

## 論文の内容の要旨

### Thesis Summary

論文題目 International Comparison of the Development Level of Inter-regional Transport

Infrastructure: Methodology Development and Policy Analysis

(幹線交通インフラの開発レベルの国際比較研究：評価手法の開発と政策分析)

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Inter-regional transport infrastructure is vital for national and regional development. Huge investments are needed in the coming decade in order to cope with the growing demand and deal with issues of maintaining the current existing stock around the world. Assessing current development status, reviewing development history and evaluating the effectiveness of the policy and investment on inter-regional transportation infrastructure will ultimately help the discussion of long-term development strategy.

The objectives of this research are: 1) Develop the practical methodology to assess and compare the development level of inter-regional transport infrastructure (expressway, high-speed railway, airport and all modes). The comparison method should capture the geographic, demographic and economic differences. 2) More importantly, apply the methodology to conduct development level comparisons, policy analysis and draw policy implications.

In the first stage of this research I further develop the practical methodology of Normalized Development Level (NDL) to assess the development level of inter-regional transport infrastructure including expressway, high-speed railway and airport. It is not only able to measure the development level of inter-regional transport infrastructure but also comparable of capturing the historical change of each system among different countries (domestic regions and international regions), and most importantly the patterns towards different modes. It is the first time that the development level comparison is measured with consideration of economic, demographic and geographic difference as well as the attributes of different transport modes. In the second stage, I apply the method to conduct development level comparisons and policy analysis on 20 countries across the globe from 1960s to 2014. Implications have been drawn for policy-makers in central, local governments as well as international organizations.

#### **I: The main contributions in the methodology part:**

Overall, two indices, namely Normalized Development Level Index on Spatial Accessibility, Normalized Development Level Index on Resources Quantity, are further developed to assess the

development level of inter-regional transport infrastructure on spatial accessibility and capacity (resources quantity). An integrated assessment approach on multi-modes infrastructure is achieved, which fills the blank research area. The improvements have been made in the NDL indices are described as follows: 1) further enrich development level comparison concept through articulating the definitions, essentially the method of which compares the supply and necessity of inter-regional transport infrastructure with other country; 2) improve the theoretical formation of necessity and justify the assumptions and simplifications of model components, which enables the comparisons based on theoretical sound and cost-effective method ; 3) unify the model construction of each transport modes, which enables the integrated assessment on all modes later on; 4) add the high-speed rail Normalized Development Level Index on Spatial Accessibility; 5) enable larger scale application of the method by solving the passing demand issues caused by international traffic which applies gravity model and use trans-country OD data set to estimate the international passing demand; 6) Most importantly, with the above improvements, the method is able to make integrated assessment on all modes. It fills the blank research area of integrated assessment on all modes. Development patterns on different kinds of modes can be identified.

## **II: The main findings in comparison results and policy analysis are described as follows:**

### ***Comparison results of the development level***

Comparison results of the development level of expressway, high-speed railway, airport on around 20 countries during 1960s to 2014, are presented in this thesis. It displays the development level changes and enables policy-makers to track the development level of each modes and all modes in the history as well as assess current development status. In detail, the application of the method widely expands to more countries and scales for 1) country level comparisons: conducted development level comparisons of 15 countries for expressway, high-speed railway, airport and integrated all modes; 2) domestic region level comparisons: conducts detailed comparisons on 2 countries at regional level, namely Japan and China, for expressway, high-speed railway, airport and integrated all modes; 3) international region level comparisons: conducted assessment on the EU for expressway development; 4) airport Infrastructure: conducts detailed international comparison on airport infrastructure. The regional development pattern reveals the effectiveness of this method.

