B-55.5 A Study on Comprehensive Assessment of Mitigation Measures for Global Warming in Transport Sector of Cities (Final Report)

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ABSTRACT

In this study, we have proposed a prediction model for emission of carbon dioxide (CO_2), which causes the global warming, from the urban transport sector and have estimated effects of CO_2 emission reduction measures on the of CO_2 emission using the model. We have also considered the feasibility of new urban transport systems and low-emission vehicles.

The model is composed of four sub-models: i) a distribution sub-model of traffic volume by transportation mode; ii) a prediction sub-model of automobiles vehicle-kilometers; iii) a prediction sub-model of public transport vehicle-kilometers; and iv) a CO_2 emission prediction sub-model. A detailed examination including a sensitivity analysis was carried out for these sub-models. In addition, we carried out a case study in Utsunomiya City to examine an applicability of the model. In the case study, CO_2 emission from urban transport sector decreases about 1% by reduction effect of automobile vehicle-kilometers decreases about 3% by increase effect of travel speed on road network and decreases about 5% by reduction effect of emission factor.

1. INTRODUCTION

In 1997, the transport sector accounts for 20.9% of the CO_2 emission in Japan and motor vehicles account for 88.0% of the CO_2 emission from the transport sector. Passenger vehicles including vans account for more than half of motor vehicles. The CO_2 emission from the transport sector increased from 1990 to 1997 by 21.3%. An increase rate of the sector is fairly larger than that of other sectors. It is assumed that a sharp increase in total vehicle-kilometers drastically caused an increase in the emission from the transport sector. The vehicle-kilometers increased from 1990 to 1997 by 18.4%.

2. RESEARCH OBJECTIVES

This paper focuses on CO_2 emission reduction measures in the urban transport sector. The research objectives are creation of the CO_2 emission prediction model in the urban transport sector, forecast of quantitative effects of the measures and a proposal of a sustainable transport system based on the forecasted quantitative effects.

3. PREDICTION MODEL OF CO_2 EMISSION IN URBAN TRANSPORT SECTOR

3.1 Outline of the prediction model

Utsunomiya City is selected as for the case study using the model because the City has public transport facilities such as railways and buses and forms comparatively independent living area including surrounding towns. Eleven measures for the CO_2 emission reduction are taken up in the case study. They are classified as shown in Table 1.

The prediction model of CO_2 emission reduction is composed of "Distribution sub-model of traffic volume by transport mode", "Prediction sub-model of automobiles vehicle-kilometers", "Prediction sub-model of public transport vehicle-kilometers", "Sub-model to predict effect of measures for reducing CO_2 emission" and "CO_2 emission prediction model " (Figure 1). It is necessary to predict CO_2 emission by transport mode, and especially to predict vehicle-kilometers by travel speed for automobiles because CO_2 emission from automobiles depends on the travel speed.

We simplified a road network within the city area to facilitate calculation of traffic volume by link. Considering regional difference in effects of CO_2 emission reduction measures,

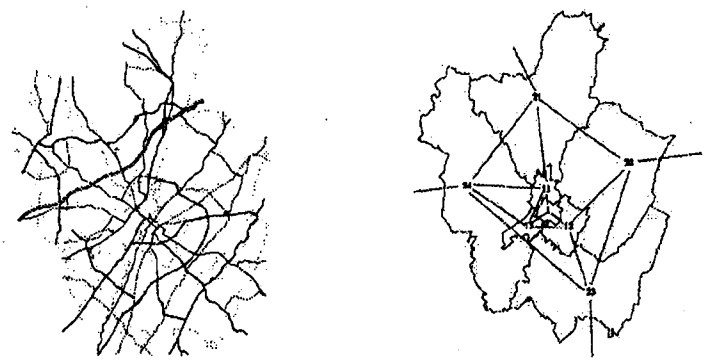

Figure 2 Simplification of road network in Utsunomiya City

Table 1 Classification of CO_2 emission reduction measures

Classification	Means	Measures
Reduction of automobile vehicle-kilometers	Reduction of total trips	. Invigoration Central City . Promotion of teleworking
	Shift to other transport modes from automobiles	. Improving service level of railways . Improving service level of buses . Promoting Park-and-Ride . Improving cycle road . Area pricing
Reduction of CO_2 emission per vehicle-kilometers	Improvement of fuel consumption efficiency of vehicles	. Promoting utilization of low emission vehicles
	Solution of traffic congestion	. Eliminating bottle-neck points . Improving highway network . Averaging peak hour traffic

