AN APPLICATION OF CONTINUOUS SPATIAL MODELS TO FREIGHT MOVEMENTS IN GREATER LONDON

TADAFUMI MAEJIMA*
Transport Studies Group, University College London, London WC1E 6BT, U.K.

ABSTRACT

This report describes an application of continuous spatial models to freight movements in Greater London. Continuous spatial models are fitted to data on the densities of generation and attraction of the freight assuming that the density is dependent on the distance from the centre of the area. The fit is measured using regression analysis and the results are examined. The graphs of the densities against the distance from the centre suggest an exponential relationship, and Clark's model is fitted to the data. The model fits fairly well to the data on densities for most groups of commodities. The correlation between the density and the distance is stronger for attraction than for generation in most groups of commodities.

Introduction

Not much research work has been done on freight movements in urban areas from the point of view of transport planning techniques. Because of the complexity and irregularity of freight movements, the modelling of freight movements is more difficult than that of passenger movements.

Models for freight movements might be divided into two categories according to their purposes. One is for short-term, operational purposes. Models such as those developed for the Swindon Freight Study fall into this category (Atkins Planning, 1975). Models in this category tend to be complicated and to include many external factors some of which are difficult to measure.

The other is for long-term, strategic purposes. Models in this category are required to be simple and easy to handle. External factors should be easy to predict or stable over long periods of time. The author has been

* Permanent address: Traffic Engineering Section, Road Division, Public Works Research Institute, Ministry of Construction, Asahi 1, Toyosato-cho, Tsukubagan, Ibaragi, Japan 300-26.
working on models in this category and examined the fit of inter-zonal
distribution models which are widely used in passenger transport planning
to data on freight movements in Tokyo Metropolitan Area (Maejima, 1971);
he has also developed a model of the gravity type introducing inter-industrial
relationships (Maejima, 1972).

This report describes the first attempt to apply continuous spatial
models to freight movements in Greater London. A continuous spatial
model describes the distribution of the densities of activity as a single
continuous function of the distance from the centre of a city. The work
described in this report deals with generation and attraction of freight (i.e.
the tonnage of freight generated from and attracted to each zone), but
further work on inter-zonal distribution of the freight movements would be
appropriate.

Continuous Spatial Models

Continuous spatial models have been developed in the course of analyses
of urban activities in relation to the geometry and general physical structure
of towns. Much work on urban transport has been done using this geometric
approach. Smeed (1971) compared various types of road network systems in
towns and Tanner (1972) presented a comprehensive urban transport model
incorporating some continuous features. Blumenfeld and Weiss (1974)
examined densities of journeys to work in London and Bristol, and tested
the fit of models to the data. MacBriar (1977) provided the most complete
list of spatial distribution functions proposed since the original work of
Clark (1951), by adding some more functions to the list of Papageorgiou
(1971). MacBriar fitted some of the functions to the data in London and
Bristol by using the entropy maximization method and found that the func-
tions for workplaces in London and Bristol became remarkably similar by
introducing non-dimensional radius.

Continuous spatial models describe the density of activity (e.g. trip-
end density) as a function of the geometric location in a town. There are
14 various functions to describe trip-end densities according to MacBriar’s
list. Some functions fitted to data by either Blumenfeld or MacBriar are as
follows:

Clark (1951) : \( D = a \exp(-br) \)
Sherratt (1960) : \( D = a \exp(-br^2) \)
Smeed (1963) : \( D = a r^{-b} \)
Tanner (1961) : \( D = a r^{-b} \exp(-cr) \)
Ajo (1965) : \( D = a \exp(-b \sqrt{r}) \)