

**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

University of Moratuwa

Sri Lanka

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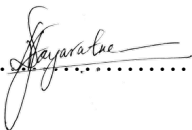
Sri Lanka

May 2020

## 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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The above candidate has carried out research for the MPhil dissertation under my supervision.

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



# TABLE OF CONTENTS

DECLARATION OF THE CANDIDATE & SUPERVISOR .....	i
DEDICATION .....	ii
ACKNOWLEDGEMENT .....	iii
ABSTRACT.....	v
TABLE OF CONTENTS.....	vii
LIST OF FIGURES .....	xi
LIST OF TABLES .....	xiii
LIST OF ABBREVIATIONS .....	xvi
LIST OF APPENDICES .....	xvii
1 INTRODUCTION .....	18
1.1 Background .....	18
1.2 Definitions .....	20
1.3 Scope of Study .....	22
1.4 Objectives.....	22
1.5 Outcomes.....	22
1.6 Arrangement of Dissertation .....	23
2 LITERATURE REVIEW .....	25
2.1 Fundamentals of Capacity .....	25
2.1.1 Capacity Definitions through time.....	25
2.1.2 Development of HCM Multi-lane Methodology through time.....	33
2.1.3 “Capacity Drop” Phenomena .....	35
2.1.4 Defining capacity based on Empirical data.....	35
2.2 HCM 2010 Multi-lane Methodology .....	36
2.2.1 Limitations of HCM 2010 Methodology .....	36
2.2.2 Base Conditions for Multi-lane Highways in HCM 2010 [7].....	36
2.2.3 HCM 2010 Capacity Estimation Framework .....	37
2.2.4 Computation of Free Flow Speed (FFS).....	39
2.2.5 Adjustment Factors .....	40
2.3 Indonesian HCM 1997 (IHCM) Urban Multi-lane Methodology.....	43

2.3.1	Limitations and Base Conditions .....	43
2.3.2	IHCM Capacity model .....	44
2.4	RDA Methodology (1998) .....	51
2.5	HCM 2010 Urban Street Segments methodology .....	52
2.6	Capacity Estimation models and methods .....	53
2.6.1	Greenshields' model .....	53
2.6.2	Greenberg's model .....	54
2.6.3	Underwood's model .....	55
2.6.4	Pipes-Munjal's model .....	56
2.6.5	Drake's model .....	56
2.6.6	Maximum Capacity method .....	57
2.6.7	Van Aerde method .....	57
2.6.8	Other capacity estimation methods .....	58
2.7	Capacity Estimation Studies .....	59
2.8	Capacity Adjustment factors .....	61
2.8.1	Lane width .....	61
2.8.2	Median type .....	63
2.8.3	Free Flow Speed (FFS) .....	63
2.8.4	Access Point Density .....	64
2.8.5	City Size .....	65
2.8.6	Shoulder type and width .....	65
2.8.7	Vehicle Composition .....	66
2.8.8	On-street Parking .....	68
2.9	Passenger Car Unit (PCU) Factor .....	68
2.9.1	PCU Estimation methods .....	68
2.9.2	Sri Lankan PCU Studies .....	72
2.10	Data Collection methods .....	73
2.10.1	Manual Data Collection methods .....	74
2.10.2	Video based methods .....	74
2.10.3	Radar based methods .....	75
2.10.4	Pressure Contact Tubes .....	75
2.10.5	Google Distance Matrix (GDM) method .....	75

