Abstract

A commodity flow survey (CFS) is conducted to analyse commodity flow characteristics and to compile statistics for goods movement in several countries. In Korea, the CFS has been conducted every five years since 1998. Freight travel information collected through this survey is mainly used to estimate freight demand as well as freight statistics. This paper provides details of the Korean CFS and introduces a procedure for regional freight demand estimation. Though freight demand focuses on commodity flow, the conversion of commodity flow into the equivalent number of trucks and traffic assignment for truck trips is also presented.

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1. Introduction

Several countries conduct a CFS periodically, and they estimate freight demand using the survey results. The CFS in the US is conducted every five years as a part of the Economic Census, and recently its fifth CFS was conducted in 2012 (RITA, 2014). A freight origin-destination (O-D) matrix is developed by the Freight Analysis Framework (FAF) modelling. In the FAF modelling, several data sources are used, but the most important is the US CFS (FHWA, 2011). In New Zealand, the primary data source for freight demand estimation is also a market survey for freight consignors and carriers. In addition, supplementary data sources, such as production data, export data and

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industry data, are used (Bolland et al., 2005). Statistics Norway (SSB) also conducted a CFS of Norwegian industry and wholesalers (Hovi and Johansen, 2008). In most countries that conduct the CFS, a freight flow matrix is estimated using the survey data.

The most recent CFS in Korea was conducted in 2011. The survey mainly consists of a shipper survey and a truck diary survey. The shipper survey is the main survey, which is used to estimate nationwide freight travel demand; it also collects shipment information such as quantity of goods, shipment destinations, transportation modes, and shipment frequency by commodity type. The sample of the shipper survey is designed by considering geographical location, number of employees, and industry type of an enterprise. Korea is administratively classified into 16 provinces and 251 counties. Enterprise size is classified into seven categories based on the number of employees, and industry type is sorted into manufacturing, wholesale, and primary industries, consisting of agriculture, forestry, fisheries, and livestock. There are about 20,000 valid samples in the shipper survey, and they are used to estimate commodity-based freight demand. A truck diary survey collects shipment information for a day, including the origin and destination, the quantity of cargo loaded and unloaded, the location of stops, and records of empty travelling. The sample for the survey is designed by considering shipment area, truck size, and truck business type (private or for-hire). Truck size is divided into three categories according to the loading weight. There are about 40,000 valid samples in the survey, and they can be used to estimate truck travel demand as well as analyse trucking characteristics.

In Korea, the national freight travel demand is estimated by using a four-step travel demand estimation method as one of the aggregate ways that is conventionally used in most countries (Beagan et al., 2007; Cantillo et al., 2012; Chow et al., 2010; FHWA, 2011). In commodity flow estimation, the origin of goods is defined as the production place of the goods, such as manufacturing factory and primary industrial area, but intermediate stops are not considered in the estimation. Goods are divided into 30 commodity types according to the Korean standard industrial classification.

This paper is divided into two parts: the CFS, and freight demand estimation in Korea. In the first part, survey details of the CFS are explained, focusing on a shipper survey and a truck diary survey used to estimate freight O-D matrices. In the second part, a commodity-based model using a four-step travel demand estimation method is presented. The procedure of freight demand estimation, from freight generation to the conversion of commodity flow into the equivalent number of trucks using survey data and truck assignment, is shown.

