FORECASTING MODEL FOR COMMODITY FLOWS INTO AND OUT OF BANGKOK

Viroat SRISURAPANON
Lecturer
Department of Civil Engineering
King Mongkut's Institute of
Technology Thonburi
Suksawads 48, Bangmod, Ratburana,
Bangkok 10140 Thailand
Fax: +66-2-427-9063
E-mail: iviranon@cc.kmitt.ac.th

Yordphol TANABORIBOON
Associate Professor
Graduate School of Civil Engineering
Asian Institute of Technology
P.O.Box 4,
Klong Luang,
Pathumthani 12120 Thailand
Fax: +66-2-524-5509
E-mail: yord@cc.ait.ac.th

abstract: This study aims to propose a model for forecasting the commodity flows into and out of Bangkok. Due to the trend of commodity flows itself, economic expansion, and some policies, a forecasting model of the commodity flows needs to be developed. The freight data collected by the Department of Land Transport (DLT) of Thailand were mainly used to observe trends of commodity flows and forecast freight demand. For the economic trends, gross regional product data collected by the National Economic and Social Development Board (NESDB) were used to strengthen the forecast freight demand in the model. The case study of commodities traded between the western part of Thailand and Bangkok was selected to perform the model. This model can be used to forecast freight demand more reliably.

1. INTRODUCTION

A number of countries have begun to conduct studies requiring freight demand forecasts to address various issues and problems related to freight transportation planning. The freight flow forecasting model is of significant importance in the synthetic transportation planning of a country. The prediction of freight flow has attracted much interest in recent years.

For developing countries, the study of freight flows at the national and regional levels received less attention. This could be due to (1) a lack of freight flow data in a form that could be readily used for forecasting purposes and (2) a lack of readily available freight demand forecasting techniques that could be directly applied. Although freight flow forecasting techniques have been developed in many countries, they can not be directly applied due to the lack of availability of suitable data sets. It is better to avoid spending excessive amount of time surmounting data problems, or trying to perfect the available data but rather to focus on the application itself, e.g., synthesize or adapt available data, and make estimates or exercise professional judgment. The simple technique of synthesizing available data sets is of highest relevance in developing countries, such as Thailand.

One of the greatest opportunities for improving the available freight data resource is through obtaining the commodity flow. In Thailand, multicommodity freight flow data has been surveyed by the Department of Land Transport (DLT) since 1967. The main portion of commodity freight pattern is into and out of Bangkok. The survey technique being used has been adapted every year. It is recognized that the quality of the survey data may be

affected by budget limitations and time constraints. The freight flow data reflects the freight demand in the past. Forecasting freight demand is not solely related to the trends of freight demands but is also correlated to the economic situation of the country. Both the quality and comprehensiveness of freight data forecasting need to be improved.

The proposed forecasting model for this study was developed to strengthen the freight forecasting technique processed by applying a macro-economic parameter, gross regional product (GRP). The GRP compiled by National Economic and Social Development Board (NESDB) can make the forecast commodity flows more reliable. An overview of commodity structure needs to be identified when processing a model for major commodity sectors. The commodity structure can be represented in two different ways, using freight volume itself and GRP data. One example is the manufacturing sector which may perform as a minor sector when the freight volume unit is used to clarify the commodity structure but it may also become a major sector when the GRP is applied to show the commodity structure. A case study of interregional freight transported between the western part of Thailand and Bangkok was used to test this model.

2. ROAD FREIGHT FLOWS INTO AND OUT OF BANGKOK

An overview of freight transport in Thailand for the year 1994 is shown in Table 1. The total amount of freight transported for this year was 387 million tons. It is observed that 344 million tons, 89 percent of the freight movements, were transported by road. The performance, in unit of million tons kms, was significantly related to road freight. Thus road freight demand should be a significant concern.

