THE DETERMINATION OF THE FREIGHT TRANSPORT ROUTE NETWORK IN BALI AND WEST NUSA TENGGARA, INDONESIA

by

Leksmono Suryo Putranto
Senior Lecturer, Civil Engineering Department,
Tarumanagara University, Jakarta
Email: ls.putranto@ftuntar-id.com

Stevanus Albertus Ayal
Transport Planner, Indotek Engineering Consultant, Jakarta

and

Ratri Parasiddha Winastwanti
Transport Engineer, Indotek Engineering Consultant, Jakarta

ABSTRACT

Freight transport route network should be determined in every area for three purposes. Firstly, it is required for the purpose of maintaining appropriate infrastructure for the freight transport itself in terms of suitable road geometry, road pavement structure and road environment. Secondly, it is required for the purpose of maintaining general traffic in an acceptable level of service. Thirdly, it is required to protect road site activities and environment from any potential hazard generating from freight transport. In order to determine freight transport route network in an area, there are several factors that should be considered, e.g. freight transport demand, land use master plan, sustainability of the environment, etc. This paper will discuss the determination of freight transport route network in Bali and West Nusa Tenggara, Indonesia. There should be freight transport route networks for container transport, heavy equipment transport and dangerous goods transport. General goods transport is allowed to use general traffic route network. In order to evaluate available alternative of routes, several criterion were used, i.e. road status, road class, road geometry, access control, annual average daily traffic (AADT), volume to capacity ratio (V/C), land use (for container, heavy equipment transport and dangerous goods routes) and additionally population density and level of public activities (for dangerous goods transport routes only). Selected route for each type of freight transport was alternative route having best score in analytic hierarchy process (AHP).

KEYWORDS
Freight Transport, Alternative Route, Analytic Hierarchy Process

INTRODUCTION

Freight transport route network should be determined in every area for three purposes. Firstly, it is required for the purpose of maintaining appropriate infrastructure for the freight transport itself in terms of suitable road geometry, road pavement structure and road environment. Secondly, it is required for the purpose of maintaining general traffic in an acceptable level of service. Thirdly, it is required to protect road site activities and environment from any potential hazard generating from freight transport. In order to determine freight transport route network in an area, there are several factors that should be considered, e.g. freight transport demand, land use master plan, sustainability of the environment, etc. This paper will discuss the determination of freight transport route network in Bali and West Nusa Tenggara, Indonesia.

LITERATURE REVIEW

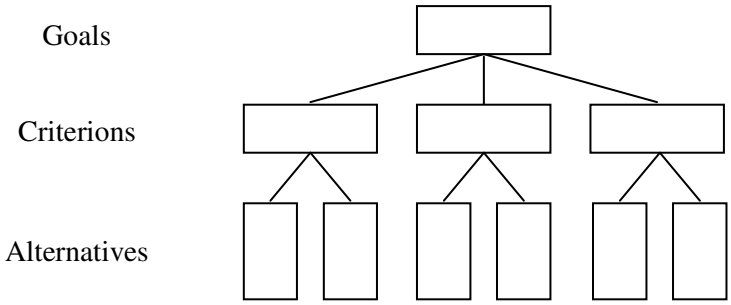
According to the Government Regulation No. 41/1993, freight transport is classified into general goods transport, container transport, heavy equipment transport and dangerous goods transport. According to the Government Regulation No.43/1993 and several subsidiary regulations, general goods transport is allowed to use general traffic route

network, whilst other goods transport should only use a pre-determined route. In order to evaluate available alternative of routes, several criterion can be used (Nelson et al, 2006; Dilgir et al, 2005; Pinella County, 2008), e.g. road class, road geometry, access control, traffic performance, land use, population density, level of road side public activities, etc.