2. Commodity flow survey in Korea

The Korean CFS is conducted every five years as a national transportation survey. It is used to estimate regional freight flow, analyse commodity movement by commodity type, understand logistics status by region, and collect basic data for transportation policies. The CFS includes various sub-surveys, such as a shipper survey (mining, manufacturing, wholesale), a truck diary survey, in and out traffic counting at logistics hubs, an truck O-D survey at toll gates, a warehouse survey, and a hazardous material survey, as shown in Figure 1.
For freight O-Ds (including commodity and truck O-D), the shipper survey and truck diary survey are used. A maritime import-export goods flow survey, in and out traffic counting of logistics hubs, and a truck O-D survey at highway toll gates are used to improve accuracy and reliability of estimated freight O-D through adjustment or validation. A warehouse survey is carried out to understand the current situation for warehouse logistics, and a hazardous material survey is also conducted to understand movement of hazardous material. The warehouse survey and hazardous material survey are not discussed further, because these surveys are not used to estimate freight O-D. The application of each sub-survey is shown in Figure 1. The Korean CFS is not an economic survey but a transportation survey, and respondents are under no obligation to respond to the survey.

2.1. Shipper survey

The main purpose of the shipper survey is to provide national commodity flow information, and the survey data is a primary resource to estimate a commodity O-D flow. The survey targets a sample of enterprises. In the 2011 Korean CFS, the total population of enterprises was about 1,200,000, and the survey population which includes only target enterprises was about 200,000. Enterprises that had less than five employees were excluded in this survey, on the basis they do not generate substantial freight movement. Survey samples were selected through a stratified sampling that considered the industry type, the size of the facility, and the location of the enterprise. Industry type was categorised into mining, manufacturing and wholesale, location into 16 provinces, and facility size into six levels (5-9, 10-19, 20-49, 50-99, 100-500 and over 501 persons) depending on the number of employees. Every firm that had over 500 employees was included in the survey. The number of valid samples was about 22,000 and the sampling rate was about 11%. The contents of a shipper survey are shown in Table 1. Commodity types are based on the Korean standard industrial classification.

| Survey contents          |
|--------------------------|
| General Information      |
| Number of total employees|
| Ownership of logistic facilities|
| Yearly income            |
| Truck ownership, etc.    |
| Monthly Information      |
| Commodity type           |
| Amount of shipments      |
| 3PL usage                |
| Movement characteristics, etc.|
| 3-day Information        |
| Amount of shipments      |
| Export frequency         |
| Consignee location       |
| Used transportation modes|
| Intermediate stops       |
| Origin & destination, etc.|

The shipper survey is based on an interview with a person in charge at the target company, so the previous contact with the interviewer who can provide logistics information is important. Interviewers visit the target company, and then non-ideal responses are adjusted through an additional visit or by phone.

2.2. Truck diary survey

A truck diary survey is conducted to estimate a truck O-D and analyse truck trip characteristics. The survey targets truck drivers, who report travel and shipment information for a specific day. The survey population size, the number of registered trucks, was about 3,200,000. Truck samples were selected through a stratified sampling that considered business type, truck size and shipment area. Business type was classified as either private or for-hire use; truck size was categorised into five levels (1 ton and less, 1-2.5, 2.5-8.5, 8.5-15 and over 15 tons) according to maximum load weights and shipment region was classified into 251 zones. The number of valid samples was approximately 42,000. The contents of a truck diary survey are shown in Table 2.
Table 2. Contents of a truck diary survey.

| Survey contents                        |
|----------------------------------------|
| **Vehicle Characteristics**            |
| Business type (private or for-hire)    |
| Vehicle size (maximum load weight)     |
| Ownership                              |
| Registration place and business area, etc. |
| **Movement Characteristics**           |
| Commodity type shipping                |
| Departure place, departure time, loading weight |
| Intermediate stops, stopping time, loading and unloading weight |
| Arrival place, arrival time, unloading weight, etc. |

The truck diary survey is conducted by targeting truck drivers. Because the survey is processed without previous contact with truck drivers, it is important to find a survey location where interviewers can interview many truck drivers. Various places such as rest areas, vehicle inspection stations, freight terminals and fuel stations were selected as survey sites. Surveyors have an interview with a target driver considering vehicle size and business type at the survey place. Truck samples are designed based on the registration place of trucks, but the registration place and the business area may be different. Thus information on the business area is collected from target drivers.

