Integrated Decision Support System for the Provision of Optimum Rural Mobility Solutions : A Conceptual Framework using Mobility Biographies

Granie R Jayalath
Faculty of Graduate Studies, University Of Colombo, Sri Lanka

Key words: *Rural mobility, modal splits, life style domains, mobility biographies, knowledge bases.*

Introduction

The efforts of governments of many developing countries and donor agencies to improve rural mobility have so far been focused on improving and expanding road infrastructure networks. Over the many years there has been massive spending on rural road provisions, yet the interventions have not effectively resolved the rural mobility burden, particularly in developing countries. Though rural populations are quite large, generally exceeding 70% of total populations in developing countries and characterized by low motorised vehicle ownership, the planning philosophy followed by local executing authorities remains auto-mobile dependent.

In the context of Sri Lanka, if the current school of thought is allowed to continue i.e. provision only of paved accessibility as the sole solution to resolve the rural mobility burden, the ongoing program which commenced in 2005, with an annual paving rate of approximately 530km per year (assuming a liner trend) will need another 122 years to have the whole rural network (64,660km) to be paved. Further the planning philosophy which is auto-mobile dependent has not yet explored the potential benefits of already available alternative modes including non-motorised and intermediate modes (Granie R, Kumarage A, 2011). As such current rural mobility solutions are not optimized, hence not commensurate with the existing demand and supply parameters.

Martin L (2003) modified the life course theory of Salomon I (1983) by adding temporal dimension, and distinguished three life style domains with the objective of understanding the travel behavior of an individual. The version of Martin L (2003) was modified again by the author (Granie R.J.,2011) and distinguished four life style domains to simulate the total longitudinal trajectories in the mobility domains of rural village commuters. Estimation of demand for mobility by income groups by the year of analysis is carried out by mapping mobility biographies of the four life style domains thus distinguished based on age groups.

Further an approach is presented to model "mode choice decisions" to have initial estimates for demand by modes in the future year of analysis. Matching interventions to suit the projected demand are determined by referring to knowledge bases, and optimum options are selected based on an appropriate benefit/cost (B/C) tool.

This paper presents a conceptual decision support framework based on an integrated approach to facilitate arriving at optimum decisions over the provision of rural mobility solutions. Research findings could be used to formulate an evidence based national policy framework for rural mobility provision in developing countries in general, and in particular for Sri Lanka.

Objectives

The main objective is to develop a conceptual decision support system (DSS) based on an integrated approach to facilitate the estimation of rural mobility demand and to derive optimum mobility solutions for a future year of analysis. To achieve this objective the following specific objectives were formulated.

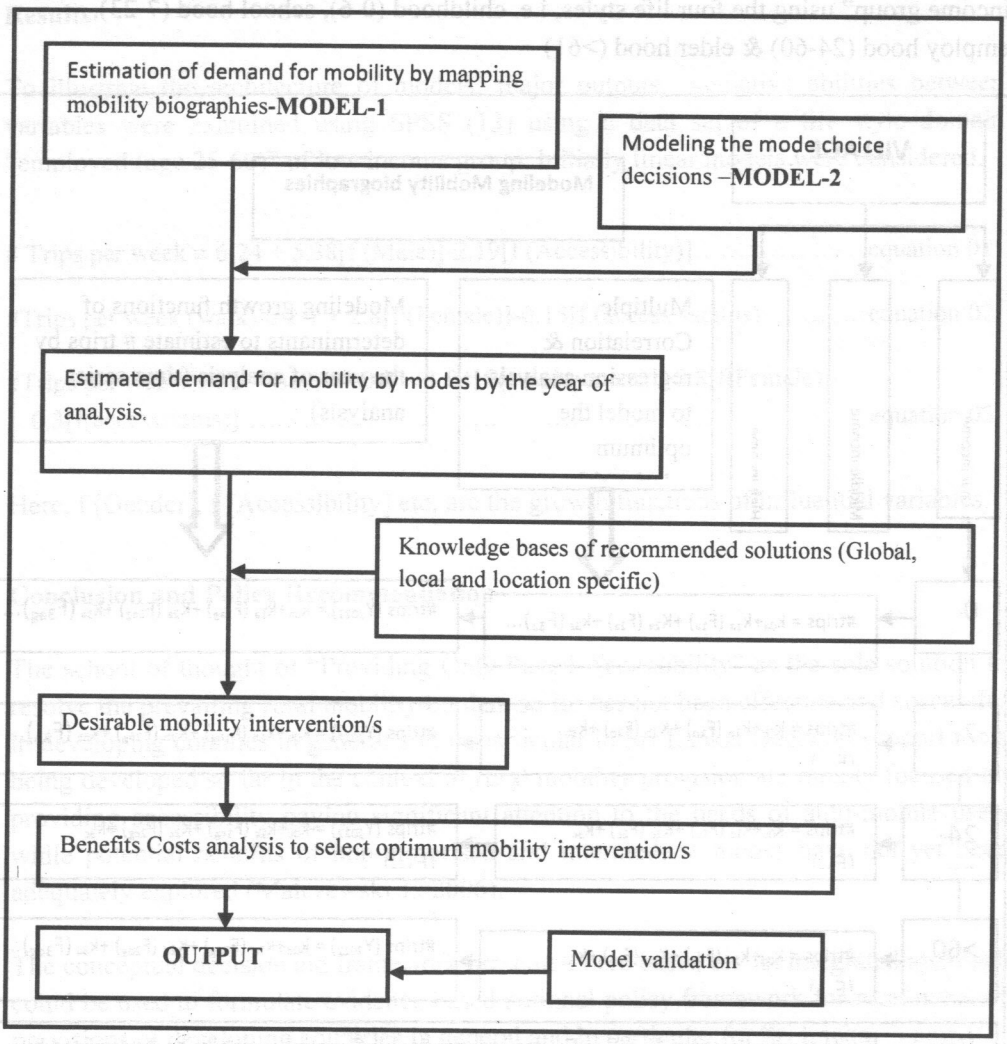
a. Develop an appropriate methodology to estimate the demand for mobility (total # trips) by village commuters by the future year of analysis
b. Develop an appropriate methodology to model mode choices by the future year of analysis
c. Compile available global, local and location specific knowledge bases on recommended solutions for mobility demand by different modes.
d. Derive a set of matching mobility interventions to suit the projected trips by modes making reference to the knowledge bases.
e. Selection of optimum mobility intervention(s) based on an appropriate Benefit-Cost analytical tools.
f. Validation of the model outputs

