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Traffic Congestion Modelling Based on Origin and Destination

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Abstract

This study attempts to make use of traffic behaviour on the aggregate level to estimate congestion on urban arterial and sub-arterial roads of a city exhibiting heterogeneous traffic conditions by breaking the route into independent segments and approximating the origin-destination based traffic flow behaviour of the segments. The expected travel time in making a trip is modelled against sectional traffic characteristics (flow and speed) at origin and destination points of road segments, and roadway and segment traffic characteristics such as diversion routes are also tried in accounting for travel time. Predicted travel time is then used along with free flow time to determine the state of congestion on the segments using a congestion index (CI). A development of this kind may help in understanding traffic and congestion behaviour practically using easily accessible inputs, limited only to the nodes, and help in improving road network planning and management.

Keywords: congestion, delay, origin and desination, traffic, travel time

1. Introduction

Traffic congestion, not limited to but especially prevalent in metropolitan cities, is one of the most conspicuously worsening problems associated with traffic engineering and urban planning, with clear implications on spheres of

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urban economy, environment and lifestyle. Traffic in cities continues to grow meteorically especially in major cities of developing countries, which are characterized by heavy economic and population growth and assimilation in business and residential districts. This naturally necessitates intense transportation of goods and passengers, increasing demand for personal vehicular ownership that over the last decade has seen exponential growth worldwide. However, the failure of sufficiently rapid infrastructural development required to cater to this burgeoning traffic frequently leads to failures of the urban transportation system, resulting in traffic jams. Quantification of congestion thus becomes essential in checking congestion in order to provide a sustainable transportation system that necessitates a well-functioning well-integrated urban economy.

2. Objective

The complexity of traffic systems in several developing countries is exacerbated due to the prevalence of heterogeneous traffic that only furthers the chaotic nature of the study. This study aims to understand the relationship between the traffic conditions of the source and the destination in portions ("segments") of an arbitrarily chosen trip on an arterial and sub-arterial road in a major metropolitan city of India characterizing extremely diverse traffic conditions, and analyze the viability of promoting the use of O-D based measures of congestion to estimate the severity of the problem in the route. For this purpose, the basic traffic parameters, such as volume, speed, density and capacity are measured or calculated at different nodes of the study route and tried against the aforementioned indicator of congestion: Congestion Index, and a review for the prepared model and the behavior of the variables used is then prepared.

3. Research survey

Congestion has been variously defined as a physical condition in traffic streams involving reduced speeds, restrained movement, extended delays and paralysis of the traffic network. The definition of congestion has been conventionally categorized on the basis of four parameters: capacity, speed, delay/travel time and cost incurred due to congestion. The volume-by-capacity ratio (v/c) is a popular preliminary measure that compares the given traffic conditions with the limiting on-capacity conditions, and is used to assess the Level of Service (LOS) of the road. Speed based measures of congestion are more efficient in explaining the degree of congestion [1]. Anjaneyulu and Nagaraj [2] developed a methodology of determining the state of congestion on road segments with the help coefficient of variation of speed. Chakrabartty and Gupta [3] estimated the cost of congestion on a route in Kolkata, based on the methodology devised by R. J. Smeed [4]. Lomax et al [1] defines congestion as the travel time or delay incurred in excess of that in light or free flow conditions. Time based measures provide a stronger basis for more generalised conclusions and indicators like Travel Time Index (TTI) and its derivative Congestion Index (CI) are easy to comprehend [5]. Though several travel time/delay based measures of congestion, this study makes use of Congestion Index (CI) because of its ease of calculation and intensive nature as a ratio. The use of origin and destination (O-D) based congestion estimation in theory is limited. Conventionally, O-D matrices are used for trip planning, traffic management and operation studies [5]. This study tries to check if a relation between congestion and the node (or O-D) volume and operational characteristics really exists.

4. Methodology

The first step was to identify a suitable route that includes substantial stretches of both arterial and sub-arterial roads and is often wrought with congestion (regular congestion). Subsequently the route was divided into segments and for this purpose, eight nodes were chosen, most of them being major rapid transit bus stops or major intersections. The next step was identification of potential factors. Both roadway as well as traffic parameters were considered, and the congestion parameter to be modelled was fixed (Congestion Index, CI). Once the expected data input was rightly identified, data were collected on site using video camera for recording node based traffic parameters and moving car method for measuring the real travel time. The data were pre-processed and source-destination and segment variables were calculated. Finally, all variables found were tested for statistical