2.3. Other surveys

A maritime import-export goods flow survey, in and out traffic counting at logistics hubs, and a truck O-D survey at highway toll gates are conducted to improve or adjust the estimated freight O-D matrices. The maritime import-export goods flow survey collects information on the inland flow of import/export commodities. This survey collects information through waybill data as well as interviews with truck drivers, and origins and destinations of import and export goods, commodity type, weight, mode and travel time are surveyed. The inland flow of import commodities obtained by the survey is combined with the flow of domestic products, but export freight flow is not considered because it is already included in domestic freight flow through the shipper survey.

In and out traffic counting at logistics hubs aims to adjust truck trips using real traffic counting data at major logistics hubs such as industrial parks, ports, container yards and freight terminals. The counting data at logistics hubs is used as special generations to complement truck generations by zone. In this survey, traffic volume of cars and buses as well as trucks is collected through 24-hour video recordings for several weekdays.

A truck O-D survey at toll gates is also aimed to complement the estimated truck O-D flow using truck travel information on the highway. Toll gate-to-toll gate trip data from toll collection systems (TCS) is real data, so it can provide a true toll gate-to-toll gate O-D flow. The TCS data, however, does not provide information about the original departure and final destination. Thus truck O-D information passing on the highway is obtained from original departure to final destination by combining the survey at toll gates with TCS data. Finally zone-to-zone matrices based on TCS data are estimated, and they are overlaid with estimated truck O-D matrices. The survey is a postal and internet survey, so the questionnaire is given to trucks which exit through toll gates, and truck drivers return it by mail or enter their responses in the web afterwards. In the survey, initial departure, final arrival place and entered toll gate are collected. Finally the survey data is combined with toll gate-to-toll gate trip data from the TCS to take a truck O-D passing on the highway as calibration data.

3. Estimation of regional freight demand

3.1. Commodity flow estimation

A commodity O-D flow is estimated for a commodity following a conventional freight demand estimation procedure. It is based on a four-step travel O-D estimation method, but the mode choice step is not applied. Inland
commodity flow for Korea is estimated focused on road freight movement, and goods movement by other modes is obtained through shipment records provided by public authorities. Figure 2 shows the procedure for the inland freight flow estimation.

As previously mentioned, import and export goods are treated separately from inland goods. Freight O-D flow for import and export goods is derived from maritime statistics, foreign trade statistics, and the maritime import-export goods flow survey. Finally, import freight O-D flow is combined with inland commodity flow estimated previously. Export commodity which is produced internally is not considered because it is already reflected in the inland commodity flow.

3.2. Freight generation

Freight generation is estimated by commodity type through statistical weighting of sample survey data for mining, manufacturing and wholesale products. Primary industrial products, such as agriculture, forestry, fishery and livestock, are obtained from census data or public records. For example, the total amount of agricultural products is obtained from a statistical agriculture year book, and the amount of products is then divided by various regions, using farmland area ratios by region and product of the agriculture census. Forest products are estimated by using forestry product data from the Korea Forest Service, and fishery products are estimated by using product data from the statistical fishery year book and fisherman data from the fishery census. Estimation of livestock products is derived from data in the agriculture census, and the Food, Agriculture, Forestry and Fisheries statistical year book.

For mining, manufacturing and wholesale products, weighted values for the estimation of total freight generation are obtained by commodity type and size of an enterprise, after removing outliers from the sample data. Moreover, shippers that do not generate goods movement are removed from the shipper population and are not considered in the calculation of weighted values. In addition, estimated freight generations are adjusted through comparison with available validation data, such as public reporting statistics or data collected by related organisations.

Equation (1) shows a simple weighting method for sample data considering outliers. We do not regard samples which generate over 95% of average produced tons in the same class. Here, a regional commodity flow is estimated for manufacture, wholesale, agriculture, forestry, fisheries, livestock and mining goods, focusing on supply logistics and excluding subsidiary goods.

