STOCHASTIC METHODS IN URBAN TRANSPORTATION PLANNING: A CASE STUDY OF KISUMU.

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ABSTRACT:

There are many urban planning problems in developing
countries. Unlike most Western Cities, Developing Country Cities
have grown rapidly and explosively in this century. Analysis of
cities in developing countries is more complex due to the
co-existence of different kinds and levels of technology with a
wider variety of urban structural forms. These make modeling
even more difficult.

Kisumu is currently the third largest town in Kenya after
Nairobi and Mombasa. The town has experienced fast growth in
area, population and commercial entrepreneurship. Its physical
structure continues to experience fast growth receiving new
residential, commercial and industrial premises. This trend
reveals a complete re-orientation of the town's settlement pattern
with the possibility for a future urban form accompanied by a
demand for transport probably unforeseen to date.

Transportation studies for Kisumu in the past by the
Department of Civil Engineering, University of Nairobi, utilized
regression analysis and the gravity model techniques. The
regression analysis is disadvantaged for being static and
deterministic in nature. The gravity model has a probabilistic
term in its formulation but it still has the static qualities
common with most models of urban transportation planning. This is
not a good experience for developing country cities which often
experience random as well as sporadic growth. Probabilistic
models are strong in specifying random components and stochastic
models such as the Markov chains are models of multivariate time

series, explicitly dynamic and geared towards analyzing the asymptotic behaviour of a process in a system.

In this pioneering study in Kisumu, Markov Chain analysis was applied to raw inter-zonal travel data observed in the town in 1982. The zonal trip interchange matrices were observed to have a purely Markovian property. Despite difficulties in defining the "discrete-time-space", it was found that long term transition probability matrices derived represented Ergodic Markov Chains which were irreducible and aperiodic. In other words, inter-zonal travel is a real life process which does not terminate in time. The first return periods calculated from the steady state transition probabilities varied widely with the shortest period always coinciding with zone 22 (East ward) in the Old Town which was a built-up area with little room for expansion, while the longest period always coincided with zone 6 (Swahili-Mkendwa) on the hilly part of the municipality with little building activity recorded during the surveys. The first return periods for home-based trips had the same range with a little difference shown at the lower limit (51 to 5882 years for home-based work trips and 49 to 5882 years for home-based non-work trips). The first return periods for non-home-based work trips had a shorter range (48 to 3846 years) while the range for total trips took an average of all the categories combined as expected in the analysis (50 to 5263 years).

It was concluded that the method was more versatile since trips were allocated to each zone in proportion to its population growth. The method avoided the cumbersome regression analysis

while it simulated the long-term travel pattern in Kisumu using data from field observations. Another conclusion was that trip distribution should be done at the target forecast date using correspondingly forecasted socio-economic factors so as to take care of any anticipated changes in the urban spatial form, normally ignored in conventional transportation planning methods where trips are distributed only at the base year. The Markov model was completely dynamic and it eliminated the static component of forecasting in conventional urban transportation planning models.

Further work was recommended in order to test for the authenticity of the discrete-time period adopted and the general applicability of the Markov model in developing countries. It was also recommended that the influence of other factors besides accessibility to employment in the assignment of growth to the urban zones be investigated.