QUALITY OF LIFE ASSESSMENT IN URBAN DEVELOPMENT AND TRANSPORT POLICYMAKING

Edited by Yoshitsugu Hayashi, Hiroyuki Takeshita, and KE Seetha Ram

ASIAN DEVELOPMENT BANK INSTITUTE
Quality of Life Assessment in Urban Development and Transport Policymaking

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Yoshitsugu Hayashi, Hiroyuki Takeshita, and KE Seetha Ram
# Contents

Tables and Figures ................................................. v  
Contributors .................................................. ix  
Acknowledgments ............................................... xi  
Foreword ....................................................... xiii  

**PART I: Quality of Life Accessibility Approach**

Part I Key Messages ............................................. xvii
*Veronica Ern Hui Wee*

1. **Introduction to the Quality of Life Accessibility Method**  
   *Yoshitsugu Hayashi* ........................................ 1

2. **Japan’s Practice of the Quality of Life Accessibility Method: Application to Motorways and Street Design**  
   *Hiroyoshi Morita* .......................................... 5

3. **Case Studies: Nanjing (People's Republic of China), Mumbai–Ahmedabad High-Speed Rail (India), Kozoji New Town (Japan), and Bangkok (Thailand)**  
   *Yoshitsugu Hayashi, Fumei Gu, Yong Jian Khoo, Hiroyoshi Morita, Tsuyoshi Takano, and Witsarut Achariyaviriy* .... 19

4. **Applications of Individual Quality-of-Life-Based Approach to Evaluate Smart Shrinkage**  
   *Noriyasu Kachi and Kenichi Tsukahara* ............... 37

5. **Quality of Life Accessibility Method to Evaluate the Transport Sector’s Contribution for Achieving the Sustainable Development Goals**  
   *Hiroyuki Takeshita* .......................................... 60

6. **Quality of Life Evaluation of the Recovery Process After the 2011 Great East Japan Earthquake and Tsunami**  
   *Tsuyoshi Takano, Hiroyoshi Morita, Hirokazu Kato, and Yoshitsugu Hayashi* .................. 73
PART II: Quality of Life Method in Existing Project Evaluation Practices in the United Kingdom, Germany, France, and Japan

Part II Key Messages
Veronica Ern Hui Wee

7. From Wider Impacts to Transformational Impacts: The United Kingdom’s Developing Agenda for Major Projects
Roger Vickerman

8. Planning Practice and Wider Economic Impacts—The Case of Germany
Werner Rothengatter

9. Cost-Benefit Analysis and Urban Transport Investments in France: Toward an Accessibility Turn?
Yves Crozet

10. Evaluation of Road Projects in Japan: Efforts to Evaluate Disaster Prevention
Mitsuhiro Yao

PART III: The Future of Project Evaluation: Applying the Quality of Life Approach

Part III Key Messages
Nghia Nguyen

11. Developing a Country Perspective on the Quality of Life Method
James Leather, Chanankarn Boonyotsawad, and Veronica Ern Hui Wee

KE Seetha Ram and Chanankarn Boonyotsawad

13. Conclusion and Policy Messages: Suggestions for Use of the Quality of Life Approach and Messages for the Future
Chanankarn Boonyotsawad and Veronica Ern Hui Wee
Tables and Figures

Tables
2.1 QOL Indicators 6
2.2 Drivability and Walkability Indicators 7
2.3 Weight for QOL Indicators by Age Group 8
2.4 Weight for Drivability Indicators by Social Group 8
2.5 Weight for Walkability Indicators by Social Group 9
2.6 Changes in Indicators Before and After the Project 15
2.7 Estimated Results of Benefits by Walkability 17
3.1 Possible Solutions 30
4.1 Target Life Service Functions and Facilities 39
4.2 Three Policy Scenarios for the Concentration of Living Service Facilities and Residential Areas 42
4.3 Components of Physical Environment and Their Calculation Method 44
4.4 Willingness to Pay in Each Residential Environment Index 44
4.5 Benefit and Cost Items for Aggregation of Living Service Facilities and Residential Areas 45
4.6 Cost Intensity of the Targeted Infrastructure and Public Facilities 46
4.7 Relocation Costs of Housing and Living Service Facilities 47
4.8 Trends in the Number of Living Service Facilities 51
4.9 Comparison of Average QOL (yen/person/month) by Region for Each Scenario 56
5.1 SDG Targets Relevant to the Transport Sector 61
5.2 Examples of SDG Evaluation Indicator Development in the Transport Sector 62
6.1 Damage from the Great East Japan Earthquake by Geographical Area 74
6.2 Time Series Needs of Survivors 76
6.3 Basic Structure of Needs for Normal Living 77
6.4 QOL Elements and Their Satisfaction Conditions 80
6.5 Data Showing the Disaster Situation 82
7.1 Appraisal of HS2 Under Revised Estimates 105
8.1 Components of Cost-Benefit Analysis for the German BVWP 114
8.2 Investment Expenditure Allocation of the BVWP 118
9.1 Grand Paris Express, Net Present Value, Internal Rate of Return, 2010–2035 129
9.2 Job Estimates in Île-de-France, With and Without the GPE Project Estimated for Three Different Scenarios of Total Employment, 2007–2035 130

10.1 History of Introduction of Project Evaluation System 145
10.2 Explanation of Evaluation Method Conducted by MLIT 145
10.3 Overview of the Great East Japan Earthquake 148
10.4 Reported Damage Caused by the Great East Japan Earthquake 149
10.5 Classification of Location Pair Rank 151

Figures
1.1 Background of the Development of the Quality of Life Accessibility Model 1
1.2 QOL Accessibility Model Concept 2
1.3 QOL Accessibility Model Equations 3
2.1 Case Study Area and Current Quality of Life Value 10
2.2 Total and Detailed Quality of Life Impact 11
2.3 Distribution of QOL Impact 12
2.4 Distribution of QOL Impact by Hospital and Leisure Access 13
2.5 Hanazono-cho Street Design Project 14
2.6 Changes in Walkability Before and After the Project 16
3.1 Spatial Distribution Accessibility Map of the City of Nanjing 20
3.2 Comparison of Medical Care Opportunities between Nanjing and Singapore 20
3.3 QOL Distribution by Age (Females), Nanjing 21
3.4 QOL Distribution by Age (Males), Nanjing 21
3.5 QOL Distribution by Income Level, Nanjing 22
3.6 QOL Distribution by Education Level, Nanjing 22
3.7 Map and Statistics of Kozoji New Town 23
3.8 Scenario Analysis of Light Rail Transit and Greening Plans, Kozoji New Town 24
3.9 Weight between QOL Factors, Dresden vs Nagoya 25
3.10 QOL Distribution Comparison of Green Scenario vs LRT Scenario 25
3.11 Weights of QOL Factors by Residents along the Proposed Mumbai–Ahmedabad High-Speed Rail Line 26
3.12 Monetary Value by QOL Factor of High-Speed Rail 27
3.13 Indian High-Speed Rail: QOL Sensitivity Analysis by Income 28
3.14 Growth in Car Ownership in Bangkok, Beijing, and Tokyo 29
3.15 Is MaaS Applicable for Bangkok? 30
3.16 Illustration of Transportation Decision-Making Scenario 31
3.17 Model of an Example of QOL-MaaS 31
3.18 QOL for an Individual vs Road Congestion and CO₂ Burden on the Planet 32
3.19 Time Profile of Traffic Congestion and CO₂ Emissions 33
3.20 Effects of Flexible Location and Time for Travel and Work 33
3.21 Sufficiency Factor 34
4.1 Concept of Small Core Formation 38
4.2 Sample of “Building Point Data” 41
4.3 Concentration of Living Service Facilities and Residential Areas for Small Core Formation 43
4.5 Spatial Distribution of Landslide Disaster Risk 49
4.6 Selection of Base Districts and Area Division 50
4.8 Change in QOL Per Capita in the No-Policy Scenario 52
4.9 QOL Change in the Facility Concentration Scenario 53
4.10 QOL Change in the Facility and Residential Area Concentration Scenario 54
4.11 QOL Change Utilizing Subsidies from the National Government for Building “Small Core” 55
5.1 Accessible Value 66
5.2 Relationship between QOL Factors and SDGs 67
5.3 Accessible Value and Perceived Value 68
5.4 Weight for Value and SDGs 69
5.5 The 5Ps and 17 SDGs 70
5.6 QOL, Sufficiency, and the 5Ps of the SDGs 71
6.1 Population by Geographical Area (right), Distribution of Seismic Intensity and Tsunami Flood Area in the Great East Japan Earthquake (left) 75
6.2 Structure of QOL for Survivors after a Disaster 77
6.3 QOL Evaluation System of Disaster Damage 78
6.4 Satisfaction Conditions of QOL Elements 79
6.5 Transition of QOL Stages 83
6.6 Transition in Numbers of Survivors Belonging to Each QOL Stage 85
6.7 Transition of QOL Stages 86
6.8 Transition of Numbers of Survivors Belonging to Each QOL Stage 87
6.9 Location of the Sanriku Coast Expressway 88
6.10 Transition of QOL Stages 89
6.11 Transition in Numbers of Survivors Belonging to Each QOL Stage in the Coastal Area 89
8.1 Modules of the German BVWP Assessment Methodology 119
9.1 Map of Grand Paris Express 128
9.2 Gravity Accessibility to Jobs by Public Transport 136
9.3 Gravity Accessibility to Jobs by Car 137
9.4 Compared Accessibility to Jobs (public transport access—car access) 138
10.1 Project Evaluation at Each Stage 147
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participants of the symposium without which it would not have been possible to make this publication successful. Finally, we are deeply indebted to all the symposium participants for their active participation during the event, and the feedback during the discussions that has echoed the success of this project.
Foreword

On 19 April 2021, I had the pleasure of giving the opening remarks at the international symposium on “Mainstreaming Quality of Life (QOL) in Evaluation of Transport and Spatial Planning”, organized by the Asian Development Bank Institute (ADBI) and Chubu University. The QOL accessibility method, invented by Yoshitsugu Hayashi, is a method that measures an individual’s happiness and enables the evaluation of transportation policies on the basis of "sufficiency" contrasting against the burden on society. It is similar to cost-benefit analysis used by economists, but it emphasizes happiness. The symposium marked the culmination of a 3-year research project that applies the QOL method to the performance-based evaluation of road transport projects. The project was funded by Japan’s Ministry of Land, Infrastructure, Transport and Tourism and conducted by Chubu University, led by Yoshitsugu Hayashi.

At the symposium, Yoshitsugu Hayashi and other leading experts, including Roger Vickerman, Werner Rothengatter, and Yves Crozet, shared experiences from France, Germany, the United Kingdom, and Japan on the philosophy and theory of the QOL method. They also discussed its application to evaluating transport projects in terms of their costs and benefits and their contribution to the achievement of the United Nations Sustainable Development Goals (SDGs) and leaving no one behind by identifying the differences in benefit due to citizens’ personal attributes.

I learned from the symposium that this research project is well aligned with the Asian Development Bank’s (ADB) approach to identifying and disseminating knowledge-based solutions for the inclusive and sustainable development of developing economies. This approach is multidisciplinary. To achieve inclusive and sustainable development of an economy, technology must be applied so as to increase individuals’ happiness in a socially harmonious way. Thus, various branches of science need to be mobilized.

The approach is also multidimensional. On the one hand, the use of local knowledge of local society, history, and geography is essential, especially in infrastructure investments. On the other hand, local interests must be coordinated by national governments’ interventions to the extent that they do not discourage local initiatives. Moreover, there are important roles not only for subnational coordination but also the regional sharing of best practices and international coordination in
financing large-scale development projects. Thus, ADB’s approach is multidisciplinary and multidimensional, and it is also “intersecting.”

I am delighted that the papers presented at the symposium are now compiled into this edited volume published by ADBI Press. The volume complements the Japanese book on the Quality of Life method, published by Akashi Shoten in 2021.

This ADBI volume comprises three parts. Part I introduces the QOL method and demonstrates its utility through the case studies of several transport and city planning projects in various Asian countries. The integrated method will help to develop effective policies and contribute to the achievement of the SDGs. The actual uses of the method are demonstrated by the case studies described in the volume. Part II discusses existing methods and philosophies in the United Kingdom, Germany, France, and Japan. It gives the background of conventional evaluation methods, especially cost-benefit analysis. These chapters demonstrate how the QOL method builds on and integrates with existing methods to provide a holistic evaluation approach that incorporates these wider impacts. Part III appraises the QOL method’s applicability for developing countries and in the post-COVID-19 context.

This ADBI volume deserves a wide readership. It will be of interest for everyone concerned with the quality of infrastructure, the cost-effectiveness and value for money of public projects, and sustainable development in general. I hope this ADBI volume will help the QOL method to become more widely accepted by transport and city planners and policy makers in the Asia and Pacific region and beyond so that the method will demonstrate its ability to promote the well-being of individuals in different societies.

Tetsushi Sonobe
Dean
Asian Development Bank Institute
PART I

Quality of Life
Accessibility Approach
Part I

Key Messages

Veronica Ern Hui Wee

Cost-benefit analysis (CBA) was first introduced for systematic evaluation of motorway projects in the United Kingdom in the 1960s, considering travel time and cost and accident damage cost. Fifty years have passed since then, and there have been various factors raised to influence the benefit and cost of projects, including environmental damage, comfort of travel, workspace environment, and accessibility to various socioeconomic services. Moving beyond CBA evaluation, the quality of life (QOL) method measures an individual’s happiness against society’s burden and facilitates the appraisal of transport infrastructure investment with a performance-based evaluation system. Such an integrated method would aid in developing policies and eventually, the achievement of the United Nations Sustainable Development Goals (SDGs).

Chubu University, led by Yoshitsugu Hayashi, conducted a 3-year research project on the evaluation of road transport projects using the QOL method funded by Japan’s Ministry of Land, Infrastructure, Transport and Tourism. In 2019, the research team visited experts Werner Rothengatter, Alain Bonnafous, Yves Crozet, and Roger Vickerman to investigate transport (road and rail, urban and intercity) project evaluation in major European countries. The results of this research were presented on 19 April 2021 at the international symposium on “Mainstreaming Quality of Life in Evaluation of Transport and Spatial Planning” organized by the Asian Development Bank Institute and Chubu University. The symposium covered the new method of evaluations and their application cases, the background philosophies and theories in the United Kingdom, Germany, France, and Japan, which were presented and discussed under the framework of wider economic benefits, QOL, and SDGs.

This edited volume captures the new research and discussions from the symposium in three parts. Part I presents QOL as an integrated method that would aid in developing policies and, eventually, the achievement of the SDGs. The utility of the QOL accessibility method
is demonstrated through the case studies of several transport and city-planning projects in various Asian countries.

Chapter 1 introduces the QOL accessibility method as a method for evaluating plans and the theory and its background philosophy of projects for transport infrastructure and urban development based on an individual’s QOL. This is determined by each citizen’s personal preference between various factors of the QOL and accessibility to services. The method replaces conventional cost-benefit analysis and is universal enough to be applied to a variety of different types of infrastructure, areal developments, and land use policies, including urban smart shrinkage for disaster resilience.

Chapter 2 describes a case study in Japan of the application of the QOL accessibility method to a transportation project, an interregional highway, and a street design project. The multifaceted effects of transportation projects, especially road projects, are expected to become more diversified in the future, and accountability for the investment effects may become more important. Also, through accumulation of knowledge on these effects, it will be possible to improve the QOL of the region itself, making it possible to comprehensively evaluate the effects over the medium and long term. The QOL accessibility method can be used to contribute to the improvement of accountability and knowledge accumulation.

Chapter 3 demonstrates the applicability of the QOL accessibility method to a variety of city planning projects. The QOL data in case studies of Nanjing (People’s Republic of China), Kozoji New Town (Japan), the proposed high-speed rail project in India, and the QOL–mobility as a service (MaaS) project in Bangkok are assessed with the QOL accessibility method to determine relevant policy recommendations to improve the QOL of residents.

Chapter 4 presents the results of a CBA using micro geo data to evaluate the aggregation of living service facilities and residential areas for forming a “small core” from the perspective of improving the QOL and disaster preparedness in a remote island municipality. The QOL accessibility method was applied for calculating the QOL of people living in a city by considering the existing road network for traffic convenience and disaster safety using micro geo data and obtaining statistics for each building containing household and individual attributes.

Chapter 5 summarizes the relationship between the QOL accessibility method and the SDGs and develops a method for evaluating the contribution of transportation projects to the SDGs by using the QOL accessibility method, which enables evaluation of the contribution to the SDGs through improved access to opportunities and facilities. The QOL accessibility method can be used to evaluate the contribution
to the SDGs through improved access to opportunities and facilities. Furthermore, the QOL accessibility method can be used to evaluate the contribution to the improvement of poverty (SDG1), gender (SDG5), and equity among regions (SDG10) because it can be evaluated by attribute and region.

Chapter 6 presents a system to evaluate the post-disaster living environment for refugees in each small district at a high spatial resolution (500-meter x 500-meter mesh) as QOL by a time series. This system is used to define priorities for damage control measures before and after the disaster to maintain QOL for refugees, specifically in the case of Japan’s eastern coastal areas, which suffered severe damage from the tsunami resulting from the Great East Japan Earthquake on 11 March 2011.
Introduction to the Quality of Life Accessibility Method

Yoshitsugu Hayashi

The “QOL accessibility model” is a method for the evaluation of plans and projects for transport infrastructure and urban development based on an individual’s quality of life (QOL) determined by each citizen’s preference between various factors of QOL and accessibility to services to fill their personal preference. This replaces the conventional cost-benefit analysis (CBA) that calculates the incremental gross domestic product (GDP) of the country or region. This method is universal enough to be applied to various projects to compare different types of

Figure 1.1: Background of the Development of the Quality of Life Accessibility Model

Scope of Research

Motivation
1. In conventional CBA the use of transport systems by retired people and children has no merit?
2. Quality of life (QOL) indicator, a nonmonetary (not GDP motivated) scientific approach to identify happiness in urban and regional development

Questions
1. Can QOL be an alternative indicator to GDP?
2. How can we choose L-T (Land Use - Transport) policies that are better for everyone, meeting SDG11 (sustainable living) and SDG16 (inclusiveness: No One Left Behind)?

Objectives
1. Investigate the changes in QOL according to economic development
2. Effectiveness of integrated L-T policies to increase QOL
   • Construction of railways x local urban development → evaluate by QOL as a common measure for both network infrastructure and areal development

CBA = cost-benefit analysis, GDP = gross domestic product, QOL = quality of life, SDG = Sustainable Development Goal.

Source: Originally presented by the author at the online international symposium on “Mainstreaming Quality of Life (QOL) in Evaluation of Transport and Spatial Planning” on 19 April 2021.
infrastructure, areal developments, and land use policies, including urban smart shrinking for disaster resilience.

The development of the model is shown in Figure 1.1.

First, the current CBA relies on the labor hypothesis, i.e., if the saved travel time and cost of a newly opened motorway or high-speed railway, as examples, compared to conventional roads and railways, would have been allocated to work, the GDP would have increased. Under the labor hypothesis, a new motorway or high-speed railway would be no value for retired people and children. This is irrelevant today.

Second, we have been thinking about evaluating the improvement of the QOL. Some economists say we should not include the effects initially in nonmonetary terms. But it is wrong to ignore the values that exist in reality. This is a fundamental problem for the QOL and gross national happiness (GNH) to be an alternative indicator to income and GDP.

Third, since the United Nations Sustainable Development Goals (SDGs) are becoming more important, we sought to see what effects a particular land use or transport policy will provide to different people such as young and old, men and women, and people of other income groups.

Figure 1.2: QOL Accessibility Model Concept

QOL = quality of life.

Source: Originally presented by the author at the online international symposium on “Mainstreaming Quality of Life (QOL) in Evaluation of Transport and Spatial Planning” on 19 April 2021.
We try to develop a new model to measure happiness and GNH instead of income and GDP to overcome the various defects mentioned earlier in conventional CBA. Figure 1.2 illustrates the concept of the QOL accessibility model. Imagine you live in the yellow district. The nearest hospital (green post) is located 20 minutes from your house. Shopping centers (purple posts) are 50 minutes away. Living in your district, the value of remotely provided services would diminish. This attenuated value is called “accessible value,” which is given to everyone in equal amounts.

However, not everyone wants all of these services. This is because the weight of each service is different between differently attributed persons. For example, access to hospitals is of little value for a young woman, but she gives more weight to the accessible value of stores. The weighted sum of the accessible values is called a person’s “perceived value.”

The QOL accessibility model is specified as a set of equations shown in Figure 1.3.

**Figure 1.3: QOL Accessibility Model Equations**

**Accessible Value**

\[ A_{ij}^m = V_j^m \cdot e^{-ac_{ij}} \]

- \( m \): QOL factor
- \( i \): Mesh block with residents living in
- \( j \): Mesh block with objective value of QOL factor \( m \)
- \( a_c \): Impedance parameter for traveling from mesh block \( i \) to mesh block \( j \)
- \( c_{ij} \): Travel cost between mesh block \( i \) and mesh block \( j \)
- \( V_j^m \): Existing value of QOL factor \( m \) exists in mesh block \( j \)
- \( A_{ij}^m \): Accessible Value of \( V_j^m \) for residents living in mesh block \( i \).

**Perceived Value**

\( (=\text{QOL for an individual}) \)

\[ QOL_i^k = \sum W_{mk} A_{ij}^m \]

- \( k \): Population group \( k \) with certain social-economic attributes
- \( W_{mk} \): Weight of QOL factor \( m \) for person \( k \) among all factors
- \( QOL_k^k \): Perceived Value = Quality of life for person \( k \) living in mesh block \( i \)

**Gross Regional Happiness**

\[ GRH_i^k = \sum P_i^k \cdot QOL_i^k \]

\[ GRH = \sum_k GRH_i^k \]

QOL = quality of life.

Source: Originally presented by the author at the online international symposium on “Mainstreaming Quality of Life (QOL) in Evaluation of Transport and Spatial Planning” on 19 April 2021.
Suppose you live in zone $i$ and value $V_j^m$ of service $m$ (medical opportunity, shopping opportunity, etc.) is provided in another zone $j$. In zone $i$, you cannot fully enjoy $V_j^m$, and it decays to an accessible value $A_{ij}^m$ (Equation (1)). $w_{km}$ (weight) is the difference between how much you want $m$ services depending on your individual’s attribute ($k$). The QOL is defined as the sum of $A_{ij}^m$ with weights $w_{km}$. This is the QOL of a person of type $k$ living in zone $i$, valuing is the difference between an older man and a young woman.

One of the merits of this method is that when you add it all up, you get Bhutan’s gross national happiness or gross regional happiness, which is an alternative to and different from GDP.

Even better, it can also be calculated by private attribute group ($k$), so we can evaluate the SDGs’ inclusiveness, “no one left behind,” whether it is good or bad for the elderly, good or bad for the younger generation, or good or bad for low-income groups, etc.
2

Japan’s Practice of the Quality of Life Accessibility Method: Application to Motorways and Street Design

Hiroyoshi Morita

2.1 Introduction

In Japan, a 14,000-kilometer (km) expressway network is planned, with about 80% of the network already completed, including the major arterial roads connecting metropolitan areas. At present, the main focus is on the development of ring routes and double networks in urban areas and connecting routes between regions. In 2020, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) formulated a new vision of road development for the years up to 2040. The vision includes the rise of new mobility and improved transportation for pedestrians and bicycles in cities. A variety of values as services for automobile traffic, bicycles, and pedestrians are being sought according to various standards, from highways to arterial roads to streets within cities.

This chapter reports on the application of quality of life (QOL) accessibility method featured in Chapter 1 to the evaluation of transportation projects, especially road projects in Japan. In project evaluation of transportation projects in Japan, for many years, only three major benefits (travel time reduction, travel cost reduction, and traffic accident reduction) have been subject to cost-benefit analysis. However, as mentioned above, as the objectives of transportation projects are becoming more multilateral, it is important to explore a more multilateral method of evaluating value. The QOL accessibility method can be used to analyze the various effects of transportation projects and to use the values of each social demographic. In addition, as will be shown later, it is possible to calculate the return of the maintenance
effect of transportation projects in detail by attribute and item. In this chapter, the results of case studies of the QOL accessibility method for two completely different projects, an expressway project and an urban street improvement project, are presented.

2.2 Method

2.2.1 QOL Indicators

The QOL accessibility method, as described in detail in Hayashi, is a model that integrates and evaluates the value of various aspects of the living environment. However, in the case of transportation projects, there are various modes of transportation such as driving and walking to a certain service. Furthermore, it is known that even in the case of using automobiles, for example, there are differences in service levels in the route itself, such as roads that are easy to drive on and roads that are prone to traffic congestion. The same is true for the walking environment, which has various service levels for pedestrians, such as comfort and safety, and it is important to incorporate these differences into the evaluation of walkability.

Based on the above, we set 15 QOL indicators in five fields (Table 2.1). In addition, for the evaluation of expressway projects, drivability is taken into account in setting the time required. In the evaluation of street projects, walkability is incorporated into the model (Table 2.2).

<table>
<thead>
<tr>
<th>Item</th>
<th>Indicator</th>
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<tbody>
<tr>
<td>Economic opportunity</td>
<td>Employment level</td>
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<tr>
<td></td>
<td>Unemployment rate</td>
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<td></td>
<td>Rent level</td>
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<td></td>
<td>Rent per month</td>
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<td></td>
<td>Commuting level</td>
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<td>Commuting time</td>
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<tr>
<td>Living opportunity</td>
<td>Commercial access</td>
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<td>Access time to retail</td>
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<td></td>
<td>Medical access</td>
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<td>Access time to hospital or clinic</td>
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<td>Public service access</td>
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<td>Access time to station or CBD</td>
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<td>Other service access</td>
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<td>Access time to 15 other city facilities</td>
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<td>Safety and security</td>
<td>Natural disaster</td>
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<tr>
<td></td>
<td>Mortality risk from natural disasters</td>
</tr>
<tr>
<td></td>
<td>Traffic accident</td>
</tr>
<tr>
<td></td>
<td>Risk of encountering traffic accidents</td>
</tr>
<tr>
<td></td>
<td>Health damage</td>
</tr>
<tr>
<td></td>
<td>Air quality level (SPM)</td>
</tr>
<tr>
<td>Residential amenity</td>
<td>Housing environment</td>
</tr>
<tr>
<td></td>
<td>Living space per parson</td>
</tr>
<tr>
<td></td>
<td>Natural environment</td>
</tr>
<tr>
<td></td>
<td>Access time to park or green</td>
</tr>
<tr>
<td></td>
<td>Noise environment</td>
</tr>
<tr>
<td></td>
<td>Noise level</td>
</tr>
<tr>
<td>Environmental burden</td>
<td>Low-carbon life</td>
</tr>
<tr>
<td></td>
<td>GHG emissions</td>
</tr>
<tr>
<td></td>
<td>Biodiversity</td>
</tr>
<tr>
<td></td>
<td>Opportunities to see wildlife</td>
</tr>
<tr>
<td></td>
<td>Waste management</td>
</tr>
<tr>
<td></td>
<td>Waste discharge</td>
</tr>
</tbody>
</table>

CBD = central business district, GHG = greenhouse gas, QOL = quality of life, SPM = suspended particulate matter.

Source: Author’s creation.
Table 2.2: Drivability and Walkability Indicators

<table>
<thead>
<tr>
<th>Drivability</th>
<th>Walkability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel time</td>
<td>Width of sidewalk</td>
</tr>
<tr>
<td>Time reliability</td>
<td>Shade</td>
</tr>
<tr>
<td>Accident risk by trip</td>
<td>Rest areas (benches, etc.)</td>
</tr>
<tr>
<td>Signal density</td>
<td>Green density</td>
</tr>
<tr>
<td>Fee</td>
<td>Diversity of roadside use</td>
</tr>
<tr>
<td></td>
<td>Safety facilities</td>
</tr>
<tr>
<td></td>
<td>Lighting facilities</td>
</tr>
<tr>
<td></td>
<td>Eyes on the street</td>
</tr>
</tbody>
</table>

Source: Author’s creation.

2.2.2 Weight Estimation

To estimate the weight of residents and users for these indicators, we surveyed 8,000 people aged 20 years or older throughout Japan in 2019 to obtain their stated preference. The questionnaire survey was conducted based on a paired comparison method in which each respondent was asked to select a preferred option from two profiles that combined the superiority of several QOL indices. From this survey, we obtained data on respondents’ choices for the QOL indices of drivability and walkability and constructed a binary choice logit model to obtain weights.

The weight for each QOL indicator are different for each age group. As an example, the weight of access time to the shopping destination tends to increase with age, while the weight of access time to the railroad station decreases. In the example of 20–39-year-olds, the access time to the train station is considered more important than the access time to the hospital, which shows the opposite trend to the weights for those over 60 years old (Table 2.3). The weights for the drivability index also differ based on gender, age, and income. Women are given more weight for drivability than men, older than younger, and lower income than higher income (Table 2.4).

The weight of the walkability index (Table 2.5) shows that not only the time required but also various factors of the walking environment are recognized as valuable by pedestrians. In addition, women place more importance on safety such as brightness and pedestrian traffic, younger generations are more sensitive to various environmental values, and shade and roofs are more important in rainy areas.
### Table 2.3: Weight for QOL Indicators by Age Group

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Unit</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>20–39</td>
</tr>
<tr>
<td>Economic opportunity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Job offer ratio</td>
<td>%</td>
<td>0.26</td>
</tr>
<tr>
<td>Commuting time</td>
<td>minutes</td>
<td>1.56</td>
</tr>
<tr>
<td>Rent</td>
<td>$100</td>
<td>1.00</td>
</tr>
<tr>
<td>Living opportunity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access time to retail</td>
<td>minutes</td>
<td>2.26</td>
</tr>
<tr>
<td>Access time to hospital</td>
<td>minutes</td>
<td>1.66</td>
</tr>
<tr>
<td>Access time to station</td>
<td>minutes</td>
<td>2.33</td>
</tr>
<tr>
<td>Safety and security</td>
<td></td>
<td></td>
</tr>
<tr>
<td>House space per person</td>
<td>square meters</td>
<td>1.08</td>
</tr>
<tr>
<td>Access time to park</td>
<td>minutes</td>
<td>2.12</td>
</tr>
<tr>
<td>Noise level</td>
<td>dB</td>
<td>1.02</td>
</tr>
<tr>
<td>Residential amenity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disaster risk</td>
<td>1 time/year</td>
<td>0.94</td>
</tr>
<tr>
<td>Traffic accident risk</td>
<td>10 times/year</td>
<td>0.90</td>
</tr>
<tr>
<td>Air quality</td>
<td>μg/m³</td>
<td>2.23</td>
</tr>
<tr>
<td>Environmental burden</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low-carbon life</td>
<td>%</td>
<td>0.55</td>
</tr>
<tr>
<td>Biodiversity</td>
<td>%</td>
<td>0.25</td>
</tr>
<tr>
<td>Waste management</td>
<td>%</td>
<td>0.75</td>
</tr>
</tbody>
</table>

**dB** = decibel, **μg/m³** = microgram per cubic meter of air, **QOL** = quality of life.

Source: Author’s calculation.