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**Figure 2. Procedure of inland freight flow estimation.**
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\[ W_{T_h} = \frac{N_h - N_{o}}{n_h} \]  

Where, $W_{T_h}$ = weight for samples in class $h$  

$N_h$ = number of population in class $h$  

$N_{o}$ = number of outliers in class $h$  

$n_h$ = number of final samples in class $h$

Freight attractions are estimated using freight generations obtained previously and a multi-regional I-O table provided by the Bank of Korea. We assume that the monetary flow can represent commodity flow as used in some countries (Sorratini et al., 2000; Giuliano et al.; 2010, Wang, 2012). Because a CFS was done only for the consignment of shippers, information on freight attraction or consumption is lacking. Thus, freight attractions are estimated using industry linkages between regions based on a multi-regional I-O table, not on the survey data.

Freight attractions in monetary values estimated using the I-O table should be converted to tons. However, there is a limitation to obtaining value-to-quantity transformation coefficients. Because of various quantities and lack of data for the transformation, it is difficult to find proper coefficients by commodity type. Therefore, in this study, a hybrid model using freight attraction ratios among regions from MRIO coefficients is proposed, which needs the technical coefficient matrix and the commodity production of each zone (Park and Kang, 2014). In other words, by using freight attraction ratios between regions from MRIO coefficients for intermediate and final demand, freight attractions by region are calculated.

3.3. Freight distribution

In this step, a freight O-D matrix between regions by commodity type is obtained. The gravity model has traditionally been used to estimate goods flow for freight distribution. The common formulation of the gravity model is shown in equation (2).

\[ X_{ij} = A O_i D_j f(c_{ij}^{-1}) \]  

In (2), freight flow $X_{ij}$ between nodes $i$ and $j$ is derived by the amount of freight generation $O_i$ and attraction $D_j$, and a deterrence function between nodes $f(c_{ij}^{-1})$. Here, $A$ is a constant. The gravity model can have various types depending on this function. In this study, the deterrence function type is estimated by commodity type using CFS data. To estimate travel deterrence functions, sample data for each commodity type should be enough and the travel frequency by distance should follow some statistical distribution.

For a few commodities that have irregular travel frequency by trip distance such as forest products, coal, metallic ores and nonmetallic products, the gravity model is not suitable. Instead, a sample distribution from CFS data is used directly for these commodities. In this study, several functional forms are considered to find a suitable deterrence function in a gravity model by commodity type. We used a curve estimation tool in SPSS to find a functional form of the deterrence function by commodity type and to estimate parameters of the functions. Here, an independent variable is distance and a dependent variable is the frequency of trip. The distribution of commodity trip distance is obtained from shipper survey data. After this statistical analysis between sample distribution and functional forms by commodity type, most confidential functions are selected. Table 3 shows significant functional forms after the test.

Table 4 shows the goodness-of-fit of the travel deterrence function by commodity type. The inverse power type function has an excellent statistical explanation for most commodity types. The travel deterrence functions for forest products (2), coal (5), metallic ores (7) and nonmetallic minerals (8) do not, however, satisfy the statistical standard. Therefore, trip distribution for these commodities is carried out using other methods rather than the gravity model. As mentioned before, a sample distribution from CFS data is directly applied to these commodities.
Table 3. Deterrence function types for gravity model.

| Function type                      | Functional form                                      |
|-----------------------------------|-----------------------------------------------------|
| Log                               | \( f(c_{ij}) = \alpha + \beta \ln(c_{ij}) \)   |
| Inverse                           | \( f(c_{ij}) = \alpha + \beta c_{ij}^{-1} \)     |
| Power                             | \( f(c_{ij}) = \alpha c_{ij}^{\beta} \)          |
| Inverse Power                     | \( f(c_{ij}) = \alpha c_{ij}^{\beta} \)          |
| Inverse Exponential & Inverse Power | \( f(c_{ij}) = \alpha c_{ij}^{\beta} \exp(-\gamma c_{ij}) \) |

Notes: \( c_{ij} \) is travel distance or time. \( \alpha, \beta \) and \( \gamma \) are parameters.

