International study on factor structure to create a city center vibrant with pedestrians

- a field survey of Kyoto, Seoul, Beijing and Florence

February 2013

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Summary

As the result of motorization, the decline of the city center is now still in progress. Streets have been transformed mainly to accommodate automobiles. Lots of automobiles still come into city centers causing several problems in the urban environment. The automobile-centered urbanization has continuously resulted in less vibrancy in the city center. The policies in a lot of cities have been made to revive city center.

Vibrancy is the index representing the current status of an area. Vibrancy is important as the base of every activity including shopping. Therefore, it is essential to understand the factors that create vibrancy for revitalizing the city center. It is also essential to regenerate the sustainable future of the city center. In this study, environmental factors on the street are examined to create high vibrancy as the first step of regeneration of the city center.

Kyoto, Seoul, Beijing, and Florence are selected as historical cities with characteristics of both commerce and tradition, to identify environmental factors in city centers. There is commonly a pedestrian zone on several streets in these city centers. Factors such as pedestrian zone, store and parking lot can be shown to be part of the environment on the streets.

Pedestrian vibrancy tends to be high in a particular part of each area according to environmental factors. Representatively, vibrancy in a pedestrian zone is higher than on a general street. It is same on a street with a store, arcade, piazza, straight connection and rectangular shape. In contrast, vibrancy is lower on the street with parking lot and parked car. In each city, the tendency is clearly distinguished. This means that vibrancy depends on such environmental factors.

Analysis by quantification method type one is done to identify the influence of multiple regression by each environmental factor on vibrancy with respect to whether it is present or absent. Usually, parking lot and parked vehicles negatively influence vibrancy. In contrast, pedestrian zone and store have a positive impact. Moreover, structural equation models are made on each surveyed city center. As a result, the total effect from pedestrian comfort to vibrancy could be obtained with the sum of direct and indirect effect in four cities. Commonly in these factor structures, pedestrian comfort including a pedestrian zone positively influences vibrancy and negatively influences existence of parking, although existence of parking has a negative impact on vibrancy.

Concerning East Asia, each city center is into two kinds of areas. These are common and

different characteristics according to each area. We created two groupings and compared the areas in terms of these groupings. The first one is well known to be central commercial area with pedestrian zone and high buildings. The other is traditional area with cultural characteristics such as preserved architecture. In structural equation models of the central commercial areas, pedestrian comfort has a negative effect on existence of parking together with a positive effect on pedestrian vibrancy. However, in the model of the traditional areas, nothing but store could influence existence of parking not only negatively but also positively.

The management of pedestrian comfort has an important effect on pedestrian vibrancy. The better the environment for pedestrians is managed in a city center, the more pedestrians come, in addition to a decrease of parking. This can be the important method to vitalize a city center.

Key words: City center, Street, Vibrancy, Pedestrian zone, Parking, Structural equation model

Acknowledgement

This dissertation is based on the study carried out at the Department of Urban management, Graduate School of Engineering, Kyoto University, from Oct. 2008 to Mar. 2013. The task to undertake Ph.D. requires a lot of effort and support. I was fortunate to have the supports from my teachers, friends and family. Therefore, it is pleasure to express my gratitude to the people.

First of all, I would like to express my sincere appreciation for my Professor Dai Nakagawa. He gave me insight about regional development. Without his kindness, I could not finish my study. Also, I am deeply grateful to Assoc. Prof. Ryoji Matsunaka. Not only his advising but also critical pointing helped me to complete my dissertation successfully. And I am also grateful to Assis. Prof. Tetsuharu Oba. He gave kind guidance and advices. Thank you for your kindness.

Specially, I appreciate Assoc. Prof. Jongjin Yoon. His invariable support helped me to do my best. For Assis. Prof. Mitsuya Matsubara, I also wish to express my gratitude. He always advised me with warm encouragement. As laboratory secretary, Asami Abe helped me together with Mamiko Awai and Kumiko Shimizu. I appreciate your warm kindness.

In addition, I am grateful to my laboratory friends; specially, Shotaro Abe, Sathita Malaitham, Taketo Nakayama, Yusuke Mampo and Ai Ogawa. And I am sure that my laboratory junior Hyunsu Choi could finish his doctoral course in the near future. And Assis. Prof. Yoongho Ahn and Assis. Prof. Hyeonduek Kim helped me to do my best. Thank you for your cheering.

I could study in Kyoto University with MEXT scholarship of Japanese Government. Thank you so much.

I started my study together with my mother and sister's love. I want to say I love you. For my son Geongi Park, together with my niece Arin Kim, I want to say there is nothing more precious than you. Finally, I confess my love again to my wife Hyunjung Kim.