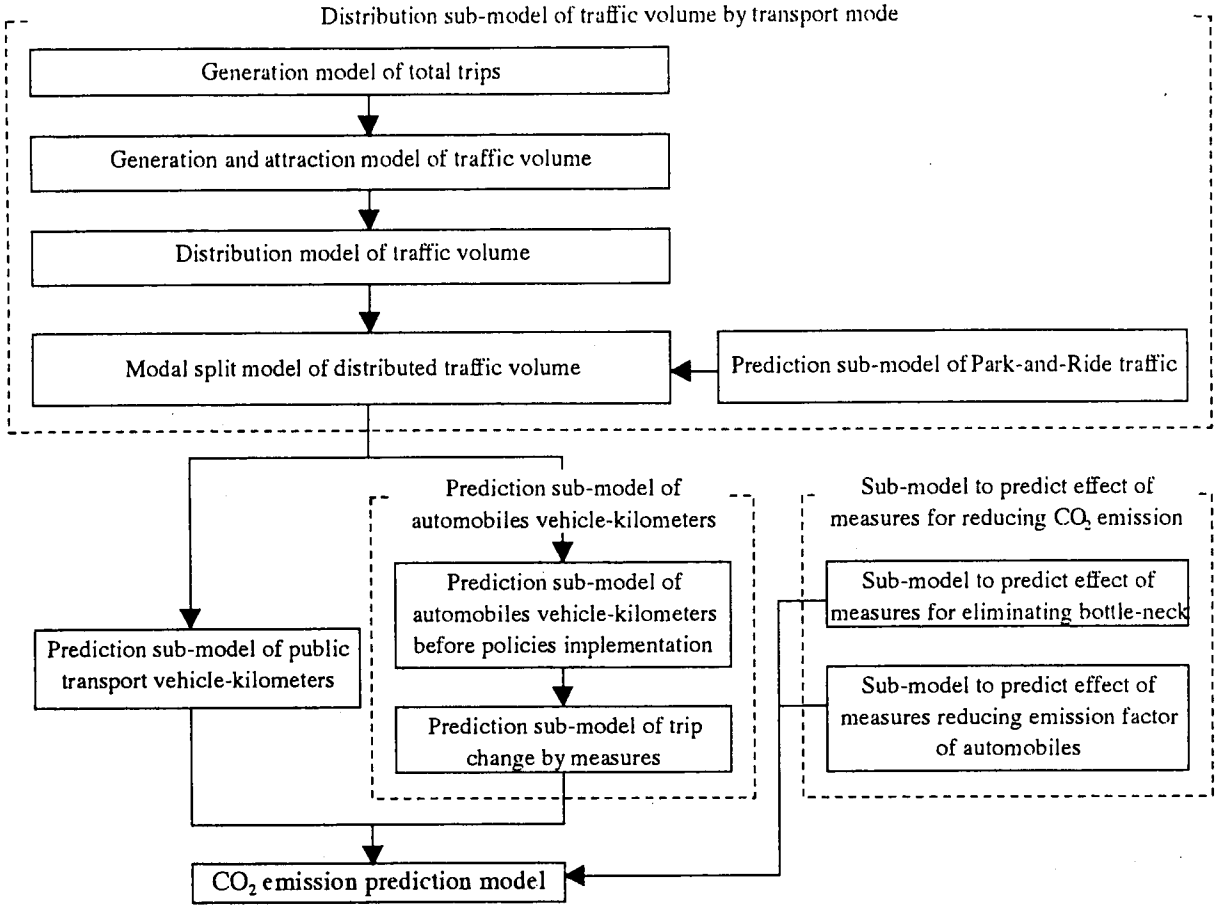

Figure 1 Structure of CO_2 emission prediction model from urban transport sector

we classified a city into three districts, which are a central business district (CBD), a district adjacent to CBD and suburb. In case of Utsunomiya City, we divided the city into 8 zones (Figure 2). And we predicted trips and CO_2 emission by zone.

3.2 Out line of the sub-models

(a) Distribution sub-model of traffic volume by transport mode

The sub-model is used to predict distributed traffic volume by transport mode from travel cost, travel time and socioeconomic indicators such as number of retained motor automobiles and number of person engaged by types of industry.

The model is composed of four levels that are generation of total trips, generation and attraction of traffic volume, distribution of traffic volume and modal split model of distributed traffic volume.