### Table 2.4: Weight for Drivability Indicators by Social Group

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Unit</th>
<th>Gender</th>
<th>Age</th>
<th>Income</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>male</td>
<td>female</td>
<td>20–39</td>
</tr>
<tr>
<td>Time</td>
<td>minutes</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Time reliability</td>
<td>minutes/10 km</td>
<td>4.6</td>
<td>7.7</td>
<td>6.6</td>
</tr>
<tr>
<td>Number of lanes</td>
<td>per 10 km</td>
<td>16.3</td>
<td>26.5</td>
<td>24.5</td>
</tr>
<tr>
<td>Signal density</td>
<td>per km</td>
<td>5.4</td>
<td>7.9</td>
<td>8.4</td>
</tr>
<tr>
<td>Fee</td>
<td>yen</td>
<td>24.4</td>
<td>29.5</td>
<td>25.3</td>
</tr>
</tbody>
</table>

**km** = kilometer.

Source: Author’s calculation.
### Table 2.5: Weight for Walkability Indicators by Social Group

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Unit</th>
<th>Gender</th>
<th>Age</th>
<th>Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel time</td>
<td>minutes</td>
<td>male</td>
<td>female</td>
<td>20–39</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Pavement width</td>
<td>meters</td>
<td>4.0</td>
<td>4.5</td>
<td>4.7</td>
</tr>
<tr>
<td>Eyes on the street</td>
<td>0 or 1</td>
<td>0.1</td>
<td>4.4</td>
<td>4.8</td>
</tr>
<tr>
<td>No. of crossings</td>
<td>no. per 100 meters</td>
<td>6.2</td>
<td>7.3</td>
<td>7.8</td>
</tr>
<tr>
<td>Brightness</td>
<td>0 or 1</td>
<td>6.5</td>
<td>11.6</td>
<td>9.8</td>
</tr>
<tr>
<td>Protection</td>
<td>0 or 1</td>
<td>5.1</td>
<td>6.4</td>
<td>6.6</td>
</tr>
<tr>
<td>Greenery</td>
<td>0 or 1</td>
<td>2.1</td>
<td>3.0</td>
<td>2.9</td>
</tr>
<tr>
<td>Rest areas</td>
<td>0 or 1</td>
<td>2.7</td>
<td>3.4</td>
<td>3.6</td>
</tr>
<tr>
<td>Diversity of space</td>
<td>10%</td>
<td>0.7</td>
<td>0.7</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Source: Author’s calculation.

### 2.3 Case Studies

#### 2.3.1 Expressway Project

**Target Project and Current QOL**

As an example of the application of the QOL accessibility method to an expressway project, the results of the Chubu–Odan Expressway case study are discussed.

The Chubu–Odan Expressway is a 132 km-long expressway project that connects Shizuoka, a regional city in Japan, with Yamanashi, and possibly further north to Nagano Prefecture. The distance between Yamanashi and Shizuoka is about 80 km, and the road is currently open except for a few sections. Shizuoka City has a population of about 700,000, and Kofu City, the main city of Yamanashi Prefecture, has a population of about 200,000, with urban development more advanced on the coast. In this case study, we will estimate the effect of the construction of Section 1 and 2, and the entire line when it is open to traffic.
The map on the right side of Figure 2.1 shows the QOL values of each area before the opening of the line. The central areas of Shizuoka City and Kofu City are in red because of their high accessibility to various services, while the mountainous areas in between are in green and blue because of their low accessibility to medical and commercial services.

Results of QOL Evaluation
Figure 2.2 shows the change in the QOL and its details when each section is constructed. While the effect of the construction of partial sections, such as Case 2 and Case 3, is around ¥3,000 million per year, the effect of Case 1 is nearly ¥13 billion per year, which is more than the sum of the two cases. It is confirmed that the effect of development increases significantly when the full line network is used rather than a partial line. In addition, Yamanashi Prefecture, which includes many of the areas along the line, has a much larger return effect than Shizuoka Prefecture. The breakdown of the effects shows that in Yamanashi Prefecture, where the line is located in a mountainous area, there is a high level of effects related to the improvement of accessibility to living facilities, especially medical facilities. There are also effects related to the improvement of accessibility to airports, entertainment facilities, and universities.
On the other hand, from the side of Shizuoka Prefecture, where urban facilities are already well developed, it is confirmed that the effect of improving access to leisure facilities is almost complete.

The distribution of the QOL change by region due to road improvement is shown in Figure 2.3. In both Case 1 and Case 3, the effect around the interchange in Yamanashi Prefecture is large, and the QOL value increases by more than ¥60,000 per person per year. In addition, it can be confirmed that the effect of road improvement spreads from the area around the interchange. In Case 3, the effect around the Tomizawa Interchange is the largest and spreads to the border of the prefecture, while in Case 1, the effect spreads over a wider area through other expressways.

In addition, the regional distribution of the increase in QOL by main service purpose in Case 3 is shown in Figure 2.4. Looking at the spread of the effect of improved convenience to the general hospital, it is confirmed that the effect of improved access is centered on the Tomizawa Interchange, which is at the edge of the development area in Case 3. This is because the access time to the general hospital, which used to take a long time before the opening of the Tomizawa Interchange, has been shortened and the convenience has increased significantly. On the other hand, when we look at the spread of the effect of access to leisure
facilities, we can confirm the spread of the effect to the entire Shimizu Ward of Shizuoka City, centering on the Shin-Shimizu junction.

The evaluation materials of the expressway companies conducted in fiscal year 2017 show that the effect of shortening the travel time, improving the convenience of expressway buses, promoting the location of factories, revitalizing tourism, and supporting emergency medical services are mentioned. However, these effects are limited to qualitative explanations, such as monitoring of related indicators and case studies, and the use of QOL indicators makes it possible to compare the spread of these effects and the relative amount of effect, which may provide an appropriate explanation of project effects.
2.3.2 Street Design Project

**Target Project**

Currently, many cities around the world are trying to reconstruct their streets from being car-centered to human-centered, and to use the roadside and streets as an integrated space where people can meet, relax, and engage in a variety of activities. Similarly, in Japan, “walkable city planning” is being promoted, especially in downtown areas, and efforts are being made to use road space not only as a space for automobiles, but also for bicycles, pedestrians, and other forms of mobility, as well as a public space that integrates not only traffic but also the roadside. The Road Bureau of the MLIT has set “park-like roads” as one of its future visions in its Road Vision 2040, and is promoting the creation of community spaces through street design. The City Planning Bureau of the MLIT has also established the “Machinaka Walkable Promotion Program” starting in 2020 and is promoting a program to support the creation of comfortable, walkable urban areas.

On the other hand, no methods have been established to evaluate the effects of these projects by focusing on the passage of pedestrians.
and bicycles and their functions in the public space. Although it is expected to have various effects such as improving the walkability of pedestrians, promoting health, increasing real estate values, and stimulating commercial activities, there are not many concrete examples of measurement. Therefore, in this section, we will first try to apply the QOL evaluation method to Hanazono-cho Street (Matsuyama City), which is one of the most advanced examples of pedestrian space development and various space utilization in Japan, focusing on “walkability”.

Hanazono-cho Street in Matsuyama City is a 250-meter-long street connecting Matsuyama City Station and Shiroyama Park in the center of Matsuyama City. It is a main street with a tramway running in the center, four lanes on the main line, and two lanes on the secondary line. In 2011, a plan was made to redistribute the road space, with the aim of changing the street from one that was mainly used by automobiles to one that is more pedestrian and bicycle friendly. The project was completed in 2017, reducing the roadway from six lanes to two lanes and widening the sidewalks from 5 meters to a maximum of 10 meters. The space created by the redistribution of road space is used as a place for various activities such as daily interaction and events.
Results of Walkability Evaluation

A total of 5,184 individual attribute weights were calculated based on the combination of attributes such as gender, age, and income. The comparison of the effect of the improvement in walkability of the walking space before and after the improvement in terms of the time value (per 10 minutes) are shown in Figure 2.6. The time value here is different from the actual time spent walking.

Sidewalk width, rest areas, and brightness, in that order, had the greatest effect, with sidewalk widening alone having an average effect of more than 2.5 minutes (per 10 minutes) compared to the effect before maintenance. There is a large difference between the maximum and minimum values for sidewalk width and brightness, confirming that a large range of effects is felt by individuals. Although the degree of protection of Hanazono-cho Street has decreased due to the removal of arcades, the total effect of each indicator is estimated to be an average of 2.4 minutes, a maximum of 4.3 minutes, and a minimum of 1.9 minutes (per 10 minutes).

Although this is an evaluation of only the differences in road structure, it suggests the possibility of quantitatively understanding the effect of the “walkability” of the redevelopment.

Table 2.6: Changes in Indicators Before and After the Project

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Hanazono-cho Street</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pavement width</td>
<td>Width of sidewalk (m)</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Eyes on the street</td>
<td>Number of pedestrians (per 100 m)</td>
<td>2,955</td>
<td>5,512</td>
</tr>
<tr>
<td>Number of crossings</td>
<td>Number of crossings ( per 100 m)</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Brightness</td>
<td>Number of street lights (per 100 m)</td>
<td>7.8</td>
<td>10.8</td>
</tr>
<tr>
<td>Protection</td>
<td>Ratio of shade</td>
<td>100%</td>
<td>68%</td>
</tr>
<tr>
<td>Greenery</td>
<td>Ratio of green</td>
<td>55%</td>
<td>55%</td>
</tr>
<tr>
<td>Rest areas</td>
<td>Number of benches (per 100 m)</td>
<td>0</td>
<td>4.8</td>
</tr>
<tr>
<td>Diversity of space</td>
<td>Ratio of commercial land use</td>
<td>70%</td>
<td>74%</td>
</tr>
</tbody>
</table>

m = meter.

Note: Data collected and measured by the authors and may differ from actual maintenance conditions.

Source: Author’s calculation.
Table 2.7 shows the results of trial calculation of benefits using the number of pedestrians and time value of money based on the change in the time required before and after the improvement. According to this calculation, Hanazono-cho Street is estimated to have a single-year benefit of ¥198 million. Since the total project cost is ¥1.25 billion, it is suggested that the investment can be recovered within 10 years even if only the effect of increased number of pedestrians and improved walkability immediately after the improvement is taken out. In addition, if the concentration of urban functions continues due to the development inducement effect, it may affect not only the walkability but also the quality of life in the region by increasing the number of residents, improving accessibility to urban functions, and increasing employment. In this case study, only the “walkability” associated with road improvement was taken up for estimation, but in the overall framework of the QOL evaluation method, it is possible to comprehensively evaluate the effects of urban development guidance and commercial revitalization from the perspective of residents’ QOL.

Figure 2.6: Changes in Walkability Before and After the Project

Decrease in generalization time (per 10 minutes)

SD = standard deviation.

Source: Author’s calculation and creation.
Table 2.7: Estimated Results of Benefits by Walkability

<table>
<thead>
<tr>
<th></th>
<th>Unit</th>
<th>Formula and Source</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>Per capita utility</td>
<td>minutes per 10 million capita</td>
<td>2.4</td>
</tr>
<tr>
<td>(2)</td>
<td>Length of street</td>
<td>m</td>
<td>250</td>
</tr>
<tr>
<td>(3)</td>
<td>Walking distance</td>
<td>m</td>
<td>(2)*2</td>
</tr>
<tr>
<td>(4)</td>
<td>Average walking speed</td>
<td>m/minutes</td>
<td>84</td>
</tr>
<tr>
<td>(5)</td>
<td>Average walking time</td>
<td>minutes</td>
<td>(3)/(4)</td>
</tr>
<tr>
<td>(6)</td>
<td>Time value</td>
<td>¥/minute</td>
<td>Calculated</td>
</tr>
<tr>
<td>(7)</td>
<td>Number of daily walkers</td>
<td>persons/12 hours</td>
<td>Survey data</td>
</tr>
<tr>
<td>(8)</td>
<td>Number of pedestrians per year</td>
<td>thousand pedestrians/year</td>
<td>(7)*365</td>
</tr>
<tr>
<td>(9)</td>
<td>Single year benefit</td>
<td>¥100 million</td>
<td>①<em>⑥</em>⑧/10^5</td>
</tr>
<tr>
<td>(10)</td>
<td>Total project cost</td>
<td>¥100 million</td>
<td>12.5</td>
</tr>
</tbody>
</table>

m = meter.

Source: Author’s calculation.

2.4 Conclusion

This chapter describes case studies of the application of the QOL accessibility method to two transportation projects: an interregional highway and a street design project. The case studies show that the multifaceted effects of road projects, such as higher-order medical care, tourism access for expressway projects, and improved pedestrian walkability for street projects can be expressed in a comprehensive framework without compromising the objectives and characteristics of each project. The effects of transportation projects, especially road projects, are expected to become more diversified in the future, and accountability for the investment effects may become more important. It is hoped that the application of this method will contribute to the improvement of such accountability.

In addition, the QOL accessibility method is an evaluation method and does not prevent the use of predictive simulations of transportation and land use that have been developed and refined. The case studies presented in this report assumed changes in travel speed as a simple method. But if the traffic volume distribution models already used in practice are combined, it will be possible to conduct evaluations that take into account the effects of reducing congestion and accidents on alternative routes. Furthermore, by combining the land use and location
models, it will be possible to evaluate the impact on indicators such as employment, commuting, and rents in the region, which were not assumed to change in this study, making it possible to understand the effects of transportation projects more comprehensively. This is also true for street design projects, and although this study uses only the sub-model of pedestrian walkability for the sake of simplicity, in reality, these projects are expected to not only improve spatial functions, but also revitalize area commerce, enhance urban functions, and guide urban development. If the accumulation of knowledge on these effects increases, it will be possible to improve the QOL of the region itself through improved access to urban functions, an increase in the number of residents, and even an increase in employment, making it possible to comprehensively evaluate the effects over the medium and long term.
3.1 Case Study of Nanjing (People’s Republic of China): Understanding Accessible Values and Differentiated Quality of Life Impacts by Age, Gender, Income Level, and Education Level

The Nanjing case study illustrates how “existing values” and “accessible values” defined in Chapter 1 look like. The lower map in Figure 3.1 shows an example of medical care, using the number of beds in hospitals as the indicator representing existing values of medical care service. The upper map representing the spatial distribution of accessible values of medical care bulges and looks like a mountain at the city center, where many hospitals are located, and it ranges along the metro line.
20 Quality of Life Assessment in Urban Development and Transport Policymaking

Figure 3.1: Spatial Distribution Accessibility Map of the City of Nanjing

Accessible Values

Distance Effect

Existing Values

Source: Authors (originally presented at the international symposium on “Mainstreaming Quality of Life in Evaluation of Transport and Spatial Planning” on 19 April 2021).

Figure 3.2: Comparison of Medical Care Opportunities between Nanjing and Singapore (by age and gender, education level, and income level)

Age and gender

Education level

Income level

MS = middle school, MA = masters.

Source: Authors (originally presented at the international symposium on “Mainstreaming Quality of Life in Evaluation of Transport and Spatial Planning” on 19 April 2021).
The importance of medical care is higher for the aged and high-income groups than the other attribute groups in Nanjing, as shown in Figure 3.2. Comparatively, there are fewer considerable differences between groups in Singapore. This may be because Singapore has developed an economy to provide medical care throughout attribute groups.

Looking at Nanjing’s case study mapping, the spatial distribution of perceived value, defined as \( QOL^k_i \) in Chapter 1, to all types of services is different from person to person depending on age and gender (Figures 3.3 and 3.4), income level (Figure 3.5), and education level (Figure 3.6).

**Figure 3.3: QOL Distribution by Age (Females), Nanjing**

QOL = quality of life.
Source: Authors.

**Figure 3.4: QOL Distribution by Age (Males), Nanjing**

QOL = quality of life.
Source: Authors.
Figure 3.5: QOL Distribution by Income Level, Nanjing

QOL = quality of life.
Source: Author.

Figure 3.6: QOL Distribution by Education Level, Nanjing

QOL = quality of life.
Source: Authors.
3.2 Case Study of Kozoji New Town on Differentiated QOL Impacts, due to Sense of Value, by LRT and Greening Policies

The case study examines whether it is better to develop transport infrastructure or plant trees to increase greenery in Kozoji New Town with a population of 45 thousand near Nagoya, the central metropolitan city with a population of 2.3 million. The new town was built about 50 years ago and is about 30 minutes from Nagoya by the Japan Rail (JR) Chuo Line (Figure 3.7).

Figure 3.7: Map and Statistics of Kozoji New Town

Case study
Kozoji new town
- 1st generation new town developed during 1960’s and 1970’s in Japan
- Acted as a dormitory suburb commuting to Nagoya

<table>
<thead>
<tr>
<th>Development Area</th>
<th>702 ha (20 km from city of Nagoya)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development Time</td>
<td>1968-1995</td>
</tr>
<tr>
<td>Aging population</td>
<td>30.12% (entire country 25.1%)</td>
</tr>
<tr>
<td>Green coverage</td>
<td>8.3%</td>
</tr>
</tbody>
</table>

Source: Authors (originally presented at the international symposium on “Mainstreaming Quality of Life in Evaluation of Transport and Spatial Planning”).
In the new town, the only public transport to the JR Kozoji Station is a bus, so we have two scenarios: one is to build an LRT line, and the other is to plant greenery with the same budget (Figure 3.8). We conducted a questionnaire survey in the Nagoya metropolitan area to estimate the weights for different categories of citizens. We also surveyed Dresden in Germany to contrast the differences in personal perception.

As shown in Figure 3.9, if you compare the people of Nagoya with those of Dresden, the people of Dresden value green space much more than those of Nagoya.

Figure 3.10 shows the results of QOL estimation. Green indicates a mesh (500 meters [m] x 500 m) with a high QOL, and red indicates a low QOL. On the far left is the current distribution of the QOL in 2017. In 2025, assuming that values remain the same as they are today and that the green space scenario is completed in 2025, gross national happiness will increase by 2%, while it will increase by 15% under the LRT scenario. However, let us say that by 2040, the people of Nagoya will become very fond of green spaces, like those of Dresden today, then the value of the LRT will decrease, while that of green space will increase. This may influence the choice between policies of green space development and LRT construction.
There is a lack of awareness on the importance of green.

The advantage of green is fully comprehended.

Considered to be an important part of daily lifestyle.

Japanese’s negative attitude toward “Greens” and “Park”

- There is a lack of awareness on the importance of green.
- The advantage of green is fully comprehended.
- Considered to be an important part of daily lifestyle.

The higher the value, the more important the factor is.

Source: Authors (originally presented at the international symposium on “Mainstreaming Quality of Life in Evaluation of Transport and Spatial Planning”).

LRT = light rail transit, QOL = quality of life.

Source: Authors (originally presented at the international symposium on “Mainstreaming Quality of Life in Evaluation of Transport and Spatial Planning”).
3.3 Case Study of India’s High-Speed Rail on Interregional QOL Impact

We also attempted to evaluate the development of India’s high-speed rail (HSR) system linking the three big cities of Mumbai (25 million population), Surat (7 million), and Ahmedabad (8 million), which is being constructed by a joint team from Japan and India. The total distance is 500 kilometers, which is about the same distance as the “Tokaido Shinkansen” linking Tokyo, Nagoya, and Osaka in Japan that opened in 1964 as the world’s first HSR. The difference is that when Japan started the Shinkansen, it was mostly used by business people. But in India today, it would not be only for business but also for a greater variety of purposes such as tourism, medical care, and others.

![Figure 3.11: Weights of QOL Factors by Residents along the Proposed Mumbai–Ahmedabad High-Speed Rail Line](image)

QOL = quality of life.

Source: Authors (originally presented at the international symposium on “Mainstreaming Quality of Life in Evaluation of Transport and Spatial Planning”).

We conducted a questionnaire survey to get the weights between the QOL factors of people living in the districts along the HSR line, differently attributed in age, gender, income level, living district, etc. Comparing the three cities of Mumbai, Surat, and Ahmedabad (Figure 3.11), “crime” is the biggest concern for all cities. Commuting
time and house rents and house prices are more important for Mumbai citizens, with less importance for Ahmedabad citizens, and even less for Surat citizens. This comes from the evidence that people in Mumbai suffer from longer commuting times, higher rents, and higher costs of housing.

The QOL calculation results were mapped in the districts along the line for the scenarios with HSR and without HSR, then subtracted for the difference. Looking at the subtracted difference in the QOL, the QOL was found to increase more near Surat and in its northern districts. This seems to be because local access railway networks to HSR stations is better developed in their hinterlands. The increased percentages of QOL were also enhanced most in the vicinity districts of the intermediate stations, as the HSR would improve their access to income opportunity, medical care, shopping, etc.

Figure 3.12: Monetary Value by QOL Factor of High-Speed Rail (₹)

The monetary value of traveling factors was also estimated from a questionnaire survey. As seen in Figure 3.12, the result is ₹441 (about $4) per hour of travel time. The time of delay, 1 hour, is worth three times more than the normal travel time, which means more damage. The value of having air conditioning is still not that great. What makes it better varies from person to person. The figure is an average of all sample
citizens in age, gender, and district. However, we can see that it differs according to high, middle, and low income. For high-income citizens, the loss of QOL due to delay is more significant than for middle- and low-income citizens.

Figure 3.13 shows the calculation of how much the benefits will be. The value of going to the hospital is in blue and cultural travel is in green. In between, there are colleges, tourism, stores, etc. For high-income citizens, the value of time, as well as culture and hospital, is high.

If the future trend of income increases as India’s economy develops, we can estimate how much the gross national happiness (GNH), which is a sum of individual citizens’ QOL, will increase in the future.

### 3.4 Case Study of Introduction of QOL-MaaS, Bangkok

This is the case study of Bangkok, in which we are proposing QOL-Mobility as a Service (MaaS), which is a combined development of the QOL approach and digital support. In Bangkok, the percentage of passenger car ownership became much more extensive than in Tokyo, even before the rise in income, as seen in Figure 3.14 (top left).
This trend has created massive traffic jams. The top right picture was taken in 1993 by Hayashi during a mission as chair for a study team from the Japan International Cooperation Agency to introduce an urban rail transit system. At that time, more than 10% of workers spent more than 8 hours for daily commuting. Although it was relaxed for some time with the construction of the urban rail network, it is starting to look the same again. There was an inflection point where the number of cars increased so rapidly that the road network could no longer catch it up (Figure 3.14, bottom right graph), and at a certain point, travel time suddenly increased (Figure 3.14, bottom left graph). Hayashi (1996) calls this inflection point “The Limit to Motorization,” analogous to the “The Limits to Growth” in the famous Club of Rome report published in 1972.

In response to road congestion, MaaS has been developed in northern Europe to help shift car users to public transport. However, in a developing megacity like Bangkok, the public transport system itself has reached full capacity (Figure 3.15), and it is very difficult to apply MaaS as it is. Therefore, we have been developing a system called “QOL–MaaS” in Bangkok (JICA/JST SATREPS project*).

---

1 JICA/JST SATREPS project “Smart Transport Strategy for Thailand 4.0” chaired by Yoshitsugu Hayashi and Thanaruk Theeramunkong.
**Table 3.1: Possible Solutions**

<table>
<thead>
<tr>
<th>Infrastructure Supply-side Solution</th>
<th>Rail transit (0 km in 1998 → 20 km in 1999 → 270 km in 2022)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand-side Solution</td>
<td>• Fixed place – time working → flexible</td>
</tr>
<tr>
<td></td>
<td>• QOL–MaaS</td>
</tr>
<tr>
<td></td>
<td>• Compatible lifestyle for new normal in post-COVID-19 era</td>
</tr>
<tr>
<td>QOL Evaluation</td>
<td>• National economy (Thailand 3.0) → individual QOL (Thailand 4.0)</td>
</tr>
<tr>
<td></td>
<td>• GDP → GNH (Bhutan)</td>
</tr>
<tr>
<td></td>
<td>• High emissions → low carbon (CO₂)</td>
</tr>
<tr>
<td></td>
<td>• Efficiency → “sufficiency” (QOL/CO₂) → Thailand 4.0 and SDGs</td>
</tr>
</tbody>
</table>

GDP = gross domestic product, GNH = gross national happiness, km = kilometer, MaaS = mobility in service, QOL = quality of life, SDGs = Sustainable Development Goals.

Source: Authors (originally presented at the international symposium on “Mainstreaming Quality of Life in Evaluation of Transport and Spatial Planning”).

Table 3.1 summarizes what is needed to solve the problem. First, there is a limit to the solutions that can be found only on the infrastructure supply side. In 2020, Bangkok has reached a 230-km-long network of urban railways since the Skytrain opened in 1999. As a comparison, Tokyo’s subway system has opened 320 km in the past 90 years. However, it is not enough just on the supply side because it is already full in Bangkok (Figure 3.15).
Second, we need to think about the demand-side management. It is not just about flexible time at work, but also about flexible places for working. We experienced this in the COVID-19 pandemic where a lot of work was done at home, in coffee shops, etc., outside the office.
The idea behind QOL-MaaS is illustrated in Figure 3.16. A man wakes up at 5:00 a.m., gets in the car at 6:00 a.m., and leaves home going directly to his office at the city center. But if you ask the AI of QOL-MaaS, it will give you the answer shown in Figure 3.17.

**Figure 3.18: QOL for an Individual vs Road Congestion and CO₂ Burden on the Planet**

QOL = quality of life.

Source: Authors (originally presented at the International Symposium on “Mainstreaming Quality of Life in Evaluation of Transport and Spatial Planning”).

People are currently using systems that guide them to the shortest route when you get into a car. When you ask your smartphone to get on a train, you will be given a transit route. It is the shortest route in terms of time. Instead, QOL–MaaS shows you how crowded it is if you travel at any given time, which is then counted as an adverse QOL, and the total QOL of the entire route is calculated. Also, for location, the QOL is calculated for all activities and travel, checking if you are happier at home than at work, or if shopping increases your QOL, etc. Then, a profile of the individual’s daily QOL is produced. Security and CO₂ will also come up and which places on the network are congested (Figure 3.18). Here, depending on the QOL factors (age, gender, income, etc.), the weights between the factors will differ, even if you live, work, and shop in the same place and travel the same route.
Figure 3.19: Time Profile of Traffic Congestion and CO₂ Emissions

Level of traffic congestion by time of the day

![Traffic congestion level graph]

Average CO₂ emissions from daily car travel (kg/person)
(From 100,000 samples simulation in BMR)

Daily CO₂ emissions (ton/100,000 agents)

BAU = business-as-usual, BMR = Bangkok Metropolitan Region.

Source: Authors (originally presented at the international symposium on “Mainstreaming Quality of Life in Evaluation of Transport and Spatial Planning”).

Figure 3.20: Effects of Flexible Location and Time for Travel and Work

Average Quality of Life (QOL)

Average CO₂ emissions (kg/person/day)

Level of sufficiency

Simulation Setting:
- 100% of flexible population
- 500 co-working space locations
- 1,000,000 agents

BAU = business-as-usual.

Source: Authors (originally presented at the international symposium on “Mainstreaming Quality of Life in Evaluation of Transport and Spatial Planning”).
Currently, all workers commute to the office, work at the office, and return home during almost the same time period of the day, resulting in two congestion peaks in the morning and the evening. It would be nice to have a co-working space in between. Suppose we could place a flexible working style and guide people to have a higher QOL by traveling in off-peak times and working wherever they want. In this case, the demand on the transport network will be leveled out and peak congestion will be reduced as shown in Figure 3.19 and Figure 3.20. The traffic congestion level difference between peak hour and off-peak hour can be reduced from 13 times to 5.5 times. This will lead to more cost-effective use of land space resources.

**Figure 3.21: Sufficiency Factor**

![Diagram showing the sufficiency factor with various scenarios: BAU, 100% flexible time, 100% flexible time + 1,000 coworking spaces.]

BAU = business-as-usual.

Source: Authors (originally presented at the international symposium on “Mainstreaming Quality of Life in Evaluation of Transport and Spatial Planning”).

CO₂ emissions will also increase by a factor of 5 instead of 28, while it will lead to a 36% increase in individual QOL and a 3% decrease in CO₂ emissions. This would be a factor of 40% improvement in QOL vs. CO₂ emissions performance (sufficiency), as shown in Figure 3.21, which is represented as the tangent in Figure 3.21. Here, if we apply flexible time to business-as-usual (BAU) (current state) and create 1,000 co-working
spaces in Bangkok, which is five times more than today, the performance (sufficiency) will increase by 1.24 times (Achariyaviriya et al. 2021).

In summary, as explained above, by guiding the permutations and combinations of activities and travel in a day that maximize the QOL, the congestion peaks in the transport network can be greatly reduced, and the happiness (QOL) of individuals can be increased. This will go a long way in designing transport for the post-COVID-19 “new normal”.

### 3.5 Conclusion

This chapter is a collection of case studies, which after introducing the QOL accessibility model, compactly demonstrates the application ways of the method to a variety of transport planning and policy making and shows the usefulness of QOL approaches. The QOL accessibility method is so powerful to contrast the differentiated benefits to differently attributed persons that it can be used for evaluation based on the SDGs’ equity norm “no one left behind”. This cannot be done by the conventional cost-benefit analysis which provides GDP increase as a mass measure of benefit for the whole society/region and therefore cannot tell anything about equity. The authors hope this method will be widely used for transport and urban planning and policy making all over the world. For understanding the relationship between an individual’s QOL and a regional economy, refer to Sugimori et al. (2022).
References


4

Applications of Individual Quality-of-Life-Based Approach to Evaluate Smart Shrinkage

Noriyasu Kachi and Kenichi Tsukahara

4.1 Introduction

“Smart shrinkage” is an urban spatial management approach that aims to provide residents with a safe, secure, and comfortable life (= higher residential quality of life [QOL]) on an ongoing basis through the appropriate management of land use in the face of a declining and aging population, declining birth rate, aging infrastructure, and increasing natural disaster risk due to climate change. In Japan, as an urban compact/urban shrinkage policy, we have examined the location optimization plan in an urban area and the small core formation in a mountainous area and a remote island. This chapter focuses on the small core formation in a mountainous area and a remote island and introduces the application of QOL evaluation.