2.11	Summary of Literature Review .....	76
3	RESEARCH PILOT STUDIES .....	78
3.1	Testing HCM 2010 Applicability to Sri Lanka .....	78
3.2	Capacity Evaluation - Pilot Study .....	80
3.2.1	Data collection of Pilot Study .....	81
3.2.2	Extraction method of Flow and Speed data .....	82
3.2.3	Method of conversion to Homogeneous flow .....	84
3.2.4	Determination of Traffic Stream model (Curve fitting) .....	87
3.2.5	Capacity Determination method .....	89
3.2.6	Determination of Capacity based 15-min flow data .....	90
3.3	Traffic Data collection method – Comparative study .....	92
3.3.1	Evaluated Data collection methods .....	93
3.3.2	TRAZER Software traffic data collection .....	93
3.3.3	TIRTL Software traffic data collection .....	95
3.3.4	Google Distance Matrix API method .....	95
3.3.5	Results of Data collection method Comparative study .....	95
4	CAPACITY DEVELOPMENT STUDY .....	97
4.1	Data Collection Methodology .....	97
4.2	Capacity Study Survey location data .....	102
4.3	Online Database for Data Storage .....	103
4.4	Summary of Location Data .....	105
4.5	Capacity Estimation Methodology .....	107
4.5.1	Capacity Estimation – Example .....	108
4.5.2	Developed Capacity values .....	111
5	CAPACITY DATA ANALYSIS .....	113
5.1	Capacity Details .....	113
5.1.1	Capacity variation with Effective Carriageway width .....	114
5.1.2	Capacity variation with Built Environment .....	115
5.1.3	Capacity variation with Access Point Density .....	116
5.2	Capacity model Development methodology .....	117
5.2.1	Capacity model for 4-lane highways .....	117
5.2.2	Capacity model for 6-lane highways .....	125

5.2.3	Combined Capacity model for multi-lane highways .....	127
5.3	Speed data .....	130
5.3.1	Speeds at Capacity .....	131
5.3.2	Free Flow Speed Data Analysis .....	132
5.3.3	Free Flow Speed (FFS) estimation model .....	133
5.4	Verification methodology of developed models .....	133
5.5	Comparison of Capacity data .....	137
5.6	Limitations of Study .....	139
6	CONCLUSIONS AND RECOMMENDATIONS .....	141
	REFERENCE LIST .....	144
	APPENDIX A: Comparative Study of Data Collection Techniques .....	152
A.1	Study Locations .....	152
A.2	Results and Discussion – Flow .....	153
A.2.1	TIRTL Instrument Flow Analysis .....	154
A.2.2	TRAZER Software Flow Analysis .....	156
A.3	Results and Discussion – Speed .....	161
A.3.1	TIRTL Instrument Speed Analysis .....	161
A.3.2	TRAZER software Speed Analysis .....	162
A.3.3	Comparison of Speed Estimation of TIRTL & TRAZER .....	163
A.4	Google Distance Matrix (GDM) API Speed .....	164
	APPENDIX B: Traffic Flow Counts .....	167
	APPENDIX C: Data Collection Location Data .....	171
	APPENDIX D: Free Flow Speed (FFS) model development .....	178

## LIST OF FIGURES

Figure 1.1: Different types of multi-lane roads [2].....	20
Figure 1.2: Homogeneous traffic stream (a), and Heterogeneous traffic stream (b) .	21
Figure 2.1: Greenshields’ speed-flow curve in 1934 [12] .....	27
Figure 2.2: HCM 2010 speed-flow curve for multi-lane highways under base conditions [7] .....	38
Figure 2.3: Image of curb (source: gettyimages) .....	41
Figure 2.4: Analysis boundary of an Urban Street segment in HCM 2010 [7] .....	52
Figure 2.5: Speed-density and speed-flow model developed by Greenshields [12]..	54
Figure 2.7: Greenberg’s speed-density curve based on empirical data [29].....	55
Figure 2.9: Base capacity vs. FFS [45] .....	64
Figure 3.1: Comparison of GDM data speeds and FFS from equation (2.1).....	80
Figure 3.2: Capacity estimation methodology .....	81
Figure 3.3: Data collection points for study.....	82
Figure 3.4: Vehicle composition observed in study.....	83
Figure 3.5: Speed-density data plot.....	88
Figure 3.6: 5-min interval speed-density plot with calibrated models.....	89
Figure 3.7: Speed-flow data with Drake’s flow curve .....	90
Figure 3.8: 15-min speed-density plot and fitted curve .....	91
Figure 3.9: Drakes speed-flow curve and 15-min speed-flow data .....	92
Figure 3.10: TRAZER video detection – A4 highway, Pannipitiya .....	94
Figure 3.12: TRAZER sample video capture point .....	96
Figure 4.1: Output file from GDM speed data collection script .....	98
Figure 4.2: Median types on multi-lane roads .....	99
Figure 4.3: Lane width details .....	100
Figure 4.4: Shoulder types available on multi-lane roads.....	101
Figure 4.5: Survey locations .....	103
Figure 4.6: TrafficStats web database.....	104
Figure 4.7: Fitted Greenshields’ model to speed-density data.....	110
Figure 4.8: Developed speed-flow relationship for location_41.....	111

