# Evaluation of Development Process for DOTO Expressway Project using Real Option Approach (ROA)

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## 1. Introduction

Nowadays, the budgets for large infrastructures, especially expressway, in Japan are limited. As many expressway projects are planned to be implemented in Hokkaido, therefore, the development process of the expressway have to be revised to achieve the effectiveness due to the budget constrain. This study examines the effects of implementing processes for DOTO expressway project by considering uncertainty in traffic volume estimation. The existing process is evaluated and compared to the process that has project extension option to implement the project later in the future using Real Option Approach (ROA).

## 2. Overview of DOTO Expressway Project

DOTO expressway is a toll road using to connect cities in eastern part of Hokkaido. The sections from Chitose to Yubari (42.1 km.) and Tokachi-shimizu to Ikeda (50.3 km.) are already in operation since 1999 and 1995 respectively, while the sections from Yubari to Tokachi-shimizu (will be called section A) and Ikeda to Kushiro (will be called section B) are under construction as shown in Figure 1.

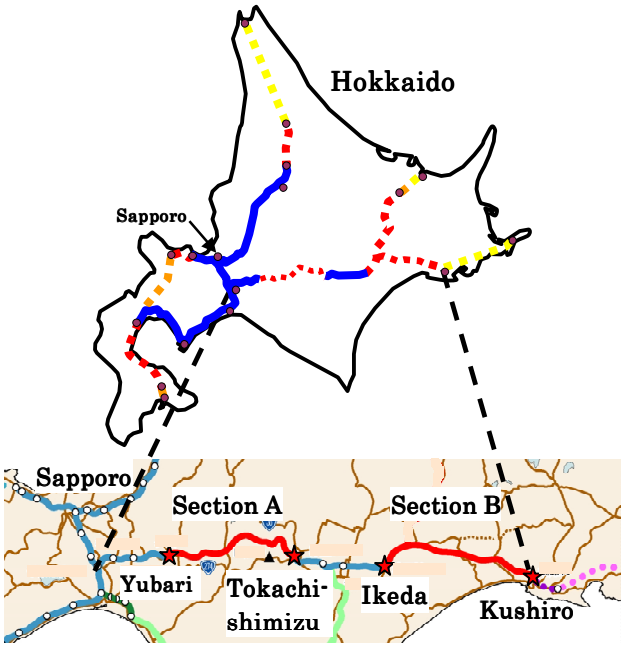


**Figure 1. Overview of DOTO Expressway project**

## 3. Expressway Development Process

Presently, DOTO expressway project (both section A and B) are constructing. The progress of the project can be summarized in Table 1.

**Table 1. Progress of DOTO expressway project**

| | Distance (km.) | Date of Approval | % Completion in 2002 |
|---|---|---|---|
| Section A | 81 | Dec 1998 | 9 % |
| Section B | 84 | Nov 1993 | 16 % |

From the progress, it can be seen that the existing development process of DOTO expressway project is to implement both section A and B simultaneously. However, it is considered to be more effective if the project have extension option to firstly complete section A and after that implement section B as shown in Figure 2. This will make more systematic expressway network and also reduce uncertainty that may occur in section B. Thus, the development process with and without extension option will be examined in this study.

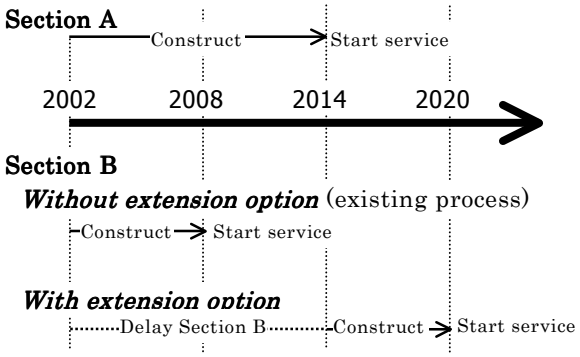


**Figure 2. The development process with and without extension option**

## 4. Traffic Volume Estimation

Forecasting traffic volume is estimated by using data from B zone OD in year 1999 and 2020. Then, the estimated traffic volume in expressway is calculated by using divert formula. The OD table that is grouping from B zone OD can be shown in Table 2 and 3.

**Table 2. OD table of Hokkaido**

| zone | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | | | | | | Δ | | ○ | ○ | ○ |
| 2 | | - | | | | | Δ | | ○ | ○ | ○ |
| 3 | | | - | | | | Δ | | ○ | ○ | ○ |
| 4 | | | | - | | | | | ○ | ○ | |
| 5 | | | | | - | | | | ○ | ○ | |
| 6 | | | | | | - | Δ | | ○ | ○ | ○ |
| 7 | Δ | Δ | Δ | | | Δ | - | | ○ | ○ | |
| 8 | | | | | | | | - | ○ | ○ | |
| 9 | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | - | ○ | ○ |
| 10 | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ | - | |
| 11 | ○ | ○ | ○ | | | ○ | | | ○ | | - |

Note ○ is the traffic volume that related with the project
Δ is traffic volume from Furano city only

Keywords : Evaluation, Development Process, Real Option Approach, Expressway project
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**Table 3. Cities in each OD zone**

| OD zone | Cities in the OD zone |
|---|---|
| 1 | Hakodate |
| 2 | Muroran, Date, Noboribetsu |
| 3 | Chitoze,Tomakomai, Eniwa |
| 4 | Sapporo, Kitahiroshima, Ebetsu, Ishikari, Otaru |
| 5 | Iwamizawa, Mikasa, Bibai |
| 6 | Yubari |
| 7 | Takigawa, Ashibetsu, Sanagawa, Akabira, Utashinai, Furano |
| 8 | Asahikawa, Wakkanai, Nayoro, Shibetsu, Fukagawa, Rumoi |
| 9 | Obihiro |
| 10 | Kitami, Abashiri |
| 11 | Kushiro, Nemuro |

In this study, it is considered that there are uncertainties in the estimated traffic volume. The uncertainty is measured by comparing the estimated traffic volume with the measured data as shown in Table 4. As a result, the estimated traffic volume in DOTO expressway project is assumed to be fluctuated with the mean of 8% and standard deviation of 22 %.