February 2013

Dongwook Park

CONTENTS

CHAPTER 1 INTRODUCTION ..... - 1 -

1.1 RESEARCH BACKGROUND ..... - 1 -

1.2 RESEARCH OBJECTIVES AND SCOPES ..... - 3 -

BIBLIOGRAPHY ..... - 4 -

CHAPTER 2 PREVIOUS STUDIES AND RESEARCH CHARACTERISTICS ..... - 5 -

2.1 GENERAL INTRODUCTION ..... - 5 -

2.2 RESEARCH ON PEDESTRIAN VIBRANCY ..... - 6 -

2.3 RESEARCH ON WALKING ..... - 6 -

2.4 RESEARCH ON INFLUENCE OF VEHICLE ..... - 8 -

2.5 RESEARCH ON STREET AND ITS STRUCTURE ..... - 9 -

2.6 CHARACTERISTICS OF THIS RESEARCH ..... - 9 -

BIBLIOGRAPHY ..... - 10 -

CHAPTER 3 SURVEY CITIES AND RESEARCH METHOD ..... - 13 -

3.1 GENERAL INTRODUCTION ..... - 13 -

3.2 SURVEYED CITY CENTERS ..... - 13 -

3.2.1 Selection of city centers ..... - 13 -

3.2.2 Outline of survey areas in each city ..... - 14 -

3.3 POLICIES FOR PEDESTRIAN FRIENDLY ENVIRONMENT IN FOUR CITIES ..... - 17 -

3.3.1 Kyoto ..... - 17 -

3.3.2 Seoul ..... - 19 -

3.3.3 Beijing ..... - 20 -

3.3.4 Florence ..... - 21 -

3.4 METHODS TO MEASURE VIBRANCY AND ENVIRONMENTAL FACTORS ..... - 23 -

3.5 ENVIRONMENTAL FACTORS SURVEYED ON STREETS OF FOUR CITIES ..... - 26 -

BIBLIOGRAPHY ..... - 34 -

CHAPTER 4 RELATIONSHIP BETWEEN PEDESTRIAN VIBRANCY AND ENVIRONMENTAL FACTORS ON STREET ..... - 36 -

4.1 GENERAL INTRODUCTION ..... - 36 -

4.2 SURVEYED RESULTS IN EACH AREA ..... - 36 -

4.3 COMPARISON OF VIBRANCY ACCORDING TO ENVIRONMENTAL FACTORS ON STREET ..... - 58 -

4.4 CONCLUDING REMARKS ..... - 76 -

CHAPTER 5 FORMULATION OF VIBRANCY BY APPLICATION OF MULTIPLE REGRESSION WITH CATEGORICAL DATA ON STREET ENVIRONMENT ..... - 77 -

5.1 GENERAL INTRODUCTION ..... - 77 -
5.2 RESULT OF QUANTIFICATION METHOD TYPE ONE IN FOUR CITIES ..... - 80 -
5.2.1 Kyoto ..... - 80 -
5.2.2 Seoul ..... - 86 -
5.2.3 Beijing ..... - 92 -
5.2.4 Florence ..... - 98 -
5.3 CONCLUDING REMARKS ..... - 104 -
BIBLIOGRAPHY ..... - 104 -

CHAPTER 6 STRUCTURAL RELATIONSHIP OF VIBRANCY AND ENVIRONMENTAL FACTORS ON STREET ..... - 106 -

6.1 GENERAL INTRODUCTION ..... - 106 -
6.2 OVERVIEW OF STRUCTURAL EQUATION MODEL AND HYPOTHESIS ..... - 108 -
6.3 STRUCTURAL EQUATION MODELS IN FOUR CITIES ..... - 112 -
6.3.1 Kyoto ..... - 112 -
6.3.2 Seoul ..... - 113 -
6.3.3 Beijing ..... - 114 -
6.3.4 Florence ..... - 115 -
6.4 CONCLUDING REMARKS ..... - 117 -
BIBLIOGRAPHY ..... - 117 -

CHAPTER 7 COMPARISON OF CENTRAL COMMERCIAL AREAS AND TRADITIONAL AREAS ..... - 119 -

7.1 GENERAL INTRODUCTION ..... - 119 -
7.2 COMPARISON OF CENTRAL COMMERCIAL AREAS AND TRADITIONAL AREAS IN THREE CITIES OF EAST ASIA ..... - 120 -
7.2.1 Characteristics of central commercial areas ..... - 121 -
7.2.2 Characteristics of traditional areas ..... - 125 -
7.3 CONCLUDING REMARKS ..... - 128 -
BIBLIOGRAPHY ..... - 129 -