Figure 5.1: Capacity histogram.....	113
Figure 5.2: Effective carriageway width vs Directional Capacity.....	114
Figure 5.3: Effective Lane width vs Lane capacity .....	115
Figure 5.4: Average lane capacity vs Built environment.....	116
Figure 5.5: Average lane capacity vs Access Point Density.....	117
Figure 5.6: Histogram (top) and P-P plot (bottom) of data set .....	119
Figure 5.7: 4-lane model Capacity variation with effective lane width.....	123
Figure 5.8: 6-lane model capacity variation with effective lane width.....	127
Figure 5.9: Comparison of speeds at capacity .....	132
Figure 5.11: Verification data locations.....	134
Figure 5.12: Comparison of estimated and model capacity.....	135
Figure 5.13: Scatter plot of model capacity and actual capacity used for validation .....	136
Figure 5.14: Comparison of FFS and estimated FFS from developed model .....	136
Figure 5.15: Scatter plot of model FFS and actual FFS used for validation.....	137
Figure 5.16: Overall vehicle composition of surveyed locations.....	139
Figure A- 1: Data collection locations .....	153
Figure A- 2: The range of the TIRTL instrument .....	154
Figure A- 3: Loci of Infra-red beams - TIRTL .....	155
Figure A- 4: Error with side mirrors in TRAZER .....	158
Figure A- 5: TRAZER flow values.....	159
Figure A- 6: TIRTL speed error values .....	162
Figure A- 7: Error distribution in TIRTL and TRAZER .....	163
Figure A- 8: Road section selected for study [source: Google maps] .....	165
Figure D- 1: FFS Curves from model (CM – Center median).....	180

## LIST OF TABLES

Table 2.1: Capacity values given in in 1950 HCM [13] .....	28
Table 2.2: Base capacity values in 1985 HCM [15] .....	30
Table 2.3: Base capacity values in 1994 and 1997 HCM [15] .....	31
Table 2.4: Summary of HCM capacity values and adjustment factors.....	34
Table 2.6: Equations describing speed-flow curves in Figure 2.2 [7] .....	38
Table 2.6: FFS values and respective capacity values .....	38
Table 2.7: Lane width reduction factors for equation (2.1) [7].....	40
Table 2.8: Adjustments to FFS for lateral clearances given in HCM 2010 [7] .....	41
Table 2.9: Adjustment factor to FFS for Median type in HCM 2010 [7] .....	42
Table 2.10: Adjustment to FFS for access point density in HCM 2010 [7] .....	42
Table 2.11: Base capacities given in IHCM 1997 [27].....	44
Table 2.12: Lane width adjustment factors for urban roads [27].....	45
Table 2.13: Directional split adjustment factors for capacity [27] .....	46
Table 2.14: Capacity adjustment factor for the effect of side friction and shoulder width [27].....	47
Table 2.15: Side Friction Class table IHCM [27] .....	48
Table 2.16: Capacity adjustment factor for the effect of side friction and curb width [27].....	49
Table 2.17: City size adjustment factor in IHCM [27] .....	50
Table 2.18: IHCM 1997 PCU factors for Urban roads .....	51
Table 2.19: Summary of base capacity values given in guidelines .....	51
Table 2.20: Directional capacity change with vehicle composition [36].....	59
Table 2.21: Vehicle composition with city size in IHCM 1997 [27].....	67
Table 2.22: Capacity change with vehicle type [36].....	67
Table 2.23: PCU values developed by Kumarage (1996).....	72
Table 2.24: Comparison of PCU values developed by Weerasinghe and Pasindu [61] .....	73
Table 3.1: Geometric details of sections considered .....	79
Table 3.2: Collected speed statistics for study .....	79
Table 3.3: Vehicle projected areas .....	85