Table 4. Deterrence function shape by commodity type.

| No | Commodity                | Functional type    | Adjusted \( R^2 \) | No | Commodity                | Functional type    | Adjusted \( R^2 \) |
|----|--------------------------|--------------------|---------------------|----|--------------------------|--------------------|---------------------|
| 1  | Agricultural products    | Log                | 0.567               | 16 | Printed Matter           | Inverse power      | 0.973               |
| 2  | Forest products          | -                  | -                   | 17 | Petroleum or Coal Products | Inverse Exponential & Inverse Power | 0.965               |
| 3  | Fishery products         | Inverse            | 0.723               | 18 | Chemicals                | Inverse power      | 0.977               |
| 4  | Livestock products       | Log                | 0.626               | 19 | Rubber or Plastic Products | Inverse power      | 0.982               |
| 5  | Coal                     | -                  | -                   | 20 | Clay, Concrete, Glass, or Stone Products | Inverse Exponential & Inverse Power | 0.981               |
| 6  | Limestone                | Inverse power      | 0.970               | 21 | Primary Metal Products   | Inverse power      | 0.978               |
| 7  | Metallic Ores            | -                  | -                   | 22 | Fabricated Metal Products | Inverse Exponential & Inverse Power | 0.982               |
| 8  | Nonmetallic Minerals     | -                  | -                   | 23 | Machinery                | Inverse power      | 0.980               |
| 9  | Food and Beverages       | Inverse power      | 0.971               | 24 | Electronic               | Inverse power      | 0.974               |
| 10 | Tobacco Products         | Power              | 0.940               | 25 | Electrical Machinery     | Inverse power      | 0.976               |
| 11 | Textile Mill Products    | Inverse power      | 0.976               | 26 | Precision Instruments    | Inverse Exponential & Inverse Power | 0.971               |
| 12 | Apparel                  | Inverse power      | 0.963               | 27 | Motorized Vehicles       | Inverse power      | 0.972               |
| 13 | Leather or Leather Products | Inverse power    | 0.963               | 28 | Transport Equipment      | Inverse power      | 0.965               |
| 14 | Lumber or Wood Products  | Inverse power      | 0.976               | 29 | Furniture or Fixtures    | Inverse power      | 0.972               |
| 15 | Pulp, Paper, or Allied Products | Inverse power    | 0.976               | 30 | Other Products           | Inverse power      | 0.973               |

3.4. Truck O-D estimation

When estimating truck O-D matrices using the commodity-based model, it is necessary to convert the estimated freight tons by commodity type into the equivalent number of truck trips for the purpose of assignment onto the highway network. In this study, a model that can convert commodity tons into truck trips is estimated. The model can be categorised as model 1 which allocates commodity tons by commodity type to each truck type, and model 2 which converts the allocated commodity tons by truck type into the number of truck trips. Three truck types are
considered according to loading capacity and truck diary survey data is used to estimate models. The truck diary survey focuses on the truck trip, so it does not cover all 30 commodities considered for the estimation of commodity tons. Therefore, conversion models are estimated for seven commodity groups (level 1) aggregated among commodity types that have similar shipment characteristics as shown in Table 5.