There are concerns about the decline in the QOL due to the disappearance of living service facilities caused by population decline and increased disaster risk in recent years. In this chapter, we present the concept of small core formation (Figure 4.1). In addition to the concentration of facilities, moving residential areas from areas with high disaster risk to safe areas will improve the QOL and disaster preparedness. The future small core formation needs to know how much the combination of small core formation and residential concentration can improve the QOL and reduce administrative costs.
This study proposes a new method for calculating the QOL of people living in a city by considering the existing road network for traffic convenience and disaster safety. In calculating the benefits and costs arising from the aggregation of such living service facilities and dwellings, we can obtain spatial information on living service facilities and dwellings from the conventional census's mesh-unit or small region-unit statistics. However, they are too coarse to apply to actual policies. Therefore, we use micro geo data developed in recent years and obtain statistics for each building containing household and individual attributes. Micro geo data allows us to calculate the benefits and costs incurred by aggregating living service facilities and residences in more detail than current statistics. This information will be helpful for the actual formation of a small core. The purpose of this study is to conduct a cost-benefit analysis of the formation of small core areas in mountainous regions and isolated islands, which are the targets of small core development, by the concentration of living service facilities and residential areas to improve QOL and prevent disasters.
4.2 Analysis Framework for Concentration of Living Service Facilities and Residential Areas to Form Small Core

4.2.1 Concept of Concentration of Living Service Facilities and Residential Areas

Living Service Facilities
The concentration of living service facilities aims to form a “Small Core.” As shown in the “Guidebook for Small Core Formation,” the dispersed living service facilities will be concentrated within walking distance. The guide lists 11 fields of daily life services: administration, medical care, health care, welfare, education and childcare, shopping, tourism and exchange, transportation, communication, finance, and others. Figure 4.1 shows concrete examples of facilities such as government offices, post offices, clinics, supermarkets, gas stations, elementary schools, and roadside stations. Japan’s national land information system has been developed in recent years and provides spatial information on topography, land use, and public facilities. It provides data on prefectural and municipal offices, medical institutions, welfare facilities, cultural facilities, post offices, stations, schools, and bus stops. Table 4.1 shows the necessary living service functions and facilities for small bases,

<table>
<thead>
<tr>
<th>Living Service Function</th>
<th>Target Facility</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administration</td>
<td>City hall and branch office</td>
<td>National land numerical information</td>
</tr>
<tr>
<td>Medical care</td>
<td>Hospital, Clinic</td>
<td>Hospital yearbook, National land numerical information</td>
</tr>
<tr>
<td>Shopping</td>
<td>Supermarket, Store</td>
<td>Japan Super Meikan, Telepoint</td>
</tr>
<tr>
<td>Education</td>
<td>Elementary school</td>
<td>National land numerical information</td>
</tr>
<tr>
<td>Finance</td>
<td>Bank and agricultural cooperative</td>
<td>Telepoint</td>
</tr>
<tr>
<td>Communication</td>
<td>Post office</td>
<td>National land numerical information</td>
</tr>
<tr>
<td>Transportation</td>
<td>Gas station</td>
<td>National land numerical information</td>
</tr>
</tbody>
</table>

which were selected based on the image of small bases, the frequency of use of living service facilities in daily life, and the availability of global information system data. A mesh with at least two functions of living service facilities is considered a base to set up a small base area. We selected the fourth-regional mesh (500 square meters) and nine adjacent meshes with at least two functions set as base areas.

The Guidebook for Small Core Formation includes the formation of small cores and “hometown village living areas.” The “hometown community life zone” is where elderly people who have difficulty finding a place to live can continue to live with peace of mind by connecting the small core and surrounding villages with community buses and other means of transport. We think the elderly will use the nearby small core instead of the distant small core. For this reason, this study assumes a hometown village living area and uses the Voronoi diagram method to set up a living area that uses the nearest core area. The Voronoi diagram is a method of drawing a living area on a map. The Voronoi diagram is usually drawn based on the linear distance between points. However, in this study, we use a network Voronoi diagram that considers road distances. In this way, we first set up a base area that consolidates living service facilities and a living area that connects the base area with surrounding villages. Next, the facilities with missing functions (functions are listed in Table 4.1) concentrate in the base area. As a condition for the concentration of living service facilities, only facilities in each living area concentrate in the base area. The same facilities can be used even after the concentration of living service facilities. Therefore, some living service functions may not be available in some base areas.

**Concept of Concentration of Residential Areas**
Residential aggregation should improve the QOL of a region by relocating people from areas with low QOL to areas with high QOL. Some of the problems that residents face when moving from their residences are that they do not want to leave the land they have lived in for many years, thus, losing their local community. It is challenging to raise money for relocation. This study sets the following conditions to alleviate these problems. The distance from the source to the destination of the relocated residence should be less than 2 kilometers. Residents relocate in units of villages. The local government will subsidize the cost of relocation by reducing the cost of infrastructure maintenance, such as municipal roads, water supply, and sewage systems, and disaster recovery by relocating residents from areas with high disaster risk. This study will relocate residents to improve QOL, but some areas have high disaster risk even after relocation. To improve a community’s disaster preparedness, a disaster prevention project is implemented in areas where the relocation improves QOL, but the disaster risk is still high.
This study examined the effect of relocation on the QOL of people living in areas with high disaster risk. As a result, it is possible to consolidate residential areas, while improving the community’s quality of life and disaster preparedness.

Organizing Data to be Used
In addition to the data shown in Table 4.1, Global Information System data for disaster risk areas for landslides (landslide risk areas, landslide hazard areas, and particular hazard areas) and floods (inundation risk areas) from the National Land Information System and building point data developed by Akiyama, Sengoku, and Shibasaki (2013) are used. Building point data is a disaggregated version of aggregated data such as the census. Building point data is one type of micro geo data that include occupant information such as the household composition of occupants and building information such as the age of construction and fire resistance of the building in the point data of the building (Figure 4.2).

![Figure 4.2: Sample of “Building Point Data”](image)


The national census is the most used data source for understanding population and household numbers. The government provides the data in small regions or meshes of 1 kilometer (km) or 500 square meters (m²). Using building point data, we can get a more detailed picture of population distribution and location of dwellings than the
data aggregated by subregion or mesh. In this study, detailed distance information from buildings such as dwellings to living service facilities is necessary to evaluate the convenience of transportation to living service facilities as the QOL of the community. Information provided on dwellings located in disaster risk areas is necessary to understand disaster risks.

4.2.2 Evaluation Perspective for Concentration of Living Service Facilities and Residential Areas

This study evaluates the concentration of living service facilities and residential areas from two perspectives. The first is an evaluation from the perspective of residents. We will evaluate the time required to reach the living service facilities and the change in the QOL. The second is an evaluation from a social point of view, using a cost-benefit analysis to examine whether the benefits generated by the concentration can cover the costs of concentrating living service facilities and residential areas.

Setting Policy Scenario for Concentration of Living Service Facilities and Residential Areas

Table 4.2 and Figure 4.3 show three policy scenarios for the concentration of living service facilities and residential areas. Scenario 1 is the business-as-usual case, in which living service facilities and residential areas are not concentrated. We compare the quality of life and net benefits in Scenarios 2 and 3 concerning Scenario 1.

<table>
<thead>
<tr>
<th>No.</th>
<th>Scenario</th>
<th>Concentration of Living Service Facilities and Introduction of Bus Service</th>
<th>Concentration of Residential Areas</th>
<th>Implementation of Disaster Prevention Projects in Areas with Low Disaster Safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No-Policy Scenario</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td></td>
<td>No policies implemented</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Facility Concentration Scenario</td>
<td>○</td>
<td>×</td>
<td>○</td>
</tr>
<tr>
<td></td>
<td>Concentrate living service facilities only</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Facility and Residential Area Concentration Scenario</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td></td>
<td>Concentrate living service facilities and residential areas</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

○ = scenario includes a measure written in each column title, × = scenario does not include it.

Source: Prepared by author.
Method for Calculating Time Series of QOL

This study defines the QOL in a residential area as a resident’s satisfaction level, which is decided based on the physical environment in a residential area and individual perception. The physical environment includes accessibility to urban facilities and services, amenities such as living space and green space, and safety and security such as natural hazards in a residential area. Individual perception of the physical environment varies depending on individual attributes, such as gender and age. Individual perception, a set of weights for each physical environment in a residential area, is estimated based on a questionnaire survey on residential choice experiments. The value of QOL is calculated based on the QOL evaluation system developed by Kawamura (2011). The QOL for an individual at time $t$ $QOL_t$ is

$$QOL_t = qol_t \cdot pop_t = (w_t \cdot LPs_t) \cdot pop_t \quad (1)$$

where $qol_t$, $pop_t$, $w_t$, and $LPs_t$ are respectively quality of life per person, population, individual weights for the physical environment, and physical environment. Table 4.3 shows the components of the physical environment and their calculation method.

This study uses the willingness-to-pay amount for each housing environment index to calculate the unit of QOL by converting it into the willingness-to-pay amount per month (monetary unit). By setting the weights ($w$) representing values by residence and age group, we
incorporate differences in values related to QOL by attribute into the estimation. Table 4.4 shows the willingness-to-pay values for each residential environment index estimated by Nishino et al. (2011).

### Table 4.3: Components of Physical Environment and Their Calculation Method

<table>
<thead>
<tr>
<th>Category</th>
<th>Component</th>
<th>Method for Calculating LPs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accessibility</td>
<td>Accessibility to educational and cultural facilities</td>
<td>Travel time to the nearest elementary school (minute)</td>
</tr>
<tr>
<td></td>
<td>Accessibility to medical institution</td>
<td>Travel time to the nearest medical institution (minute)</td>
</tr>
<tr>
<td></td>
<td>Accessibility to a commercial facility</td>
<td>Travel time to the nearest commercial facility (minute)</td>
</tr>
<tr>
<td>Amenity</td>
<td>Residential space</td>
<td>Total floor space of residence per person (m²/person)</td>
</tr>
<tr>
<td></td>
<td>Landscape</td>
<td>Unity of surrounding buildings</td>
</tr>
<tr>
<td></td>
<td>Surrounding natural environment</td>
<td>Percentage of green space area in the same mesh</td>
</tr>
<tr>
<td>Safety and Security</td>
<td>Water-related disaster risk</td>
<td>Water-related disaster risk (flood, landslide)</td>
</tr>
</tbody>
</table>

LPs = life prospects, m² = square meter.

Source: Nishino et al. (2011).

### Table 4.4: Willingness to Pay in Each Residential Environment Index (yen/person/month)

<table>
<thead>
<tr>
<th>Residential Environment Index</th>
<th>Young People 20–39 years old</th>
<th>Middle-Aged People 40–59 years old</th>
<th>Elderly People Over 60 years old</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel time to the nearest elementary school (minute)</td>
<td>865</td>
<td>774</td>
<td>820</td>
</tr>
<tr>
<td>Travel time to the nearest medical institution (minute)</td>
<td>808</td>
<td>709</td>
<td>820</td>
</tr>
<tr>
<td>Travel time to the nearest commercial facility (minute)</td>
<td>886</td>
<td>855</td>
<td>1,388</td>
</tr>
<tr>
<td>Total floor space of residence per person (m²/person)</td>
<td>898</td>
<td>869</td>
<td>243</td>
</tr>
<tr>
<td>Unity of surrounding buildings</td>
<td>12,333</td>
<td>13,049</td>
<td>5,955</td>
</tr>
<tr>
<td>Percentage of green space area in the same mesh</td>
<td>14,975</td>
<td>16,583</td>
<td>7,425</td>
</tr>
<tr>
<td>Flood risk</td>
<td>20,033</td>
<td>32,440</td>
<td>16,861</td>
</tr>
</tbody>
</table>

m² = square meter.

Source: Nishino et al. (2011).
Nishino et al. (2011) calculated values from a questionnaire in the Nagoya metropolitan area. It is not appropriate to apply it directly to the hilly and mountainous areas and isolated islands targeted in this study because of differences in individual values, income, and prices. We should conduct a similar questionnaire survey in the target areas, however, we are not able to conduct such a survey in this study. Therefore, we introduced a regional modification factor (Ueda et al. 1999) to modify QOL in region $j$ based on region $i$, as shown in Equation (2), to consider the differences in income and prices among regions. We considered differences in income and prices among regions by multiplying the QOL by this regional modification factor. The regional modification factor $\phi_j$ in region $j$ is

$$\phi_j = \frac{P_j}{P_i} \cdot \frac{Y_j}{Y_i},$$

where $P$ and $Y$ are, respectively, the consumer price regional disparity index (Ministry of Internal Affairs and Communications 2010a) and average taxable income per capita (Ministry of Internal Affairs and Communications 2014, 2010b).

Method for Calculating Benefits
Table 4.5 shows the benefit and cost items of the cost-benefit analysis.

Table 4.5: Benefit and Cost Items for Aggregation of Living Service Facilities and Residential Areas

<table>
<thead>
<tr>
<th>Item</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benefit</td>
<td>Change in QOL (in monetary terms)</td>
</tr>
<tr>
<td></td>
<td>Reduction of maintenance costs for infrastructure (municipal roads,</td>
</tr>
<tr>
<td></td>
<td>water supply culverts, combined treatment septic tanks)</td>
</tr>
<tr>
<td></td>
<td>Disaster recovery costs reduced through disaster mitigation</td>
</tr>
<tr>
<td></td>
<td>Reduction in the cost of maintaining obsolete public facilities</td>
</tr>
<tr>
<td>Cost</td>
<td>Cost of housing relocation</td>
</tr>
<tr>
<td></td>
<td>Cost of relocating living service facilities</td>
</tr>
<tr>
<td></td>
<td>Cost of disaster prevention projects in areas with low disaster safety</td>
</tr>
<tr>
<td></td>
<td>Cost of introducing bus transportation</td>
</tr>
<tr>
<td>Discount Rate</td>
<td>4%</td>
</tr>
<tr>
<td>Period</td>
<td>30 years from 2010 to 2040</td>
</tr>
</tbody>
</table>

QOL = quality of life.

Source: Prepared by author.
Using Ozeki et al. (2010) as a reference, we calculate the reduction of infrastructure maintenance and renewal costs, one of the benefits. We target municipal roads, water supply, sewerage, and combined treatment septic tanks as infrastructure that will no longer be needed due to residents relocating elsewhere. Road networks that connect regions, such as national and prefectural roads, are not included in the scope of this study. Some maintenance and renewal costs can be reduced by relocating public facilities such as schools and medical institutions among the life service facilities. Table 4.6 shows the cost intensity of the infrastructure and public facilities targeted in this study.

<table>
<thead>
<tr>
<th>Item</th>
<th>Types of Cost</th>
<th>Renewal Frequency</th>
<th>Cost Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Supply</td>
<td>Pipe replacement cost</td>
<td>40 years</td>
<td>¥2,500/m/year</td>
</tr>
<tr>
<td>Sewerage</td>
<td>Construction and renewal cost</td>
<td>50 years</td>
<td>¥250/m/year</td>
</tr>
<tr>
<td></td>
<td>Maintenance and management cost</td>
<td>Every year</td>
<td>¥7,3000/tank/year</td>
</tr>
<tr>
<td>Merged Septic Tank (average of 5 to 7-person tanks)</td>
<td>Maintenance and management cost</td>
<td>Every year</td>
<td>¥7,3000/tank/year</td>
</tr>
<tr>
<td>Municipal Road</td>
<td>Renewal cost</td>
<td>15 years</td>
<td>¥313/m²/year</td>
</tr>
<tr>
<td>School</td>
<td>Renewal cost</td>
<td>60 years</td>
<td>¥8,500/m²/year</td>
</tr>
<tr>
<td></td>
<td>Major renovation cost</td>
<td>30 years</td>
<td></td>
</tr>
<tr>
<td>Medical Institution</td>
<td>Renewal cost</td>
<td>60 years</td>
<td>¥6,668/m²/year</td>
</tr>
<tr>
<td></td>
<td>Major renovation cost</td>
<td>30 years</td>
<td></td>
</tr>
</tbody>
</table>

m = meter, m² = square meter.


We calculated maintenance and renewal costs for municipal roads, waterworks, schools, and medical institutions using the cost intensity in the Comprehensive Management Plan for Public Facilities of the Ministry of Internal Affairs and Communications (Fine Collaborative Research Institute 2014). We calculated maintenance and renewal costs for sewerage systems and combined treatment septic tanks using the cost intensity used by the Ministry of the Environment (2002). We assumed that a certain amount of money is spent annually on maintenance. We need to calculate disaster recovery costs by considering the frequency...
of disasters in each region. For example, the expected damage caused by floods is calculated based on the damage probability and the number of assets, using the “Flood Control Economy Research Manual (Draft)” prepared by the Ministry of Land, Infrastructure, Transport and Tourism (2005). The method for determining the damage probability of landslides is that of Shinozaki et al. (2010). However, it is not easy to use these methods in this study because we could not obtain detailed data. Therefore, in this study, the disaster recovery cost per year is calculated from the actual disaster recovery cost of Iki City and is used as the expected disaster recovery cost in the future. We can get the expected disaster recovery cost of ¥249,783,000 per year by calculating the annual average with the disaster recovery costs from fiscal year (FY)2001 to FY2014 from the Iki City accounts. We can calculate the cost intensity (yen per household) by dividing the expected disaster recovery cost by the number of households in the inundation-predicted areas and landslide risk areas. We can calculate each mesh’s expected disaster recovery cost by multiplying the expected cost by the number of households in the flooded area or landslide risk area. As a result, relocating houses can reduce the damage and the disaster recovery cost.

Table 4.7 shows the costs of relocating dwellings and living service facilities and their calculation methods. The costs for relocating dwellings are moving costs, construction costs, demolition and clearance costs, and changes in housing costs. The relocation costs for living service facilities are construction costs and removal and disposal work costs.

<table>
<thead>
<tr>
<th>Target</th>
<th>Item</th>
<th>Method for Calculating Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing</td>
<td>Moving cost</td>
<td>Calculated from Shimizu and Sato (2011) as ¥70,000 per household</td>
</tr>
<tr>
<td></td>
<td>Construction cost</td>
<td>From the data on public housing construction, we calculated ¥11,750,000 per household, referring to the main incidental construction cost of public housing in general areas.</td>
</tr>
<tr>
<td></td>
<td>Demolition and land clearing cost</td>
<td>Calculated by multiplying the total floor area of relocated dwellings by ¥10,000/m².</td>
</tr>
<tr>
<td></td>
<td>Change in housing cost</td>
<td>The difference in land prices between the base area and other areas is calculated using the base land price and converted into annual prices.</td>
</tr>
<tr>
<td>Facility</td>
<td>Construction cost</td>
<td>From Wada and Ohno (2013), the construction cost of the office was used and calculated using ¥259,154/m².</td>
</tr>
<tr>
<td></td>
<td>Removal and disposal cost</td>
<td>From Wada and Ohno (2013), we used ¥30,988/m² for schools and ¥33,528/m² for business establishments for facilities other than schools.</td>
</tr>
</tbody>
</table>

$m^2 = \text{square meter.}$

Sources: Public housing construction data based on Ministry of Land, Infrastructure, Transport and Tourism (MLIT) standard construction costs for projects under the jurisdiction of the housing bureau in fiscal 2014; demolition and land clearing cost based on National Federation of Demolition Workers’ Associations current situation and issues at building demolition sites; base land prices based on MLIT national land numerical information, https://nlftp.mlit.go.jp/ksj/ (accessed 22 August 2022).
The cost of a disaster reduction project is assumed to be one project per mesh by calculating the cost per year of one project based on the past results of disaster reduction projects conducted in the target area. We calculated the average cost per year for one disaster reduction project from the cost of disaster reduction projects conducted from 2006 to 2011, obtained from the policy evaluation of Iki City, Nagasaki Prefecture (Iki City n.d.) and was ¥18,737,000 per project per year. We introduced a small community bus in a base area where living service facilities and not enough bus routes are concentrated. A community bus is assumed to be the bus service introduced in the base area where living service facilities are concentrated. The initial cost of introducing a bus service is estimated at ¥14,030,000, and the annual maintenance cost is estimated at ¥12,000,000. We calculated the cost of the community bus using the initial investment cost and annual operation cost for community buses in the *Handbook for Regional Public Transport Development* by MLIT (2009).

### 4.3 Case Study of Iki City, Nagasaki Prefecture

#### 4.3.1 Overview of Iki City, Nagasaki Prefecture

The formation of “small centers” targets mountainous regions and remote islands. Iki City in Nagasaki Prefecture, a remote island, was targeted in this study. Figure 4.4 shows the distribution of population and living service facilities in Iki City. The municipal merger of the
towns of Gonoura, Katsumoto, Ashibe, and Ishida created Iki City in 2004. The population has been decreasing due to the outflow of young people from the city, and it is predicted that the population will decrease from 29,377 in 2010 to 18,657 in 2040 (Iki City 2015). Figure 4.5 shows the distribution of landslide hazard areas.

4.3.2 Selection of Base Districts

Figure 4.6 shows base districts with a concentration of living service facilities.

As shown in the photographs taken during the field survey (Figure 4.7), the areas that serve as the bases for living service facilities are characterized by having a more significant number of stores, gas stations, and other living service facilities than the areas outside the base zones. In Iki City, there are 17 base areas where living service facilities are concentrated.
Figure 4.6: Selection of Base Districts and Area Division

Source: Author’s mapping using data in Table 4.1.

Figure 4.7: Photographs of Each Site

Source: Photographs taken by the author.
4.3.3 QOL Change by Implementing Policy Scenarios

The QOL is composed of accessibility, amenity, and safety and security. We calculate the QOL per capita for each category. The QOL per capita is the monetary equivalent of the average QOL gained by living in an area. The higher the amount value, the higher the QOL in that region. This study used Nishino et al. (2011) values to calculate the QOL and calculated the regional modification factor to correct the disparity between regions. The regional modification factor for Iki City was 0.715.

QOL Change in the No-Policy Scenario

The no-policy scenario evaluates its impact on residential QOL. Table 4.8 shows the results of future projections of the number of living service facilities that will disappear due to future population decline. The number of living service facilities will decrease overall, with supermarkets decreasing the most.

<table>
<thead>
<tr>
<th>Living Service Facility</th>
<th>2010</th>
<th>2040</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>Clinic</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>Supermarket</td>
<td>11</td>
<td>5</td>
</tr>
<tr>
<td>Store</td>
<td>86</td>
<td>82</td>
</tr>
<tr>
<td>Elementary School</td>
<td>17</td>
<td>16</td>
</tr>
<tr>
<td>Bank and Agricultural Cooperative</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Post Office</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>Gas Station</td>
<td>28</td>
<td>25</td>
</tr>
</tbody>
</table>

Note: 2040 is an estimate.
Source: Author’s calculations using data in Table 4.1.

Next, Figure 4.8 shows the per capita QOL in Iki City in 2010 and the change in the QOL by 2040 under the current trend based on the future projection of disappearing living service facilities.
The distribution of the QOL per capita in Iki City in 2010 shows that the QOL tends to be low in areas with few facilities and areas in the disaster risk zone. In the breakdown of the QOL, accessibility (transportation convenience) tended to be higher around the city hall and branch offices. In contrast, residential amenities tended to be higher in the suburbs than around the city hall and branch offices. Regarding the amount of change in the QOL by 2040, only accessibility (transportation convenience) will change because only the facilities will disappear. In the case of Iki City as a whole, the decrease in accessibility due to the disappearance of living service facilities is slight. However, accessibility decreases significantly in the southern region, where the facilities disappear.

**QOL Change in the Facility Concentration Scenario**

The facility concentration scenario concentrates living service facilities in the base area. Since the spatial distribution of living service facilities changes, accessibility, and QOL change. Figure 4.9 shows the QOL per capita and the amount of change in QOL after the concentration of living service facilities. Although the QOL is higher in the base area, QOL is lower where the living service facilities relocated. Expressly, QOL per person declined sharply in area 2. The cost-benefit analysis shows that the cumulative net benefits over 30 years are \( ¥6,523 \) million.
QOL Change in the Facility and Residential Area Concentration Scenario

In the facility and residential area concentration scenario, in addition to the concentration of living service facilities, residential areas are relocated from meshes with low QOL to meshes with high QOL. Figure 4.10 shows the QOL per capita and its change after the concentration of living service facilities and residential areas.

Per capita, the QOL was high in many areas, and disaster risk was positive in more than 90% of the areas. Regarding the amount of change in the QOL per capita, the concentration of living service facilities and the concentration of residential areas improved QOL in all relocated areas. Accessibility has dramatically improved.
Utilize Subsidies from the Government for Building “Small Core”

Figure 4.11 shows the change in the QOL per person compared with the no-policy scenario and the cumulative net benefits over 30 years by area resulting from the fourth scenario. The fourth scenario includes implementing the third scenario and utilizing the existing three projects: “depopulated community reorganization and restructure project” (moving assistance for residents), “community activation promotion project” (facility moving assistance), and “local public transport assurance and maintenance improvement project” (bus introduction assistance). Their assistance rate for each is 1/2. Utilizing the subsidies from the national government brings the net benefit received by the local government authority to ¥5,162 million and changes the amount to positive. For the results by area, every area except area 3 shows positive cumulative benefit over 30 years.
Comparison of Average QOL by Region for Each Scenario

Table 4.9 shows the average QOL per capita by region for each scenario.

In Iki City as a whole, the QOL per capita is better in both the facility concentration scenario and the facility and residential area concentration scenario than in the no-policy scenario. In the case of the no-policy scenario, by region, in the facility concentration scenario, the QOL improved in most of the regions due to the change in the distribution of living service facilities. However, in some regions, such as region 2, the QOL per capita decreased. In the facility and residential area concentration scenario, the QOL has improved in all regions because all residents relocate to improve the QOL.
Table 4.9: Comparison of Average QOL (yen/person/month) by Region for Each Scenario

<table>
<thead>
<tr>
<th>Area No.</th>
<th>No-Policy Scenario</th>
<th>Facility Concentration Scenario</th>
<th>Facility and Residential Area Concentration Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-5,840</td>
<td>-4,310</td>
<td>5,073</td>
</tr>
<tr>
<td>2</td>
<td>-4,183</td>
<td>-5,029</td>
<td>2,991</td>
</tr>
<tr>
<td>3</td>
<td>22,413</td>
<td>22,315</td>
<td>31,795</td>
</tr>
<tr>
<td>4</td>
<td>11,527</td>
<td>11,781</td>
<td>15,040</td>
</tr>
<tr>
<td>5</td>
<td>9,897</td>
<td>10,397</td>
<td>17,411</td>
</tr>
<tr>
<td>6</td>
<td>11,120</td>
<td>11,516</td>
<td>18,615</td>
</tr>
<tr>
<td>7</td>
<td>10,265</td>
<td>10,417</td>
<td>19,112</td>
</tr>
<tr>
<td>8</td>
<td>-2,617</td>
<td>-2,272</td>
<td>9,330</td>
</tr>
<tr>
<td>9</td>
<td>891</td>
<td>1,395</td>
<td>7,886</td>
</tr>
<tr>
<td>10</td>
<td>5,681</td>
<td>7,384</td>
<td>19,645</td>
</tr>
<tr>
<td>11</td>
<td>11,477</td>
<td>11,815</td>
<td>17,081</td>
</tr>
<tr>
<td>12</td>
<td>22,161</td>
<td>22,743</td>
<td>31,779</td>
</tr>
<tr>
<td>13</td>
<td>10,867</td>
<td>10,763</td>
<td>10,868</td>
</tr>
<tr>
<td>14</td>
<td>13,855</td>
<td>14,358</td>
<td>28,071</td>
</tr>
<tr>
<td>15</td>
<td>5,851</td>
<td>10,913</td>
<td>20,241</td>
</tr>
<tr>
<td>16</td>
<td>-2,735</td>
<td>-1,887</td>
<td>4,014</td>
</tr>
<tr>
<td>17</td>
<td>9,070</td>
<td>12,615</td>
<td>14,402</td>
</tr>
<tr>
<td>Whole</td>
<td>4,883</td>
<td>5,820</td>
<td>6,993</td>
</tr>
</tbody>
</table>

QOL = quality of life.

Source: Author’s mapping and calculations using data in Table 4.1, Equations (1) and (2), Figure 4.2, and Table 4.4.

4.4 Conclusion

This chapter presents the results of a cost-benefit analysis using micro geo data to evaluate the aggregation of living service facilities and residential areas for forming a small core from the perspective of improving the QOL and disaster preparedness in a remote island municipality. The main points from the study follow.

- Using micro geo data for each building that includes information on individual attributes and households, we can calculate the QOL in more detail from the spatial distribution of living
service facilities and dwellings than conventional statistics such as meshes and small regions.

- The QOL per capita improved more in the facility concentration scenario than in the non-policy scenario. The QOL per capita improved more in the facility and residential area concentration scenario.

- The cost-benefit analysis results showed that the cumulative net benefits over 30 years were significantly negative and not realized in the facility concentration scenario. The cumulative net benefits over 30 years were positive and feasible in the facility and residential area concentration scenario. However, suppose the actual cost of the measures, excluding the local QOL, is considered. It is difficult for local governments to raise the cost of the concentration of living service facilities and residential areas with their finances in both the facility concentration scenario and the facility and residential area concentration scenario.

- The cost-benefit analysis results of the facility concentration scenario did not change due to applying three projects to the use of government subsidies to create a small core. The three projects are “depopulated community reorganization and restructure project” (moving assistance for residents), “community activation promotion project” (facility moving assistance), and “local public transport assurance and maintenance improvement project” (bus introduction assistance). The results showed that the facility and residential area concentration scenario is financially feasible for local governments even if focusing on the actual cost of measures excluding the QOL.