One of suitable method to evaluate the alternative routes is analytic hierarchy process (AHP). There are three principals of AHP (Saaty, 1994), i.e.:

- Decomposition, i.e. breaking up the problems into its elements. This process should be continuously carried out until no further fragmentation could be made (Figure 1).
- Comparative Judgment, i.e. conducting evaluation on relative importance of a pair of elements on a certain level related to the higher level.
- Synthesis of Priority, i.e. sorting the elements based on relative importance through synthesis procedure (priority setting). The magnitude of the priority is expressed in eigenvector value. The higher the eigenvector value, the more important the element.

FIGURE 1
DECISION HIERARCHY



METHODOLOGY

In the determination of network route of container transport, heavy equipment transport and dangerous goods transport, the following approaches have been made:

- The freight transport demand was projected from the 2006 Indonesian National Origin-Destination Survey.
- Based on the above freight transport demand and the existence of centers of freight transport and centers of activity along with the pattern of studied area development, the pattern of freight transport was predicted.
- In order to facilitate the freight transport demand and pattern, several alternative routes were chosen based on the criterions shown in Table 1.

TABLE 1
ALTERNATIVE ROUTES CRITERIA

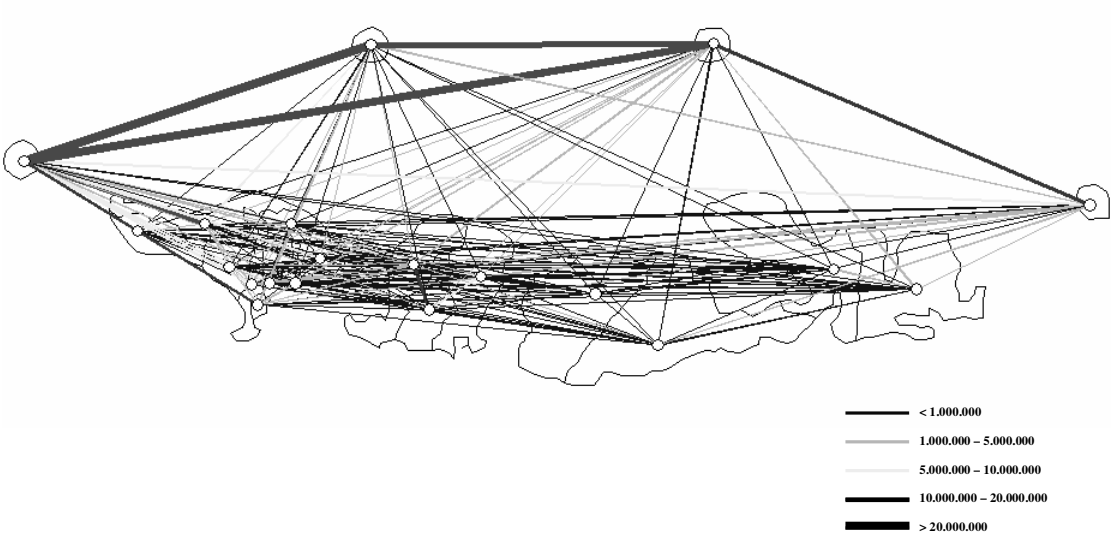
Criteria	Rate	Evaluate	Reject
Route Purpose	Route serves many focal points	Route serves some focal points	Route serves no focal points
Part of Truck Routes	Yes	Could be	No
Alternative	No alternative route available	Limited alternate route	Better routes to choose from
Network Completion	Improves the network grid by joining one or more existing routes	Limited value in grid completion	Dead end route
Route Length	Significantly shortens normal travel distances	Limited improvement to travel distance	No distance reduction over existing routes
Coverage	Significantly reduces trips off the freight network	Marginally decreases trips off the freight route	No reduction in trips off the freight route

- Route selection was carried out using AHP based on several criterions, i.e. road status, road class, road geometry, access control, annual average daily traffic (AADT), volume to capacity ratio (V/C), land use (for container, heavy equipment transport and dangerous goods routes) and additionally population density and level of public activities (for dangerous goods transport routes only).
- In the selected route, some improvement might be required such as upgrading of road class, improvement on road geometry, etc.