Table 5. Aggregation of commodity type.

| Level 1 | Level 2                   | Level 1 | Level 2                          |
|---------|---------------------------|---------|----------------------------------|
| No      | Commodity                 | No      | Commodity                        |
| 1       | Agricultural, forestry, fishery and livestock products | 4       | Chemical products                |
|         | 1 Agricultural products   | 17      | Petroleum or Coal Products       |
|         | 2 Forest products         | 18      | Chemicals                        |
|         | 3 Fishery products        | 19      | Rubber or Plastic Products       |
|         | 4 Livestock products      | 20      | Clay, Concrete, Glass, or Stone Products |
| 2 Mining products | 5 Coal                  | 9       | Food and Beverages               |
|         | 6 Limestone               | 10      | Tobacco Products                 |
|         | 7 Metallic Ores           | 11      | Textile Mill Products            |
|         | 8 Nonmetallic Minerals    | 12      | Apparel                          |
|         | 21 Primary Metal Products | 13      | Leather or Leather Products      |
|         | 22 Fabricated Metal Products | 14      | Lumber or Wood Products          |
|         | 23 Machinery              | 15      | Pulp, Paper, or Allied Products  |
|         | 24 Electronics            | 16      | Printed Matter                   |
| 3 Metallic and machinery products | 25 Electrical Machinery | 7       | Others                           |
|         | 26 Precision Instruments  |         | 29 Furniture or Fixtures         |
|         | 27 Motorized Vehicles     | 30      | Other Products                   |
|         | 28 Transport Equipment    |         |                                  |

3.5. Allocation of freight tons by truck type (model 1)

Model 1 is a function that allocates commodity tons by each commodity group to three truck types (light, medium and heavy) according to load limit. The load limit of a light truck is less than 2.5 tons, and for heavy truck is more than 8.5 tons. The dependent variable of the model is the loaded tons on the truck by commodity type, and the independent variable is trip distance between traffic analysis zones. In the results of a regression analysis, a Power function for all truck types was selected as a functional form with the highest goodness-of-fit by commodity type. The functional form is shown in equation (3).

$$y_{ij}^{m} = \alpha c_{ij}^{\beta}$$  \hspace{1cm} (3)

Where, $y_{ij}^{m}$: Loaded tons of truck type $k$ between $i$ and $j$ (ton)
$c_{ij}$: Trip distance between $i$ and $j$
i, j: Traffic analysis zone (1, …, 251)
m: Commodity group (1, …, 7)
k: Truck type (light, medium, heavy)
$\alpha$, $\beta$: Parameters
3.6. Conversion of tons into truck trips (model 2)

Model 2 converts truck loaded tons that are estimated from model 1 into the number of truck trips by truck type using equation (4). The truck loaded tons are converted into total truck trips using average loaded tons (ton/trip) and loaded trip ratio (loaded trips/total trips) by truck type. Model 2 is composed as follows. Both $A_{ijk}$ and $LR_{ijk}$ in equation (4) are calculated using results from the truck diary survey.

\[
T_{ijk} = \frac{\sum_{m} Y_{ijk}^{m}}{A_{ijk} \cdot LR_{ijk}}
\]  

(4)

Where, $T_{ijk}$: Number of total truck trips of truck type $k$ between $i$ and $j$ (trip)

$A_{ijk}$: Average loaded tons of truck type $k$ between $i$ and $j$ (ton)

$LR_{ijk}$: Loaded trip ratio of truck type $k$ between $i$ and $j$

3.7. Traffic assignment for truck trips

Traffic assignment is carried out by combining a truck O-D estimated by model 1 and model 2 and a passenger O-D including cars and buses. The road network and attribute data such as volume delay function (VDF), provided by the Korea Transport Database (KTDB) center, and a user equilibrium assignment model is applied for traffic assignment. After traffic assignment, the truck O-D is adjusted iteratively by comparing observed and assigned traffic volumes at traffic counting points. Figure 3 shows the result of traffic assignment using the EMME/3 package. There is much freight traffic along the Seoul-Busan corridor where import and export commodities are mainly shipped in Korea. Table 6 shows the gap between observed and assigned traffic volumes on highways. The number of observations with optimum difference represents approximately 78% of the total number of observations.

| Difference            | No. of Points | Ratio (%) |
|-----------------------|---------------|-----------|
| Over 30% (Overestimation) | 132           | 13.0      |
| -30 ~ +30% (Optimum)  | 790           | 77.6      |
| Under -30% (Underestimation) | 96            | 9.4       |
| Total                 | 1,018         | 100.0     |