- In addition to the introduction of bus services and the concentration of living service facilities, it is essential to combine the concentration of residential areas to create a small core for improving the QOL and reducing disaster risk.
References


5 Quality of Life Accessibility

Method to Evaluate the Transport Sector’s Contribution for Achieving the Sustainable Development Goals

Hiroyuki Takeshita

5.1 Sustainable Development Goals, City Development, and Transport Projects

5.1.1 What are the Sustainable Development Goals?

The Sustainable Development Goals (SDGs), adopted at the United Nations (UN) Summit in September 2015 are international goals to be achieved globally by 2030. The Millennium Development Goals (MDGs), based on the UN Millennium Declaration adopted in 2000, mainly targeted developing and emerging countries. The SDGs have expanded the MDGs to all countries, and are comprehensive economic, social, and environmental goals that include economic growth, innovation, and employment, etc. The SDGs consist of 17 goals and 169 targets associated with each goal, and the philosophy is to “leave no one behind” on the planet.

Since the adoption of the SDGs, various organizations have been attempting to track the progress of countries and cities toward the SDGs. The UN has established 244 (232 if overlaps are excluded) global indicators to evaluate the progress of the targets of each SDG. The private sector is also in the process of proposing indicators for evaluation.
5.1.2 Transport Sector and the SDGs

Among the 17 goals and 169 targets of the SDGs, there are several that are directly or indirectly related to the transport sector. The Sustainable, Low Carbon Transport Partnership summarizes the targets that are directly or indirectly related to the transport sector (Table 5.1).

Table 5.1: SDG Targets Relevant to the Transport Sector

<table>
<thead>
<tr>
<th>No.</th>
<th>Definition of Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct</td>
<td></td>
</tr>
<tr>
<td>3.6</td>
<td>By 2020, halve the number of global deaths and injuries from road traffic accidents</td>
</tr>
<tr>
<td>7.3</td>
<td>By 2030, double the global rate of improvement in energy efficiency</td>
</tr>
<tr>
<td>9.1</td>
<td>Develop quality, reliable, sustainable, and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all</td>
</tr>
<tr>
<td>11.2</td>
<td>By 2030, provide access to safe, affordable, accessible, and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities, and older persons</td>
</tr>
<tr>
<td>12.c</td>
<td>Rationalize inefficient fossil-fuel subsidies that encourage wasteful consumption by removing market distortions, in accordance with national circumstances, including by restructuring taxation and phasing out those harmful subsidies, where they exist, to reflect their environmental impacts, taking fully into account the specific needs and conditions of developing countries and minimizing the possible adverse impacts on their development in a manner that protects the poor and the affected communities</td>
</tr>
<tr>
<td>Indirect</td>
<td></td>
</tr>
<tr>
<td>2.3</td>
<td>By 2030, double the agricultural productivity and incomes of small-scale food producers, particularly women, indigenous peoples, family farmers, pastoralists, and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets, and opportunities for value addition and nonfarm employment</td>
</tr>
<tr>
<td>3.9</td>
<td>By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water, and soil pollution and contamination</td>
</tr>
<tr>
<td>6.1</td>
<td>By 2030, achieve universal and equitable access to safe and affordable drinking water for all</td>
</tr>
<tr>
<td>7.2</td>
<td>By 2030, increase substantially the share of renewable energy in the global energy mix</td>
</tr>
<tr>
<td>11.6</td>
<td>By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management</td>
</tr>
<tr>
<td>12.3</td>
<td>By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses</td>
</tr>
<tr>
<td>13.1</td>
<td>Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries</td>
</tr>
<tr>
<td>13.2</td>
<td>Integrate climate change measures into national policies, strategies, and planning</td>
</tr>
</tbody>
</table>

SDG = Sustainable Development Goal.

Source: Sustainable, Low Carbon Transport Partnership.
In addition, since the transport sector is considered to be related to the SDGs in many ways, the development of indicators specific to this sector is being carried out mainly by international organizations, including United Nations’ departments (Table 5.2).

Table 5.2: Examples of SDG Evaluation Indicator Development in the Transport Sector

<table>
<thead>
<tr>
<th>Example</th>
<th>Proposer</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>City Prosperity Initiative</td>
<td>UN–Habitat</td>
<td>A set of indicators consisting of six axes, including quality of life, developed to assess the prosperity and sustainability of the city as a whole, and organized in correspondence with the SDGs, especially SDG11, so that they can be used as guidelines for SDG assessment.</td>
</tr>
<tr>
<td>Sustainable Urban Transport Index</td>
<td>Gudmundsson and Regmi (ESCAP)</td>
<td>The report was developed to assess the achievement of the SDGs in Asian cities from the perspective of the transport sector and was published as a report in 2017.</td>
</tr>
<tr>
<td>Sustainable Inland Transport in the post-2015 Development Agenda</td>
<td>United Nations Economic Commission for Europe (UNECE)</td>
<td>UNECE’s evaluation indicators and post-2015 targets for sustainable transport, which are not based on each of the SDGs, but on four unique perspectives.</td>
</tr>
<tr>
<td>Sustainable Urban Mobility Indicators</td>
<td>World Business Council for Sustainable Development (WBCSD)</td>
<td>Indicators developed in a project launched by the WBCSD to address global transportation issues. It is used as a tool in conjunction with the policy.</td>
</tr>
</tbody>
</table>

SDG = Sustainable Development Goal.


As shown above, it is clear that the transport sector is directly and indirectly involved in achieving the SDGs. For the corresponding targets, the global indicators defined by the United Nations are designed to evaluate the contribution of the transport sector to the targets directly related to the sector, or to clearly separate the contribution of the sector. However, for indirect targets, it is difficult to evaluate the contribution of the transport sector. For example, Indicator 11.6.2, “Annual average
level of fine particulate matter in urban areas,” which corresponds to Target 11.6, is directly affected by the transport sector. Although the data are easy to obtain, it is difficult to assess the contribution of the transport sector alone from it. Indicator 13.1.1, which corresponds to Target 13.1, is “Number of fatalities, missing persons, and direct injuries per 100,000 people”; 13.1.2, “Number of countries that have adopted and implemented national disaster reduction strategies in line with the Sendai Framework for Disaster Reduction 2015–2030”; and 13.1.3 “Percentage of local governments that have adopted and implemented local-level disaster reduction strategies in line with the national disaster reduction strategy”, which are not directly related to the transport sector.

As for the direct targets, Indicator 9.1.1, which corresponds to Target 9.1, is clearly defined as “the percentage of the rural population living within 2 km [kilometers] of all seasonally available roads,” but the data used to assess it are not regularly collected. Thus, some indicators are classified as Tier II, which makes evaluation difficult in some countries.

Furthermore, a critical issue that can be pointed out is that among the indicators taken up as SDG global indicators, those related to the transport sector are indicators at the macro level, such as national and regional. In other words, even if a country as a whole achieves the target values of the indicators on average, when viewed on an individual or detailed regional basis, it leads to the fact that those who are far from the target are not visualized. This is a far cry from the principle of no one left behind. Therefore, in order to evaluate the contribution to the SDGs, it is desirable to be able to assess where and to whom the effects are.

5.1.3 Cities and the SDGs

One of the SDGs related to cities is SDG11: “Make cities and human settlements inclusive, safe, resilient and sustainable”. Unlike the other SDGs, SDG11 specifically targets the urban space. This is because cities are made up of a wide variety of systems, and an integrated approach is required to achieve this goal, taking into account not only SDG11 but also various other goals (UN n.d.). For example, air quality improvement and waste management in Target 11.6 are also linked to the achievement of SDG3 and SDG12.

Furthermore, more than half of the world’s population currently lives in urban areas, and this figure is expected to reach two-thirds by 2050. On the other hand, cities in developing and emerging countries do not have sufficient urban infrastructure: it is an urgent issue to review urban development and management without which sustainable
development will be difficult. For this reason, it can be said that urban development itself has been taken up under SDG11.

**New Urban Agenda**

Following the adoption of the SDGs, the United Nations Human Settlements Programme (UN-Habitat) adopted “The New Urban Agenda” (UN-Habitat 2016) at the Third United Nations Conference on Human Settlements in Quito, Ecuador in 2016, providing a framework for sustainable urban development and in particular accelerating SDG11. This New Urban Agenda presents three principles: “no one left behind” (social sustainability), “ensure a sustainable and inclusive urban economy” (economic sustainability), and “ensure environmental sustainability” (environmental sustainability).

Furthermore, “The New Urban Agenda Illustrated,” published in 2020 (UN-Habitat 2020), presents “spatial sustainability” as the fourth principle in addition to the above three principles. This is the concept that the spatial conditions of a city can enhance its ability to create social, economic, and environmental value and well-being. Through urban planning and development, governments need to achieve equitable access to various opportunities and promote sustainable relationships with nature and ecosystems.

However, the New Urban Agenda only presents concrete guidelines for future urban development based on the SDGs and does not specify evaluation indicators. As described in Chapter 2, the quality of life (QOL) accessibility method proposed in this book is based on the sum of perceived values, which is calculated by multiplying the convenience of access to various social, economic, and environmental opportunities by the weights of each individual for the values. In other words, it can be said that this concept is the same as the concept of “spatial sustainability” presented in the New Urban Agenda Illustrated, and through the evaluation of spatial sustainability, the contribution of SDGs to urban planning and development can be evaluated.

**Localization of SDG Indicators**

On the other hand, proposals for guidelines to address the SDGs as a whole at the city and municipal levels are also under way. For example, the Sustainable Development Solutions Network (SDSN) published *Getting Started with the SDGs in Cities* (SDSN 2016). This provided guidelines for stakeholders that laid out a process for adapting, implementing, and monitoring the SDGs at the local level in order to adapt them to ambitious but realistic local agendas through evidence-based decision-making backed by citizen support and input. In addition, the SDSN has set up indicators for each SDG in the SDG Index and Dashboards Report.
for European Cities 2019 (SDSN 2019) and 2019 US Cities Sustainable Development Report (Lynch, LoPresti, and Fox 2019) and is attempting to assess the achievement of SDGs at the city level in Europe and the United States.

In Japan, the Subcommittee for Studying Municipal SDGs, established within the Institute for Building Environment and Energy Conservation with the support of the Housing Bureau of the Ministry of Land, Infrastructure, Transport and Tourism, has presented guidelines for tackling the SDGs at the municipal level as SDGs for Our Cities and Communities – Introduction Guideline (IBEC 2018). Furthermore, after the proposal of this guideline, in response to requests from local governments for indicators to specifically evaluate their progress toward achieving the SDGs, the committee presented SDGs for Our Cities and Communities – List of Indicators for Progress Management (2018) as a draft set of indicators to measure progress. This is a set of indicators based on the SDG Global Indicators by the United Nations Statistical Commission and localized for local governments in consideration of the availability of statistical materials in Japan.

However, indicators that measure the degree of achievement of the SDGs at the city level attempt to evaluate the degree of achievement based on average figures for the entire city. Therefore, there remains the issue of not being able to visualize individuals and regions that are far away from the goals described in section 5.2.

5.2 Relationship between the QOL Accessibility Method and the SDGs

The QOL accessibility method defines the QOL as the sum of the “perceived value” in each individual and/or each zone. This perceived value is obtained by multiplying (1) the “accessible value”, which is obtained by multiplying the “existing value” in the neighborhood zone by the transport convenience between the residential zone and the zone of the “existing value”, and (2) the “weight” for values calculated from individual attributes and their social environment, etc.

Therefore, at first, the relationship between accessible value, weight for values, perceived value and the SDGs is organized, and links this to the construction of a method for evaluating the contribution of the transport sector and/or cities to the SDGs using the QOL accessibility method.
5.2.1 Accessible Value and the SDGs

Chapter 3 of this book has already mentioned that cost-benefit analysis, the conventional evaluation method for transport or city development projects, has evaluated mobility improvements, such as reduced travel time and reduced travel expenses, only from the perspective of generation.

Accessible value, on the other hand, is an indicator of the effect from the perspective of the return side, which is the extent to which people in other regions are able to enjoy the various values provided by each region through this mobility improvement or city development (Figure 5.1).

The QOL accessibility method consists of the existing value of each region as a QOL evaluation factor, which consists of five factors and 15 components. Figure 5.2 shows the QOL factors and related SDGs, including four targets that are already included in the QOL evaluation factors and several targets that are expected to be evaluated by the QOL accessibility method, albeit indirectly.

For example, the SDGs Indicator for Target 4.3 “Improving access to higher education,” which is a target related to the QOL assessment component, is “4.3.1 Percentage of youth or adults participating in formal and non-formal education or training in the past 12 months, by gender”. This indicator is not directly related to transport projects or urban development.
development, but if there are many areas and people with poor physical access to education and training opportunities, the percentage of people participating in education and training will be low. Therefore, the QOL accessibility method will be evaluated in the form of how much access to livelihood and cultural opportunities and the level of commuting to and from work or school has been improved by the transport project or city development. Other targets that can be evaluated indirectly will also be evaluated in the same way, through the improvement of accessible values through transport projects.

In addition, the QOL accessibility method evaluates the QOL not only by QOL factors, but also by region and by attribute, making it possible to visualize which regions and which attributes have or have not improved the QOL of people through the implementation of transport projects or city development.

In other words, by comparing the QOL between incomes and between genders, it will be possible to evaluate SDG1, “Eliminate...
Poverty” and Goal 5, “Achieve Gender Equality,” as well as SDG10, “Eliminate Inequality among People and Nations,” by comparing the QOL between regions, leading to the realization of the SDG principle, “No One Left Behind”.

### 5.2.2 Weight for Values of Individual, Perceived Value, and the SDGs

Accessible value is determined by the amount of existing value and the convenience of transport and is the same for all people living in the same area. However, it can be said that the sense of value for the accessible value varies depending on the attributes of the individual or social environment, etc. Figure 5.4 shows the relationship between accessible value and perceived value.

For example, the value of halving the time required to get from one district to each opportunity due to the implementation of a certain transport project depends on the attributes and social circumstances of the individual, such as poverty level, health level, education level, etc. As shown in Figure 5.3, the weight of employment opportunities for

---

**Figure 5.3: Accessible Value and Perceived Value**

<table>
<thead>
<tr>
<th>Accessible Value</th>
<th>Weight</th>
<th>Perceived Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identical value in the same place</td>
<td></td>
<td>Different for each individual</td>
</tr>
</tbody>
</table>

- **Accessible Value** for Job:
  - Time: 30 min 60 min
  - Weight for Job ($/min):
    - Low Income: 9,800
    - High Income: 27,000
- **ΔQOL ($1,000/month)**: 294

- **Weight for Medical Care ($/min):**
  - Low Income: 13,100
  - High Income: 17,500
- **ΔQOL ($1,000/month):** 399

- **Weight for Education ($/min):**
  - Low Income: 1,576
  - High Income: 5,525
- **ΔQOL ($1,000/month):** 473

QOL = quality of life.

Note: The numbers in the figure show the weights of the Nagoya metropolitan area and the QOL improvement effects based on these weights.

Source: Author.
low-income people (in this case, the weight per commuting time by income level in the Nagoya metropolitan area) is one-fifth that of high-income people. Therefore, we can see that in order to increase the achievement of SDG1, infrastructure development and attraction of employment opportunities to areas where low-income people live are required. Similarly, it can be seen that the development of infrastructure and the attraction of medical opportunities to areas where the population is aging will lead to a higher achievement of SDG3.

This also means that by introducing weights for individual values, the QOL accessibility method evaluates the SDGs related to individual situations, such as SDG1 “End Poverty,” SDG2 “Zero Hunger,” SDG3 “Health and Well-Being for All,” SDG4 “Quality Education for All,” and SDG5 “Achieve Gender Equality,” by expressing them in the form of weights for values (Figure 5.4).

![Figure 5.4: Weight for Value and SDGs](image)

QOL = quality of life, SDG = sustainable development goal.
Source: Author.

### 5.2.3 QOL Accessibility Method and SDGs

It has already been mentioned that the SDGs consist of 17 goals and 169 targets associated with each goal, but the 17 goals can be summarized as the “5Ps”. The correspondence between the 5Ps and each target is shown in Figure 5.5.
Figure 5.5 shows that the goals classified as “People” include those related to the weight of values in the QOL accessibility method, and the goals classified as “Prosperity” include those related to existing value through city development and accessible value through transport development in the QOL accessibility method. In addition, “Peace” and “Partnership” are considered to be reflected in the values of individuals through the formation of social environment.

On the other hand, even if the QOL is improved, it is a problem if the burden on society and the planet increases. Therefore, it is necessary to evaluate the QOL together with “sufficiency”, which is obtained by dividing QOL by “planetary social cost”, the sum of social cost and global environmental burden. This planetary social cost is related to the goal categorized as “Planet”.

From the above, QOL in the accessibility method and evaluation by sufficiency can be re-expressed as a function of the above, and thus can be said to be an evaluation method that encompasses all the SDGs (Figure 5.6).
5.3 Summary

This chapter summarizes the relationship between the QOL accessibility method and the SDGs and develops a method for evaluating the contribution of transport projects to the SDGs by using the QOL accessibility method. The method can be used to evaluate the contribution to the SDGs through improved access to opportunities and facilities. Furthermore, the QOL accessibility method can be used to evaluate the contribution to the improvement of poverty (SDG1), gender (SDG5), and equity among regions (SDG10) because it can be evaluated by attribute and region.
References


6

Quality of Life Evaluation of the Recovery Process after the 2011 Great East Japan Earthquake and Tsunami

Tsuyoshi Takano, Hiroyoshi Morita, Hirokazu Kato, and Yoshitsugu Hayashi

6.1 Introduction

The Great East Japan Earthquake that occurred on 11 March 2011 is the most powerful earthquake on record in Japan. Many people were victims of a tsunami of over 10 meters, which was triggered by this earthquake and crashed into the northeast coast. Additionally, much infrastructure, such as roads, power supply, power plants, and disaster-prevention facilities were destroyed by the tsunami. This damaged infrastructure inhibited disaster evacuation and rescue activities and many disaster survivors had to take shelter in uncomfortable surroundings for long periods with a food supply shortage.

In examining proactive measures against future disasters, it is necessary to discuss measures not only to decrease the numbers of people killed or injured but also to maintain the living standards of the people displaced. Therefore, measures to avoid isolation through transport network redundancy and adaptation measures such as preparing evacuation shelters are required.

Following a disaster, survivors’ needs and the need for infrastructure vary from hour to hour. The effects of damage control measures taken before and after a disaster should be evaluated from the immediate aftermath through to restoration in each area. Also, it is necessary to define priorities for maintaining survivors’ living standards.

This study aims to establish a system to evaluate the post-disaster living environment for survivors in each small district at a high spatial
resolution (500 meters [m] x 500 m mesh) as “quality of life (QOL)” by a time series. This system can define priorities for damage control measures both before and after the disaster to maintain the QOL for survivors.

### 6.2 Damage in the Great East Japan Earthquake

The Great East Japan Earthquake struck the Tohoku district. The damage extended over a broad area. Especially in Iwate and Miyagi prefectures, the tsunami and earthquake wreaked enormous damage. This study covers these areas.

Populations in 2005 of the two prefectures were about 2.35 and 1.33 million, respectively (Table 6.1). The population is concentrated in the Kitakami Basin, the inland area of Iwate Prefecture, and Sendai City, the biggest city of Miyagi Prefecture (Figure 6.1). Both prefectures have suffered from tsunamis on the Pacific side since olden days: Meiji Sanriku Earthquake (1896), Showa Sanriku Earthquake (1933), Chile Earthquake (1960), etc. People in these areas have taken countermeasures each time, such as moving upland and preparing big coastal levees. But these areas suffered a great deal of damage again in the Great East Japan Earthquake. Damage from both the earthquake and the tsunami was serious.

Table 6.1 shows “direct damage” from the Great East Japan Earthquake, such as human suffering and physical damage and recovery costs of infrastructure facilities, was enormous. The number of dead or missing was over 22,000 people across the country, and the total damage to buildings and infrastructure was close to ¥17 trillion.

<table>
<thead>
<tr>
<th></th>
<th>Iwate</th>
<th>Miyagi</th>
<th>Entire Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population (2010)</td>
<td>1,330,147</td>
<td>2,348,165</td>
<td></td>
</tr>
<tr>
<td>Area (km²)</td>
<td>15,278.89</td>
<td>7,285.76</td>
<td></td>
</tr>
<tr>
<td>Dead or missing</td>
<td>6,257</td>
<td>11,790</td>
<td>22,152</td>
</tr>
<tr>
<td>Total damage (¥ billion)</td>
<td>About 16,916</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*km² = square kilometer.*

Sources: Fire and Disaster Management Agency (2017), Board of Audit of Japan (2015).
On the other hand, “indirect damage”, such as the impact on the economy due to dysfunction of infrastructure and facilities and worsening of the living conditions of survivors, became a huge problem. A number of problems occurred, such as disruptions in the supply chain for economic activities. For the living environment of survivors, there was an increase in deaths associated with cold, hunger, and reduced medical services, health and environmental degradation, and a lack of privacy associated with long-term shelter life.

Table 6.2 shows the needs of survivors in a time series, with information drawn from newspaper articles after the Great East Japan Earthquake and surveys of survivors from past disasters (e.g., Tsunapro 2011; Joh 1997). According to the information, the needs of survivors are changing as time goes by. Immediately after a disaster, needs for life maintenance are greatest, but as time passes, hygienic needs increase, and finally, return to the prior level of social life takes priority. In this way, the needs of survivors are changing every moment from immediately after the disaster occurs. For this reason, preparatory countermeasures for supporting these needs to enable survivors to bounce back to the prior level of social life at an early date and follow up systems immediately after the disaster are desired.
6.3 Methodology for Quantifying Quality of Life in a Disaster

6.3.1 Structure of QOL for Survivors

The QOL accessibility method, as described in detail by Hayashi (2019), is a model that integrates and evaluates the value of various aspects of the living environment. However, when a disaster strikes, it becomes difficult to receive the services that we take for granted during normal times. In addition, the needs of survivors change drastically during emergencies.

In this section, we explain our assumptions for estimating QOL for survivors, which changes in stages after a disaster. We apply an idea of cycles for satisfying daily needs (Nojima, Kameda, and Hayashi 1993). In the research, the basic structure of the needs for normal living is classified as shown in Table 6.3.

The shorter the cycle, the more necessary is the factor. In addition, as shown in Table 6.2, shorter cycle items would be revealed in a short period. So, the structure of the QOL for survivors after a disaster has a

---

**Table 6.2: Time Series Needs of Survivors**

<table>
<thead>
<tr>
<th>Time</th>
<th>Needs of Survivors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immediately after the disaster</td>
<td>Life maintenance:</td>
</tr>
<tr>
<td></td>
<td>Accessibility of emergency shelter or healthcare center, food, drinkable water, provision against the cold in shelter</td>
</tr>
<tr>
<td>Evacuation phase (short term)</td>
<td>Hygienic environment:</td>
</tr>
<tr>
<td></td>
<td>Opening of shelter and supply of food and drink, etc.</td>
</tr>
<tr>
<td></td>
<td>Ensuring sanitary conditions of toilets, development of bathing facilities, change of clothes</td>
</tr>
<tr>
<td></td>
<td>Fear of secondary disasters caused by aftershocks, information such as on safety of family members</td>
</tr>
<tr>
<td>Evacuation phase (long term)</td>
<td>Good hygiene environment:</td>
</tr>
<tr>
<td></td>
<td>Ensuring privacy, improvement of sanitary conditions, suppression of infection</td>
</tr>
<tr>
<td>Recovery phase</td>
<td>To have a social life:</td>
</tr>
<tr>
<td></td>
<td>Moving into temporary housing, securing means of transport to resume work or school</td>
</tr>
</tbody>
</table>

Source: Authors.
Table 6.3: Basic Structure of Needs for Normal Living

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirements for maintaining life</td>
<td>Hour–day cycle</td>
</tr>
<tr>
<td>(food, sleep, etc.)</td>
<td></td>
</tr>
<tr>
<td>Requirements for maintaining health or public health</td>
<td>Day–week cycle</td>
</tr>
<tr>
<td>(bathing, cleaning, etc.)</td>
<td></td>
</tr>
<tr>
<td>Requirements for social life</td>
<td>Day–week cycle</td>
</tr>
<tr>
<td>(work, education, etc.)</td>
<td></td>
</tr>
<tr>
<td>Requirements for cultural life</td>
<td>Week–month cycle</td>
</tr>
<tr>
<td>(hobby, rest for mental condition, etc.)</td>
<td></td>
</tr>
</tbody>
</table>

Source: Authors.

A hierarchical structure that corresponds to the living environment and the elapsed time, which is based on the psychological state of survivors. More specifically, we assume that the QOL structure in a disaster consists of four stages: Stage 1: maintenance of life, Stage 2: maintenance of health or public health, Stage 3: maintenance of social life, and Stage 4: maintenance of cultural life (Figure 6.2).

Figure 6.2: Structure of QOL for Survivors after a Disaster

QOL = quality of life.
Source: Authors.
6.3.2 Basic Structure of Disaster QOL Evaluation System

Figure 6.3 shows the basic structure of the disaster QOL evaluation system. In the system, the QOL is derived from the transition of survivors’ needs (QOL elements) and infrastructure recovery condition after disaster.

The concrete process is shown in Figure 6.3. First, (a) infrastructure and building availability is evaluated by real data or simulation and recovery data after a disaster. Based on the situation, (b) satisfaction of each QOL element is judged. Finally, (c) QOL is divided into four stages based on whether or not it has reached each QOL judging level, and QOL stages are judged in each individual district. Then, the QOL stages are output for each small district.

6.3.3 Judgment of Satisfaction Condition

Satisfaction conditions of the QOL elements in each district are based on infrastructure requirements that are necessary for supplying corresponding services or goods. Two types of QOL elements provide satisfaction conditions: residential area and transport. Each satisfaction condition is described below and shown in Figure 6.4.

- QOL elements in the residential area are judged as satisfied if all infrastructure supporting QOL elements are available.
QOL elements satisfied by transport: identifying the reachable area from the residential area considering road and public transport connectivity. If the destination is located in the reachable area, the element is judged as satisfied. For example, to ensure “opportunity for bathing” (satisfaction of need for bathing) at least one of the conditions below should be functioning normally:
- A combination of “bathing facilities” and “transport”
- A combination of “lifeline (gas and water)” and “housing”

This relationship is formulated as shown in Equation (1).

\[ y = (x_1 \land x_2) \lor (x_3 \land x_4) \]  

(1)

where, \( y \): opportunity of bathing, \( x_1 \): housing, \( x_2 \): lifelines (gas and water), \( x_3 \): transport, \( x_4 \): bathing facility. If present, the variable is set to 1, otherwise it is set to 0.

As for the recovery of facilities, roads, and transport systems, the area where QOL elements are satisfied would be expanding.

Finally, the judgment conditions for the QOL elements that can be satisfied with help from other regions are as follows. We suppose that a support base is located on the road within the boundary of the target

**Figure 6.4: Satisfaction Conditions of QOL Elements**

QOL = quality of life.

Source: Authors.
region (Iwate and Miyagi), and the reachable area from the support base is judged as the supportable area.

### 6.3.4 Extraction of Index

The index is extracted based on surveys of survivors from past disasters (e.g., Tsunapro 2011; Joh 1997). In Table 6.4, the QOL elements and their satisfaction conditions (combination of required infrastructure) are shown.

**Table 6.4: QOL Elements and Their Satisfaction Conditions**

<table>
<thead>
<tr>
<th>QOL Element (opportunity or environment)</th>
<th>Satisfied in Residential Area</th>
<th>Satisfied by Transportation</th>
<th>Satisfied with Help from Other Regions</th>
<th>Judgment Method (required infrastructure)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency Care</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>(Medical Facilities ∧ Transportation) v Help from other regions</td>
</tr>
<tr>
<td>Medicine</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Stock v (Drugstore ∧ Transportation) v Help from other regions</td>
</tr>
<tr>
<td>Drinking Water</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>(Housing ∧ Running water) v (Transportation ∧ Transportation) v Help from other regions</td>
</tr>
<tr>
<td>Food (quantity)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>(Shopping facility ∧ Transportation) v Help from other regions</td>
</tr>
<tr>
<td>Sleeping Place</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Housing v Shelter</td>
</tr>
<tr>
<td>Cold Protection</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>(Housing v Shelter) ∧ (Heating Energy v Blanket)</td>
</tr>
<tr>
<td>Medical Care</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>(Medical Facilities ∧ Transportation) v Extraordinary clinic</td>
</tr>
<tr>
<td>Food (quality)</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>(Shopping facility ∧ Transportation) ∧ Lifeline</td>
</tr>
<tr>
<td>Bathing</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>(Housing ∧ Lifeline) v (Bathing facilities v Temporary bathing facilities) ∧ (Transportation)</td>
</tr>
<tr>
<td>Toilet</td>
<td>✓</td>
<td></td>
<td></td>
<td>Toilet ∧ Water and sewerage</td>
</tr>
<tr>
<td>Clean Clothing</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>(Housing ∧ Running Water) v (Shopping facility ∧ Transportation) v Help from other regions</td>
</tr>
<tr>
<td>Fresh Air</td>
<td>✓</td>
<td></td>
<td></td>
<td>Equipment for ventilation</td>
</tr>
<tr>
<td>Thermal Environment</td>
<td>✓</td>
<td></td>
<td></td>
<td>Refrigeration and heating equipment ∧ Lifeline</td>
</tr>
<tr>
<td>Privacy Protection</td>
<td>✓</td>
<td></td>
<td></td>
<td>Housing v Temporary housing v (Shelter ∧ Partitions)</td>
</tr>
</tbody>
</table>

*continued on next page*
6.3.5  Data and Judgments of Satisfaction Condition for Evaluation

The data used for analysis are shown in Table 6.4. For evaluation, we process and organize the data in accordance with the framework of the evaluation of the previous section. First, we use recovery condition data after a disaster on a priority basis. If we cannot obtain the data, we assume that the tsunami inundation area had suffered outage and outside this area had no damage. However, we corrected the damage level for facilities in a regional flood based on information such as news, since the data that we use include areas with low-level damage as well as areas with enormous damage. Also, for information such as the restoration of lifeline conditions, the data which are reported in units of municipalities were allocated to the district (offshore tsunami) in accordance with the rate of recovery. Similarly, the number of deaths was assigned to the mesh belonging to the tsunami inundation area damage information for each municipality.