Table 1 Modal split for freight transport for the year 1994

Mode	Road	Rail	Inland Waterway	Coastal Shipping	Air Transport	Total
- Volume						
(1000×tons)	344193	7749	13609	22039	56	387646
(%)	88.80	2.00	3.51	5.68	0.01	100
-Performance						
(Million tons kms)	81527	3107	1122	3127	38	88921
(%)	91.68	3.49	1.26	3.52	0.04	100

Source: Transport management information system sub-division, Ministry of transport and communications

The total amount of road freight transported into and out of Bangkok and the surrounding areas for the year 1994 was 198 million tons. Of all regions for road freight movement as shown in Table 2, the main portion, 28 percent of the total freight, was transported to and from the western region. This region including 6 provinces, Kanchanaburi, Prachuap Khiri Khan, Petchaburi, Ratchaburi, Samut Songkhram and Suphan Buri, was most significant.

Table 2 Road freight transport into and out of Bangkok for the year 1994.

Regions	Volume (1000×tons)	Percentage
Northern	41188	20.80
Northeastern	33385	16.86
Central	27753	14.01
Eastern	30533	15.42
Western	56217	28.39
Southern	8971	4.53
Total	198047	100

Source: Transport management information system sub-division, Ministry of transport and communications

Road freights transported to and from the western region for the year 1994 are shown in Tables 3 and 4. The total amount of road freight transported out of the western region was about four times greater than the total amount of road freight transported into this region. It is noted that about 75 million tons, 72 percent of the total road freight into and out of the western region were transported into and out of Bangkok and the surrounding areas. The interregional freight flow between both regions was, therefore, most significant.

The interregional road freight transported between the western region and Bangkok was selected to test the proposed forecasting model for a case study. The western region, specially defined for this study, includes 6 provinces, Kanchanaburi, Ratchaburi, Samut Songkhram, Suphan Buri, Samut Sakhon and Nakhon Pathom.

Table 3 Road freights transported to western region for the year 1994

Origins	Volume (1000×tons)	Percentage
Bangkok and vicinity	7828	49.49
Northern	1564	9.89
Northeastern	1338	8.46
Central	1514	9.57
Eastern	429	2.71
Western	2985	18.87
Southern	160	1.01
Total	15818	100

Source: Transport management information system sub-division, Ministry of transport and communications

Table 4 Road freights transported from western region for the year 1994

Destinations	Volume (1000×tons)	Percentage
Bangkok and vicinity	48389	78.15
Northern	6279	10.14
Northeastern	2816	4.55
Central	598	0.97
Eastern	671	1.08
Western	2985	4.82
Southern	178	0.29
Total	61928	100

Source: Transport management information system sub-division, Ministry of transport and communications

3. A FORECASTING MODEL

The freight flow demand is exogenous and may originate from an input-output model, if one is available, or from other sources, such as the observed flow of observed past demand. The model may be integrated with economic models as well. For a proposed model, freight volumes were estimated using two different techniques, the direct and indirect techniques. The former technique uses time series analysis applied to survey freight data. The collection of this was conducted by Department of Land Transport. The survey method and the compilation of data have been adapted every year, hence data from recent years may be more reliable than the data in the past. The accuracy of forecast freight data relies on the survey data. In a practical sense, the compilation of survey freight data is very costly and time consuming. This may also influence the accuracy of survey data. The reliability of the forecast data therefore needs to be improved. The latter technique, using GRP data, is applied to estimate the freight flow demand in terms of trading price of each commodity. Since the growth rates of freight volumes and GRP for each commodity sector are consistently correlated, it seems appropriate to assume that the growth rates of each commodity are the same as the growth rates of freight volumes. Both techniques have their own advantages. The suitability of a selected technique depends on whether the data indicated the commodity structure comes from a major and minor sector. A proposed forecasting model for commodity flows into and out of Bangkok is shown in Fig. 1. Before formulating regression models, it is necessary to observe the overview of commodity structures using both data, freight volumes and the GRP so that the commodities can be classified into their appropriate sectors. Major commodity sectors used for forecasting freight volumes are more effective than minor commodity sector. A commodity may occur as a major sector when the freight volume units are considered. However the same commodity may appear as a minor sector in terms of GRP. This can be checked interchangeably between the two estimating techniques.