RESULTS

Figure 2 shows the freight transport demand and pattern in Bali and West Nusa Tenggara in 2008 (20 years from the study year in 2008). This was resulted from standard four steps transport modeling.

FIGURE 2
DESIRED LINES OF FTREIGH TRANSPORT IN BALI AND WEST NUSA TENGGARA (2028)



It can be seen that Bali and West Nusa Tenggara were not quite important in terms of national freight transport. Thickest desired lines were connecting external zones. However some significant freight transport movements were found in movements related to the capital city of Bali (Denpasar) and capital city of West Nusa Tenggara (Mataram).

Alternative routes for Bali is presented in Table 2 and Figure 3. There were only two alternative routes, i.e. North corridor and South corridor. Starting from Ubung (a freight terminal near Denpasar), the South Corridor was divided into two sub routes, i.e. a route serving to Padang Bai (ferry terminal) and another route serving to Tanjung Benoa (ocean harbour).

Alternative routes for West Nusa Tenggara is presented in Table 3 and Figure 4. There were only two alternative routes, i.e. mainly road transport corridor and road transport corridor with significant role of ferry transport. Both corridors in fact was still disconnected between Sumbawa Besar and Banggo due to very poor road condition between those cities and lack of ferry service between those cities. Current freight transport to most areas in the East of Sumbawa Island was dominated by ship transport directly connected to Lombok Island or other islands. As some parts of the alternative routes could not be evaluated using the previously discussed criterions, it was impossible to apply AHP for evaluating alternative routes in West Nusa Tenggara. However some suggestion for improvement will be discussed later.

TABLE 2
ALTERNATIVE ROUTES FOR BALI

Corridors		Routes
North	North	Gilimanuk - Cekik – Celukan Bawang – Seririt – Singaraja – Kubu Tambahan – Bondalem – Abang – Amlapura – Candidasa – Padang Bai
South	South 1	Gilimanuk – Cekik – Negara – Pekutatan – Antosari – Selemadeg – Tabanan – Sempidi – Ubung – Denpasar (By Pass) – Tohpati – Kusamba – Padang Bai.
	South 2	Ubung – Denpasar (Imam Bonjol/By Pass Ngurah Rai) – Mumbul – Peken – Nusa Dua-Tanjug Benoa