The quantity of food, water, and sleeping places is not considered. Thus, it is judged as satisfied if all of the infrastructure that supports the QOL elements is available, even if not available for the whole population. In addition, the reachable area in the event of the disaster was set by the following procedure:

### Table 6.4  continued

<table>
<thead>
<tr>
<th>QOL Element (opportunity or environment)</th>
<th>Satisfied in Residential Area</th>
<th>Satisfied by Transportation</th>
<th>Satisfied with Help from Other Regions</th>
<th>Judgment Method (required infrastructure)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>✓</td>
<td></td>
<td></td>
<td>School ∧ Transportation</td>
</tr>
<tr>
<td>Employment</td>
<td>✓</td>
<td></td>
<td></td>
<td>Workplace ∧ Transportation</td>
</tr>
<tr>
<td>Shopping</td>
<td>✓</td>
<td></td>
<td></td>
<td>Shopping facility ∧ Transportation</td>
</tr>
<tr>
<td>Housing</td>
<td>✓</td>
<td></td>
<td></td>
<td>(House ∧ Lifeline) ∨ Temporary housing</td>
</tr>
<tr>
<td>QOL Indicator for Normal Times</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>QOL Value Accessibility Model</td>
</tr>
<tr>
<td>(Hayashi, 2019)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

QOL = quality of life.

Notes: / : necessary to consider (not considered in this study)
//: not necessary to evaluate in this study
1∧: logical conjunction or meet in a lattice, e.g., the statement A ∧ B is true if A and B are both true; else it is false
2∨: logical disjunction or join in a lattice, e.g., the statement A ∨ B is true if A or B (or both) are true; if both are false, the statement is false
3Transportation includes road network, car, bus, train, and gasoline.

Source: Authors.
(i) Exclude the mesh which had a population of fewer than 10 people before the disaster occurs. Then calculate the shortest time from other districts to each destination facility by network calculation using the data in normal times (using motor vehicles).

(ii) Maximum reachable time in all meshes is assumed to be the limit condition.

(iii) In a disaster, if the shortest time to the destination considering road conditions and facility availability is less than the limit value set by (ii), the district is judged as reachable.

**Table 6.5: Data Showing the Disaster Situation**

<table>
<thead>
<tr>
<th>Data</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road network (before disaster)</td>
<td>ArcGIS Data Collection 2011 (ESRI Japan)</td>
</tr>
<tr>
<td>Road network recovery</td>
<td>Driving data (2011, Honda &amp; Pioneer or Toyota car navigation system)</td>
</tr>
<tr>
<td>Tsunami flood area</td>
<td>ESRI Japan</td>
</tr>
<tr>
<td>Medical facilities (before disaster)</td>
<td>National Land Numerical Information Download Service (Ministry of Land, Infrastructure, Transport and Tourism)</td>
</tr>
<tr>
<td>Medical facilities recovery</td>
<td>Portal Map for Rescuing Disaster Areas (based on Google maps), Kahoku online network</td>
</tr>
<tr>
<td>Shopping facilities</td>
<td>ArcGIS Data Collection 2011 (ESRI Japan)</td>
</tr>
<tr>
<td>Shopping facilities recovery</td>
<td>Portal Map for Rescuing Disaster Areas (based on Google maps), Kahoku online network</td>
</tr>
<tr>
<td>Temporary housing</td>
<td>Civil Construction Division, Miyagi Prefecture, Construction location of emergency temporary housing in Iwate Prefecture (based on Google Maps)</td>
</tr>
<tr>
<td>Water service restoration</td>
<td>Ministry of Health, Labor and Welfare, Japan</td>
</tr>
<tr>
<td>Gas service restoration</td>
<td>Japan Gas Association HP, Ministry of Economy, Trade and Industry, Agency of Natural Resources and Energy, Natural Resources and Fuel Department, Oil Distribution Division</td>
</tr>
<tr>
<td>Bathing institution (before disaster)</td>
<td>ArcGIS Data Collection 2011 (ESRI Japan)</td>
</tr>
<tr>
<td>Bathing institution</td>
<td>Portal Map for Rescuing Disaster Areas (based on Google maps)</td>
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<tr>
<td>Temporary bathing institution</td>
<td>Portal Map for Rescuing Disaster Areas (based on Google maps)</td>
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<tr>
<td>Gas station (before disaster)</td>
<td>ArcGIS Data Collection 2011 (ESRI Japan)</td>
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<td>Gas station opening situation</td>
<td>Portal Map for Rescuing Disaster Areas (based on Google maps)</td>
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<tr>
<td>School (before disaster)</td>
<td>National Land Numerical Information Download Service (Ministry of Land, Infrastructure, Transport and Tourism)</td>
</tr>
</tbody>
</table>

ESRI = Economic and Social Research Institute.

Source: Authors.
6.4 Results of Analysis

We analyzed the following three cases: (i) situation with support (help from other regions) (close to the Great East Japan Earthquake situation); (ii) situation without support (help from other regions); and (iii) situation with all the Sanriku coast freeway opened to traffic. The result of (i) is shown first and is compared with the result of (ii). The result of (i) clears the self-supporting area even if there is no support. It can clarify the knowledge that will become useful in the case of investigation of priority attachment of disaster response.

Then, comparing (iii) and (i), we analyzed the effect of constructing road infrastructure as an advance measure to decrease the QOL attrition.

6.4.1 Situation with Support (Close to the Great East Japan Earthquake situation)

Transition of the QOL Stages

Figure 6.5 shows the transition of the QOL stages from 14 March to 11 May 2011 in each district after The Great East Japan Earthquake (11 March 2011).

The trend of the total recovery of the QOL in the inland areas is earlier than in the coastal areas due to serious infrastructure destruction by the tsunami in the coastal areas.

Figure 6.5: Transition of QOL Stages

QOL = quality of life.

Source: Authors.
First, we focus on the coastal areas. On 14 March, the third day after the disaster, in some areas the QOL recovered from Stage 1 to Stage 2 by reviving the function of road infrastructure connecting to the inland areas. This effect can be attributed to “Kushinoha Sakusen (Teeth of Comb Operation)”. This strategy, in cooperating with the Self-Defense Forces, aimed to quickly recover road functions and make various routes to the coastal area where serious damage was assumed owing to the tsunami. However, many districts were still in Stage 1 in the coastal area of northern Miyagi Prefecture on 18 March 2011. For example, Onagawa town located on the Oshika Peninsula in Miyagi Prefecture was still at Stage 1 until 31 March 2011. The QOL stage is low in the long term. Also, on 11 May, 2 months after the disaster, in Minamisanriku town, Miyagi Prefecture, almost the entire town recovered to Stage 2. This town began to discuss moving a group shelter from near the coast to an inland area from 26 March, and between April and the beginning of May, the survivors had a group shelter inland. What this example makes clear is that to avoid such confusion, they should examine a group shelter beforehand, and it is necessary to plan how to form agreement among inhabitants in the districts where the QOL stage is lower after suffering over a long term.

On 11 May 2011, many districts had recovered to Stage 2. Here, compared with the tsunami flood area (Figure 6.1), we realize that the area of Stage 2 on 11 April is larger than that of the tsunami flood. It means that even if a house was not directly damaged by the tsunami flood, the QOL environment for survivors falls greatly in the long term, because important institutions including supermarkets and hospitals were damaged and the main road on low-lying coastal land had been closed by the tsunami. In addition, the damage to lifelines such as water and sewage facilities makes the quality of the living environment decline over a huge area extending to the whole supply district.

Second, we focus on the inland area. In Kurihara City, Iwate Prefecture, which is an area that recorded seismic intensity 7, the recovery speed of QOL was slow because the recovery rate of water services covering the whole city was low. It worsened the hygiene in restrooms and prevented survivors from bathing.

Comparing Morioka City, a metropolitan area in Iwate Prefecture and Sendai City which is also a metropolitan area, in Miyagi Prefecture, recovery of QOL was quicker in Morioka City than in Sendai City due to Sendai’s the delay in recovering the entire piped network service of city gas. On the other hand, many houses in Morioka City use liquefied petroleum gas. The merit of using liquefied petroleum gas is that it is easy to recover the gas service by changing gas tanks individually. After the disaster, this supported quick recovery. However, in this chapter,
we have not been able to consider the employment opportunities after the disaster. For this reason, very few areas reached Stage 3 (stage of maintenance of social life).

**Population Transition in Each District at Different QOL Stages**

Figure 6.6 shows the transition of the population belonging to each QOL stage. The method of counting the population in this case assumes that survivors keep living in the same district where they lived before disaster.

Not only the survivors who are in shelters but also those in their own houses are forced to live inconvenient lives due to the damage to the lifelines or the cutting off of the transport network. But their needs for government and voluntary support are different according to their QOL stage. Therefore, counting the numbers of survivors based on the QOL stage will help to decrease the mismatching of support between the survivors and the government or volunteer support. From Figure 6.6, until 31 March 2011, the QOL stage for the survivors had improved. But on 11 April, the trend was changed due to a big aftershock on 7 April.

When comparing the inland areas with the coastal areas, the survivors in areas in a low QOL stage decreased sharply, because the convenience of movement improved by restoring traffic on the roads that had been interrupted. Furthermore, an early restoration of facilities such as supermarkets around their houses or shelters also improved.

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**Figure 6.6: Transition in Numbers of Survivors Belonging to Each QOL Stage**

*(left) whole region, (center) inland area, (right) coastal area*

QOL = quality of life.

Source: Authors.
their QOL stage. Even in the coastal areas, the number of survivors in Stage 1 decreased over time. However, the improvement to a higher QOL stage did not progress, and remained in the same stage after 11 May. The reason is that restoration of the infrastructure damaged by the tsunami took a long time.

6.4.2 Situation Without Support

In Section 6.4.1, the QOL is calculated following the assumptions that if the damaged area can connect with other regions by road, the survivors can satisfy their need for goods and that means their QOL would then rise. However, goods to support the survivors cannot necessarily be delivered just because the area was connected with other areas when the damaged area is huge. In fact, during this disaster, the shortage of gasoline constrained transport for delivering goods into the damaged area. In this study, this situation is called “without support situation”. Here, a calculation of the QOL is given considering no support. A comparison of the transition of the QOL stages (1 week after the disaster) between the situations with support and without support is displayed in Figure 6.7.

Figure 6.7: Transition of QOL Stages (left) with support, (right) without support

QOL = quality of life.

Source: Authors.
On 14 March (the third day after the disaster), it was obvious that the coastal areas in Stage 1 with support expanded more widely than those without support. This result means that the Kushinoha Sakusen mentioned in Section 6.4.1 could raise the QOL stage from the bottom up compared with the case of no support from other regions.

On 18 March (7 days after the disaster), areas that had recovered up to Stage 2 without support were extending, but there were many areas still in Stage 1 in the coastal areas. However, some districts along the coast had recovered to the same level as those receiving support. From the above, it is possible to identify self-supporting areas where the roads are well-connected so that they can receive support from others or help themselves.

Figure 6.8 shows the transition of the number of survivors belonging to each QOL stage under the situations of with support and without. Without support, the population belonging to Stage 1 on 14 March is predicted to increase by about 10% (around 350,000). This reveals the number of survivors when material and medical support cannot be actually delivered from outside, even though road access to the other regions is complete. Especially, when limited resources cannot be transported to the disaster areas, it could support making it a high priority.

**Figure 6.8: Transition of Numbers of Survivors Belonging to Each QOL Stage**

(Left) with support, and (right) without support

QOL = quality of life.

Source: Authors.
6.4.3 Situation Where the Sanriku Coast Expressway Was Opened to Traffic

The Sanriku Coast Expressway is under construction on high ground considering the effects of the damage from the tsunami. It is expected to act as an emergency road for the evacuation of residents. This study calculates the QOL stage under the assumptions that the whole freeway that has been planned is opened and is undamaged. Figure 6.9 shows the location of the Sanriku Coast Expressway.

Figure 6.9: Location of the Sanriku Coast Expressway

![Location of the Sanriku Coast Expressway](image)

Source: Authors, using Driving Data (2011) and Ministry of Land, Infrastructure, and Tourism.

Figure 6.10 shows a comparison of transition of the QOL stages (1 week after the disaster) in each area between the real situations (with the Sanriku Coast Expressway partly available) and the case when the whole road is totally available. In the real situation, the QOL stage of the Sanriku coastal area reached only Stage 1 on 14 March. On the other hand, in the case with the whole Sanriku road available, the QOL stage recovered up to Stage 2 on the same day. From Figure 6.11, in the same case, it is clear that the population at Stage 1 decreased by about 8.5% (around 120,000 people) by 14 March. This shows that the Sanriku Coast Expressway functioned as an emergency road after the
Figure 6.10: Transition of QOL Stages
(left) partly available, (right) totally available

The Sanriku Coast Expressway is partly available (Actual)
14 March 18 March

The Sanriku Coast Expressway is totally available
14 March 18 March

QOL = quality of life.
Source: Authors.

Figure 6.11: Transition in Numbers of Survivors Belonging to Each QOL Stage in the Coastal Area
(left) partly available, (right) totally available

About 1.43 million people
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
14 March 18 March 31 March 11 April 11 May

About 1.43 million people
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
14 March 18 March 31 March 11 April 11 May

QOL = quality of life.
Source: Authors.
disaster. But the difference between the partly functioning case and the totally functioning case was small until 1 week after the disaster. This is because houses and facilities were destroyed by the tsunami so that it was difficult to have a self-supporting life in the districts, even if the whole road was open.

From the above, although reinforcement of the road network is useful to maintain and improve the QOL after a disaster, it is necessary to implement countermeasures such as raising the safety of facilities in the target areas and avoiding functional deterioration to suppress a decline in the QOL in the medium and long term.

6.5 Conclusion

This study aims to establish a system to evaluate the post-disaster living environment for survivors in each small district at a high spatial resolution (500 m x 500 m mesh) with regard to the QOL of survivors. We apply this system to the East Japan coastal areas that suffered from severe damage from the Great East Japan Earthquake on 11 March 2011. The findings are:

- Recovery of the QOL in the inland areas was faster than in the coastal areas where infrastructure was completely destroyed by the tsunami.
- In the coastal areas, recovery of the QOL was fast in the districts that had a resilient road network giving access to inland areas.
- In the districts where the Sanriku Coast Expressway routed in higher altitudes from the sea level, the QOL recovered more quickly among the districts of the coastal areas. It was shown that redundancy of a road network contributed to the maintenance and improvement of the QOL immediately after the disaster.
- Although the road network along the coast was repaired, recovery of the QOL was not observed for a long time in many coastal areas. It became clear that the damage to infrastructure including roads, railways, lifelines, and other facilities in the coastal areas had a long-term influence on the decline of the QOL.
- Improvement of infrastructure resilient against disaster is needed.
References


PART II
Quality of Life Method in Existing Project Evaluation Practices in the United Kingdom, Germany, France, and Japan
Part II

Key Messages

Veronica Ern Hui Wee

Part II discusses the existing methods and philosophies in the United Kingdom (UK), Germany, France, and Japan. It provides a background of the traditional evaluation methods, such as cost-benefit analysis (CBA) which was first introduced for systematic evaluation of motorway projects in the UK in the 1960s, considering travel time and cost and accident damage cost. There has since been more awareness of additional factors that influence the benefit and cost of projects, including environmental damage, comfort of travel, workspace environment, and accessibility to various socioeconomic services. The chapters in Part II demonstrate how the quality of life (QOL) accessibility method builds on and integrates with existing methods to provide a holistic evaluation approach that incorporates these wider impacts.

Chapter 7 discusses the UK’s well-developed formal evaluation procedure for transport investments, which uses a CBA while considering a wider range of impacts, without being monetized. The UK pioneered the formal inclusion of wider economic impacts in the Transport Analysis Guidance that has been in place for over 20 years. Through a discussion of the UK’s evaluation procedure and the recent high-speed rail network (HS2) project, the chapter explores the issues in defining transformational projects in the current appraisal guidance and the ways in which the guidance may need to be amended if such projects are to be treated consistently and robustly.

Chapter 8 presents the German method of assessing the federal transport infrastructure plan, which includes several aspects of sustainability and nonmonetary components. However, the components have not been integrated comprehensively and systematically, as noted by scientists and environmental groups. The chapter discusses recent scientific ideas from Germany’s Federal Environmental Agency and environmental stakeholders that have been taken up through initiatives that have recently started for preparing a legal reform of transportation planning in Germany.
Chapter 9 discusses the use of CBA as a key reference in France and possible alternatives to evaluate and design urban transport that is safe, affordable, resilient, and aligned with the Sustainable Development Goals in the context of French transport. The chapter assesses the use of CBA in light of the case studies of the Paris Grand Express project, the return of tramways in French city centers, and the mobility trends in urban outskirts where car use is dominant.

Chapter 10 focuses on the functional evaluation of road infrastructure in the context of natural disasters in Japan. Following the Great East Japan Earthquake in March 2011, a new disaster prevention function assessment was introduced. This assessment is not a concept of traffic volume efficiency, but a completely new concept that evaluates the connectivity of a region in the event of a disaster. The chapter reflects on the need to improve the sophistication of evaluation methods and review them from time to time, following the changing values and needs of society.
7

From Wider Impacts to Transformational Impacts: The United Kingdom’s Developing Agenda for Major Projects

Roger Vickerman

7.1 Background

The United Kingdom (UK) has a well-established Transport Analysis Guidance (TAG) that has been in place for more than 20 years (Department of the Environment, Transport and the Regions 1998a, 1998b; Vickerman 2000). The current guidance is contained in a series of modules (Department for Transport 2018), which are being constantly updated. Cost-benefit analysis (CBA) is at the heart of appraisal for the economic case. CBA has been widely used in the UK since the 1960s and has been refined continually over the years both in terms of the basic principles and the specific values used. Successive reports of the Standing Advisory Committee on Trunk Road Assessment refined the basic approaches taken culminating in its 1999 report on Transport and the Economy (SACTRA 1999). Values of time savings and accident costs are regularly updated to reflect changing economic circumstances.

The formal CBA does not include the monetization of such factors as greenhouse gas emissions, environmental pollution, landscape impacts, impacts on biodiversity, or noise. These are assessed separately in terms of either physical measures such as tons of carbon or decibels or subjective evaluations of the scale of impact of a project for example on visual intrusion. All these factors are summarized in an appraisal summary table that can be used transparently to make a final decision based on judgment.
The process works well for routine investment decisions based on transport needs such as junction improvements or dualling of lengths of highway. For these the evaluation of user benefits in the standard CBA is typically the major driver, but one which can be modified where there are significant environmental impacts. It is more problematic for large-scale projects with diverse policy drivers. These include major investments on mega projects such as the high-speed rail line (HS2) between London, Birmingham, Manchester, and Leeds, the proposed third runway at Heathrow Airport, and the Lower Thames Crossing (a new tunnel between Kent and Essex to relieve congestion at the Dartford Crossing on the M25 to the east of London). These have important strategic implications, involve very large initial investments, and often bring the economic case into conflict with environmental considerations.

In such cases, it is essential to ensure that the economic case is robust and sufficiently takes into account the full impact on both local and national economies. Implemented originally for Crossrail, a new west–east railway tunnel under Central London, the concept of wider economic impacts has been refined and brought into the CBA analysis for projects where these are considered to be significant. This has led in turn to an increased emphasis on projects which contribute to the current government’s “levelling up” agenda to rebalance the economy between London and the southeast of England and the rest of the UK. Such projects which are claimed to have transformational impacts requires further development.

In this chapter, we review the current state of the appraisal guidance with a particular emphasis on the use of wider economic impacts and how these may need to be modified when dealing with projects with transformational objectives. This requires not just a reconsideration of the basic economic analysis but also an understanding of the underlying economic geography of a project which involves connecting cities rather than just improving accessibility within a monocentric urban area.

7.2 Appraisal Guidance

At the heart of the guidance is a formal CBA of the user benefits and costs. This is based on principles enshrined in the UK Treasury’s Green Book (HM Treasury 2020) to ensure consistency across all government investment decisions. The Green Book determines key elements such as the discount rate and the appraisal period. The discount rate, based on a social time preference definition, is currently set at 3.5% for 30 years and then declines to 3.0% for up to 75 years and 2.5% beyond to reflect the greater uncertainty over benefits in the more distant future.
The appraisal period for most projects is set at 30 years but for infrastructure projects is increased to 60 years. The Green Book also incorporates key government policy initiatives, and the latest version focuses on the “levelling up” agenda as a core element in government strategy toward regional development and rebalancing the economy.

Within the framework of the Green Book, TAG establishes key values such as value of time savings and accident costs in addition to demand modelling requirements (Department for Transport 2018). TAG is continually under review to ensure best practice. This led in the 2000s to a detailed framework for incorporating wider economic impacts together with recommended elasticities to establish the value of such impacts. The current round of discussions is set out in documents on the appraisal and modelling strategy and the subsequent Route Map for Updating TAG (Department for Transport 2019b, 2020).

7.3 Issues in the Route Map

The Route Map has identified five core issues and two further policy issues for discussion. The five core issues are:

- **Lower economic growth.** Forecasts of economic growth are critical to the modelling of future transport demand. Following the shocks to the economic system in the 2008–2009 recession, it has been less easy to predict future trends in growth, and particularly whether these have changed the underlying relationship between economic growth and transport demand. This has been compounded by the 2016 referendum decision to leave the European Union. The 3 years of uncertainty following this have impacted seriously on confidence in the UK economy and the terms of the Withdrawal Agreement of 2019 (HM Government 2019) and the subsequent agreement on the future relationship reached in December 2020 have also led to renewed uncertainty over future economic growth. This has, of course, been compounded by the novel coronavirus disease (COVID-19) pandemic in which the UK economy suffered the worst of all the Group of Seven (G7) economies.

- **Uncertainty and defining scenarios.** Increased uncertainty presents problems in using the standard methodology. Carefully defined scenarios can be a useful way of building uncertain futures into an appraisal process. This includes rigorous use of sensitivity testing of outcomes.

- **Length of the appraisal period.** The standard appraisal period used in the UK for infrastructure projects is 60 years. While this is probably appropriate for the majority of transport
investments and longer time horizons present even greater forecasting issues over uncertainty, low discount rates make future benefits more significant than has been typical historically. Where projects are designed to have significant long-term impacts on a wide range of economic and social indicators, there may be a case for using longer appraisal periods.

- **Changing values of costs and benefits.** There is a continual program of reevaluating appropriate values of the parameters used in appraisal. Central to this is the value of time savings that form a major part of the user benefits in transport appraisal (Department for Transport 2017). This particularly applies to business travel time savings that tend to be valued more highly and thus constitute a larger part of benefits in projects that increase speeds significantly (Wardman et al. 2013). Concern has been raised that changing the means of communications that enable business travelers to continue working while travelling, using Wi-Fi installed on trains, for example, reduce the gains from faster travel. The switch to web-based conferencing and work-from-home arrangements during the COVID-19 pandemic also poses new challenges for future appraisal.

- **Scheme cost uncertainty and optimism bias.** All methods of appraisal need to account for the tendency toward optimism bias in both scheme costs and potential benefits. There is always danger that applying standard uncertainty adjustments to both costs and benefits may not be appropriate in every case. There is the additional concern that allowing for optimism bias encourages the search for additional sources of benefit as compensation leading to a continual process of defining additional benefits and increasing skepticism about their validity.

### 7.3.1 Levelling Up and Transformational Impacts

These represent a new policy objective for the central government in the UK as enshrined in the revised Green Book (HM Treasury 2020). To some extent this can be seen as incorporating the now standard use of wider economic impacts in appraisal although with the clear provision that it has to demonstrate the net impact of such impacts at a national level. It also emphasizes the importance of measuring the distributional impacts of projects on specific groups at the individual and community levels. Understanding the underlying economic impacts of transport projects is a key to this through effects on productivity, labor, and
housing markets. Matching the political imperative to demonstrate a levelling-up agenda with the appraisal tools to justify individual projects is a key challenge in this area.

### 7.3.2 Environmental Issues

Environmental issues continue to pose issues in appraisal (Department for Transport 2021). While there is no formal monetary evaluation of greenhouse gas emissions in UK appraisal, the carbon impact is estimated in physical terms and reducing greenhouse gas emissions is a core element in government policy. Increasingly, concern over particulate emissions and their direct impact on health at a local level has become important and this has been highlighted by the reduction in traffic levels during the initial lockdown stages of the COVID-19 pandemic. The value of the natural environment is a further element of concern. This has been mainly dealt with through subjective judgments of landscape and biodiversity impacts and visual intrusion, but a more consistent quantitative measure of these impacts is now being developed.

### 7.4 Wider Economic Impacts

Wider economic impacts (WEI) arise when market failures in markets affected by transport improvements have an impact on welfare and value for money. While the impacts are generally positive, they can also be negative in certain circumstances, such as when markets are affected by subsidies, and hence the term impacts is used rather than the more common wider economic benefits. WEIs are included in appraisal in the UK whenever the effects are likely to be significant (Department for Transport 2019a). This requires an initial economic impact assessment, but it is important to note that this is not just a question of the size of the investment or the size of any change in accessibility or transport costs as sometimes a relatively small change can produce disproportional effects if it unlocks economic potential.

There are three main sources of WEIs: induced investment, employment effects, and productivity. Transport improvements can lead to induced investment through the creation of new developments that are dependent on transport improvement, sometimes referred to as unlocking potential, and through output change in imperfectly competitive markets. A conventional CBA would assume perfect competition such that any change in the cost of transport would pass through directly in output price changes, whereas under imperfect competition price-cost margins may be adjusted leading to an output change.
Employment effects can be the result of changes to labor supply, for example, through changes in the propensity to work as a result of new opportunities and higher real wages as travel costs fall due to improved accessibility. Furthermore, workers may move to more or less productive jobs having an impact on output and productivity.

The most studied aspect of WEIs is the impact on productivity through changes in agglomeration that arise from changes in access to economic mass (economic density) resulting from the lower transport costs occasioned by improved accessibility.

**Market Failures**

The first step to identifying WEIs is to examine the possibility of market failures in markets impacted by transport improvement. These can arise for a number of reasons. As noted above, imperfect competition results in a situation where price is not equal to marginal cost. This may arise due to there being a small number of firms in a market, where barriers to entry prevent easy entry or exit in a market, or where for other reasons firms may be able to exert market power.

Taxation is a further possible source of distortion that can have impacts on both investment decisions and labor supply decisions. Allowing for these tax wedges in appraisal is an important adjustment (Venables 2007). Changes in product variety resulting from lower costs of market access can provide significant welfare gains. In labor markets, search and matching barriers that lead to frictional unemployment can be reduced by improved accessibility and lower transport costs. Similarly, wage rigidities that lead to structural unemployment may be reduced.

**Agglomeration**

Most attention in the adoption of WEIs has been through the impact on agglomeration through increased access to economic mass (sometimes referred to as effective density), and the consequent impact on productivity. The static effects arise when reduced travel costs bring firms and employees closer, thus, increasing clustering and raising productivity. This is fairly simple to estimate in theory in terms of the elasticity of productivity with respect to agglomeration (Graham 2007; Graham and Gibbons 2019; Graham, Hörcher, and Vickerman 2021). The dynamic effects are less straightforward as they depend on changes in economic activity leading to further changes in density, and increases in productivity in one area may arise at the expense of losses in another. This means that it may not be possible to focus on a relatively narrowly defined area of impact in order to pick up these effects. It is important to stress, however, that this is not necessarily a zero-sum game: gains in one area need not be at the expense of losses in another and, if they are, the gains
may strongly outweigh the losses and this would especially be the case where the objective of an investment is part of the levelling-up agenda.

**Problems with the WEI Methodology**

The WEI methodology used in the UK (Department for Transport 2019a) is robust and under continual review to ensure it is fit for purpose if there are problems. First among these is identifying the extent of market failures and hence the need to consider whether WEIs are likely to be important in a particular application (Laird and Venables 2017). Secondly, estimating agglomeration elasticities poses a number of questions. Traditional agglomeration studies use sectoral specialization as the basis of analysis but increasingly it is believed that skill or occupational specialization may be more important (Venables 2017). Regional and local variations in likely elasticities and their variation between different modes of transport mean that it is not possible to use a standard national set of parameters. This raises the question of the most suitable type of data (e.g., area based or firm level) and the cost of analysis.

Whereas the early studies and the most common applications of the approach relate to improvements that affect defined labor markets in largely monocentric urban areas, defining access to economic mass in a multicentric context is becoming more critical with the need to consider, for example, high-speed rail links between a set of major cities. It is known that density declines fairly steeply around access points (Graham, Gibbons, and Martin 2010) but does this mean that there is relatively little impact from intercity connections. The application of the conventional methodology suggests this would be so (Graham and Melo 2011). However, in connecting cities accessibility becomes discontinuous and connectivity may become more important to businesses than a simple measure of accessibility based on a continuous time or cost parameter (Venables 2017).

**Transformational Impacts**

Driven by the policy decision to support the so-called levelling-up in the UK economy, a redistribution of economic activity toward regions away from London and the Southeast, projects that have a transformational impact should now receive priority. The Green Book defines transformational change as “a radical permanent qualitative change in the subject being transformed, so that the subject when transformed has very different properties and behaves or operates in a different way”.

Note that this explicitly refers to qualitative rather than quantitative change and emphasizes behavioral change. This introduces a strategic dimension in which a specific policy objective provides an external
constraint on the detailed (quantitative) economic case in which the CBA is central.

From the point of view of the quantitative guidance, this requires a specific estimate of the balance of local and national impacts. Agglomeration elasticities will need to be updated to reflect this and estimates of the distributional impacts on specific groups are needed.

**Case Study of HS2**
The HS2 high-speed rail network that is proposed to link London with Birmingham, Manchester, and Leeds is based in part on a claim to have a transformational impact on the northern regions (Vickerman 2018). The project has been appraised in two main stages, the first linking London and Birmingham and the second in two diverging branches, one serving Manchester and the other Leeds via the East Midlands and Sheffield. All evaluations to date have shown a much greater return from the full network than from the first stage to Birmingham (HS2 Ltd 2013). It has been difficult to agree on an appropriate methodology to produce consistent estimates of the regional distribution of gains (HS2 Ltd 2014; KPMG 2013). Application of the standard methodology suggests relatively small WEI benefits (Graham and Melo 2011).