Methodology

Methodological framework was developed to achieve the specific objectives stated above. Brief outline of the conceptual decision aid system is illustrated in figure 1.

Figure 2 illustrates the process of mapping the mobility biography of a life style domain (example - "employed (25Y-60Y)" under the low income category).

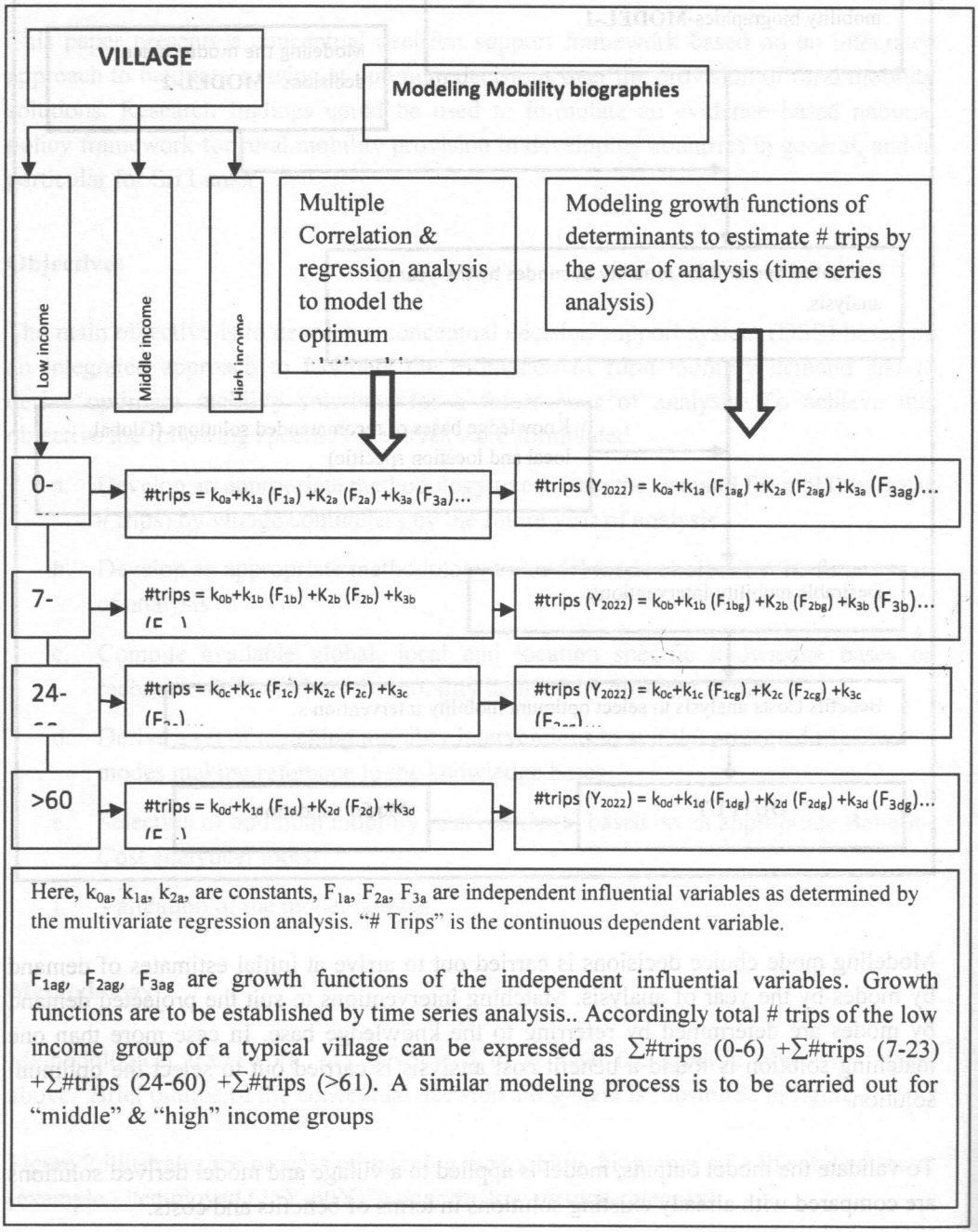
Figure 1 : An Outline of the Conceptual Decision Aid System