CHAPTER 8 CONCLUSION ..... - 130 -

8.1 SIGNIFICANCE OF THIS STUDY ..... - 130 -
8.2 RECOMMENDATION FOR FUTURE WORK ..... - 131 -

LIST OF FIGURES

FIGURE 1 FLOW DIAGRAM OF THIS STUDY ..... - 4 -
FIGURE 2 RATE OF PEDESTRIAN FATALITIES IN 26 OECD COUNTRIES, 2009 ..... - 7 -
FIGURE 3 LOCATION AND FIGURE OF SURVEY AREAS IN KYOTO ..... - 15 -
FIGURE 4 LOCATION AND FIGURE OF SURVEY AREAS IN SEOUL ..... - 16 -
FIGURE 5 LOCATION AND FIGURE OF SURVEY AREAS IN BEIJING ..... - 16 -
FIGURE 6 LOCATION AND FIGURE OF SURVEY AREAS IN FLORENCE ..... - 17 -
FIGURE 7 ADVERTISEMENT FOR THE CHARTER OF 'WALKING TOWN, KYOTO' ..... - 18 -
FIGURE 8 SIGN AND ADVERTISEMENT FOR SMOKING-BAN AREA IN CENTRAL AREA OF KYOTO - 19 -
FIGURE 9 DISTRIBUTION MAP OF HISTORICAL AND CULTURAL RESERVE IN BEIJING ..... - 20 -
FIGURE 10 PASSO DUOMO AND CHANGE OF ORDINARY BUS ROUTES IN FLORENCE ..... - 21 -
FIGURE 11 CHANGE OF SIGHTSEEING BUS ROUTES IN FLORENCE ..... - 22 -
FIGURE 12 MAP OF ZTL IN FLORENCE ..... - 22 -
FIGURE 13 SIGN BOARD FOR NO PARKING AREA BY ZTL ..... - 23 -
FIGURE 14 METHOD TO MEASURE VIBRANCY ON STREET ..... - 24 -
FIGURE 15 METHOD TO MEASURE ENVIRONMENTAL FACTORS ON STREET ..... - 26 -
FIGURE 16 SIGNS FOR THE PEDESTRIAN ZONE IN SURVEY CITIES ..... - 27 -
FIGURE 17 ARCADE IN KYOTO ..... - 29 -
FIGURE 18 VIBRANT ATMOSPHERE IN PIAZZA DELLA SIGNORIA OF FLORENCE ..... - 30 -
FIGURE 19 A STREET VENDOR IN SEOUL ..... - 30 -
FIGURE 20 STREET PARKING REQUIREMENTS ACCELERATING URBAN SPRAWL ..... - 31 -
FIGURE 21 CONCEPT OF STREET PARKING IN JAPAN ..... - 32 -
FIGURE 22 PERMIT CARD FOR PARKING IN FLORENCE ..... - 33 -
FIGURE 23 DISTRIBUTION OF VIBRANCY RATE IN SHIJO ..... - 37 -
FIGURE 24 DISTRIBUTION OF PEDESTRIAN ZONE IN SHIJO ..... - 37 -
FIGURE 25 DISTRIBUTION OF PARKED CAR IN SHIJO ..... - 38 -
FIGURE 26 DISTRIBUTION OF PARKED MOTORBIKE IN SHIJO ..... - 38 -
FIGURE 27 DISTRIBUTION OF PARKED BICYCLE IN SHIJO ..... - 38 -
FIGURE 28 DISTRIBUTION OF VIBRANCY RATE IN GION ..... - 39 -
FIGURE 29 DISTRIBUTION OF PARKED CAR IN GION ..... - 40 -
FIGURE 30 DISTRIBUTION OF PARKED MOTORBIKE IN GION ..... - 40 -
FIGURE 31 DISTRIBUTION OF PARKED BICYCLE IN GION ..... - 41 -
FIGURE 32 DISTRIBUTION OF VIBRANCY RATE IN MYONGDONG ..... - 42 -
FIGURE 33 DISTRIBUTION OF PEDESTRIAN ZONE IN MYONGDONG ..... - 42 -
FIGURE 34 DISTRIBUTION OF PARKED CAR IN MYONGDONG ..... - 42 -

FIGURE 35 DISTRIBUTION OF PARKED MOTORBIKE IN MYONGDONG ..... - 43 -
FIGURE 36 DISTRIBUTION OF PARKED BICYCLE IN MYONGDONG ..... - 43 -
FIGURE 37 DISTRIBUTION OF VIBRANCY RATE IN INSADONG ..... - 44 -
FIGURE 38 DISTRIBUTION OF PARKED CAR IN INSADONG ..... - 44 -
FIGURE 39 DISTRIBUTION OF PARKED MOTORBIKE IN INSADONG ..... - 45 -
FIGURE 40 DISTRIBUTION OF PARKED BICYCLE IN INSADONG ..... - 45 -
FIGURE 41 DISTRIBUTION OF VIBRANCY RATE IN WANGFUJING ..... - 46 -
FIGURE 42 DISTRIBUTION OF PEDESTRIAN ZONE IN WANGFUJING ..... - 46 -
FIGURE 43 DISTRIBUTION OF PARKED CAR IN WANGFUJING ..... - 47 -
FIGURE 44 DISTRIBUTION OF PARKED MOTORBIKE IN WANGFUJING ..... - 47 -
FIGURE 45 DISTRIBUTION OF PARKED BICYCLE IN WANGFUJING ..... - 48 -
FIGURE 46 DISTRIBUTION OF VIBRANCY RATE IN NANLUOGUXINAG ..... - 48 -
FIGURE 47 DISTRIBUTION OF PARKED CAR IN NANLUOGUXINAG ..... - 49 -
FIGURE 48 DISTRIBUTION OF PARKED MOTORBIKE IN NANLUOGUXINAG ..... - 49 -
FIGURE 49 DISTRIBUTION OF PARKED BICYCLE IN NANLUOGUXINAG ..... - 49 -
FIGURE 50 DISTRIBUTION OF VIBRANCY RATE IN CENTRO ..... - 50 -
FIGURE 51 DISTRIBUTION OF PEDESTRIAN ZONE IN CENTRO ..... - 51 -
FIGURE 52 DISTRIBUTION OF PARKED CAR IN CENTRO ..... - 51 -
FIGURE 53 DISTRIBUTION OF PARKED MOTORBIKE IN CENTRO ..... - 52 -
FIGURE 54 DISTRIBUTION OF PARKED BICYCLE IN CENTRO ..... - 52 -
FIGURE 55 DISTRIBUTION OF VIBRANCY RATE IN SANTACROCE ..... - 53 -
FIGURE 56 DISTRIBUTION OF PEDESTRIAN ZONE IN SANTACROCE ..... - 53 -
FIGURE 57 DISTRIBUTION OF PARKED CAR IN SANTACROCE ..... - 54 -
FIGURE 58 DISTRIBUTION OF PARKED MOTORBIKE IN SANTACROCE ..... - 54 -
FIGURE 59 DISTRIBUTION OF PARKED BICYCLE IN SANTACROCE ..... - 55 -
FIGURE 60 INCREASE OF PEDESTRIAN ZONE IN CENTRO ..... - 55 -
FIGURE 61 PICTURE BEFORE AND AFTER ESTABLISHING PASSO DUOMO ..... - 57 -
FIGURE 62 DIFFERENCE OF VIBRANCY RATE AS A FUNCTION OF PEDESTRIAN ZONE ..... - 61 -
FIGURE 63 DIFFERENCE OF VIBRANCY RATE AS A FUNCTION OF STORE ..... - 63 -
FIGURE 64 DIFFERENCE OF VIBRANCY RATE AS A FUNCTION OF PARKING LOT ..... - 65 -
FIGURE 65 DIFFERENCE OF VIBRANCY RATE AS A FUNCTION OF PARKED CAR, PARKED MOTORBIKE AND PARKED BICYCLE IN SURVEY CITIES ..... - 68 -
FIGURE 66 DIFFERENCE OF VIBRANCY RATE AS A FUNCTION OF PARKED CAR, PARKED MOTORBIKE AND PARKED BICYCLE IN SURVEY AREAS ..... - 69 -
FIGURE 67 DIFFERENCE OF VIBRANCY RATE AS A FUNCTION OF ARCADE ..... - 70 -
FIGURE 68 DIFFERENCE OF VIBRANCY RATE AS A FUNCTION OF STREET VENDOR ..... - 71 -