It can be observed that in the case of trade between Bangkok and the western region of Thailand, manufacturing and agriculture are major sectors using the GRP data. Mining is a minor sector when the GRP scheme is used because its price is relatively cheap when

compared with the price of manufacturing. In contrast, mining performs as a main sector when it is considered in terms of freight volume.

4. FREIGHT FLOW FORECASTING

All commodities were grouped according to the following four sectors: agriculture, manufacturing, mining and construction. Then the commodity structure was observed. With respect to the GRP, the total GRP increased gradually from the year 1981 whereas after 1990 it increased rapidly as depicted in Fig. 2. It is also shown that before 1987 agriculture used to be a major sector however in recent years, manufacturing has become a main sector.

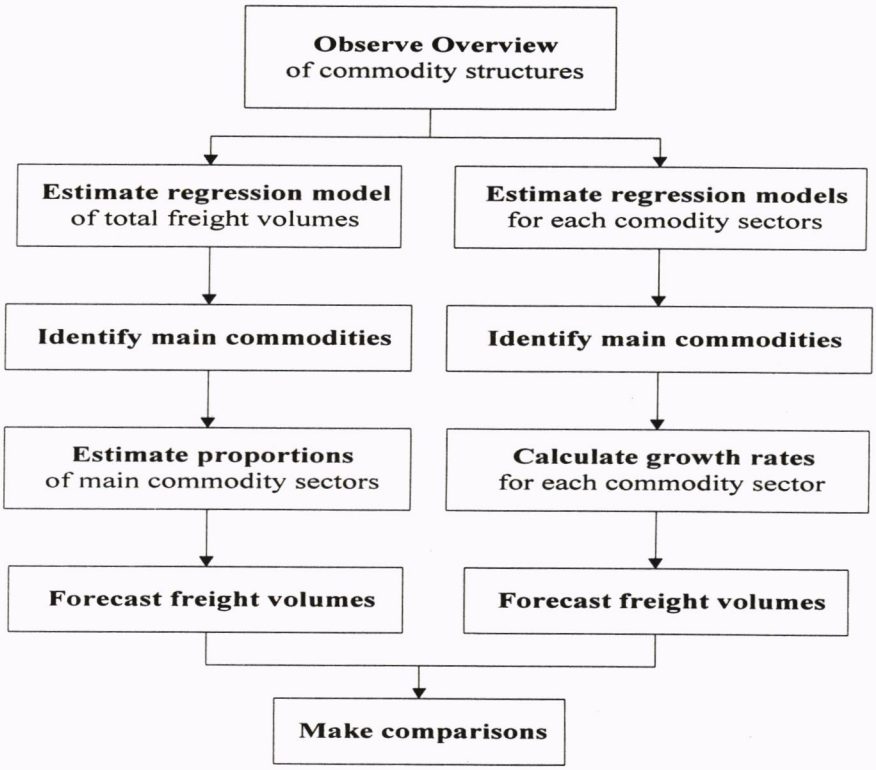

Fig. 1 A forecasting model for commodity flows

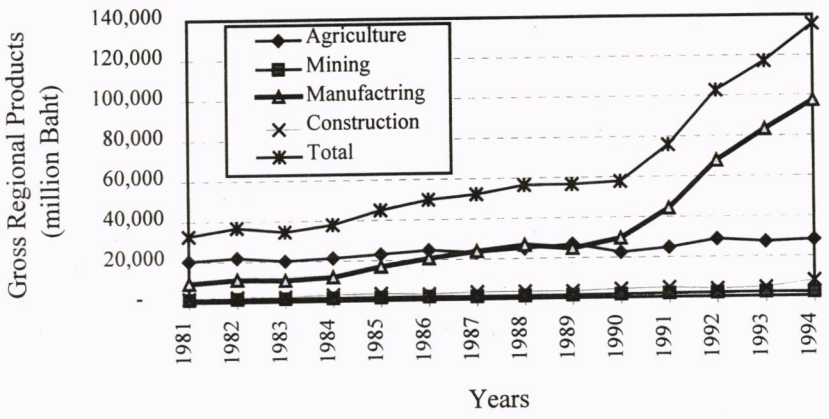

Fig. 2 Gross regional products of the western regions

Trends of the GRP and freight survey data were considered simultaneously. To observe the trends, the simple linear regression model shown in Eq. (1) was applied.

$$y = a + bx \tag{1}$$

where,

y : estimated commodity, million Baht or million tons
x : year
a, b : constants

Using the GRP data, the regression models of each commodity sector are estimated as shown in Table 5. It can be observed that the 'coefficient of determination', which described the adequacy of the model, was highest in a manufacturing sector compared to other sectors.