FIGURE 2
ALTERNATIVE ROUTES FOR BALI

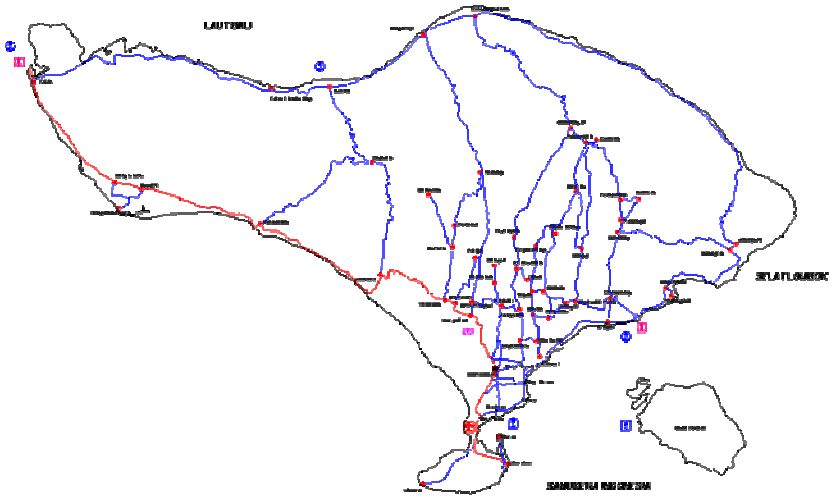


TABLE 3
ALTERNATIVE ROUTES FOR WEST NUSA TENGGARA

Corridors	Routes
Mainly Road Transport	Lembar-Mataram-Narmada-Mantang-Kopang-Terara-Masbagik-Pringgabaya-Kayangan-Ferry Transport to Sumbawa Island-Labuhan Tano-Alas-Utan-Sumbawa Besar-Lape-Plampang-Empang-Banggo-Sawele-Dompu-Sila-Palibela-Bima-Wawo-Sape-Bugis
Road Transport with Significant Ferry Transport	Lembar-Mataram-Narmada-Mantang-Kopang-Terara-Masbagik-Pringgabaya-Kayangan-Ferry Transport to Sumbawa Island-Labuhan Tano-Alas-Utan-Sumbawa Besar-Ferry Transport to Cruise through Saleh Bay-Banggo-Sawele-Dompu-Sila-Palibela-Bima-Wawo-Sape-Bugis

FIGURE 4
ALTERNATIVE ROUTES FOR WEST NUSA TENGGARA

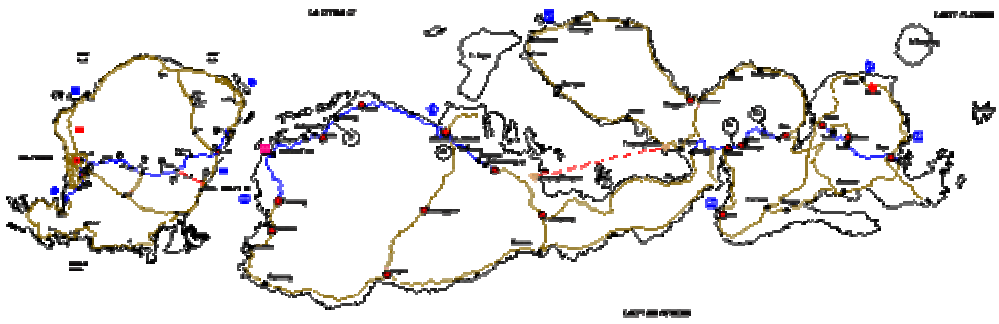


Figure 5 shows the comparison between North corridor and South corridor of Bali using AHP. It can be seen that in terms of road status, AADT, V/C, population density and level of public activities, north corridor was better than south corridor. Meanwhile in terms of road class, road geometry, road condition, access control, and land use, south corridor was better than north corridor. Table 4 shows the eigenvector value for north corridor and south corridor for container and heavy equipment transport route and for dangerous goods transport route. Based on the result south corridor was suggested for container and heavy equipment transport route whilst the north corridor was suggested for dangerous goods transport route.