FIGURE 69 DIFFERENCE OF VIBRANCY RATE AS A FUNCTION OF CONNECTION TO PIAZZA ..... - 71 -
FIGURE 70 DIFFERENCE OF VIBRANCY RATE AS A FUNCTION OF STREET CONNECTION ..... - 73 -
FIGURE 71 DIFFERENCE OF VIBRANCY RATE AS A FUNCTION OF STREET SHAPE ..... - 75 -
FIGURE 72 CATEGORY SCORES OF QUANTIFICATION IN SHIJO ..... - 80 -
FIGURE 73 CATEGORY SCORES OF QUANTIFICATION IN GION ..... - 82 -
FIGURE 74 CATEGORY SCORES OF QUANTIFICATION IN BOTH AREAS OF KYOTO ..... - 84 -
FIGURE 75 CATEGORY SCORES OF QUANTIFICATION IN MYONGDONG ..... - 86 -
FIGURE 76 CATEGORY SCORES OF QUANTIFICATION IN INSADONG ..... - 88 -
FIGURE 77 CATEGORY SCORES OF QUANTIFICATION IN BOTH AREAS OF SEOUL ..... - 90 -
FIGURE 78 CATEGORY SCORES OF QUANTIFICATION IN WANGFUJING ..... - 92 -
FIGURE 79 CATEGORY SCORES OF QUANTIFICATION IN NANLUOGUXIANG ..... - 94 -
FIGURE 80 CATEGORY SCORES OF QUANTIFICATION IN BOTH AREAS OF BEIJING ..... - 96 -
FIGURE 81 CATEGORY SCORES OF QUANTIFICATION IN CENTRO ..... - 98 -
FIGURE 82 CATEGORY SCORES OF QUANTIFICATION IN SANTACROCE ..... - 100 -
FIGURE 83 CATEGORY SCORES OF QUANTIFICATION IN BOTH AREAS OF FLORENCE ..... - 102 -
FIGURE 84 HYPOTHESIS RELATED TO VIBRANCY AND LATENT VARIABLES IN SURVEY CITIES .- 111 -
FIGURE 85 STRUCTURAL EQUATION MODEL IN KYOTO ..... - 112 -
FIGURE 86 STRUCTURAL EQUATION MODEL IN SEOUL ..... - 113 -
FIGURE 87 STRUCTURAL EQUATION MODEL IN BEIJING ..... - 114 -
FIGURE 88 STRUCTURAL EQUATION MODEL IN FLORENCE ..... - 115 -
FIGURE 89 HYPOTHESIS IN CENTRAL COMMERCIAL AREA AND TRADITIONAL AREA ..... - 120 -
FIGURE 90 STRUCTURAL EQUATION MODELS IN SHIJO, KYOTO ..... - 121 -
FIGURE 91 STRUCTURAL EQUATION MODELS IN MYONGDONG, SEOUL ..... - 122 -
FIGURE 92 STRUCTURAL EQUATION MODELS IN WANGFUJING, BEIJING ..... - 123 -
FIGURE 93 STRUCTURAL EQUATION MODELS IN GION, KYOTO ..... - 125 -
FIGURE 94 STRUCTURAL EQUATION MODELS IN INSADONG, SEOUL ..... - 126 -
FIGURE 95 STRUCTURAL EQUATION MODELS IN NANLUOGUXIANG, BEIJING ..... - 127 -

LIST OF TABLES

TABLE 1 ISSUES RELATED TO URBAN ENVIRONMENT ..... - 5 -

TABLE 2 SHOPPING STREETS DESIGNATED AS PEDESTRIAN ZONE IN KYOTO ..... - 18 -

TABLE 3 ENVIRONMENTAL FACTORS MEASURED ON THE STREET ..... - 25 -

TABLE 4 DIFFERENCE OF VIBRANCY RATES ON GENERAL STREET AND PEDESTRIAN ZONE IN CENTRO, 2008 AND 2010 ..... - 56 -

TABLE 5 DIFFERENCE OF VIBRANCY RATE ON GENERAL STREET, PREVIOUS PEDESTRIAN ZONE AND NEW PEDESTRIAN ZONE IN CENTRO, 2008 AND 2010 ..... - 56 -