Each model is to be used to forecast the GRP for each sector for the years 1994 and 2015. This is used to calculate the growth rates of each sector by using Eq. (2).

$$G_p^r = \left(y_p^{2015} / y_p^{1994}\right)^{1/21} - 1 \tag{2}$$

where,

G_p^r : growth rate of GRP of the region r

y_p^{2015} : estimated commodity P for the year 2015

y_p^{1994} : estimated commodity P for the year 1994

Table 5 Regression models and growth rates of each commodity sector

Commodity sectors	Regression models (Million Baht)	Coefficients of determination, R^2 (%)	Growth rates (%)
Agriculture	y = -1146973.115 + 589.273x	76.02	1.7561
Manufacturing	y = -12004025.493 + 6056.959x	79.05	4.8975
Mining	y = -108318.802 + 55.3026x	67.39	2.2445
Construction	y = -588898.511 + 298.1574x	71.24	3.6077

Freights into and out of Bangkok were estimated separately.

4.1 Freight Transported Into Bangkok

Using the existing freight flow data and the growth rates calculated from GRP data, the freight volume can be estimated by using Eq. (3). The results are shown in Table 6.

$$f_p^* = f_p\left(G_p^r + 1\right)^t \tag{3}$$

where,

f_p^* : estimated freight volume of commodity P

f_p : existing freight volume of commodity P

G_p^r : growth rate of GRP of the region r

t : time elapse, years

Using the time series data of the total road freight volume from the year 1981 to the year 1995, the model for estimating the total road freight volume, f^*, which is shown in the Eq. (4) is formulated with a coefficient of determination of 86.80 percent. The total estimated freight volume transported into and out of Bangkok is 157 million tons for the year 2015.

$$f^* = -7734.4 + 3.916x \tag{4}$$

Using the available freight data, the three trends shown in Fig. 3 were apparent. These trends were: the total road freight, sand and gravel transported into and out of Bangkok, and total road freight transported from the western region to Bangkok. It is observed that these trends were similar between the years 1990 and 1994 and that the proportions of the freight volumes were approximately constant. The average proportion of freight volumes transported from the western region to Bangkok in the past 5 years, 0.255 of the total freight transported into and out of Bangkok. Using this average proportion, the total freight volume transported from the western region to Bangkok was estimated to be 40 million tons for the year 2015. Using the freight volume structure for the year 1994, the freight volume for each sector can be estimated as shown in Table 6. The mining sector

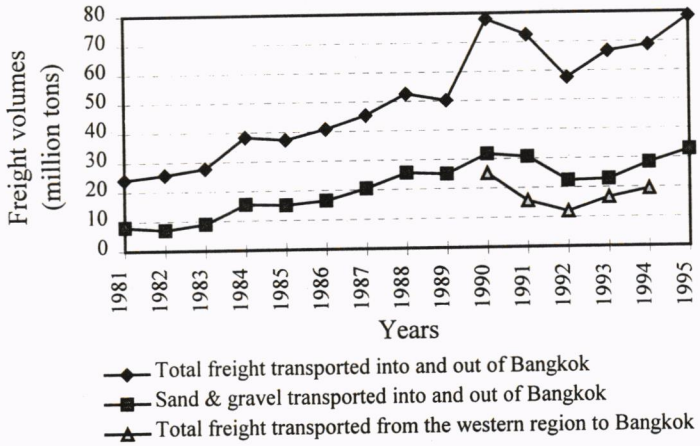

Fig. 3 Comparisons of road freight volumes

was 87 percent of the total freight volume and performs as the major sector. The mining sector can not be observed using the GRP data since the price of mining is low compared with the prices of other sectors.