Modeling mode choice decisions is carried out to arrive at initial estimates of demand by modes by the year of analysis. Matching interventions to suit the projected demand by modes are determined by referring to the knowledge base. In case more than one matching solution is found a benefit cost analysis is carried out to select the optimum solution.

To validate the model outputs, model is applied to a village and model derived solutions are compared with already existing solutions in terms of benefits and costs.

Figure 2: The process of mapping the mobility biographies. Example, for the "low income group" using the four life styles, i.e. childhood (0-6), school hood (7-23), employ hood (24-60) & elder hood (>61)



Here, k_{0a}, k_{1a}, k_{2a}, are constants, F_{1a}, F_{2a}, F_{3a} are independent influential variables as determined by the multivariate regression analysis. "# Trips" is the continuous dependent variable.

F_{1ag}, F_{2ag}, F_{3ag} are growth functions of the independent influential variables. Growth functions are to be established by time series analysis.. Accordingly total # trips of the low income group of a typical village can be expressed as $\sum$#trips (0-6) +$\sum$#trips (7-23) +$\sum$#trips (24-60) +$\sum$#trips (>61). A similar modeling process is to be carried out for "middle" & "high" income groups

Results

To illustrate the architecture of models' major outputs, predictive abilities between variables were examined using SPSS (13) using a data set of a life style domain "employed (age 25-60)" of low income group. Initially linear models were considered.

Trips per week ≡ 6.24 + 5.38[f (Male)]-2.19[f (Accessibility)]..... .....equation 01

#Trips per week (walk) ≡ 2.7 + 2.8[f (Female)]-0.15[f (access –status) .....equation 02

#Trips per week (walk +Bus) ≡(-0.8) +1.04[f (employment)]+0.8[f(Female)]-
0.3[f(accessstatus)]..... equation 03

Here, f [Gender], f [Accessibility] etc, are the growth functions of influential variables.

Conclusion and Policy Recommendation

The school of thought of "Providing Only Paved Accessibility" as the sole solution to resolve the prevailing rural mobility burden, so far has not been effective and successful in developing counties in general and in particular in Sri Lanka. Decision support tools being developed so far in the context of rural mobility provision are mainly focused on providing accessibility paying significant attention to the needs of auto-mobile users while potential benefits of non-motorised and intermediate modes have not yet been adequately explored (Malczewski J., 2006).

The conceptual decision aid framework presented here based on an integrated approach could be used to formulate evidence based national policy framework for rural mobility provisions of developing countries in general and in particular for Sri Lanka.

References

Granie R.J, Kumarage, A. (2011), *An Integrated approach for the provision of optimum rural mobility solutions- A conceptual frame work,* Annual transactions of Institute of Engineers , Sri Lanka ,Volume-1,Part-B, October 2011, pp 220-231

Malczewski, J. (2006), GIS based Multi-criteria decision analysis: A survey of literature, *International Journal of Geographic information Science,* Vol. 20, No 7, August 2006, pp.703-726

Mokhtarian, P.L., Salomon, I., Redmond, L.S. (2001). *Understanding the Demand for Travel: It's Not Purely 'Derived'*. Innovation, 14

Martin .L. (2003), *Mobility biographies – A new perspective for understanding travel behavior*, 10th international conference on travel behavior research, LUCERNE, 10-15 August 2003.

Salmon. I., (1983), Life styles-A broader perspective in travel behavior- *Recent advancement in travel demand Analysis*, pp 209-310, Gower, Aldershot, Hants.