TABLE 6 STREET DISTANCE AND NUMBER OF PEDESTRIANS IN SURVEY AREAS ..... - 58 -

TABLE 7 NUMBER OF PHOTOGRAPH FOR VIBRANCY AND ENVIRONMENTAL FACTORS IN SURVEY AREAS ..... - 58 -

TABLE 8 NUMBER OF STREETS DESIGNATED AS PEDESTRIAN ZONE IN SURVEY AREAS ..... - 60 -

TABLE 9 NUMBER OF STREETS WITH STORE IN SURVEY AREAS ..... - 62 -

TABLE 10 NUMBER OF STREETS WITH PARKING LOT IN SURVEY AREAS ..... - 64 -

TABLE 11 NUMBER OF STREETS WITH PARKED CAR IN SURVEY AREAS ..... - 66 -

TABLE 12 NUMBER OF STREETS WITH PARKED MOTORBIKE IN SURVEY AREAS ..... - 67 -

TABLE 13 NUMBER OF STREETS WITH PARKED BICYCLE IN SURVEY AREAS ..... - 67 -

TABLE 14 NUMBER OF STREETS WITH ARCADE IN KYOTO ..... - 70 -

TABLE 15 NUMBER OF STREETS WITH STREET VENDOR IN SEOUL ..... - 70 -

TABLE 16 NUMBER OF STREETS CONNECTED TO PIAZZA IN FLORENCE ..... - 71 -

TABLE 17 NUMBER OF STREETS STRAIGHTLY CONNECTED ON THE BOTH EDGES IN SURVEY AREAS ..... - 72 -

TABLE 18 NUMBER OF STREETS WITH RECTANGULAR SHAPE IN SURVEY AREAS ..... - 74 -

TABLE 19 ENVIRONMENTAL FACTORS SURVEYED IN FOUR CITIES ..... - 78 -

TABLE 20 RESULTS OF QUANTIFICATION ACCORDING TO CATEGORY OF ITEMS IN SHIJO ..... - 81 -

TABLE 21 RESULTS OF QUANTIFICATION ACCORDING TO CATEGORY OF ITEMS IN GION ..... - 83 -

TABLE 22 RESULTS OF QUANTIFICATION ACCORDING TO CATEGORY OF ITEMS IN BOTH AREAS OF KYOTO ..... - 85 -

TABLE 23 RESULTS OF QUANTIFICATION ACCORDING TO CATEGORY OF ITEMS IN MYONGDONG ..... - 87 -

TABLE 24 RESULTS OF QUANTIFICATION ACCORDING TO CATEGORY OF ITEMS IN INSADONG .. - 89 -

TABLE 25 RESULTS OF QUANTIFICATION ACCORDING TO CATEGORY OF ITEMS IN BOTH AREAS OF SEOUL ..... - 91 -

TABLE 26 RESULTS OF QUANTIFICATION ACCORDING TO CATEGORY OF ITEMS IN WANGFUJING ..... - 93 -

TABLE 27 RESULTS OF QUANTIFICATION ACCORDING TO CATEGORY OF ITEMS IN NANLUOGUXIANG ..... - 95 -
TABLE 28 RESULTS OF QUANTIFICATION ACCORDING TO CATEGORY OF ITEMS IN BOTH AREAS OF BEIJING..... - 97 -
TABLE 29 RESULTS OF QUANTIFICATION ACCORDING TO CATEGORY OF ITEMS IN CENTRO..... - 99 -
TABLE 30 RESULTS OF QUANTIFICATION ACCORDING TO CATEGORY OF ITEMS IN SANTACROCE..... ..... - 101 -
TABLE 31 RESULTS OF QUANTIFICATION ACCORDING TO CATEGORY OF ITEMS IN BOTH AREAS OF FLORENCE ..... - 103 -
TABLE 32 INDEX OF FITNESS IN STRUCTURAL EQUATION MODEL..... - 109 -
TABLE 33 LATENT VARIABLES AND MEASURED VARIABLES IN STRUCTURAL EQUATION MODEL .... - 110 -
TABLE 34 TOTAL EFFECTS IN FOUR CITIES..... - 116 -
TABLE 35 TOTAL EFFECTS IN CENTRAL COMMERCIAL AREAS ..... - 124 -
TABLE 36 TOTAL EFFECTS IN TRADITIONAL AREAS ..... - 127 -

Chapter 1 INTRODUCTION

1.1 Research background

The growth of motorization has created not only urban sprawl but also the decline of the city center, which traditionally played a main role in urban life. Cities and streets have been transformed mainly to accommodate automobiles. Nowadays, there are still extreme numbers of automobiles in city centers causing traffic jams and pollution of the urban environment. Pedestrians suffer the risk of injury or death when walking. In the case of old or disabled people, there is a more serious risk.

Together with the expansion of the increased urban use of cars, the decline of historic central areas in cities has made for poor energy efficiency and higher social costs such as crime and obesity. Suburbanization contributes further to this problem. As one phenomenon of motorization, large-scale stores in the suburbs affect the size of stores in the city center. Accordingly, the variety of traditional stores has declined. Not only for a low-carbon society but also for human health, it is reasonable to consider the importance of walking as a way of mobility.

Walking could be the most basic method of mobility. It is not expensive, using human calories without the emissions produced by fuel. Furthermore, it provides pleasure and health and it is equally accessible to all regardless of social position or income. However, walking is usually an ignored transport mode, although it must be a part of one's trip. Even policy departments of government have not generally focused on the positive functions of walking because there has been no awareness or strong insistence about its importance.

The vitalization of a city is related to people. People walk for a variety of purposes, seeking goods and services or as an activity with several objectives. In particular, walking to seek goods and services in a city center could be regarded as sojourning. Not only walking but also sojourning are representative indexes of pedestrian activities that make a city center livable, charming and flourishing.

In the history of urban planning, there have been outstanding prospective theories on environments improving livability. They were made by pioneers such as Howard (1898), Corbusier (1935), Jacobs (1961) and Dantzig and Saaty (1973). They realized that a pedestrian-friendly environment is a key point to developing a city. Representatively, Jacobs (1961) criticized theories such as the radiant city (or La Ville Radieuse) of Le

Corbusier and the garden city of E. Howard although they were universally believed. Instead of them, she insisted that the chance for people to contact each other must be increased to create safe and livable cities, because everyone is a stranger to each other in the city streets. Safety in the city is the result of various social relations, so the presence of people in itself can contribute to a better city. The more kinds of activities by various people that are created, the more areas are livable.