The percentage errors and absolute errors of the forecast freight volumes of the two techniques are shown in Table 6. It is observed that the percentage error of the forecast freight volume of manufacturing is lowest. It seems appropriate to estimate the freight volume of the manufacturing sector by using GRP data since it performs as a main sector of commodity structure in unit of money and the accuracy is high. The forecast freight volume of the mining sector has both the largest percentage error and absolute error. It seems more suitable to estimate the mining freight volume by time series of freight data since it makes up 87 percent of the total freight volume. For the agriculture and construction sectors, the proportions of GRP and freight volume are small, therefore they have an insignificant effect to the total forecast freight volume. The absolute differences of forecast freight volumes are small, even if the percentage errors are high.

Table 6 Forecast freight flows from the western region to Bangkok

Commodity sectors	Freight volumes for the year 1994 (tons)	Freight volumes* for the year 2015 (tons)	Freight volumes** for the year 2015 (tons)	Absolute errors (million tons)	Percentage errors
Agriculture	722161 (4 %)	1025713	1313960	0.288	-28.10
Manufacturing	1518005 (8 %)	4143201	3996585	0.147	3.54
Mining	16956050 (87 %)	26545665	34161139	7.615	-28.69
Construction	235921 (1 %)	496586	475306	0.021	4.29
Total	19432137 (100 %)	32211165	39946990	7.736	-24.02

Remarks: * forecast data using growth rates of GRP data
** forecast data using trends of freight volume data

4.2 Freight Transported out of Bangkok

Using the two techniques, GRP and freight volume time series data, the freight volumes transported from Bangkok to the western region were estimated as shown in Table 7. To observe both commodity structures using the GRP and freight volume data, the manufacturing performs as a major sector. The accuracy of forecast freight flow for this sector is highest. Variations of the errors from the other sectors occurred since the total amount of freight transported from Bangkok to the western region was not high which was about 20 percent of the total freight volume transported from the western region to Bangkok. The agriculture sector constitutes a small proportion of the total freight volume which was about 4 percent. This may cause some difficulties when attempting to accurately forecast its volume. Petroleum constitutes the largest portion of the mining sector and is generally imported from other countries. Therefore the estimated value for this sector may not rely solely on the GRP. By synthesizing other economic factors, such as, imports and the GRP of other regions, to the model, the accuracy of freight forecasts may improve.

Table 7 Forecast freight flows from Bangkok to the western region

Commodity sectors	Freight volumes for the year 1994 (tons)	Freight volumes* for the year 2015 (tons)	Freight volumes** for the year 2015 (tons)	Absolute errors (million tons)	Percentage errors
Agriculture	153716 (4 %)	221558	391451	0.170	-76.68
Manufacturing	1700574 (51 %)	4641554	4330663	0.311	6.70
Mining	979544 (29 %)	1561216	2494496	0.933	-59.78
Construction	526262 (16 %)	1107732	1340173	0.232	-20.98
Total	3360096 (100 %)	7532060	8556783	1.025	-13.60

Remarks: * forecast data using growth rates of GRP data
** forecast data using trends of freight volume data

5. CONCLUSION

The forecasting model of commodity flows was proposed. To apply the model, the commodities were grouped to show the commodity structures obtained from using "GRP" and "freight survey data." The GRP data was recorded in terms of money units while the freight volume unit was used for the freight survey data. The appropriate technique for forecasting the freight volumes of each commodity sector depends on which data can indicate the sector to be a majority of the commodity structure. A commodity which occurs as a major sector with respect to the GRP may perform as a minor sector with respect to volume. In contrast, a the minor sector with respect to the GRP may become a major sector with respect to freight volume.

From the case study, manufacturing has the best performance for forecasting freight volumes using the GRP data for both into and out of Bangkok, since it is a major sector of the commodity structure. Mining performs as a minority when it is described by the GRP

but becomes a major sector when it is considered in terms of freight volume. Therefore, the appropriate way to forecast the freight volume of the mining sector is to use "volume time series data" instead of "GRP time-series data."