Table 3.4: Speed statistics of vehicles surveyed .....	85
Table 3.5: Comparison of derived PCU factors with PCU factors in literature.....	86
Table 3.6: Flowrate calculation example .....	86
Table 3.7: Sample set of Flow, Speed and Density data.....	87
Table 3.8: Fitted models to 5-min interval speed-density data .....	88
Table 3.9: Fitted models to 15-min interval speed-density data .....	91
Table 4.1: Details of Loc_1 .....	102
Table 4.2: Data location highlights .....	105
Table 4.3: Sample set of data from Location_41 .....	108
Table 4.4: Example conversion of 15-min classified flow to uniform flowrate .....	109
Table 4.5: Developed capacity values.....	112
Table 5.1: Model Summary .....	120
Table 5.2: ANOVA table for regression .....	120
Table 5.3: Coefficient table of regression.....	121
Table 5.4: Built Environment type factors for equation (5.1).....	122
Table 5.5: 4-lane model capacity table .....	124
Table 5.6: Model summary and ANOVA table for 6-lane section .....	125
Table 5.7: Coefficient table for 6-lane model.....	126
Table 5.8: 6-lane model capacity table .....	127
Table 5.9: Capacity constant factor for equation (5.4) .....	128
Table 5.10: Lane width adjustment factors for equation (5.4).....	128
Table 5.11: Access Point Density (APD) adjustment factors for equation (5.4).....	129
Table 5.12: Median type adjustment factors for equation (5.4).....	129
Table 5.13: Built Environment adjustment factors for equation (5.4).....	129
Table 5.14: Speed data of study locations.....	130
Table 5.15: Developed capacity and FFS data.....	134
Table 5.16: Capacity comparison table.....	138
Table 5.17: Capacity values estimated from different models in literature .....	138
Table 5.18: Overall vehicle composition and standard deviation .....	140
Table A- 1: Study locations .....	152
Table A- 2: TIRTL flow summary.....	154
Table A- 3: Error % per lane in TIRTL – Location P1 .....	155



Table A- 4: Summary of TRAZER results .....	157
Table A- 5: Lowest and highest flows observed during study.....	160
Table A- 6: Sample means and variances .....	161
Table A- 7: Statistical data of TIRTL speed survey .....	161
Table A- 8: Statistical data of TRAZER software speed survey .....	163
Table A- 9: Parameters available in Google Distance Matrix API.....	164
Table A- 10: GPS coordinates of survey locations.....	165
Table A- 11: Statistical data of Google Distance Matrix speed survey.....	166
Table B- 1: Speed data of location: Loc_41 .....	167
Table B- 2: Flow data of location: Loc_41 .....	168
Table C- 1: Summary of geometric details of study locations.....	172
Table D- 1: FFS regression model summary .....	178
Table D- 2: FFS model regression coefficients .....	179
Table D- 3: Summary of model developed FFS values .....	181

## 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

## LIST OF APPENDICES

Appendix	Description	Page
APPENDIX A	Comparative study of data collection techniques	152
APPENDIX B	Sample flow count of a study location	167
APPENDIX C	Location data summary	171
APPENDIX D	Free Flow Speed (FFS) Model Development	178