**Table 4. Comparing estimated and measured traffic volume in Hokkaido expressway**

| Section | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|
| Kunnui - Ochamanbe | Measured data (M) | | | - | 1759 |
| | Estimated data (E) | | | - | 1892 |
| | (E - M)/ M | | | - | 0.08 |
| Ochamanbe - Toyoura | 2510 | 2442 | - | 2291 | 2438 |
| | 1528 | 1570 | - | 1693 | 1892 |
| | -0.39 | -0.36 | - | -0.26 | -0.22 |
| Wassamu - Asahikawakita | - | - | - | 1524 | 1548 |
| | - | - | - | 1709 | 1778 |
| | - | - | - | 0.12 | 0.15 |
| Asahikawakita - Asahikawatakazu | - | - | - | 2873 | 3001 |
| | - | - | - | 3664 | 3769 |
| | - | - | - | 0.28 | 0.26 |
| Oiwake - Yubari | - | - | 1820 | 2064 | 2072 |
| | - | - | 2411 | 2453 | 2493 |
| | - | - | 0.32 | 0.19 | 0.20 |
| Otofukegeobihiro - Ikeda | 797 | 880 | 945 | 951 | 941 |
| | 992 | 1038 | 1089 | 1139 | 1185 |
| | 0.24 | 0.18 | 0.15 | 0.20 | 0.26 |

Growth factor method is used for estimated future traffic volume in this study. From the historical data, it is expected that the traffic volume will increase 1 % annually until year 2020. After that, the traffic volume is assumed to be constant.

## 5. Monte Carlo DCF

The basic assumptions using in evaluation process can be summarized in Table 5.

**Table 5. Basic assumptions using in evaluation process**

| | Section A | Section B |
|---|---|---|
| Construction period | 12 years | 6 years |
| Construction cost | 319 billion yen | 234.4 billion yen |
| Maintenance cost | 34 million yen per year | |
| Based year | Year 2002 | |
| Project life | 40 years | |
| Social discount rate | 4 % | |

Benefits from the expressway project are accrued from saving in travel time and travel cost. Considering uncertainty in traffic volume, the benefit is simulated using Monte Carlo discount cash flow (Monte Carlo DCF). The estimated benefits resulted from the simulation for both with and without extension option can be shown in Figure 3.

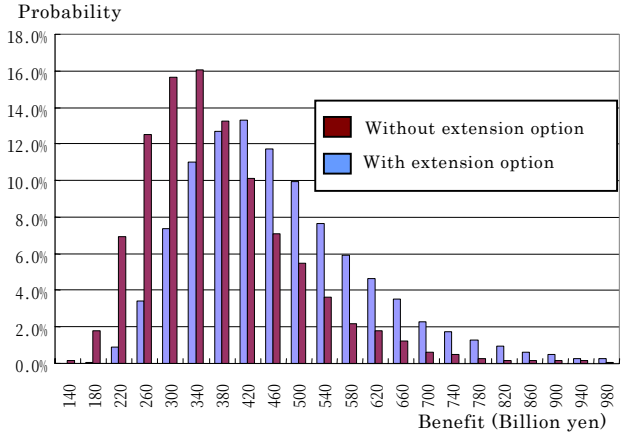


**Figure 3. Benefit distribution of the project**

The results from the evaluation of DOTO expressway project can be summarized in Table 6. The result shows that the net benefits of the project in case with and without extension option are –9.5 and –200.6 billion yen respectively. Despite the loss in net benefit in both cases, it is obviously that the project value is increased when the extension option exist. The value of the option is, therefore, the difference between with and without option case (191.1 billion yen).

**Table 6. Summarized of simulation results**

| | Without option | With option |
|---|---|---|
| Construction Cost | 475.8 | 405.6 |
| Maintenance Cost | 100.4 | 78.9 |
| Total Cost (C) | 576.2 | 484.5 |
| Total Benefit (B) | 375.6 | 475.0 |
| Net Benefit (B-C) | -200.6 | -9.5 |
| Value of option | 191.1 | |

## 6. Conclusions and Recommendations

This study examines the effect when the DOTO expressway project has option to extend the construction of section B. The results show that the value of the project in case with extend option is greater than in case without the option. Therefore, it is recommended that DOTO expressway section A from Yubari to Tokachi-shimizu should be constructed first. Then, the expressway section B from Ikeda to Kushiro will be constructed after section A is already in operation.

## 7. References

1. Study Group on Road Investment Evaluation, *Guidelines for the Evaluation of Road Investment Projects*. Japan Research Institute, Tokyo, 2000
2. Trigeorgis, L. : Real Options: Managerial Flsxibility and Strategy in Resource Allocation. The MIT Press, Cambridge, 2002