A review of the project for the UK government in the face of rapidly increasing costs showed a reduced value for money on the basis of the standard methodology (Oakervee Review 2020). As Table 7.1 shows, the estimated benefit-cost ratio (BCR) allowing for WEI has fallen from around 2.3 to between 1.3 and 1.5, making the project much more marginal.¹

¹ The eastern leg via Sheffield has since been truncated to serve only a new hub in the East Midlands and a change to links to the West Coast Main Line near Manchester as well as a delay to the completion of the line to London Euston (the southern terminus of the West Coast Main Line). These are justified on cost grounds due to the constraint on government finances. These changes are not reflected in these figures.
The Oakervee Review noted that the reduced value for money derived mainly from the increased cost estimates, although these remained uncertain. The benefits were based on the standard 60-year appraisal period. If this was increased to 100 years reflecting a presumed long-term transformational impact, the BCR would increase to around 2. The Review also noted that that the TAG framework only considers the static WEI and ignores dynamic effects on land use, which would be expected to be significant in the case of such a major project. Furthermore, the project has been appraised on a stand-alone basis with no allowance for likely complementary rail or other investments. This raises the question of how to define the limits of a project that is designed to have transformational impacts.

**Capturing Transformation**

Looking more closely at the characteristics of a transformational project, we can identify a number of potential indicators. These are not all necessary or sufficient to ensure transformation but most such projects will have some or all of these characteristics. Transformational projects will typically have significant feedback effects in which changes in one sector or occupation will promotes changes in others through forward or backward linkages. There are also likely to be tipping points or threshold effects in which small changes in certain parameters such as accessibility or connectivity can lead to significant changes in behavior.

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**Table 7.1: Appraisal of HS2 Under Revised Estimates**

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<tr>
<td>Revenue</td>
<td>31.1</td>
<td>43.6</td>
<td>45.4</td>
<td>45.4</td>
</tr>
<tr>
<td>Net cost</td>
<td>31.5</td>
<td>39.8</td>
<td>62.2</td>
<td>69.1</td>
</tr>
<tr>
<td>BCR (no WEI)</td>
<td>1.8</td>
<td>1.9</td>
<td>1.2</td>
<td>1.1</td>
</tr>
<tr>
<td>BCR (with WEI)</td>
<td>2.3</td>
<td>2.3</td>
<td>1.5</td>
<td>1.3</td>
</tr>
</tbody>
</table>

BCR = benefit-cost ratio, WEI = wider economic impacts.

This is similar to the unlocking effect but can also be experienced where, for example, certain time thresholds are overcome. Bringing a journey time under a key threshold such as 3 hours is seen to have a significant impact on the potential for daily return journeys. Identifying these thresholds or tipping points thus becomes a key element in understanding the potential for transformation.

For a change to become transformational any such impacts need to be self-sustaining and not just short-term reactions to new opportunities. Analytically, transformational projects often occur in situations where there are multiple equilibria, and the question is how to shift the outcome from one of these equilibrium points to another, which induces significant change.

The potential for transformation depends on identifying a number of key elements. First and foremost is a clear policy intention that the primary objective of a project is to focus on transformation and the levelling-up agenda. This changes expectations and ensures that all stakeholders are clear as to the primary focus so that discussions, and particularly objections, do not get side-lined in a debate on irrelevant issues. What then becomes important is the identification of the transmission mechanisms that can secure the transformational change and the complementary policies that can promote this change. The presence of complementarities is seen to be a critical element in ensuring transformation.

### 7.5 Implications for Appraisal

Even with the addition of WEI, appraisal is still based in the traditional marginal analysis that defines key parameters such as willingness to pay and agglomeration elasticities. By definition, transformational projects involve non-marginal changes that imply increasing returns and cumulative causation (Laird, Nash, and Mackie 2014). Handling such changes places critical importance on defining the policy objective. In such cases, the narrative of the expected outcomes and the expected transmission mechanisms become critical. This is not just a question of defining policy options but requires detailed analysis of the way these options are expected to impact on behavior in order to be included robustly in appraisal in a way that is both transparent and challengeable (Vickerman 2015). Size is probably not the main determinant of transformational effects. Larger projects may create more opportunities for transformation, but it is behavioral change and the importance of complementary policies and packages of interventions that are the principal drivers of the dynamic process that is critical to such change.
The economic process lying behind these drivers is one of increasing returns driving dynamic agglomeration. The next step is to understand where and how these apply. Traditional analysis has explored agglomeration in the context of sectoral concentration in locations to exploit traditional Marshallian externalities. It is now recognized that this agglomeration may equally apply within skills or occupations. This is one element of moving from a largely monocentric urban model to a model of competing cities, or as Venables (2017) has described it the relative effects of “expanding cities and connecting cities”.

This raises the question of how and when to assess potential transformational impacts. Already there is clear guidance about the analysis of WEI in appraisals. This requires an initial economic impact report as part of the TAG process (Department for Transport 2019a). Rather like an environmental impact report, this assesses the extent to which a specific project in a specific location may have impacts that go beyond the parameters of the standard CBA. This involves an examination of the extent of imperfect competition in local markets due to scale economies, barriers to entry, subsidies, or similar factors. This avoids undertaking potentially costly WEI analysis where there is unlikely to be much impact.

Transformational projects will fall into a similar category, but one which it is less easy to define in terms of objective indicators. In this case, the economy case needs to consider first the policy narrative that places a project in a category that is intended to have transformational impacts. Secondly, there needs to be careful definition of the behavioral changes necessary to achieve the transformation; these will focus on the dynamic factors in agglomeration that lead to changes in land use or relocation of employment or residences. In most cases, this will identify a series of complementary measures that are necessary to achieve the transformational effect of the transport project. Such measures will need to be costed into the scheme costs insofar as they create additional benefits for the main project. Although in many cases, it may be difficult to separate the complementarity effect from direct local benefits from the complementary measures.

7.6 Concluding Remarks

Transformation may be easy to define in theory, but it could be much more difficult to define in practice in terms of metrics and to find clear evidence of its effect. The first and most important step is to recognize the importance of the narrative and the identification of the behavioral change needed to effect transformation. This places increased emphasis
on micro studies of individual relationships rather than the development of big comprehensive “black box” models.

Within this broad approach, it is important to recognize the specificity of estimated elasticities, not least those relating to agglomeration effects, and in understanding how increasing returns occur. This is not just about scale but about the potential for change. There is also a need to move from a more simplistic definition of accessibility, based solely on generalized cost, to a greater understanding of the role of connectivity. There is a need to understand how business to business links work in the context of competing (and cooperating) cities. This implies a reduced emphasis on commuting as the basis for analysis and the link between residences and workplaces as the basis of access to economic mass and agglomeration. Such a link may in any case become less important in a post-COVID-19 world where for many the daily commute to an office is replaced by a more flexible working arrangement. But it seems too big a leap to suggest that this will spell the end of agglomeration effects or the importance of efficient transport both to and between different workplaces. In this world, transformational effects will become of even greater importance.
References


HS2 Ltd. 2013. The Economic Case for HS2. London: High Speed Two (HS2) Ltd.


8
Planning Practice and Wider Economic Impacts—The Case of Germany

Werner Rothengatter

8.1 Introduction

The standard macroeconomic evaluation method applied for preparing the German Federal Transport Master Plan (BVWP)\(^1\) consists of four components: economics, environment, spatial development, and urban development. The macroeconomic evaluation is based on a conventional cost-benefit analysis (CBA) that places the savings of generalized costs of users (time and operation costs) into the center of analysis. The impacts on the environment, spatial development, and urban development are assessed partly in monetary and in nonmonetary terms. The results of the nonmonetary part serve as additional information for preparing a priority list of projects. The comprehensive master plan is subject to a strategic environmental analysis at the end of the assessment steps.

The procedure mentioned above developed for the German Ministry of Transport has been attacked by transport scientists, the Federal Environmental Agency, and other stakeholder groups because of missing goal orientation and systems-based analysis. Alternative procedures have been developed by scientific teams that can be found in the recent proposals of transport associations for legal reform of planning in the German transport sector. The basic elements of these alternatives are defining clear goals and setting controllable targets, introducing a systems analysis for determining a goal-conforming network configuration, and applying a holistic approach for assessing the comprehensive master plan.

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\(^1\) BVWP = Bundesverkehrswegeplanung (Federal Planning of Transport Infrastructure).
The chapter is organized as follows. In Section 8.2, the components of the BVWP are presented in detail, starting with the CBA, including economic and monetized environmental and safety benefits. This is followed by the description of nonmonetary components for environmental, spatial, and urban impacts. The project-related environmental assessment is extended by a strategic environmental assessment for the comprehensive master plan, including all network adjustments. A problem for developed economies like Germany is the high need for maintenance and investment, which require separate treatment. Section 8.3 presents critical comments from the scientific side, which have been brought forward in the last decade. This is accomplished by more recent publications of the Federal Environmental Agency and of environmental stakeholders. These ideas have been taken up through initiatives that have recently started for preparing legal reform of transport planning in Germany (Section 8.4). Section 8.5 gives the conclusions.

8.2 Methodology of Cost-Benefit Analysis

A base scenario is defined for the year 2030 characterizing the situation without any network investments. Candidate projects are proposed by the ministries of transport of the 16 German states, the railway infrastructure manager, and the Inland Waterway Administration, which are finally checked through a bottleneck analysis carried out by the Federal Ministry of Transport. The impacts of a project are calculated by comparing key indicators (e.g., transport cost and time) for the network configuration without and with the candidate project on the base of a transportation forecast for 2030.

The components of CBA are summarized in Table 8.1. The investment costs are calculated as annuities of the initial investment expenditures, applying a social discount rate of 1.7%. All components are calculated on a yearly basis and at the end related to the yearly investment costs (annuity) by the benefit over cost ratio.

The traditional components of CBA (the changes of operating and time costs for users) are still at the core of analysis but they have been further differentiated and extended:

- Implicit utility has been added to capture the economic benefits of induced and diverted transport. In particular, passenger transport can divert from air or road to rail although there is no time advantage for rail. However, people can use the time spent on rail for working or for leisure activities, a benefit that is now integrated into the assessment.
### Table 8.1: Components of Cost-Benefit Analysis for the German BVWP

<table>
<thead>
<tr>
<th>Components of Cost-Benefit Analysis</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment costs</td>
<td>Annuities of investment expenditures, social discount rate 1.7%</td>
</tr>
<tr>
<td>Change of vehicle operating costs</td>
<td>Change of vehicle operating costs for passenger and freight transport, all modes and sectors</td>
</tr>
<tr>
<td>Change of transportation time</td>
<td>Change of transportation time for passenger and freight transport, all modes, travel purposes and sectors</td>
</tr>
<tr>
<td>Change of costs for loading units</td>
<td>Change of costs of freight transport resulting from higher efficiency (inventory holding, cost on capital employed)</td>
</tr>
<tr>
<td>Change of punctuality and reliability</td>
<td>Change of costs of freight transport resulting from higher reliability of supply chains</td>
</tr>
<tr>
<td>Implicit utility of changed transport behavior</td>
<td>Additional utility stemming from induced and diverted travel activities in passenger transport (“rule of the half”)</td>
</tr>
<tr>
<td>Change of transport safety</td>
<td>Change of accident rates, differentiated by impact categories, evaluated by monetary figures</td>
</tr>
<tr>
<td>Change of noise impacts</td>
<td>Change of noise levels differentiated by noise levels, impacted areas and population, evaluated in monetary terms</td>
</tr>
<tr>
<td>Change of pollutant emissions of users</td>
<td>Change of exhaust emissions and GHG emissions evaluated by specific monetary terms</td>
</tr>
<tr>
<td>Emissions from infrastructure provision</td>
<td>Life cycle emissions from infrastructure provision, maintenance, and operation</td>
</tr>
<tr>
<td>Utility for other transportation modes</td>
<td>Additional benefits for users of other transportation modes stemming from investments in a competing mode</td>
</tr>
<tr>
<td>Change of maintenance and operating costs</td>
<td>Change of maintenance and operating costs of the improved infrastructure</td>
</tr>
</tbody>
</table>

BVWP = Bundesverkehrswegeplanung (Federal Planning of Transport Infrastructure), GHG = greenhouse gas.

Source: German Ministry of Transport (2016).

- Utility for other modes can occur if road transport is shifted to rail and congestion on roads decreases accordingly.
- Change of costs of loading units in freight transport and impacts of improved punctuality and reliability have been introduced for considering important factors influencing logistics decision-making on supply chains and the choice of modes.
- Emissions stemming from the provision of infrastructure are included now. For instance, infrastructure works may cause energy consumption and carbon dioxide emissions that can
reach a substantial order of magnitude depending on the size of the project.

- The cost values for safety and environment are taken from recent studies of the German Federal Environmental Agency.²

### 8.2.1 Treatment of Environmental and Spatial Impacts, Strategic Environmental Analysis

**Nature and Environment**
The monetized results for this category (see pollutant emissions of users in Table 8.1) are complemented by further analyses of environmental risk. This concerns the following aspects:

- Consumption of land in habitat and natural protection areas
- Cutting up landscape in spatially coherent areas
- Sealing of areas
- Cutting up flood plains
- Cutting up water protection areas
- Land take in cultural priority areas

The results of the assessment were weighted and summarized by scoring points. At the end, the number of scoring points were used to categorize the projects by high, medium, or low environmental risks.

**Spatial Development**
German spatial development planning is based on the concept of “decentral concentration”, which means that the attributes of social service (administration, education, health, culture) are allocated according to a hierarchical principle to the regional centers of all categories. This is coherent with a polycentric development of cities in space and the formation of development axes. These principles are manifested in the Spatial Development Act of 2008,³ which defines the categories of centers and regulates their development alongside defined spatial axes. The idea behind is avoiding an over-concentration of activities in big agglomerations and a balanced development of regions in space.

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The evaluation of the contribution of investment projects to the goals of spatial development is based on two sub-criteria:

- **Change of regional connectivity:** scoring points from 1 (very positive) to 6 (highly insufficient)
- **Change of regional accessibility:** scoring points from 1 (no deficits) to 4 (high deficits)

These indicators are quantified on the base of network analysis and regional structural data.

### 8.2.2 Urban Development

In Germany, the intra-urban parts of federal roads and railways are the responsibility of the federal government with respect to planning and financing of renewal and maintenance. In the case of new investments, assessment problems can occur with respect to:

- Impacts of cutting up urban areas and generating separation effects
- Change of accessibility of urban areas
- Change of land values

These impacts are evaluated by constructing a matrix of the intensity of effects (columns) and the contribution to urban development (rows). This allows for identifying highly positive and highly negative impacts of investment projects that are used for preparing the final decisions on project rankings.

### 8.2.3 Strategic Environmental Assessment

Strategic environmental assessment (SEA) of federal transportation investment is an obligatory step of evaluation according to the Directive 2001/42/EC of the European Union. The methodology, elaborated by the German Federal Environmental Agency and the Ministry of Transport, consists of further specifications of the bullet points listed in Section 8.2.1, giving guidelines for the measurement of the sub-criteria, and for the application to the different types of investment (e.g., greenfield, brownfield investments, or upgrades). The important difference compared with the project-related environmental assessment consists in the application of the assessment methodology to the comprehensive master plan.
The SEA results are summarized by scoring the results with respect to the single sub-criteria and allocating the project to three categories:

- Low environmental impacts of the network plans
- Medium environmental impacts of the network plans
- High environmental impacts of the network plans

The identification of medium or high environmental impacts leads to feedback of the project assessment (Section 8.2.1). Problematic projects can be eliminated, devaluated with respect to their priority, or referred back to the planning authorities.

**8.2.4 Interdependency Analysis**

Projects can induce complementary (synergetic) effects or substitution (competitive) effects. For instance, road projects in the same corridor will induce synergies for road transport (improve the roadside accessibility of regions alongside the corridor), while they can induce negative impacts on rail (modal shift because of time and operation cost savings on roads). From this follows that intramodal and intermodal interdependencies should be investigated to check the overall impacts of investment on the transport flows and their compliance with respect to the goals of planning (e.g., reducing carbon footprint of transport).

When preparing the federal transport master plan, consultants had investigated several projects with respect to such effects, however, this analysis was not carried out on the network scale.

**8.2.5 Investment for Replacement and Upgrades Investments**

In developed economies major transport investment activities for developing the transportation system had been taken decades ago, at a time when traffic volumes were much lower, and the forecasts did not come out with high traffic load figures as they are observed today. In Germany, the budget allocated to replacement and upgrades is already much bigger (69% of total investment) than the budget for new investment (Table 8.2).
In the railway sector, the importance of maintenance, replacement, and upgrade investments has been identified as a main challenge in the last decade. A concept for planning and stable financing of such investments, called the Performance and Financing Agreement, has been developed, which was signed by the Federal Ministry and Transport and the rail infrastructure manager of Deutsche Bahn Netz AG. The third upgrade of this agreement started in January 2020 and includes the following elements:

- Time horizon is extended to 10 years, 2020–2029.
- Total investment planned for replacement, maintenance, and minor upgrades is €86.2 billion.
- The railway infrastructure management company will contribute €22.8 million.
- The federal government will contribute €51.4 billion from the federal budget and €12 billion from other sources.

The infrastructure manager must provide transparent documentation on network quality, particularly for engineering structures like bridges and tunnels. For instance, about 1,200 bridges are considered for renewal and 300 bridges have been identified for urgent major maintenance works. The implementation of these plans is controlled by the public network agency and an independent auditor.

The progress to be achieved by this type of arrangement consists of decoupling the current investment needs for network maintenance from the rigid budget rules. The latter would require a yearly application and approval of funding and the fulfilment of fiscal specificity requirements.

<table>
<thead>
<tr>
<th>Transport Mode</th>
<th>New Projects</th>
<th>Modernization, Major Upgrades</th>
<th>Replacement/Maintenance</th>
<th>Other Investment</th>
<th>Sum Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road</td>
<td>34.1</td>
<td>19.6</td>
<td>67.0</td>
<td>12.0</td>
<td>132.8</td>
</tr>
<tr>
<td>Rail</td>
<td>26.7</td>
<td>19.7</td>
<td>58.4</td>
<td>7.4</td>
<td>112.3</td>
</tr>
<tr>
<td>Inland Waterways</td>
<td>2.7</td>
<td>3.5</td>
<td>16.2</td>
<td>2.2</td>
<td>24.5</td>
</tr>
<tr>
<td>Total</td>
<td>63.6</td>
<td>42.8</td>
<td>141.6</td>
<td>21.6</td>
<td>269.6</td>
</tr>
</tbody>
</table>

**BVWP** = Bundesverkehrswegeplanung [Federal Planning of Transport Infrastructure].

Notes: Road means all federal roads, rail means all federal railways, inland waterways means all federal inland waterways.

Source: German Ministry of Transport (2016).
which lead to high administrative burdens and low certainty about timely fund allocations to the extent that the agreement will lead to substantially higher efficiency of maintenance works for the railways.

### 8.2.6 Overview of the Modules of the BVWP

Figure 8.1 shows the four modules of the BVWP for evaluating the projects plus the strategic environmental assessment for the comprehensive master plan. The question is how to bring the results of the modules together, for instance, applying a multi-criteria analysis or other methods. The BVWP does not include a principle or a guideline for this task. It is up to the ministry to use the results of environmental, spatial, or urban impact analysis for changing the priority list, eliminating projects with low performance for the nonmonetary criteria, or allocating them to a low-priority category. Projects that show little environmental risk while removing serious bottlenecks are allocated highest priority ranks because it can be assumed that the legal approval processes will proceed without major difficulties. This is politically important as the German legislation allows for a long litigation process if project opponents go to court.

![Figure 8.1: Modules of the German BVWP Assessment Methodology](image)

**Figure 8.1: Modules of the German BVWP Assessment Methodology**

- **Module A:** Cost-benefit analysis
- **Module B:** Nature and environment
- **Module C:** Spatial development
- **Module D:** Urban development
- **Strategic Environmental Analysis**

*BVWP = Bundesverkehrswegeplanung (Federal Planning of Transport Infrastructure).*  
*Source: Author.*
8.3 Critical Comments from Scientists and Environmental Stakeholders

Scientists and environmental stakeholders have criticized the BVWP methodology for over 10 years. The Scientific Advisory Committee of the Federal Ministry of Transport (2009) published recommendations for strategic planning of mobility and transport and two of its members have extended the basic ideas in further publications (Beckmann and Rothengatter 2016; see also Beckmann, Klein-Hitpass, and Rothengatter 2012). Critical comments were brought forward mainly with respect to the following points:

- The underlying goals are defined only qualitatively and in general terms such that control of the target achievement is not possible.
- The BVWP evaluates single projects but does not assess the comprehensive master plan with respect to the achievement of sustainability goals.
- The priority list resulting from the CBA assessment leads to a fragmentation of project activities over space without considering the interdependencies (synergies, substitutional effects).
- The CBA was carried out based on a narrow neoclassical concept of welfare for which the normative assumptions are no longer valid (Rothengatter 2015).
- Only one scenario for the future development of economic and social indicators was analyzed; alternative scenarios have not been developed.
- The analysis is based on comparative statistics (with and without comparisons for the year of forecasting), while the dynamics and feedback are neglected.

The German Federal Environmental Agency launched a study (IWW et al. 1999) that showed that it is possible to derive a federal transportation plan consistently from a set of targets and associated limit values for negative human and environmental impacts (e.g., transport safety, exhaust pollution, climate change). The plan could be checked with respect to feasibility and target achievement in the large (contribution of the comprehensive master plan to macro targets of economic, social, and environmental sustainability) as well as in the small (feasibility of single projects with limits of regional pollutants’ concentration).

This conforms with the recommendation of the Scientific Advisory Committee (2009) of the Ministry of Transport that introduced a three-
level process for adjusting the BVWP methodology to the actual policy needs (see Beckmann and Rothengatter 2016):

**Strategic level:** The assessment process starts with the definition of the networks and areas to be considered and the projects to be analyzed. In the latter case, a bottleneck analysis is helpful for identifying the present weaknesses and shortcomings. A major issue consists of a clear definition of goals with respect to removing weaknesses and providing future-oriented sustainable infrastructure. For most of these goals, defined quantitative targets can be set as benchmarks that can be tested in the large for the whole comprehensive master plan and in the small for regional projects. On this basis, scenarios can be elaborated as sets of measures that include intended changes for the infrastructure as well as the associated conditions for infrastructure use.

Also, the methodology of the assessment is to be defined, i.e., whether it is based on conventional CBA and extended by nonmonetary components or whether an integrated approach is preferred by modeling transport, economic, and environmental impacts by an integrated assessment model. If the decision is taken to apply a modular approach, then the question arises as to how to aggregate the different monetary and nonmonetary outcomes. This can lead to additional methodological approaches, e.g., on the basis of multi-criteria analysis or in employing an advisory committee for preparing a final recommendation.

**System level:** The different scenarios developed are specified in terms of infrastructure projects, corridors, and networks. The impacts of the scenarios on the set of goals are tested based on target achievements. For the economic assessment, an evaluation of wider economic impacts is preferred that relates to the comprehensive networks of the scenarios, not to single projects. The same holds for the environmental assessment, which is done according to the strategic environmental assessment concept as introduced in Section 8.2.4. The methodology to be applied can be multi-criteria analysis, computed equilibrium modeling, or system dynamics for quantifying wider macroeconomic impacts. The latter has the advantage that time profiles and changes of trends can be modeled more easily. A model that is applied for assessment tasks of the European Union (EU) Commission is the ASTRA model (Assessment of Transport Strategies; see Fiorello, Fermi, and Bielenska 2010). The assessment model was developed for the EU countries plus the United Kingdom, Norway, and Switzerland, and differentiated by regions (NUTS 2) as well as economic sectors. It includes population, economy, transportation, and the environment.

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4 NUTS is the regional classification in the EU from NUTS 0 (countries) to NUTS 3 (counties).
**Project level:** The detailed design and alignment of projects is analyzed at the project level. On this basis, the detailed investment costs, regional improvements, and regional and/or local environmental risks can be quantified, according to the methodology as it is applied in the BVWP approach. This leads finally to selecting the appropriate design and spatial alignment and to generating information on the project priority within a corridor. As the projects will receive interest at the local level and conflicts may arise, it is important to organize mediation processes as early as possible. Prominent examples, as the project of a new underground railway station in the city of Stuttgart, have shown that starting mediation too late may lead to conflicts with stakeholder groups that are not easy to channel (see https://www.bahnprojekt-stuttgart-ulm.de/en/).

### 8.4 Strategic Assessment in the Context of Initiatives for Legal Reform of Transport Infrastructure Planning

In the past years, the preferences of Germany’s citizens have changed with respect to mobility and protection of the environment. Years ago, the biggest German automobile club pushed policy makers toward better roads and less regulation by calling for “free traveling for free citizens”. Meanwhile, there is a broad societal consensus that fighting climate change is the biggest challenge for the coming decades and this is propagated by most political parties. The dissatisfaction of scientists and environmental groups with the present transport policy and its planning methods now finds broader political support. Against this background, initiatives for starting legal reform of transport infrastructure planning in Germany have been taken. The main pillars of these initiatives are:

- Clear orientation of transport legacy toward sustainability
- Setting specific targets such that the contribution of transport policy measures can be controlled
- Preference for public and nonmotorized transport
- Participation of citizens in the planning process
- Checking the comprehensive master plan with respect to sustainability goals
- Coordination of federal, state, and community plans

The ideas of scientists and environmental groups or organizations (e.g., the Federal Environmental Agency) have been integrated as described in Section 8.3.
8.5 Summary and Conclusions

The German method of assessing the federal transport infrastructure plan has included several aspects of sustainability but this has not been done comprehensively and systematically, and the assessment results mainly supported the observed trends of mobility and freight transport. Scientists and environmental groups have propagated a change of transportation planning and assessment methods toward a better integration of sustainability issues. In particular, the contribution of the comprehensive master plan to wider economic benefits and to strategic environmental improvements should form basic components of an integrated assessment methodology. While these voices had been ignored by the policy makers for a long time, it seems that the changed societal preferences, particularly with respect to global warming issues, prepare the political landscape for a radical change of the existing planning legacy and planning practice in the German transport sector.
References


9

Cost-Benefit Analysis and Urban Transport Investments in France: Toward an Accessibility Turn?

Yves Crozet

9.1 Introduction

France has a long tradition of investment in transport infrastructure. It has its roots in the work of 19th century engineer-economists, such as Jules Dupuit (1804–1866). As early as the 1840s, anticipating certain Marshallian variables in market analysis, he outlined the demand curve and founded the notion of consumer surplus. A century later, in the middle of the 20th century, these categories have become central in the cost-benefit analysis (CBA). Indeed, comparing the economic benefits of different infrastructure projects requires knowing the relative variations in consumer surplus. However, with the development of rapid transport modes, the time savings linked to speed have become preponderant in the cost-benefit balance of transport projects. This is how the development of the motorway network on the one hand and high-speed rail lines on the other hand was justified in France.

On this basis, since the end of the 1950s, a reflection on accessibility has developed, which has given a key role to speed gains because they widen the field of accessible amenities (Morris, Dumble, and Wigan 1979). This view of things has been particularly prevalent in urban areas and their peripheries. This is evidenced by the creation of urban expressways but also the development of public transport networks, particularly trains and subways. This focus on speed gains has, however, been gradually called into question in France over the past forty years. The best example of this new direction has been the return
of tramways in several dozen French cities which have also decided to
destroy certain urban highways and reduce the road space dedicated to
cars to increase the space given to pedestrians and cyclists.

These new trends can be interpreted as another way of thinking
about accessibility to urban amenities, focusing less on the speed of
travel than on the quality of life and the inclusion of the Sustainable
Development Goals (SDGs) defined by the United Nations (United
Nations 2019). As can be seen, this new situation challenges the usual
CBA. But to materialize, it requires a real turning point in accessibility
approach, abandoning the priority given to the search for speed. But
this is only one possible direction. Another is to put speed gains back at
the heart of the CBA because they were supposed to be the source of a
rebound in economic growth.

In this chapter, these two ways of rethinking the role of CBA in
urban areas are addressed. We first present the Grand Paris Express
(GPE) project and the expected wider economic benefits (WEBs)
associated with it. Then we detail the components of the “accessibility
turn” by taking the example of the return of tramways to the city centers
of several dozen French cities, and show that the accessibility turn is
facing a new challenge in the less dense areas of the urban peripheries,
where the car is the dominant mode of transport.

9.2 Speed Gains and Wider Economic Benefits:
The Case of the “Grand Paris Express”

The CBA is directly linked to the concept of welfare and its evaluation on
the basis of the changes in consumer surplus. Speed gains are therefore
considered a source of opportunities by reducing the generalized cost
of transport. A higher number of accessible economic opportunities
potentially lead to a higher consumer surplus. But this usual way of
considering the economic impacts of transport infrastructures has
been transformed in order to assess not only the welfare gains but also
the potential impacts on the gross domestic product (GDP). This new
methodology has been applied in France to the GPE project.

9.2.1 CBA and Wider Economic Benefits: From Welfare
Economics to Economic Growth?

The main advantage of CBA is its capacity to compare costs and benefits
by producing a single dimensional result, the net present value (NPV),
which is expressed in money. Presenting the effects of a transport
infrastructure project in monetary terms has the considerable merit of
being easy to understand. The NPV and the internal rate of return (IRR) help the public decision-maker about the best possible choices.

The difficulty arises when the projects, which have strong political support at the local or national level, have low IRRs, which cannot be used to justify them. This is the case for a large number of urban public transport projects that do not generate significant time savings for users, leading to small gains in consumer surpluses and therefore a low IRR. It is also the case for large and so-called “transformational” projects at a metropolitan level. Would it be possible to measure the utility of these projects, which is stated loud and clear by their proponents, by another method providing results that are as comprehensible, but more favorable as those obtained from CBA, that is to say in positive monetary impacts on GDP?

In order to solve this problem, methodologies have been developed in the United Kingdom (UK) and France which, although different, share the same goal.

- In the UK, the concept of wider economic effect (WEE), also known as wider economic benefit (WEB), was developed in the last 15 years or so (Venables 2007; Graham 2007). WEBs are largely due to agglomeration effects. They have been evaluated in detail for the HS2 project (DFT 2013). The study stated that this new high-speed rail line could increase GDP by £15 billion per year from 2037, the date by which the entire line would be open. This sum could justify the £60 billion cost of the project even after discounting.

- In France, the measurement of accessibility improvements is recommended in the context of the economic appraisal of urban transportation for which it is laid down that the indicators of accessibility attempt to measure the satisfaction individuals obtain from the transport system.

There are therefore methodological differences between the two approaches, but they are both based on causality from speed gains to per capita productivity. In both methods, a reduced generalized cost of transport increases travel flow and the productivity of the players. An improvement in travel speed would give every individual the opportunity to use their skills better, thus increasing the utility of the journey, hence their income, and finally the collective product. Workers would find jobs that are better suited to their skills, and firms would find a workforce that is better suited to their needs. It should be noted that in the French method, these productivity gains are short-term, with a given production capacity. In the UK WEB method, the agglomeration effects are keys. Productivity gains appear because the most productive zones
are better connected to peripheral zones whose per capita productivity is lower. This has a structural impact as thousands of workers can work in more productive zones, and these zones are more productive because of a better connectivity leading to some positive clustering effects. It is exactly what is expected in the Île-de-France region from the GPE project (Crozet 2018).