In today's society, people spend a lot of time in the city where a great variety of human and business exchanges take place. The streets are the place where the city's character is represented. In addition, people's various activities give life to the cities. Although there could be disadvantages to using commercial areas in city centers, compared with large-scale suburban retail stores which provide low prices by the merits of volume sales, city centers are not just areas for commerce but also areas with historical value and regional identity. Moreover, city centers are becoming more important for the elderly and non-car users nowadays as the aging society and the society of high-energy efficiency are emphasized.

OECD (2011) announced that a city center is the place where is really necessary to give more priority and service space to non-motorized travel modes and public transportation. For example, there are some indexes to determine the condition in a city center, such as providing safe and secure pedestrian access to public transport or the center, a parking policy to decrease the use of motor vehicles, and car-free areas.

Prospective theories about urban planning were reviewed by Smith et al. (1997). He concluded that the urban environment should be filled with features such as livability, character, connection, mobility, personal freedom and diversity. In particular, he stated that open space area, outdoor amenity and walkability are critical.

A city is safe and convenient when it is vitalized with human activity. Therefore, it is important to examine the condition of the streets to encourage pedestrian vibrancy. Such vibrancy is one of the most important factors indicating the current status of one area. It is the origin of every activity including shopping in a city center. A commercial area with high vibrancy could be regarded as an area with certain factors which indicate high vibrancy. To revitalize the city center, it is essential to understand the factors in a commercial area. These factors might be essential for creating vibrancy and regenerating the sustainable future of the city center. Therefore, this research focuses on environmental factors in city centers which make high vibrancy as the first step of regeneration in a city center.

1.2 Research objectives and scopes

In this study, Kyoto, Seoul, and Beijing are selected as historical cities in East Asia having characteristics of both commerce and tradition, to identify environmental factors in city centers. Florence is also chosen for comparison as a historical city in Europe with the same characteristics. Several streets in the commercial areas of three city centers have been designated as pedestrian zones to make pedestrian comfort high. An analysis of the relationship of vibrancy and environmental factors on streets will be attempted. Pedestrian zones, stores, parked vehicles, street shape, street connection and so on are shown as the factors.

This study clarifies the relationship between pedestrian vibrancy and environmental factors in city centers. We got the data about the vibrancy and environmental factors from a field survey in the city centers of four cities. Then, we applied several analysis methods to clarify their relation. The detailed purposes of this study are as follows:

- To identify current conditions in each city center
- To consider the relationship among pedestrian vibrancy and several environmental factors on the street
- To clarify the common structure among vibrancy and environmental factors in four cities by structural equation model

This study consists of eight chapters as shown in Figure 1. In Chapter 1, the background and purpose of the study are described. In Chapter 2, previous studies related to this study are introduced, clarifying features of this study. In Chapter 3, four cities are introduced with research methodologies. In Chapter 4, the relationship between pedestrian vibrancy and environmental factors is described. In Chapter 5, considerations are made about the results after quantification method type one. In Chapter 6, structural equation models are made to identify the hypothesis and to compare them in each city. In Chapter 7, differences are identified by comparison between central commercial areas and traditional areas in three cities of East Asia. Finally, this study is summarized and recommendation is suggested for the wok in the future in Chapter 8.

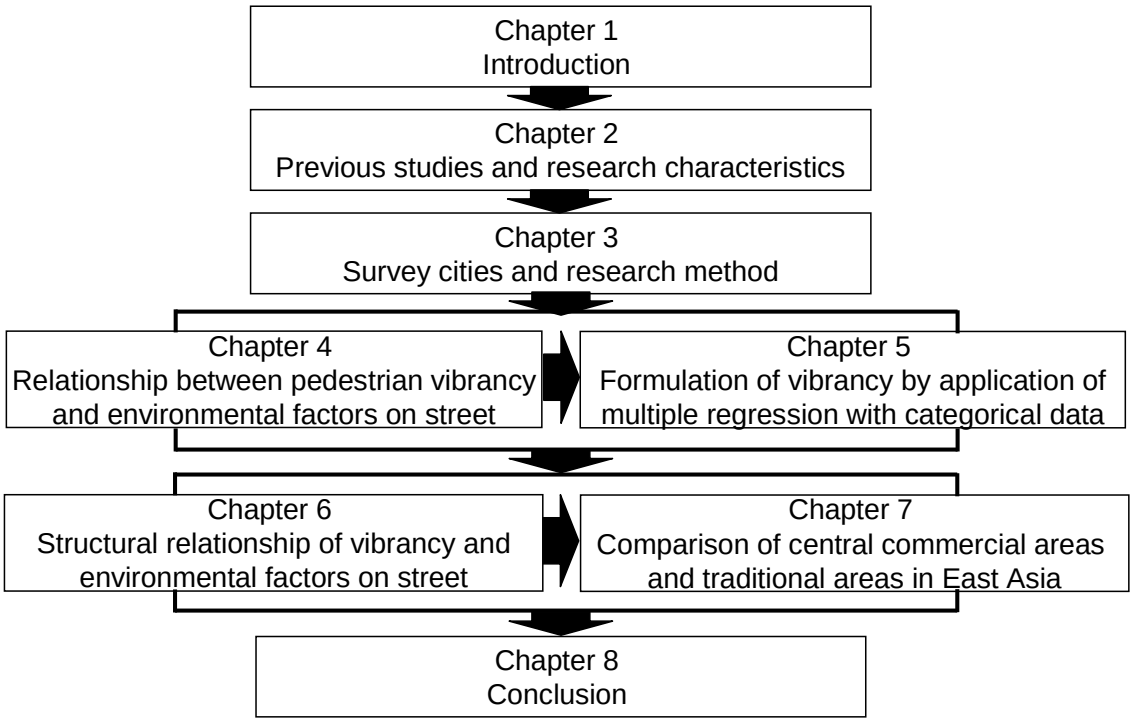

Figure 1 Flow diagram of this study

Bibliography

Corbusier, L. (1967). *The radiant city: elements of a doctrine of urbanism to be used as the basis of our machine-age civilization* (P. Knight, E. Levieux, and D. Coltman, Trans.). New York: Orion. (Original work published 1935).