#### **1) Country level comparisons:**

***Expressway:*** (1)General trends: the Netherlands has the highest development level in this international comparisons. The EU countries generally slowed down its development pace after 1975s. The development level of Spain has a sharp increase after joining the EU in 1986. China and Korea are observed to have the highest development pace among the selected countries. (2) Regarding the Netherlands, the rationale of the comparatively high level of development, is partially because of its

transport and logistic sector has been playing key role in its economy as the direct contributor, while transport infrastructure built by most of other countries are mainly for the indirect contribution to economy growth. Similar approach can be observed in Singapore's port and airport development. (3) In the EU, the trend of slowing down the development after 1975s can be interpreted as the reflections on the oil dependency. As the oil crisis occurred in the mid-1970s, the Netherlands revised its expressway development master plans into various versions with lower density comparing with the version before the oil crisis. Other EU countries also share similar development pace, which is slowed down after 1975s. Another reason is many countries in the EU started to shift the focus of regional development to metropolitan development after 1980s. (4) Spain enjoyed a sharp increase in the development level after joining the EU in 1986. It catches up with the EU 12 countries' benchmark level in 2005. It has benefited from the EU funding and policy on improving the connectivity in the EU. (5) The highest (or exceptional) growth rate have been observed in China and Korea. It is partially due to the acceleration of investment on infrastructure in response to the Asia financial crisis in 1997 and globe financial crisis in 2008.

**High-Speed Railway:** General trends: Japan maintained the highest development level until 2010. Korea surpassed Japan in 2010 and several countries are approaching the same development level as Japan. After 2000, the countries newly adopted the high-speed railway technology increased their development level sharply, which shapes a new dynamic in the high-speed railway development in terms of technology development as well as expansion of projects.

**Airport:** China's airport development level decreased sharply comparing with other countries. Take its aggressive development in expressway and high-speed railway into consideration, China has been taking a different approach in airport development.

**Integrated Assessment on all modes** (1) In general, this research integrates the NDL for expressway, high-speed railway and airport, using the triangle to represent the mode pattern and the integrated development level suggested by the size of the triangle. Each mode at the certain year is compared with the base line year of national NDL 1 of Japan. The shape of the triangle indicates national "mode choice" or development outcomes. (2) Several countries are more expressway oriented development, namely Italy, Belgium and the Netherlands. Another group is the countries which have relatively higher level in airport than other modes, including the UK, France, Germany, Norway and the US. Norway is more relied on the airport infrastructure in the inter-regional development. One more interesting pattern is that Korea and China both developed towards expressway and high-speed railway. It might indicate these countries have made wise decision toward the energy efficient mode. In terms of the overall integrated development level, Japan, Germany, Korea, the US and Belgium have the highest level. Lower density countries have the pattern more towards airport development with only one exception, China.

## 2) Domestic region level comparisons:

**Japan Airport:** (1) The airport development in Japanese regions has following patterns: a) initial development level is high; b) the disparity between regions becomes gradually larger; c) the level of advanced regions are the lowest; d) regions located in the edge of the country have higher development level. (2) A gap between infrastructure provision and operation has been identified in Japan's civil aviation development. (3) The policy, which intended to focus the development in metropolitan airports, is not effective in the past twenty years.

**Japan Expressway:** The disparity between regions becomes smaller and smaller. It demonstrates the effectiveness of Japanese policy on regional balance development

**Japan High-speed Railway:** The development of high-speed railway started from the advanced regions, namely Kanto and Kansai as well as Kinki. Later other regions caught up with the advanced region. The Chugoku region have a high development level, partly because of its location, which plays the role of connecting west and east. Similar trend has been observed in China as well.

**Japan Integrated All Modes:** The regions located in the edge of the country have higher airport development level than other modes. It might reveal the investment decision (or the outcome of the investment) of inter-regional transport infrastructure are more toward air transport. Secondly, compared to high-speed railway, NDL within these regions, expressway NDL has higher value. The regions located in the middle of the country have higher high-speed railway development level than other modes. The regions in the middle as well as the advanced regions are taking a more balanced approach in each mode of development as the NDL value are similar in each mode. The size of the triangle reveals the integrated NDL. The advanced regions in Japan do not have the highest NDL. It helps the policy-maker to make decision on specific mode with the consideration of other modes.

## 3) International region level comparisons: Expressway Development of the EU

The results reveal the expressway development trend of the EU 12 and the EU28, which can assist the EU and other region to set the benchmark for its expressway development.

## 4) International Comparison on Airport Infrastructure Development

The metropolitan regions in Japan locate in the lowest bound of the development level across the entire country. In order to draw insights from international comparison, we have conducted the detailed regional comparison for another three large economy in the World, namely the UK, France and Germany. The findings are the metropolitan regions in all the other three countries have comparably high development level. It further reveals the issue that Japan should focus on the improvements of its airport development in its metropolitan regions.