9.2.2 The Promises of the Grand Paris Express

The GPE project was presented in April 2009. The economic objective of the project was to increase the attractiveness of the entire Île-de-France region by improving the transport links and, hence, increasing the size of the agglomeration.

At a first glance, the Île-de-France region already has an excellent network of public transport, which includes 14 metro lines that connect the city of Paris and some of the nearby municipalities, several tram lines (some of which are still under construction), as well as 13 suburban train lines. However, the suburban train lines are saturated, and the quality of service is often subpar. While the network is extensive and provides
excellent connectivity in the city of Paris, the lines do not provide adequate connectivity between the different suburbs of Paris. This challenge is particularly acute due to the fact that the suburbs of Paris have very significant potential for economic growth and employment. To address this challenge, the organizing authority of transport of the Île-de-France region had planned a circular metro line around Paris called “Arc Express” in the early 2000s (Crozet 2018).

The GPE has partly taken up this idea (see line 15 in Figure 9.1) by adding new sections to the network: the extension of line 14 to the south (Orly airport) and north to Saint-Denis; line 16 to the east; line 17 to Charles de Gaulle airport; and finally, line 18 to the southwest to serve in particular the Saclay cluster comprising several prestigious universities and research centers.

The GPE is an ambitious, transformational project for Île-de-France. To calculate the NPV of the investment, the Société du Grand Paris (SGP) proposed to add an assessment of the WEBs resulting, among other things, from agglomeration effects. The first CBA (including a WEBs assessment) was conducted in 2013. The results from that work are presented in Table 9.1.

| Table 9.1: Grand Paris Express, Net Present Value, Internal Rate of Return, 2010–2035 |
|-------------------------------------------------|----------------|
| (€ billion 2010)                                |                |
| 1 Time gains                                    | 27.6           |
| 2 Reliability                                   | 3.4            |
| 3 Comfort                                       | 2.2            |
| 4 Environmental and urban gains                 | 10.4           |
| 5 Directs effects of jobs reallocation          | 5.5            |
| 6 Agglomeration effects                         | 6.3            |
| 7 New jobs                                      | 12.2           |
| 8 Total benefits                                | 67.6           |
| 9 Building and operating costs                  | −37.9          |
| 10 Taxes on road                                | −0.8           |
| 11 Total cost                                   | 38.7           |
| 12 Net present value                            | 28.9           |
| 13 Internal rate of return                      | 8%             |

The total cost of the project as well as its operating costs will amount to €38.7 billion by 2035. When the WEBs are excluded from the calculation, the project’s benefits exceed the costs by €4.9 billion. The rate of return on the project derived from such a net gain is lower than 4%, the criteria set out for public projects in France. The official government rules on CBA also require the calculation of the ratio of NPV per euro publicly invested. With an NPV of €4.9 billion, that ratio amounted to 0.16. When WEBs amounting to €24 billion are considered, the ratio increases to 1.05, which implies that the benefits of the project exceed its cost, hence, making the project look very attractive.

The additional economic activity resulting from the GPE project was expected to bring new jobs to Île-de-France. The number of jobs could change, as shown in Table 9.2. Before the GPE project, the Île-de-France master plan provided for an additional 610,391 jobs created between 2007 and 2035. With the GPE, the number of jobs expected in 2035 is much higher: 750,141 in the “low” scenario and 990,154 in the “high” scenario. With the GPE, the growth of employment is greater at the center of the agglomeration, where gains from productivity are expected to be higher.

<table>
<thead>
<tr>
<th>Year</th>
<th>Scenario without GPE</th>
<th>Scenario GPE “low”</th>
<th>Scenario GPE “high”</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>5,570,301</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2035</td>
<td>6,180,692</td>
<td>6,320,442</td>
<td>6,560,455</td>
</tr>
<tr>
<td>Total</td>
<td>3,653,348</td>
<td>4,060,224</td>
<td>4,589,565</td>
</tr>
<tr>
<td>Center</td>
<td>2,006,953</td>
<td>2,120,468</td>
<td>1,970,890</td>
</tr>
<tr>
<td>Periphery</td>
<td>2,080,988</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

GPE = Grand Paris Express.
Source: SGP and SETEC (2014).

By adding the WEBs of the GPE project to the future growth estimates, Île-de-France’s GDP could grow by as much as 70% between 2007 and 2035, or 1.9% per year on average in the “low” scenario. This result would come from jobs that are both more productive (+50%) and more numerous (+13.5%). In comparison, without the project, the economic growth trajectory over the past year amounted to about 1.5% per year, and the GDP of Île-de-France increased by 45% between 1990 and 2014.
Caution, however, is needed when interpreting the results of WEB assessments of the GPE project. First, almost 75% of the WEBs are estimated to accrue from the generation of new jobs and the reallocation of jobs in the economy. These estimates, however, rely on a host of assumptions. In particular, the study does not account for the fact that many additional jobs estimated for Île-de-France due to the GPE investment are likely to come from elsewhere in Île-de-France, or from other regions of France. The GPE project will have winners, but there will be losers too. This implies that the assessments of job creation are overstated. Moreover, the agglomeration benefits are conditional on the predictions of macroeconomic trends for France. These concerns were raised by the General Commission for Investment as part of its review of the GPE project:

The opinions of the CGI and the counter-expert reports on which they are based have highlighted (...): A negative or low socio-economic profitability of certain sections if they were evaluated according to the traditional assessment methods of infrastructures transport used by other operators. The innovative evaluation methods used rely heavily on the pace and location of populations and jobs, which are outside the purview of the SGP; Risks of undervaluing the costs of building and operating the network...¹

Since these comments, the project has been facing a cost drift (at least €10 billion). The financing of the whole project remains fragile. The government has been obliged to postpone the realization of some segments and the economic shock of the pandemic has had a big negative impact on economic growth and employment in the Paris region. If it is clear that public transport supply had to be improved in Île-de-France, as in other metropolitan areas, putting the focus only on speed gains was probably too simplistic. Urban accessibility has to be addressed in another way.

### 9.3 From the “Mobility Turn” to the “Accessibility Turn”

“Mobility turn” is an expression proposed by Urry (2007) to sum up the main changes in our way of life due to the development of fast modes of transport. Thanks to speed gains, even in urban areas, people are crossing many kilometers per day with the same travel time budget: around 1 hour

¹ Letter of the Commissioner Louis Schweitzer to the Prime Minister (2016).
per day; that is to say there is a “rebound effect”. Travel speed gains did not lead to a lower consumption of time but to a higher consumption of space. From an individual viewpoint, it is easy to understand that speed gains are extending the scope and intensity of our daily activities. But from a collective viewpoint, especially by taking into account the SDGs, a higher consumption of space implies a lot of external costs (accidents, noise, pollution, CO$_2$ emissions, etc.). Livable cities with a high quality of life have to consider accessibility improvements not only as the result of speed gains. Therefore, public policies have to shift to a new set of measures based on an “accessibility turn”.

9.3.1 The French “Tramway Mania”:
Rediscovering the Quality of Locations

At the beginning of the 20th century, many French cities were equipped with a light rail (i.e., tramway) network (for instance, more than 1,000 kilometers [km] in the Paris agglomeration). But the diffusion of cars and the increasing road traffic lead almost all the municipalities to eliminate the tramway (except some cities like Saint-Étienne), in order to give more space to cars and buses. But it was not the end of the tramway. During the 1990s a “Tramway Mania” was observed in France. Following the pioneer cities (Nantes, Grenoble, and Strasbourg), many large and medium-sized French agglomerations decided to launch (or to relaunch) one or several tramway lines. The list is impressive: Orleans, Lyon, Montpellier, Paris, Marseille, Nice, Toulouse, Nancy, Caen, Clermont-Ferrand, and Bordeaux. Such a rising tide leads us to wonder about the reasons so many cities have followed the example of the three pioneer cities.

If the “mobility turn” did not lead to a lower travel time budget, it is because travel time is not a cost that travelers are trying to reduce. This kind of optimization is valid only in a static approach. But from a dynamic rationale, the main goal of individuals is not to reduce the travel time but to increase the ratio between a given activity and the related generalized cost of transport. Once again, from a collective viewpoint, the quality of life depends on the amount and the quality of opportunities available in different areas. It is therefore necessary to consider not only the cost of travel but the number of accessible amenities, which the concept of accessibility does.

One of the most influential works on accessibility concepts and definitions was produced 60 years ago by Hansen (1959, p.74), who defined “accessibility at point 1 to a particular type of activity at point 2 as directly proportional to the size of the activity at point 2 and inversely proportional to a function of the distance separating the two points.
The total accessibility at point 1 to the activity is the summation of the accessibility to each of the points around point 1.” As a consequence, accessibility incorporates two different aspects: the possibility of social interactions on the one hand and the distance that has to be crossed on the other hand. Because of this double dimension, some approaches of accessibility put more emphasis on the costs of transport, while the others are focused on land use. (See the Appendix for more details of the accessibility concepts).

In a paper presented at a recent International Transport Forum roundtable, Miller (2019) indicated that from an academic perspective, an indicator of accessibility should consider four axioms that lead to four assumptions about how to measure accessibility:

- Travel cost
- Quality of the location, that is to say, its “attractiveness”
- Individual preferences and constraints in determining both travel cost and location attractiveness
- The set of locations to be included in a given accessibility calculation

The second and the fourth axioms must not be neglected. The quality of the location is not only the fruit of the number of the accessible jobs or shops but depends on the quality of life associated to those amenities. It is not enough to have quick access to a job; it is also important to know what kind of other activities and services are available in the surroundings. The focus has not to be put on only one location, for instance, the central business district. Accessibility indicators have to be improved for the whole urban area, especially the peripheries.

As underlined by Martens (2019) at the same roundtable, accessibility indicators must avoid the risk of being polarized in the transportation system, without considering the impacts it may have on the functioning of the metropolitan area. Accessibility indicators have to take into account not only the individual benefits of improving the transport system, but also the collective impacts of accessibility gains on land use. Therefore, the solution lies in considering the density issue as well as all the elements that can help reduce the generalized cost through improvements in comfort, frequency, or reliability, rather than through increased speeds.

Thus, by developing relatively slow transportation means like tramways, during the last 3 decades, the French mobility policies have proposed to the inhabitants to reconsider their own vision of accessibility to urban amenities. Instead of focusing on speed and the distance it gives, city dwellers are invited to consider the advantages of density and of certain closeness in their choices. The zones crossed by
the new tramway lines are made denser again. Along the new tramway lines, new flats and offices have been built, leading to “rebuild the city on the city” as an expression has it in France. It is a good example of the accessibility turn.

9.3.2 The Components of the Accessibility Turn

The main change associated with the accessibility turn is that, within the decision-making process, the quality of the location and its attractiveness becomes more important than the travel cost. This new deal leads to rethink mobility policy and investment, focusing less on increasing speed and individual time gains, but instead improving accessibility by thinking on land use (density, mixed land-use...). Travel speed is not the only factor making urban area attractive. Mixed land use developments that put activities and people closer together at various scales can help keep main characteristics of the city (i.e., a place of interaction) intact (Crozet 2020).

As indicated by Banister (2008), accessibility issues have to cope with the three main challenges of sustainability:

- A social challenge: how can we ensure that the residents of a metropolitan area, irrespective of social rank, continue to have access to all urban amenities? What is called by Martens (2019) a “people-centered approach to accessibility”.
- An environmental challenge because of the external cost of mobility (space consumption, emissions of pollutants, noise, accidents...).
- An economic challenge related to an increasing cost of passengers’ mobility for public finance and for commuters due to congestion.

The accessibility turn needs a simultaneous consideration of these three challenges via the transport system but also on the land use side of equation. By promoting walking, cycling, and public transport, policy makers are setting up another objective. Accessibility improvements are no more obtained mainly by a speed increase but rather by combining increases in density with investment in (slower) but high-quality alternatives to car travel. Public authorities are no more focused on transport as a pure technical problem, but as a component of a system giving the priority to density and land use optimization. They take into account the complex interactions between land use and transport but also social conditions and the environmental challenges of sustainable development. The objective is no more the satisfaction of a given travel demand via adding transport supply without caring about the related feedback mechanisms.
Hence, it is obvious that the accessibility turn can only be achieved if there is a common language for the integration of planning and decision-making between transport and land use development toward the common goal of enhancing the quality of life. This means that a new accessibility paradigm should now lead to a new approach that pursues the collective interest and assesses strategies and measures based on land-use priorities. Sustainability concerns have brought the need for better accessibility to the forefront of policy agenda. Yet, the alignment of accessibility improvement to the SDG objectives must be achieved by improving the urban functions within denser catchment areas of trips, rather than by increasing the size of the catchment areas via higher speed, be it by car or even by public transit.

Focusing on density and multifunctional attractiveness of urban spaces, thanks to the development of public transit, namely, new tramway lines, is important. But this is not enough because it concerns mainly the city center, while the periphery remains mostly in a rationale of urban sprawl. For instance, in the city center of many metropolitan areas, the width of the street has been reduced to the benefit of pedestrians, cyclists, and public transport. But in the peripheries, car dependency remains strong, and it is difficult to fight against it (Crozet 2020). How to implement the accessibility turn in the less dense parts of the agglomeration?

### 9.4 Sustainable Development Goals and Accessibility Issues in the Peripheries

In France, more than two-thirds of the population live in urban areas. But the demographic growth is mainly taking place on the outskirts of urban areas where public transport is poorly developed. As a result, with the exception of the Paris region, more than 70% of working people use the car to get to work (INSEE 2021). Public transport often attracts less than 10% of commuters. This situation invites us to return to the CBA, which makes it possible to understand why, in the urban outskirts, the accessibility turn is less an investment issue than a pricing issue of car use.

#### 9.4.1 Private Costs: Lessons of Accessibility Maps

Let us compare accessibility to jobs with different modes of transport at the scale of the Lyon urban area, 1.5 million inhabitants with only one-third living in the dense part with a high level of public service.
Figure 9.2 presents a gravity-based indicator of accessibility to jobs in the different zones of the conurbation. This indicator has been calculated on the basis of the travel speed, by car or by public transport, and the frequency of peak hour public transport services. The travel cost has been calculated only on the basis of the cost paid by the user (Crozet 2017). It can be seen that accessibility, by public transport or by car, is greatest in the central part of the conurbation, where the job density is the highest. Accessibility decreases the farther one moves from the center. But it does not decrease in the same proportions. In the inner suburban ring, the car provides a level of accessibility which is very much higher than public transport, even though the private cost is 2.5 times higher. This is due to the mean travel speed, which is much higher by car as the public transport network is less dense in this zone. It is therefore not surprising that the car accounts for more than 90% of motorized trips in the peripheral zones of the conurbation. In addition, the fact that the car provides good accessibility to jobs encourages urban sprawl. The increasing attractiveness of the city center and the increase in the number of inhabitants and the population density in the central zone do not prevent major urban development in peripheral areas.
The question that is then posed for public policy makers is whether such urban sprawl is sustainable. Do the accessibility indicators remain the same if we take account of the collective cost of urban travel rather than just its private cost?

**9.4.2 Toward a Distance Fee Paid by Road Users**

What happens to the accessibility maps if we consider the external costs? Figure 9.4 shows the accessibility differential between public transport and the car applying a per kilometer cost for the latter of €0.50, i.e., twice the private cost because of the internalization of the external costs. In the case of public transport, we have kept the cost of €0.10 per kilometer. This map reveals a different situation from Figures 9.2 and 9.3. We can see that public transport provides better accessibility to jobs not only in the central part of the conurbation but also along the major public transport routes. This allows us to better understand the public policies that are pursued in the conurbation, which aim to dissuade the use of cars as much as possible, by imposing additional constraints on speed and the cost of car use (pay parking) and by extending the public transport network, particularly the tramway lines (Crozet 2017).

We can see that, in many ways, accessibility is better for public transport than the car. However, it is noteworthy that even though the
cost of a car is five times higher than that public transport, in some peripheries not well connected to public transport, the car still have an advantage. It is therefore legitimate to ask if it is financially justifiable to seek to improve public transport acceptability “whatever it takes” in peripheral zones. When accessibility is better for the car, even by internalizing the external costs of the car, the first option is neither to invest in new roads nor to invest in new public transport lines (trains or buses), but to increase the cost paid by car users.

Cars have to be considered because of their impact in terms of pollution, congestion, or accidents. Therefore, a kind of “car containment” is necessary. If the car remains an important mode of transport, it is necessary to introduce a road pricing scheme taking into account the external costs of road traffic, including the use of road infrastructure. But the design of these pricing mechanisms need to be well informed from the equity perspective. According to the mobility needs of different user groups, the pricing mechanisms must be designed fairly, and the CBA can help design a fair urban road pricing by addressing the acceptability issues (Crozet and Mercier 2017). It is also important to notice that pricing alone is not enough. The objective of road pricing is not only to reduce congestion. The road pricing scheme is just a component of
an urban mobility package, including the development of public transit, more public space for two-wheelers and pedestrians, and in the coming years shared mobility (Crozet 2020).

9.5 Conclusion

As part of the cost-benefit analysis, economists have incorporated travel time into their calculations to define individual and collective utility. For this, they considered time as a major component of the generalized cost of transport. The logical result of this choice is to give a key role to speed. The higher it is, the lower the generalized cost, increasing consumer, surplus and collective welfare accordingly. For this reason, many transport projects today are still focused on improving travel speed, whether in urban areas or for long distances. But in both cases, this is done today at the cost of decreasing returns. As we have shown with the example of the Grand Paris Express, significant public subsidies are necessary, which do not compensate for time savings.

For environmental, economic, and social reasons, it is therefore necessary to change the paradigm. In the light of the SDGs defined by the United Nations, mobility must abandon the logic of “always more”. Public policies must redefine their objectives. Today, it is no longer a question of improving accessibility at all costs. As the return of tramways in many French cities has shown, urban densification, reliability and frequency of transport services are more important than speed.

However, public transport cannot meet all travel needs, especially in the urban outskirts, where the population is constantly growing. In these areas, the car retains a significant market share. This situation will continue with the diffusion of electric cars, which emit less nuisance. Also, contrary to past trends, the regulation of road traffic is now done via an increase in the general cost of travel: lower average speeds and higher monetary cost. Nothing else than an accessibility turn!
References


Appendix

Accessibility and Urban Accessibility: Some Issues

Accessibility is defined as a function of accessible amenities on the one hand and transport supply on the other hand (Hansen 1959).

\[ A_i = \sum_j D_j f(c_{ij}) \]

With,

- \( A_i \) = Accessibility to destinations \( D \) from point \( i \)
- \( D_j \) = Activity at points \( j \)
- \( c_{ij} \) = Generalized costs (time, price, comfort... of the trip)

When a gravity-based metric of accessibility to urban jobs (\( E \)) is chosen, the function of Hansen’s formula becomes a negative exponential. The measure of accessibility (\( A \)) from zone \( i \) to all opportunities (\( E \)) located in zone \( j \) is written:

\[ A_i = \sum_{j=1}^{n} E_j \exp(-\beta c_{ij}) \]

This equation actually contains:

- The travel “disutility” or “impedance” is measured by the generalized cost. The choice of a negative exponential function leads to accessibility decreasing rapidly if the generalized cost of transport increases.
- The generalized cost takes into account an objective value, the monetary cost, but also a subjective value, the time cost. It depends on the value of the time and therefore the assumptions are made about the preferences and the individual constraints, which are also integrated in the value given to the parameter \( \beta \) reflecting the sensitivity to the cost of trip.
- The location “attractiveness” depends on the kind of chosen opportunities, for instance, the number of jobs.
- The set of locations depends on the size of the area considered as relevant for the measurement of accessibility.
Looking at these assumptions, we realize that the choices made to define the accessibility index can be biased. The monetary measure of the value of time leads to a cardinal approach that strongly values the surplus gains resulting from an increased speed, especially for the few people having a high value of time. The value of the parameter $\beta$, even if it is made on the basis of observed behavior, also affects the results. In other words, even when accessibility is measured using a scientific, positive approach, the normative dimension of the results should still be questioned.
10

Evaluation of Road Projects in Japan: Efforts to Evaluate Disaster Prevention

Mitsuhiro Yao

10.1 Introduction

This chapter explores the historical background of project evaluation in Japan. Project evaluation began with an instruction from Prime Minister Ryutaro Hashimoto in December 1997. The Prime Minister instructed ministries related to public works projects, including the Ministry of Land, Infrastructure, Transport and Tourism (MLIT), to implement project evaluation at the construction stage and to utilize cost-benefit analysis (CBA) for project approval in response to criticisms of public works projects such as cost escalation, environmental impact, and project delay. In line with this instruction, project evaluation for approval, including CBA and project reevaluation at the construction stage, has been implemented since 1999. In addition, evaluation after project completion was introduced in 2003 (Table 10.1).

Focusing on road projects, before the instruction of the Prime Minister, the Road Bureau of the MLIT had been carrying out trial implementation of CBA for several national highway projects since the late 1990s. After the trials, the Road Bureau established a project evaluation system based on the instruction. The Road Bureau has been conducting project evaluation for all its projects and requesting all local governments to introduce the same evaluation system for their projects. As for now, almost all the projects were evaluated before, during, and after construction in line with each project evaluation manual.

From a legal view, the Policy Evaluations Act was enacted in 2001 and all kinds of evaluations, including project evaluation and policy evaluation of regulations, were reorganized by this act. This act covers all kinds of evaluations carried out by related ministries. In line with
the act, the Basic Policy on Administrative Evaluation was formulated by the Ministry of Internal Affairs and Communications. Based on the formulated basic policy, the MLIT drew up the Basic Plan, covering policy assessment, policy checks, individual public works evaluation, evaluation of individual research and development proposals, policy evaluation of regulations, and evaluation of special taxation measures. Table 10.2 provides a brief explanation of each evaluation. Public works project evaluation is categorized into Individual Public Works Evaluation.

<table>
<thead>
<tr>
<th>Table 10.1: History of Introduction of Project Evaluation System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dec 1997</td>
</tr>
<tr>
<td>Mar 1998</td>
</tr>
<tr>
<td>Apr 1999</td>
</tr>
<tr>
<td>Aug 2001</td>
</tr>
<tr>
<td>Apr 2003</td>
</tr>
</tbody>
</table>

Source: Data organized by author.

<table>
<thead>
<tr>
<th>Table 10.2: Explanation of Evaluation Method Conducted by MLIT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Policy assessment</strong> (project evaluation method)</td>
</tr>
<tr>
<td><strong>Policy check</strong> (performance evaluation method)</td>
</tr>
<tr>
<td><strong>Individual public works evaluation</strong> (project evaluation method)</td>
</tr>
<tr>
<td><strong>Evaluation of individual R&amp;D proposals</strong> (Project evaluation method)</td>
</tr>
<tr>
<td><strong>Policy evaluation of regulations</strong> (project evaluation method)</td>
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<tr>
<td><strong>Evaluation of special taxation measures</strong> (project evaluation method)</td>
</tr>
</tbody>
</table>

MLIT = Ministry of Land, Infrastructure, Transport and Tourism, R&D = research and development.

10.2 Summary of Project Evaluation System

Focusing on the public works evaluation system (Figure 10.1), all public works projects such as highway projects, dam projects, and so on, are evaluated by the national or local government. In the case of highway projects, evaluation can be divided into four stages: planning, project approval, construction, and completion. All highway projects need to receive all kinds of project evaluation at each stage. Brief explanations are given for each project evaluation as follows.

10.2.1 Evaluation at the Planning Stage

At the planning stage, several project proposals based on the identified political objectives are compared and evaluated by a third party, consisting of scholars and experts, before approval of a road project. Necessity and validity of the project are examined at this stage. The evaluation system was introduced in 2010 and the accumulated total number of national projects evaluated is 64. Ten national projects were evaluated in 2020.

10.2.3 Pre-project Evaluation for Project Approval

After confirming the preconditions for adopting the project, whether to adopt the project is determined by looking over the cost-benefit analysis, the impact of the project, and the project implementation environment. Budget allocation is determined after approval of the project. Pre-project evaluation is important in that the evaluation result directly connects with whether the project has a budget or not. Therefore, it is not too much to say that the result of pre-project evaluation attracts the most public attention.

As is often the case with many countries, benefit-by-cost (B/C) value included in the pre-project evaluation, also attracts public attention because the result of the evaluation has much influence on budget allocation, and B/C is easy to understand at a glance. However, close attention should be paid to the fact that B/C is merely one of the important indexes to evaluate the project. The evaluation system was introduced in 1998 and the accumulated total number of national projects evaluated is 1,767. In 2020, 45 national projects were evaluated.

10.2.3 Reevaluation Under Construction

The project is reevaluated every 5 years after the construction work starts until project completion. To be exact, reevaluation of the project is also conducted 3 years after approval. This evaluation system was
introduced mainly because (i) there is a possibility that the social and economic conditions surrounding the evaluated project would change drastically as many public works projects take a considerably long time to complete, and (ii) the long execution period of a project might lead to price escalation. When no improvement and progress were found, the project was suspended or terminated. The evaluation system was introduced in 1998 and the accumulated total number of national projects evaluated is 5,615. Eighty-six projects were readjusted and 34 projects terminated. In 2020, 187 projects were evaluated with the result were cancelled or terminated.

10.2.4 Post Evaluation After Project Completion

Post evaluation is carried out within 5 years after project completion in order to confirm the effectiveness and environmental impacts of a completed project. As necessary, improvements and appropriate planning and research for similar projects are examined. The evaluation system was introduced in 1988 and the accumulated total number of national projects evaluated is 596. In 2020, 33 national projects were evaluated.

Disaster prevention function evaluation, which is discussed in Section 10.3, was introduced in pre-project evaluation for project approval. Pre-project evaluation includes (i) cost-benefit analysis where

![Figure 10.1: Project Evaluation at Each Stage (before, during, and after construction)](image-url)
the project cost is examined against three benefits of travel time saving, operating cost saving, and accident cost saving; (ii) project impacts on motorists and pedestrians in terms of congestion mitigation, accident reduction, and better walking space; (iii) impact on society in terms of life of residents (access to medical facilities etc.), regional economy, and the environment; and (iv) project environment, including relationship with other programs and residents’ cooperation. However, the disaster prevention function was not covered when the evaluation system began in 1998.

10.3 Beginning of Disaster Prevention Function Evaluation

Japan focused on the B/C value from the latter half of the 1990s to the early 2000s, although it is merely one index to examine a project. However, the B/C value has attracted many people including discussions on whether projects with B/C values of less than 1.0 should be approved. Other issues noted are that projects in rural areas are at a disadvantage in terms of relatively small traffic volume; that the B/C does not include disaster impact or environmental impact at all; and that such negative impacts as environmental impact should be capitalized and included as a minus benefit, and so on.

One of the biggest triggers to reconsider the benefit impact of infrastructure regarding the disaster prevention function is the Great East Japan Earthquake that occurred on 11 March 2011. The earthquake with magnitude of 9.0 was so large that it brought a tsunami of over 7 meters high to areas such as Soma and Miyako. An overview of the Great East Japan Earthquake is summarized in Table 10.3.

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<thead>
<tr>
<th>Date and time of incident</th>
<th>Friday, 11 March 2011, around 14:46</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seismic intensity level</td>
<td>9.0 (provisional value)</td>
</tr>
<tr>
<td>Location and depth</td>
<td>Off the coast of Sanriku (approximately 130 km east-southeast of Oshika Peninsula), approximately 24 km deep (provisional value)</td>
</tr>
<tr>
<td>Seismic intensity of main regions</td>
<td>Seismic intensity level of 7: northern Miyagi Seismic intensity level of 6 higher: southern and central Miyagi Prefecture, Nakadori and Hamadori in Fukushima Prefecture</td>
</tr>
<tr>
<td>Tsunami readings observed at major tide stations (as of 13 April, 16:00)</td>
<td>Soma: maximum height – over 9.3 m, 11 March, 15:51 Miyako: maximum height – over 8.5 m, 11 March, 15:26 Ofunato: maximum height – over 8.0 m, 11 March, 15:18 Ayukawa, Ishinomaki: maximum height – over 7.6 m</td>
</tr>
</tbody>
</table>

km = kilometer, m = meter.

The earthquake killed about 16,000 people and severely damaged existing infrastructure. The reported damage caused by the Great East Japan Earthquake is listed in Table 10.4. However, expressways that were on high ground, taking consideration of a tsunami, were still under operation and served as emergency transportation routes for residents to evacuate. The expressways also accelerated the recovery of the damaged area along the sea. For example, the partially opened section of the Sanriku Longitudinal Expressway contributed to evacuation and recovery, because it has received no damage from tsunami, while National Highway Route 45 was severely damaged and all traffic was blocked. In addition, about 60 residents evacuated to Miyako Road by climbing up its embankment to escape the tsunami. However, such disaster prevention function of expressways or roads as a lifeline had not been fully considered in previous project evaluations.

Table 10.4: Reported Damage Caused by the Great East Japan Earthquake

| Number of people missing and dead | Dead: 15,885 people  
Missing: 2,623 people  
(reported by police on 10 April 2014) |
| Building damage (houses) | Completely destroyed: 127,305  
Half-destroyed: 272,941  
Partly destroyed: 741,752  
Total/half loss by fire: 297  
(reported by police on 10 April 2014) |
| Number of evacuees | 263,392 (reported by Reconstruction Agency on 10 April 2014)  
468,653 (14 March 2011, when the number of evacuees peaked) |
| Damage to nationally managed rivers | 2,115 sections were damaged (reported by MLIT) |
| Damage to bank revetment | A total of 190 km-long revetment out of 300 km were completely or half-destroyed in Iwate, Miyagi, and Fukushima prefectures. |
| Damage to ports | Number of damaged international and major ports: 11  
Number of damaged local ports: 18 (reported by MLIT) |
| Damage to sewerage and wastewater | Damage was found at 54 treatment facilities and 71 pumping facilities in 11 prefectures  
Sewage drains were also damaged (reported by MLIT) |
| Damaged roads | 15 expressways, 69 sections of national highways, 102 sections of national highways managed by prefectures, and 540 sections of prefectural roads (reported by MLIT) |
| Flooded areas | 58 km² in Iwate, 327 km² in Miyagi, and 112 km² in Fukushima (reported by Geographic Survey Institute) |

km = kilometer, km² = square kilometer, MLIT = Ministry of Land, Infrastructure, Transport, and Tourism.