Dantzig, G.B., & Saaty, T.L. (1973). *Compact City. A Plan for a Liveable Urban Environment.* San Francisco: W. H. Freeman & Co Ltd.

Howard, E. (1998). *Tomorrow: A Peaceful Path to Real Reform.* London: Routledge. (Original work published 1898).

Jacobs, J. (1961). *The Death and Life of Great American Cities*. New York: Random House.

OECD International Traffic Safety Data and Analysis Group. (2011). *Road safety annual report 2011*, Paris: OECD.

Smith, T., Nelischer, M., & Perkins, N. (1997). Quality of an urban community: a framework for understanding the relationship between quality and physical form. *Landscape Urban Plann, 39*, 229–241.

Chapter 2 Previous studies and research characteristics

2.1 General introduction

As automobiles occupy the street and pedestrians begin to claim a safe and pleasant environment, walking rights have become one of the current urban trends. Nevertheless, car traffic has become the central part of daily life and an unavoidable experience in the public realm. In addition, several problems have become clear, such as land use for parking lots. People have recognized the importance of walking instead of car use as the space for people has diminished. Therefore, walking and bicycle use have been recently encouraged for several reasons.

There are many subjects and issues related to urban environmental issues like Table 1. In this chapter, the characteristics in the literature related to this research study are described. Research on vibrancy, pedestrian, vehicle and street are outlined in order. Finally, the character of this study is suggested.

Table 1 Issues related to urban environment

Type of issues	*Representative factors*	*Following effects*
- Pedestrian vibrancy	- Increase of car ownership	- Loss of vibrancy in city center
	- Street space for pedestrians	- Increase of pedestrians
- Walking	- Improvement of walking space	- Benefit improved and visitors increased
	- Pedestrian-oriented environment	- Increased travel by walking and bicycling
	- Suburban sprawl	- Increased obesity
- Vehicle	- Effect of car traffic on street	- Psychologically negative effect on walking
	- Campaign policy	- Reduced illegal parking number
- Street and its structure	- Lack of pedestrian amenities on street	- Discouragement of walking
	- Commercial environment on street	- Triggering shopping activity

2.2 Research on pedestrian vibrancy

Longstreth (2000) announced that a new building, opened in 1928, several miles from downtown was the first major store to move out of the city center in Los Angeles. From that point, the regional mall started to become prosperous, in relation to the fast growth of car ownership in LA. And gradually it produced a loss of vibrancy on streets in downtown. These phenomena have happened in almost all cities together with the development of the motor vehicle. However, it is indicated that that there is ironical phenomenon that the vehicle traffic-free environments made the basement of vitalization for the city center nevertheless it is opposite to common sense in those days (Brambilla and Longo, 1977).

OECD (1988) indicates that the definition of a pedestrian is a person who travels by foot or pushes a pram, a wheelchair, a bicycle or a moped in most of the OECD Member countries. People walk as window shoppers, a walker for a pet dog, or while playing something et al. People also walk not just to reach a specific destination but also only for pleasure or exercise. However, a pedestrian is a vulnerable road user during travel because motored transport can be an actual danger while pedestrians walk on the street. Pedestrians may feel fear of injury or death due to the threat of offensive motor-vehicles.

Several of the factors attracting pedestrians to the street were researched and the database was analyzed by the quantification method type one (Iino, 2009). However, the shape or structure of street was not considered. In the method of that research, environmental factors about topology were not used and structural relationship was not revealed. Similarly, the relation between pedestrians and several factors was analyzed, by using the quantification method type one (Park et al., 2010).

2.3 Research on walking

From the aspect of street and urban design, the needs of pedestrians have not been adequately considered. However, people concerned with cities and town have started to pay attention to the pedestrian and there has been an emphasis on disregarded pedestrians' needs since the 1960s in many cities. Nevertheless, there are many things left now to improve. OECD (2011) shows the pedestrian fatalities as a percentage of all road fatalities by comparing several nations in Figure 2. In particular, Korea and Japan show significantly higher rate than other nations. It means pedestrian friendly management is not yet effective in two countries and it is urgent policy.

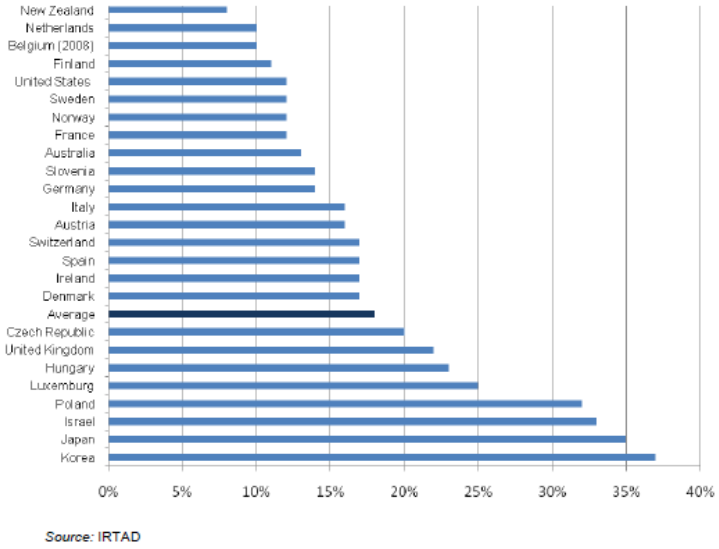

Figure 2 Rate of pedestrian fatalities in 26 OECD countries, 2009 [1]

