had an R-squared value of 0.86. The two models were combined to create a single model that predicts both 4-lane and 6-lane roads. In addition to the capacity models, a regression model was developed to estimate the Free Flow Speed (FFS) of roads. The predictor variables of the FFS model are lateral clearance, built environment and median type. Verification of developed models were done by surveying 10 road sections. It was observed that all three models accurately predicted flow and speed from the statistical tests done (Mean Absolute Percentage Error <10%).

Important findings from the research study includes the development models to estimate four-lane and six-lane capacity values, and FFS. The typical base capacity for a 4-lane urban road was found to be 2044 pcu/h/l. The base capacity for a 6-lane sub-urban road section was estimated to be 2108 pcu/h/l. Even though the capacity values are comparable with capacity values in guidelines such as the HCM (1900-2200 pcu/h/l) since the speeds at capacity are in the range of 20km/h the traffic streams are susceptible to breakdown. The typical FFS of a rural road section with 2m lateral clearance and a center median was 50km/h. Sub-urban and urban road sections with similar conditions have 36km/h and 35km/h FFS speeds respectively. The findings of this research can be used for transport planning and traffic engineering studies in Sri Lanka as well as for further research in the area of capacity estimation.

Keywords: Capacity, urban roads, multi-lane roads, heterogeneous traffic, regression model, Free Flow Speed

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LIST OF ABBREVIATIONS

Abbreviation	Description
PCU	Passenger Car Unit
LOS	Level of Service
HCM	Highway Capacity Manual
RDA	Road Development Authority
BPR	Bureau of Public Roads
FFS	Free Flow Speed
BFFS	Base Free Flow Speed
GDM	Google Distance Matrix
API	Application Program Interface
IHCM	Indonesian Highway Capacity Manual
TIRTL	The Infra-Red Traffic Logger
MAE	Mean Absolute Error
MAPE	Mean Absolute Percentage Error
PLM	Product Limit Method
RV	Recreational Vehicle
MC	Motorcycle
2W	Two-wheeler (Motorcycle)
TW/3W	Three-wheeler
LMV	Light Motor Vehicle
LV	Light Vehicle
HMV	Heavy Motor Vehicle
HV	Heavy Vehicle
SCV	Small Commercial Vehicle
LCV	Light Commercial Vehicle
MCV	Medium Commercial Vehicle
HCV	Heavy Commercial Vehicle
MAV	Multi Axle Vehicle
OSV	Oversized Vehicle

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