FIGURE 5
COMPARISON BETWEEN NORTH CORRIDOR AND SOUTH CORRIDOR OF BALI USING AHP

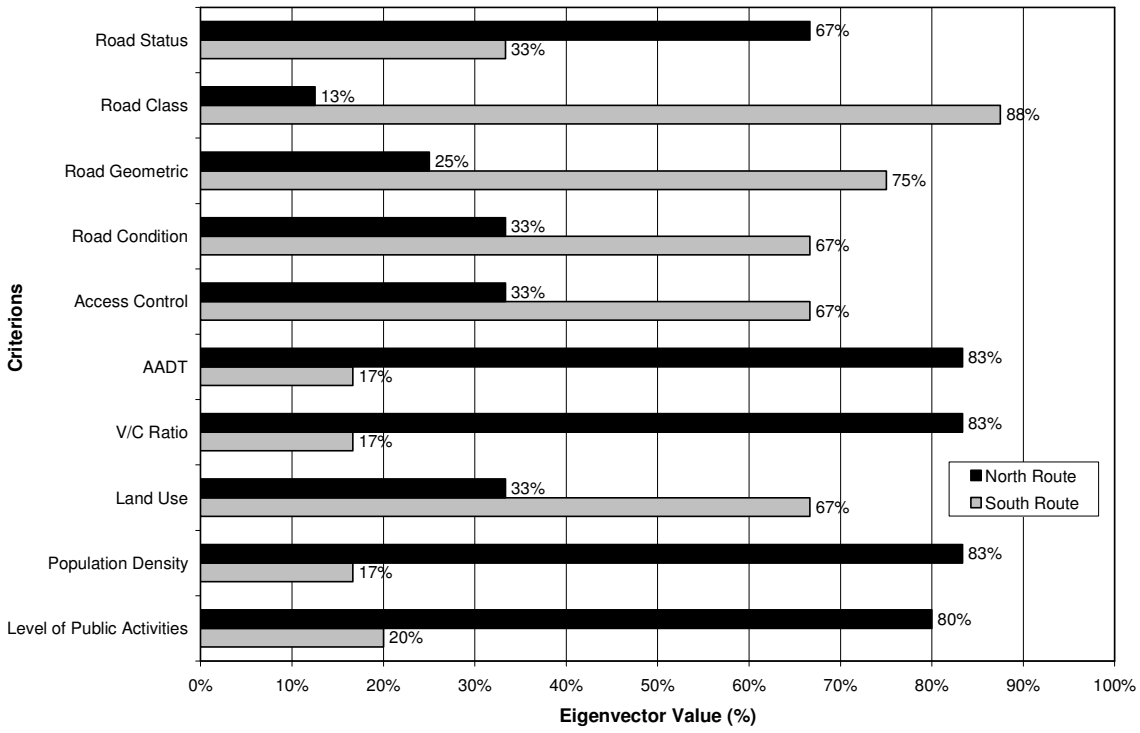


TABLE 4
EIGENVECTOR VALUE FOR EACH CORRIDOR AND EACH TYPE OF FREIGHT TRANSPORT

Route	Eigenvector Value	
	Container and Heavy Equipment	Dangerous Goods
North Corridor	0.30	0.54
South Corridor	0.70	0.46

DISCUSSIONS

From the results of alternative routes evaluation, some improvements are still required in order that the selected route can perform optimally. For Bali freight route, the required improvements are as follows:

- The road classes for some links such as Ngurah Rai By Pass and Tohpati-Kusamba By Pass have not yet determined. This should be overcame because one of the requirements for a freight transport route is that it should consists of series of road links with same or higher road classes than the required road class.
- Some part of the South route has not yet been installed with appropriate road safety equipments. This was especially true for Selemadeg area and Kusamba-Angentelu link.
- In general access control in South route was satisfactory in urban area. However in inter-urban area access control should be improved in order to increase road user safety.
- In a freight transport route, routine maintenance of road condition is very important. Although road betterment has been carried out in Bali but Gilimanuk-Cekik link requires attention for road betterment.
- The location of Ubung freight terminal is recommended to be moved to Tohpati-Kusamba By Pass to avoid potential conflict with the general traffic.
- In the North route, it is recommended to develop Singaraja freight Terminal.
- To avoid overloading, Cekik dan Seririt weighing bridges should be reactivated whist Batubulan weighing bridge is recommended to be moved to Tohpati-Kusumba By Pass.

For West Nusa Tenggara freight route, the required improvements can be listed as follows:

- The road classes for some links such as Sumbawa Besar-Banggo and Talabiu-Bima-Raba need to be determined.
- In Sumbawa Besar-Dompu link, road widening and road betterment is required.
- Road safety equipments such as guard rail, sign and marking are required to be installed in some spots.
- In Lombok Island with limited length of the West-East corridor might not justify a dedicated freight transport terminal. Instead, it can be integrated with the ferry terminals (Lembar and Kayangan). If in the future a dedicated freight terminal is required the proposed location is Cakranegara (in the border of Mataram city).
- In Sumbawa Island, Sumbawa Besar can be functioned as a freight terminal in West of Sumbawa, whilst Dompu is proposed to be a freight terminal in the East of Sumbawa.
- Kediri weighing station shoud be removed to Rumak. New weighing bridge needs to be provided in Eastern area of Lombok Island such as in Simpang Negara and Sape.

CONLUDING REMARKS

Freight transport is a very important for economic development of a nation. Therefore the determination of freight transport network route is essential. For this purpose affecting factors need to be identified and a suitable evaluation and selection procedure needs to be implemented. AHP can be used as a reasonable method to carry out such task.

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