Notes: difference (%) = (observed traffic volumes – assigned traffic volumes)/observed traffic volumes
4. Concluding discussion

In this paper, the freight O-D estimation procedure and the freight model using the Korean CFS data were presented. The estimated national freight O-D is an important source for the National Transportation Master Plan, the National Logistics Master Plan, and feasibility appraisal for transport and logistics facilities projects. It is also used to calculate freight statistics such as tons and ton-km. Though the national freight O-D in Korea has been estimated using CFS data, the accuracy of a freight O-D can be improved.

Conducting the Korean CFS has a legal basis such as the National Transport System Efficiency Act, the Framework Act on Logistics Policies and the Designated National Statistics in Statistics Korea. However, it is not easy to obtain freight shipment information from private enterprises because it is not mandatory for them to respond to the survey. To improve data quality and confidence in freight O-D, the CFS needs to be conducted as a mandatory survey, although survey items are limited to specific data only.

Freight flow can be estimated using a commodity-based method or a truck-based method. Though the former was used in this study, the latter may provide better results for vehicle analysis or trip assignment. Freight flow in a metropolitan area may be particularly better estimated using a truck-based method, because freight flow in a metropolitan area has more frequent, shorter and smaller shipment characteristics in comparison to inter-regional freight flow. Therefore, a commodity-based method for inter-regional freight flow may not be suitable for estimating freight flow in metropolitan areas. Moreover, at the metropolitan level, truck flow estimates may be more important than commodity flow estimates depending on urban transportation policies. The unexpected error induced when converting commodity flow into truck flow may also be reduced. That is, a more suitable method should be applied to estimate freight flow according to the use of freight flow and spatial range for the estimation.

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References

Beagan, D., Fischer, M., Kuppam, A., 2007. Quick Response Freight Manual II, Publication No. FHWA-HOP-08-010.
Bolland, J., Weir, D., Vincent, M., 2005. Development of a New Zealand National Freight Matrix, Land Transport New Zealand Research Report 283.
Cantillo, V.M., Jaller, M.A., Holguin-Veras, J., 2012. Development of National Freight Demand Model with Limited Data and Resources, Transportation Research Board 91st Annual Meeting.
Chow, J.Y.J., Yang, C.H., Regan, A.C., 2010. State-of-the-Art of Freight Forecast Modeling: Lessons Learned and the Road Ahead. Transportation 37, 1011-1030.
FHWA 2011. The Freight Analysis Framework Version 3 (FAF3): A Description of the FAF3 Regional Database And How It Is Constructed.
Giuliano, G., Gordon, P., Pan, Q., Park, J., Wang L., 2010. Estimating Freight Flows for Metropolitan Area Highway Networks Using Secondary Data Sources. Networks and Spatial Economics 10 (1), 73-91.
Hovi, I.B., Johansen, B.G., 2013. Commodity Flow Matrices for Norway as of 2008, TOI Report 1253.
Park, M., Kang, J., 2014. Estimating Regional Freight Attractions in Korea using a Hybrid Multi-Regional Input-Output Model. 93rd Annual Meeting of the Transportation Research Board, Washington, D.C.
Research and Innovative Technology Administration (RITA) 2013. Commodity Flow Survey Overview and Methodology, www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/commodity flow survey/index.html, Accessed August 2014.
Sorratini, J. A., Smith, Jr., R.L., 2000. Development of a Statewide Truck Trip Forecasting Model Based on Commodity Flows and Input-Output Coefficients. Transportation Research Record: Journal of the Transportation Research Board No. 1707, 49–55.
Wang, J., 2012. Estimating Regional Freight Movement in Australia Using Freight info Commodity Flows and Input-Output Coefficients. 20th International Input-Output Association conference in Bratislava.