THE UNIVERSITY OF MORATUWA

USE OF ELECTRICITY CONSUMPTION FOR TRAFFIC MODELING OF A SUBURBAN AREA

BY

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The undersigned certify that they have read, and recommended to the faculty of Engineering of University of Moratuwa, Sri Lanka for acceptance, a thesis entitled, "Use of Electricity Consumption for Traffic Modeling of a Suburban Area" submitted by Tissa U. Liyanage in partial fulfillment of the degree of Doctor of Philosophy.

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Abstract

The history of urban travel demand studies spreads over a period of more than fifty years. Most of them are recorded from developed countries, with just a handful from developing countries. The scarcity of reliable and up-to-date socio-economic data to the required formats, and fewer possibilities of acquiring electronic data bases are the most apparent reasons for this situation. Often, data bases from more than one type of non-related data sources are required to run a complete travel demand forecasting model. This has restrained the calibration and forecasting of travel demand models in developing countries.

In particular, little attention has been given to forecasting travel in small and medium communities except for a few instances from developed countries. The primary reason for this is that, forecasting travel for small communities is not considered important, when statewide or national level travel forecasting models have not been developed, and specially due to the limited financial and technical capacities in the respective agencies. National level travel surveys are however not adequately sensitive to small and medium urban centres as they do not represent local travel behaviour adequately. But the need for travel demand forecasting in small communities is great with respect to infrastructure development planning. Many researches have shown that there is a strong relationship between trip generation and the combined income of a household. But it is very difficult to collect the income data in developing countries, and no proper and reliable data sources are available. In this context, more readily available electricity consumption data, for both households and for non-households can be used as a cost effective approach for ascertaining travel demand, given that such data can be easily measured either in terms of disaggregate household or aggregate area level, at a much lesser cost.

There are a number of advantages to use electricity consumption as an explanatory variable for travel forecasting. The electronically available disaggregated data sets can be easily used in many forms at the data preparation stage. This helps to use the data in aggregate or disaggregate forecasting according to the user requirements. The monthly updated data can be aggregated into any form of small zones by sorting them with addresses. The spatial location of the user can be geo-referenced and located with these addresses. Therefore, the use of GIS for travel modeling is possible. Since the electricity

is accessible to many users in urban areas, variations of the land use changes can be assessed in time with updated data.

Generalized functional forms for trip generation, mode selection, and trip distribution in suburban areas using electricity consumption as the main explanatory variable are suggested herein. The trip generation forecasting is explained by electricity consumption at household level with the hypothesis that household electricity consumption behaving as a surrogate variable for the combined income of that household. This model fit has been strengthened by introducing some of the socio-economic variables as well. Mode split models have also been calibrated using household electricity consumption, and functional forms for each mode and are presented separately. Both the trip generation and the mode selection by non-electricity users have been incorporated with category analysis techniques. The concept of traffic attraction to a destination zone based on its economic strength has been used here relating to the non-household electricity consumption level as a surrogate variable for the economic strength of that zone. The assignment of traffic in local road network is suggested with available commercial software popular for small areas to have a complete series of traffic forecasting models.

The up-to-date electricity consumption data in electronic format could be obtained from the Lanka Electricity Company Ltd (LECO) or Ceylon Electricity Board (CEB) free of charge or at a nominal fee. Therefore, this approach will give a very economical use of a model that has been calibrated in a state-of-the art method to suit the local traffic environment. The simple and cost effective approach will be especially helpful for the local authorities for infrastructure development and planning.

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Tissa U. Liyanage
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To

my wife, Nalini

daughter, Helli

and

our Parents.

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List of Abbreviations

ADT – Average Daily Traffic

ATM – Automated Teller Machines

CBC - Cluster Bus Company

CBD - Central Business District

CD – Compact Disc

CEB - Ceylon Electricity Board

CMC – Colombo Municipal Council

CMR - Colombo Metropolitan Region

CoV - Coefficient of Variation

CTB – Ceylon Transport Board

DCS - Department of Census and Statistics

DOT – Department of Transportation

DSD – Divisional Secretariat Divisions

ECU – Electricity Consumption Unit

FHWA – Federal Highway Authority

GDP – Gross Domestic Product

GIS – Geographic Information System

GND – Gramaseva Niladhari Division

GWhrs – Giga Watt Hours

HC - Hourly Capacity

ITE - Institute of Transportation Engineers

kWh – Kilo Watt Hour

LECO - Lanka Electricity Company (Private) Limited

LSE - Least Square Estimation

MC – Municipal Council

MWhrs – Mega Watt Hours

NCHRP – National Highway Cooperative Research Program

NhEcu – Non- Household Electricity Consumption

NTC - National Transport Commission

OD – Origin and Destination

PEF - Pedestrian Environment Factor

POA - Private Omnibus Association

PS – Pradeshiya Sabha

RDA – Road Development Authority

RMV – Registrar of Motor Vehicles

RTB - Regional Transport Board

SLCTB - Sri Lanka Cluster Bus Company

SLR – Sri Lanka Railway

SMITE - Spreadsheet Model for Induced Travel Estimation

STEP - Suburban Travel Estimation Program

TAZ - Traffic Analysis Zone

TC – Town Council

U.S. – United States

UC – Urban Council

UDA – Urban Development Authority

UK – United Kingdom