10.4 Disaster Prevention Function 
Evaluation Method

Based on the Great East Japan Earthquake experience, a new method to evaluate the disaster prevention function was introduced first into pre-project evaluation for project approval in fiscal year 2011, resulting in revisions to the earlier manual in 2015.

In the revised manual, the target disasters were defined as earthquakes, tsunamis, heavy rain, heavy snow, and volcanic eruptions. Disaster scenarios are drawn according to local conditions, including disaster characteristics. If the area is prone only to typhoons or earthquakes, the two disaster types have been chosen for disaster scenarios to examine the project effects. In the disaster prevention function analysis for expressway projects, such hubs as ports, interchanges, and main local government buildings are classified into four categories: wide area hub, transportation hub, regional hub, and disaster-stricken hub. For example, main local government buildings that are expected to work as disaster centers are classified in the wide area hub category. The transportation hubs include ports and interchanges of expressways, which are key infrastructure bases for transport during disasters.

“Vulnerability” is redefined in the evaluation of disaster prevention function as the degree of vulnerability of the road network to disasters. The calculation method is as follows:

(i) Select two hubs and calculate travel time between the two hubs for each route;
(ii) Calculate the re-defined vulnerability as follows, which is the degree of change in travel time between normal and disaster conditions; and

\[
\text{vulnerability} = 1 - \frac{\text{Travel time under normal conditions}}{\text{Travel time during disasters}}
\]

(iii) Evaluate location pairs consistent with the disaster reduction strategy and rank them A to D according to the degree of change in travel time (Table 10.5).

The disaster vulnerability index value ranges from 0 to 1, and the bigger the value, the more vulnerable to disasters the area is. In other words, the route can be recognized as resilient to assumed disaster when the index value is 0. The method does not include complicated calculation so that it is not difficult to understand. This is one of the key points when developing a new index for project evaluation. The method should be simple enough to understand. It is true that each project should be evaluated carefully from many aspects, however, the evaluation method should be understandable even for laypersons.
The MLIT published the calculation results of location pair rank in the Shikoku area. Its size is 19,000 km², accounting for 5% of Japan’s total area, and with about 3.7 million residents living along the coast, while the central area is mountainous. The population density is 200 km⁻². The southern area has many ranked D-hub connections, than the northern area. This means that the road network in the northern area is well-developed, while it is not so well-developed in the southern area.

There are similar calculation results of location pair rank in the Kyushu area, which is located in the south of Japan. Its size is 45,000 km², accounting for 12% of Japan, and with about 14 million residents. The population density is 318 per km². The Kyushu area is known for its many earthquakes and typhoons. It has so many volcanoes and active faults that many earthquakes have occurred in the area. Therefore, multiple disaster scenarios (i.e., earthquakes, heavy rain) are assumed to evaluate disaster prevention functions. The number of D-rank location pairs in the earthquake scenario and the heavy rain scenario are 107 and 27, respectively. In terms of disaster prevention, the number of D-rank connections should be decreased with new or ongoing highway projects.

### 10.5 Example of Disaster Prevention Function Evaluation

Japan has many kinds of disasters. Twenty percent of all earthquakes with magnitude six or over are concentrated on a small island. In addition, Japan experiences on average about 10 typhoons each year, causing heavy rains every time. Thus, several scenarios should be assumed to evaluate disaster prevention functions based on disaster characteristics. The MLIT published the result of disaster prevention analysis carried out in Japan.

#### Table 10.5: Classification of Location Pair Rank

<table>
<thead>
<tr>
<th>Rank</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0 Times of disaster and normal times are the same</td>
</tr>
<tr>
<td>B</td>
<td>0–1/3 Times of disaster less than 1.5 times that of normal times</td>
</tr>
<tr>
<td>C</td>
<td>1/3–1 Times of disaster 1.5 times more than normal times</td>
</tr>
<tr>
<td>D</td>
<td>1 Unreachable in times of disaster</td>
</tr>
</tbody>
</table>

out for National Highway Route 55 (“Anan–Aki Expressway”) in the Shikoku area.² The evaluation of location pairs are consistent with the disaster reduction strategy and visualizes the disaster prevention impact of National Highway Route 55. In reality, the project started after the Great East Japan Earthquake has improved the vulnerability of the two location pairs, from D rank to B rank, exemplified by the pair connecting the Kochi Prefectural Office and Aki City.

10.6 Conclusion

Road infrastructure is essential to human flow and logistics. The novel coronavirus disease (COVID-19) pandemic is not a natural disaster; however, it reminded us of how important it is to keep roads operative and safe under such natural disasters as earthquakes and typhoons did. Roads play a wide range of roles, and it is difficult to evaluate them adequately based on the cost-benefit analysis (CBA) alone. In Japan, project evaluations are carried out after confirming an investment’s efficiency through CBA and comprehensively considering factors such as traffic congestion, traffic accidents, disasters, and residents’ cooperation before deciding on project implementation. Many natural disasters occur in Japan, and a new disaster prevention function assessment has been introduced based on the Great East Japan Earthquake experience in 2011. This assessment is not a concept of traffic volume efficiency but a completely new concept that evaluates the right of the people living in the area in terms of whether the regions are connected in the event of a disaster. In order to properly evaluate the various effects of road projects, it is necessary to improve the sophistication of evaluation methods and review them from time to time, following the changing values and needs of society. For example, demand for home deliveries increased due to people refraining from going out and avoiding being in close quarters with others due to the spread of COVID-19, but it is difficult to understand the effects of road maintenance in supporting these logistics. Besides, it seems impossible to predict in which aspects projects are reviewed when understanding the effects of road maintenance, assuming that the spread of electric vehicles will be accelerated in the future. Furthermore, it is also difficult to see whether it is appropriate to measure road maintenance effects based on maintenance duration when self-driving cars are widespread in society and in-vehicle activities have changed.

PART III

The Future of Project Evaluation: Applying the Quality of Life Approach
Part III  
Key Messages  

*Nghia Nguyen*

Part III appraises the quality of life (QOL) accessibility method’s applicability for developing countries and in the post-COVID-19 context. The chapters in this part are adapted from the comments of James Leather and the panel discussion between speakers and Junyi Zhang in the symposium.

**Chapter 11** presents the QOL method and case studies presented in Parts I and II from the perspective of the Asian Development Bank (ADB) and developing countries. In fact, the QOL method is aligned with ADB’s research. From the perspective of a development institution, this chapter also seeks to examine some of these broader impacts, while at the same time localizing them within the developing member countries of the Asia and Pacific region.

**Chapter 12** focuses on ideas and issues of the QOL approach in the post-COVID-19 era through the panel discussion of experts with different knowledge and backgrounds, emphasizing the importance of the transportation system associated with the QOL of citizens in every aspect. The chapter discusses the possibility to design systems that can improve the QOL and meet the needs of people under the central agenda.

**Chapter 13** discusses the applicability of the QOL accessibility method over the traditional cost-benefit analysis (CBA) with the objectives of the development of travel policies and achievements of the Sustainable Development Goals, using the example of the Chubu-Oudan Expressway in Japan. However, the chapter suggests an integrated approach between the QOL method with the traditional CBA to evaluate the cost-effectiveness of projects and policies in the future to generate better results in terms of monetizing and perceived value from the national, regional, and provincial levels to the individual level.
11

Developing a Country Perspective on the Quality of Life Method

James Leather, Chanankarn Boonyotsawad, and Veronica Ern Hui Wee

11.1 Introduction

This chapter discusses the quality of life (QOL) method and case studies presented in Parts I and II of this edited volume from the perspective of the Asian Development Bank (ADB) and developing countries, as raised by James Leather during the international symposium on “Mainstreaming Quality of Life in Evaluation of Transport and Spatial Planning” held on 19 April 2021. From the perspective of a development institution, this chapter also seeks to examine some of these broader impacts, while at the same time localizing them within the developing member countries of the Asia and Pacific region.

11.2 Links to the Work of the Asian Development Bank

The QOL method parallels ADB’s research on the monetization of noneconomic benefits. ADB previously examined the broader assessment portfolio that is being used in Europe, which is discussed in Part II of this edited volume. It is a sustainable transport appraisal rating that provides a quantitative and qualitative assessment of economic, 

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1 This chapter is adapted from the comments by James Leather in Session 2 of the International Symposium on “Mainstreaming Quality of Life in Evaluation of Transport and Spatial Planning” held on 19 April 2021 and was prepared by Chanankarn Boonyotsawad (intern, ADBI) and Veronica Wee (CBT associate, ADBI).
social, environmental, and risk project implementation and project cost, which helps to address the issue of optimism bias.

The walkability indicator, discussed in Chapter 2 of this volume, was also an indicator that ADB has used, particularly when looking at urban livability. One of the priority areas under ADB’s new strategy is “livable cities”, so developing walkability and a wide range of transport options and solutions are a priority.

11.3 Scale of Evaluation

An interesting consideration is the scale at which evaluation occurs. In the past, ADB provided a lot of physical infrastructure, such as building several hundred kilometers of railway lines and upgrading several hundred kilometers of road. However, when looking at large-scale goals, like the Sustainable Development Goals (SDGs) or the Paris Agreement on climate change, it is crucial to understand what is happening in terms of network impacts in order to see significant improvements at a country-level for meeting the SDGs and the Paris Agreement. An example would be, for rural connectivity, for people living within 2 kilometers of an all-season road, you need to look at and manage the whole road network. By providing physical infrastructure or assessment of one-off infrastructure, there can be an impact in itself, but the impact is not known across the whole network.

A similar idea is applied to road safety. In order to build safer roads, we must do our best to incorporate a safe system around those roads that covers safe vehicles, vulnerable road users, post-crash car insurance, and even behavioral components, such as speed safety, helmet wearing, seat belt wearing, etc. The question is whether a project can be designed to have a meaningful impact on the whole road system as opposed to the 100 kilometers of road covered by a single infrastructure project. The scale is important, particularly when looking at evaluation of the large-scale goals, such as the SDGs and the QOL.

However, it is interesting to note that the QOL method can be applied at a variety of scales. The discussion in Chapter 4 on connectivity is reminiscent of a debate on transport-oriented development. That was usually focused on mega-cities, but the example in Chapter 4 was related to small communities and consolidating facilities together. It scrutinizes how to replicate those village communities to create the QOL within a city context, as in Singapore. That is why Singapore is always highlighted as an outstanding city in terms of land use and accessibility. The city center and the facilities and services around those areas are developed in order to connect the areas together. As was highlighted in terms of the smaller communities, how you conglomerate the particular
facilities that are needed even at a small level can be similar to that of a big city like Singapore.

11.4 Comments on Differences between People

A key element of the QOL method is its consideration for the differences between people and evaluation of their different needs. There are some factors to further note in the application of this evaluation method.

First, the dimensions considered by the QOL method are discussed. The case study applications of the QOL method highlighted personal attributes such as age and gender. As has been demonstrated, as we are getting older, our priorities change, and the priorities of men and women are different. However, from the perspective of a development agency such as ADB, the disposable income dimension is also a key factor to be considered as a dimension that is essential for people’s quality of life.

Second, the lack of user choice must be taken into account. From a development point of view, in urban areas, many public transport users are so-called “captive users” who have no choice. It is not a situation of deciding between a private car or public transport for daily commuting. It is important to note that these users have no options to public transport. Their only option is to walk for several hours or use the often-poor and inconvenient public transport system.

Finally, there is a push for emergent solutions for urban transport that can guide an evaluation method that is sensitive to varying needs across the population. Shared bikes and shared scooters, for example, which are a part of the transport system, are not going to provide a sufficient solution. They are a niche transport mode for certain areas and not everyone wants to use a scooter. That is why we must provide a wide range of transport systems and services that are suitable for the whole population. Disaggregating the information regarding the population’s age and gender is useful for consideration in supporting this.

11.5 Lack of Data

A major drawback to this method is that it is underpinned by huge data. This kind of model is data intensive. In most developing countries, especially in the Asia and Pacific region, there is a lack of data. Where there is sufficient data, they are not disaggregated enough to reach the required level to apply the QOL method. This has been an issue in how we undertake the fundamental economic analysis. For example, do we know the costs of operating a vehicle and if we do not know, what will the vehicle mix be? Can we measure the carbon dioxide emissions?
Do we know the numbers of diesel and gasoline vehicles, if we are looking at particulate matter, vehicle-kilometers travelled, or such?

### 11.6 Further Evolution of the Evaluation Model

The dimensions and challenges of evaluation will change and evolve over time, and new areas must be incorporated. So, even if we try to identify what is important for a high quality of life now, it may change in the future and, as all the presentations showed, it varies by gender and age. From a development point of view, an added focus on income is needed. Furthermore, in terms of externalities, there needs to be further innovation on how to quantify and measure these negative externalities, for example, in terms of transport, externalities such as road safety, air pollution, and climate change impacts. For the externalities, whether it is in terms of quality of life or street dimensions, how can they be monetized or otherwise valued? Can it be used in similar areas within transport? These are areas that need to be addressed but we are struggling, given the current limited ability for monitoring and measuring.

However, with new technology, we can access the data in a variety of ways than was possible in the past. In the past when studying transportation, researchers had to stand on the side of the road with a clicker and count the cars. Now, researchers can use satellite imaging and little widgets in car engines to assess emissions and usage. We can now get to a point where we could use data in almost real time to understand what people’s choices are and how they take advantage of those choices.

All in all, the quality of life is a promising indicator and can be used in different ways in a range of different cities. Moving forward, the crucial issue to be addressed is how to get sufficient and sensible data for the model to be applied.
12

Project Evaluation
in the Post-COVID-19 Era

KE Seetha Ram and Chanankarn Boonyotsawad

12.1 Introduction

Compared to the preceding perspectives and research, the quality of life (QOL) approach could be regarded as a unique methodology that relates to people's lives in all dimensions. It also links to the Sustainable Development Goals, which are mutually important international goals to improve the quality of life for a high income and equitable population.

The critical question is how can the QOL approach be applied for project evaluation or be combined with cost-benefit analysis, a traditional method that has been used previously? Also, one of the challenges, particularly in developing countries, is the availability of data, as discussed in Chapter 11. This chapter discusses ideas and issues related to the QOL approach from the panel discussion between experts with different knowledge and backgrounds, which allows readers to benefit from divergent perspectives.

The novel coronavirus disease (COVID-19) pandemic since 2019 has affected people’s lives in all dimensions. Daily life and working style have changed, and travel in particular has been reduced or disrupted. These have had a massive impact on the economy.

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1 This chapter is adapted from the panel discussion in Session 3 of the international symposium on “Mainstreaming Quality of Life in Evaluation of Transport and Spatial Planning” held on 19 April 2021 and was prepared by Chanankarn Boonyotsawad (intern, ADBI) under guidance of Veronica Wee (CBT associate, ADBI).
12.2 Predictions for Post-COVID-19 Era Transport

All our assumptions on transportation is that it could help the economy. Now they are being challenged because we are under an unstable transportation situation. The economy collapsed, so we are stuck. KE Seetharam from the Asian Development Bank Institute asked, “From now on, what are the perceptions that people have regarding transportation after the COVID-19 pandemic? What should be the priorities of the post-COVID-19 era transport policy?”

Junyi Zhang of Hiroshima University emphasized the QOL approach that might be a new method to evaluate and forecast policy to reach people’s requirements. He said “When I heard about the term ‘evaluations’, I remember my time when I worked as a consultant in Tokyo more than 15 years ago. We did a lot of work on cost-benefit analysis and applied those to some difficult models to evaluate and to meet the requirements of the Ministry of Transport and municipalities to help them assess different transportation policies or transportation projects.”

COVID-19 brought many changes. Some people may feel happier because they can stay at home and work, but some people feel deeply unhappy because they lost their careers and cannot find a new job because of the restricted accessibility. Some people miss traveling because they prefer face-to-face communication. The COVID-19 pandemic changed people’s behavior, which is an important consideration. So, we need to emphasize people’s behavioral changes in policy making in the future and discuss how to evaluate projects or plans.

The existing approach always considers cost-effectiveness by calculating the benefits and costs in terms of money, but, in reality, it is difficult to monetize everything. For example, once we construct roads, we expect time saving, and then time saving brings some benefits such as job opportunities and market accessibility, and these affect the economy. Any improvement to transportation can bring benefits to society, but these benefits may not be allocated to all people equally as in the sense of Hayashi’s quality of life (QOL) approach (as discussed in Chapter 3 of this volume). Zhang added “I appreciate the individual variation in the benefits calculation from the projects because, in this world, we have various societies that we need to concern and relate to life balancing. It is a very comprehensive framework.”
12.3 Critique of the Quality of Life Method

Zhang further noted that he was concerned about the definition of QOL since it depends on each person’s background. Therefore, the meaning will be different. He cited Veenhoven’s work (2006) that describes of QOL in four dimensions: livability of the environment, life ability of the individual, external utility of life, and inner appreciation of life. Livability of the environment refers to the habitability of an environment. The life ability of the individual represents how the individual can be equipped to deal with the problems of life. Therefore, we can assume that transportation is closely related to the first and second dimensions.

Zhang asked, how do you feel when you walk on an accessible road to go to a beautiful park? When you talk about QOL, do you refer to, for example, accessible transportation project benefits? Do you talk about how much a transportation project brings more chances for people to go to different places to access jobs, hospitals, and other urban facilities? If you mean something in that sense, QOL is a chance for everyone. In that sense, we can imply that surrounding people with a good environment can make people perceive the quality.

Not only a chance, but it is also a choice of life. For instance, building good quality roads for bicycles so people can have healthier lives, but there should be other alternatives for people who do not use bicycles. All people should gain benefits when they use the same road. That is my key point. Zhang said that people have the chance to make opportunities for their own different stories.

Zhang noted that his last concern is how we can invest in transportation to improve the local city environment to attract people to come back to the city?

Roger Vickerman from the University of Kent and Imperial College London gave his perspective about the QOL approach that brings us different evaluation dimensions. “I think it is important to remember that cost-benefit analysis is not strictly speaking about measuring GDP. It is about measuring welfare, and I think we need to think about how welfare relates to the quality of life rather than how the quality of life relates to GDP.”

He further noted that we are moving toward a post-COVID-19 era. According to the effects of the pandemic, people change their behavior, including the way they use transportation. For example, they may avoid traveling in peak hours or go to the office only 3 days a week rather than 5 days a week because they can work from home and because they are fearful of the virus despite little evidence that the virus rests on surfaces.
in public transport, or it can be transmitted through droplets in the air on public transport because public transport is notably clean compared to other places.

Our cities have not been built for cycling and walking. So, we occasionally see pop-up cycle lanes, which annoy people who use the road, especially in major cities. We have to consider how we can redesign cities and remodel transportation systems. These are huge challenges we will experience.

Yves Crozet, from the Institute of Political Studies, University of Lyon, remarked on the conflict between the objective of quality of life (QOL) and the former cost-benefit analysis (CBA) method. If you consider CBA, you will have a lot of different dimensions to take into account. But finally, you will have only one index, which is the monetary dimension. In contrast, if you look at QOL, you will have a lot of different dimensions, and they are related to the Sustainable Development Goals. For the public decision-maker, one of those goals may be more important than the others. But what is the significant indicator of QOL that you have to consider?

Mitsuhiro Yao, director of International Affairs Office, Planning Division, Road Bureau at Ministry of Land, Infrastructure, Transportation and Tourism of Japan, said, “I am not familiar with the quality of life approach, but I have some comments regarding the COVID-19 pandemic. I was in charge of emergency aid related to the severe acute respiratory syndrome (SARS) pandemic in the People’s Republic of China in 2002, so I had a duty to support the government to recover from the SARS pandemic. What I found after the pandemic is that everything recovered very well in a short time compared to the case of COVID-19. SARS did not have a big impact on global travel. In the case of COVID-19, governments chose to restrict travel.”

Werner Rothengatter, from the Karlsruhe Institute of Technology, noted that the aspect of environment-friendly transport is not merely to increase walking and cycling in a city. He raised the example of Copenhagen, which took 30 years to transform the city to become a bike-friendly city. Now, city transportation is 50% biking and only 25% car traffic. There were many transformations through better infrastructure, systematic preference, and political preference for bikers and nonmotorized transportation.

Next, he noted that the traditional cost-benefit analysis approach has been based on the welfare concept and not on the base of the GDP concept, but it was too narrow. It concentrated only on the generalized cost, whereas time savings, cost savings, and others will be evaluated at very narrow approaches such as the CO₂ emissions evaluation for climate change. Because of that reason, the welfare-based concept evaluation
should be extended. It is not only the impact on the transportation market, but it is also the impact on all markets for products influenced by transportation. This is a basic difference, and the next step is to combine the transportation impacts with economic prosperity.

Friedrich List, a German economist, convinced Germany in 1834 to catch up with the United Kingdom, a leading economy around 1840, by integrating and investing in transportation, particularly railways. List assumed that the railway system would connect all the regions and the economic prospects could generate growth.

Rothengatter then moved on to address the new evaluation method, quality of life (QOL). He echoed James Leather’s concerns on the data requirements for additional analysis of the QOL and other elements of integrated assessment. We indeed need more data and more complex models. However, first, we have to address that the modeling part, along with a sound basis of the results, is very transparent and simple for the politicians and every person can understand the same message. We can learn from climate change research how they did. I think we can do it also for transportation systems. So, it cannot be only an assessment of a project of the whole system. Furthermore, we have to extend the assessment also to the quality of life aspects although we cannot quantify all of these impacts in monetary terms.

The above message shows that the transportation system is related to QOL in every aspect. However, because of the difficulty in renovating city plans or investing in the transportation system requires a large budget, people in many countries choose to solve the problem independently.

12.4 Impact of COVID-19 on Developing Countries

We have heard that after the pandemic, developing countries have reported more sales of motor cars because people are afraid to use public transport and they do not have much choice to use nonmotorized transport. So, they have ended up using more cars, which seems good for some auto companies but worse in increasing traffic jams. Seetharam queried what is the scenario for developing countries?

Yoshitsugu Hayashi from Chubu University gave his perspective about the quality of life for developing countries: “I have been very much fascinated by a variety of thoughts on evaluation of transport projects. From mega city to local area, yes, we are applying. From mega transport systems such as high-speed rail to connect long-distance cities to local street redesign to be more walkable or bikeable are all important
to quality of life as Zhang said. That is a huge paradigm shift. In the 20th century, the concept was people for the economy. It is a labor force for the economy. Now, we are in the 21st century, the concept has changed. It is now the economy for people. So, economic enhancement is not bad, but it should be used for people. That is one tremendous change.”

Hayashi added that for both developed and developing countries in the post-COVID-19 era, they have not sought economic growth. They might have other things that concern them. So, they should start with the quality of life. Life means living and alive. The economy is only an input to the life aspect, but the quality of life is a perception of life. So, that is very different.

“That is why I was so much concerned to figure out a common base indicator. When I was involved in assessing the Tokyo Bay bridge project, I applied the cost-benefit analysis approach to evaluate the impact. It showed that if a project had more traffic, it is a better project than others. Then, I was curious why a project that has many numbers of people driving is much better, so I started studying the quality of life approach.”

In the COVID-19 pandemic, transport may be considered as a kind of virus carrier, and that is a negative side of it. Somehow, we can prove this fact by research.

Vickerman added “I think it does demonstrate the vibrancy of research and our willingness to try and get to grips with some of the real challenges the world faces in the future. We have been doing it for a long time. Then I think we have got to continue doing it.”

Crozet noted that it is clear that the more you increase the GDP, the more you have perverse effects.

Yao agreed, “yes, I am from the government. I know the budget is limited so we have to peruse economic research for projects, but it is imperative to measure many indicators from the point of view of quality of life so there are two kinds of evaluations for budget approval and quality of life; these two evaluations are completely different.”

Zhang commented, “I think we have to try to do our best, but in reality, we are scientists. Unfortunately, we cannot decide which project has to be implemented because politicians will decide. So, according to the scientists’ duty, we try to provide more reliable, more comprehensive, and more scientific sound evidence for different indicators to support our idea. I think the quality of life is one of the bigger categories for supporting politicians and policy makers to make more publicly acceptable policies, so preparing more reliable indicators is our responsibility of being scientists.”
12.5 Conclusions

Rothengatter gave some final comments. We all agree that the traditional concepts of GDP measurement or the traditional neoclassical welfare measurement are not enough. They have to be extended. That was a clear outcome of the discussion. The quality of life (QOL) approach is one way to overcome these traditional concepts that everything involves an evaluation, not only either GDP growth or saving time or saving operational costs.

Hayashi is the father of the recent QOL approach. The research mentioned several times that it relates to happiness. He used happiness instead of QOL. Two famous scholars contributed to the happiness theory. The first is Martin Seligman and the theory of authentic happiness. He pointed out that authentic happiness consists of two common components. The first is a subjective component of feeling, and the second is an objective component that means living a meaningful life, which is much more long-term orientated. Another scholar is Daniel Kahneman, whom economists know well because he won the Nobel Memorial Prize in 2002 for economics. He emphasized the difference between instant happiness, having pleasant and enjoying pleasant moments, and long-term satisfaction. Long-term satisfaction can be measured with objective terms, which is the approach of this project. Long-term satisfaction can be increased by providing infrastructure for mobilizing people’s desires and preserving an environment that people can live in pleasantly.

In conclusion, the key message is that there is a possibility to construct quantitative indicators for happiness measurement or long-term satisfaction. This project demonstrates that it is possible to design systems that can improve the quality of life and meet the needs of people under the central agenda that no one is left behind.
Reference

Conclusion and Policy
Messages: Suggestions for Use of the Quality of Life Approach and Messages for the Future

Chanankarn Boonyotsawad and Veronica Ern Hui Wee

As discussed throughout this edited volume, although cost-benefit analysis (CBA) has been the traditional principle used for policy or project evaluation, there are limitations to assigning monetary values to the variety of impacts of a project in order to calculate a complete and reliable effect in all aspects in reality. Moreover, indirect impacts and long-term effects are imprecisely captured.

In the international symposium on “Mainstreaming Quality of Life in Evaluation of Transport and Spatial Planning” held on 19 April 2021, a new project assessment form was presented, the quality of life (QOL) approach concept, to use in conjunction with the traditional CBA.

QOL is a concept that has been set as a goal in policies and used as an indicator to appraise the success of development in many countries. However, QOL does not have a clear and standard definition. So, there are differences in its meaning, including the variables used to measure results. The World Health Organization’s definition is “The individuals’ perceptions of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards, and concerns” (WHO 2012). As such, the QOL indicators including a person’s physical health, psychological state, level of independence, social relationships, personal beliefs, and level of independence were evaluated on their ability to perform daily life, and relationships to salient features of the environment.

When the ability to carry out daily life and access various resources at an individual level is one of the critical indicators of QOL, we can determine that by assessing the ability to travel to access the required resources. The QOL accessibility method, based on the accessibility to
the basic facilities necessary for living and recreational facilities related to mental health, from travel cost and the difficulty of traveling to access these facilities and other related factors, seeks to concretely measure these QOL indicators.

The QOL accessibility method is applicable to not only travel policy, but also the achievement of the Sustainable Development Goals (SDGs). For instance, access to medical care or education has been raised because public transport has improved, economic growth from manufacturers and buyers can access the market more easily and quickly, and pollution and global warming problems have reduced due to an increase in the number of walkable or bikeable roads. Those can be calculated from the accessible value section of the QOL accessibility method and weight according to the SDGs’ indicators in each goal.

A prime example of using the QOL approach compared to the traditional cost-benefit analysis (CBA) is the Chubu-Oudan expressway in the Yamanashi Prefecture. This expressway links the Yamanashi and Shizuoka prefectures, which are medium-sized cities and in mountainous areas. The traditional CBA shows that this project can generate substantial economic value by only costing a certain amount of money for investment than building all facilities within those cities and when the project is appraised by the QOL approach, it found that local residents will benefit from more traveling options and can access diverse resources easier.

As the assessment of conformity with the SDGs, the expressway project directly and indirectly impacted society. The direct impact relates to SDG11, “Sustainable Cities and Communities”, that aims to provide and ensure that everyone can access adequate, safe, affordable housing, essential services, and transportation. The indirect effects relate to SDG1 “No Poverty”, SDG2 “No Hunger”, and other goals because the expressway can increase the accessibility of facilities and reduce the inequality of those two goals.

The QOL approach thus supports an integrated approach to transport and city planning, where a project is assessed in the context of the existing network. This will shift project design from a project view with the main goal of business development to a harmonized view that seeks to create integrated networks with seamless transportation for the connectivity of people while considering sustainability and social issues. Applying the QOL approach with the traditional cost-benefit analysis to evaluate the cost effectiveness of projects and policies might be better than using either method alone because it can show the result in terms of monetizing and perceived value in a broad range of national, regional, provincial, and individual levels.
Reference

Quality of Life Assessment in Urban Development and Transport Policymaking

Quality of life (QOL) evaluation of transport infrastructure measures the performance of infrastructure projects relative to their impact on individual happiness and social burden. *Quality of Life Assessment in Urban Development and Transport Policymaking* spotlights new research and perspectives on this integrated approach for aiding transport infrastructure policymaking while contributing to sustainable development.

Part I introduces QOL evaluation and explores transport and city-planning projects in Asian countries that have successfully applied it. Part II discusses QOL evaluation methods in France, Germany, Japan, and the United Kingdom and how countries can build on traditional infrastructure project evaluation methods to cover their wider implications for the environment, comfort of travel, workspace conditions, and socioeconomic services. Part III appraises the applicability of the QOL accessibility method for developing countries in the post-COVID-19 pandemic era.

*Quality of Life Assessment in Urban Development and Transport Policymaking* draws on discussions held during the Asian Development Bank Institute–Chubu University International Symposium on Mainstreaming Quality of Life in Evaluation of Transport and Spatial Planning. It is an ideal resource for practitioners, researchers, and others looking to better understand holistic approaches to urban development and transport project evaluation and policymaking.

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The Asian Development Bank Institute (ADBI) is the Tokyo-based think tank of the Asian Development Bank. ADBI provides demand-driven policy research, capacity building and training, and outreach to help developing countries in Asia and the Pacific practically address sustainability challenges, accelerate socioeconomic change, and realize more robust, inclusive, and sustainable growth.