(b) Prediction sub-model of automobiles vehicle-kilometers

The sub-model is used to predict automobile vehicle-kilometers by travel speed and link on the road network from predicted traffic volume of automobile, capacity by road link, relation between traffic volume and travel speed and time fluctuation of traffic volume. Automobile vehicle-kilometers are predicted dividing vehicle-kilometers of arterial roads and that of feeder roads. Arterial road is defined the roads where traffic volume by types of automobiles and travel speed in peak hour are surveyed in road traffic census by Ministry of Construction. Feeder road is defined the road excepting arterial road. Automobile vehicle-kilometers of arterial roads are predicted using traffic assignment on simplified road network

and traffic volume in road traffic census. Those of feeder roads are predicted using generated and attracted traffic volume by zones and automobiles vehicle kilometers per trip, because road traffic census is not implemented on feeder roads.

(c) Prediction sub-model of public transport vehicle-kilometers

Vehicle-kilometers of public transportation is predicted from route length in the city, frequency of operation and number of cars. We predicted it from regression model between vehicle kilometers and number of passengers, if passengers of public transport increase by implementation of CO_2 emission reduction measures.

(d) CO_2 emission prediction model

The sub-model is used to predict CO_2 emission from urban transport sector multiplying predicted vehicle-kilometers and emission factors

4. Effect of CO_2 emission reduction measures from urban transport sector

In the case study, we estimated effect of eleven measures for CO_2 emission reduction divided between reduction effect of automobiles vehicle-kilometers and increase effect of travel speed on road network (Figure 3). CO_2 emission from urban transport sector decreases about 1% by reduction effect of automobile vehicle-kilometers decreases about 3% by increase effect of travel speed on road network and decreases about 5% by reduction effect of emission factor. In case of 3 and 5, the measures related railways have little effect in Utsunomiya City because railway network is poor in the city.

We have problems about CO_2 emission prediction model that it is necessary to predict effect of CO_2 emission measures in the city of different scale from Utsunomiya City.

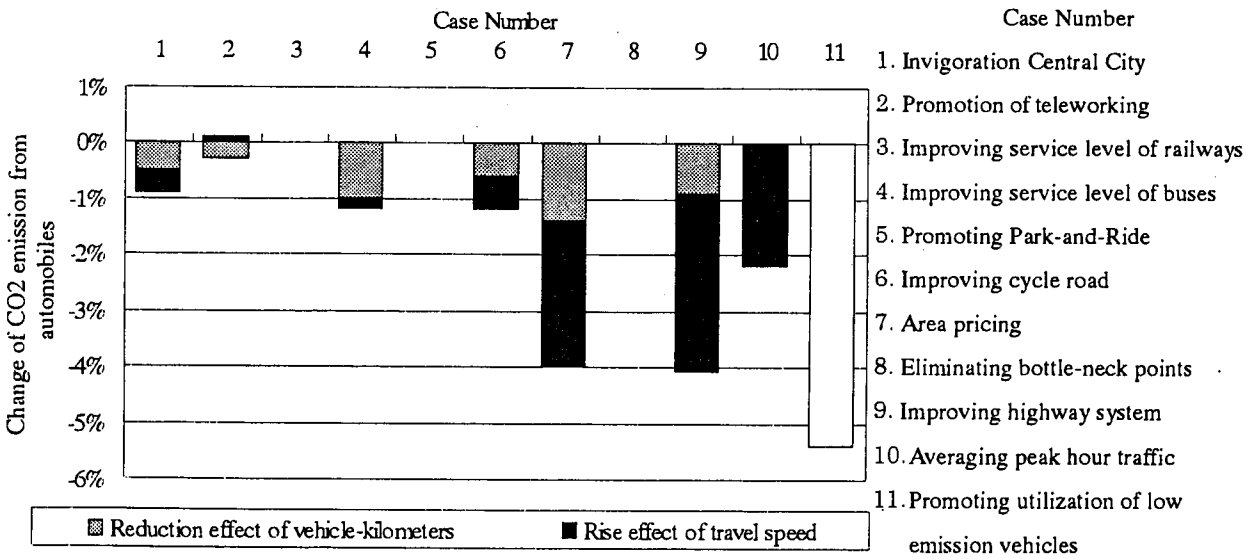

Figure 3 Effect of CO_2 emission reduction policies from automobiles in Utsunomiya City