European Cooperation in Science and Technology (2010) assured that walking is the best solution about many transport-oriented problems. It could solve the challenging problems such as heath problems and energy cost. It also influence he revitalization in local econoies. Fujisawa et al. (2003) supposed a wider sidewalk, to simulate the benefit of pedestrian space. As a result, the benefit was improved and the numbers of public transportation users and visitors were both increased. Lee (2008) suggested that the stores in the commercial area of Shimokitazawa could be classified into four groups: a street-oriented store, a store for social meeting, a specialized store and a store supporting daily life. They are clustered into seven groups by accessibility and capacity of accommodation. In addition, it is shown that vibrancy was created in an existing urban area by introducing a transit mall (Kitamura et al., 2005). The liveliness of the area could be revitalized by pedestrian oriented development, such as better accessibility and traffic control.

The more pedestrians come together in an area the better the situation is made for the region. For example, Jacobsen (2003) showed that collision rates by motorcycle declined as the number of pedestrians or users taking a bicycle increased, although it is common sense that the collision rate is related to the number of pedestrians or bicycle-users. Therefore, the policy to increase the number of pedestrians or bicycle-user is even important to elevate the safety of people walking and bicycling.

Walking is emphasized for several benefits. It is showed that rates of obesity are related to environmental characters (Rundle et al., 2007). The pedestrian oriented

[1] Quotation of table in paper by OECD (2011), Source: IRTAD

environments such as high street connectivity, and mixed land use make it easy to travel by walking or taking a bicycle. The pedestrian oriented environment increases activities in daily lives, including walking, taking the bicycle, and using public transportation instead of private vehicles. Vandegrift et al. (2004) suggested that the pattern of a suburban area played an important role in increased obesity. Activities such as commuting to school or office without the use of private transportation are not easy in suburban areas. Therefore, urban planning for reducing suburban sprawl is needed to lessen the human cost caused by obesity.

2.4 Research on influence of vehicle

Illegal parking of vehicles destroys the environment on the street, as related to vitality in regions. So, there have been many surveys or social experiments. In one instance, Oba and Nakagawa (2009) suggested that users could be classified into three groups according to private attributes and psychological factors concerning illegal parked bicycles in the central commercial areas of Kyoto. Therefore, the countermeasure to reduce the illegal parking of bicycles needs to be considered from the point of the heterogeneity of user attributes. Crankshaw (2008) showed that no street parking in front of stores is one of the best indexes in a historic downtown. Shoup (2005) insists that the subsidy for parking at work is 2.9 times higher than the cost of driving to work. He criticizes the fact that urban planners usually disregard the cost of parking.

There are researches on the influence of vehicle use on pedestrians. For example, Yamamoto et al (2001) suggested that the influence of cars on pedestrians and bicycles can be measured in the central area of Kyoto. Almost the same streets were targeted as shijo area in the current study. But the factors were not enough because factors like pedestrian zones were not included. The effect of car traffic on pedestrians and bicycle was measured. Fujii et al. (2008) introduced several cases of mobility management in the cities of the world. As a part of urban traffic planning, a supplementary relationship is shown among car-dependent lifestyles, the decline of public transportation, and suburbanization. To break and solve this cycle, a comprehensive policy is needed, like communication, regional development and transportation system. Specifically, road pricing was the most unpopular measure to decrease car use, and in contrast, the prohibition of car traffic was the most popular. In addition, environmental concern was important to create attitudes positive for TDM measures.

There are surveys about the bicycle as a kind of vehicle which creates a negative impact on pedestrians. For example, Hasebe (2009) measured the danger that pedestrians feel

when seeing a moving bicycle. At least six meters distance is necessary for pedestrians to feel safe on the street with bicycles, although the bicycle is a pedestrian-friendly vehicle.

2.5 Research on street and its structure

There is a theory that movement is related to the street form. It is found that the form of an urban grid privileged certain spaces through movement patterns (Hiller et al., 1993). They suggested that the configuration of an urban grid is the principal maker of movement patterns. The urban design for well used areas is important to the configuration of large-scale urban systems. A study (Hiller and Iida, 2005) found that the correlation between a street network and movement pattern in the context of space. An individual road choice is not connected to the network effect. In addition, Topp (1990) insisted that there was not any way to moderate cars gathering on a street. Not separating but integrating the separate street is necessary to increase the spatial level of a region. It is shown that pedestrian route choice and destination choice behavior was impacted by the location patterns of retail facilities (Bogers and Timmermans, 1986). Crankshaw (2008) showed that streetscape design is important. Good design of districts makes an area more vibrant because it makes the area more accessible.

Street patterns influence the choice of methods to go out: walking, bicycle, public transportation and private vehicle. Cervero and Radisch (1996) introduced the effect of the new urbanism, a movement returning to compact neighborhoods with grid-like street patterns. Compared with the neo traditional neighborhood and conventional suburban community, the new urbanism design was proved to make use of a higher share of non-automobiles. And it is shown that good topography in an area attracts non-motorized traffic (Rodriguez D.A. and Joo, J., 2004). This means pedestrian oriented development is related to walking and riding a bicycle.

2.6 Characteristics of this research

The purpose of this study is to identify what kinds of environmental factors on street increase pedestrian vibrancy. It is essential to revitalize a city center. Therefore, pedestrian vibrancy and environmental factors in four city centers were measured by field survey. Then, the gathered data are quantitatively compared to determine which factors make an area vibrant.

The common environmental factors on street are selected in Kyoto, Seoul, Beijing, and

Florence. One is pedestrian-orient environment such as pedestrian zone and store. Another is street environment made by vehicles such as parking lots and parked vehicles on street. The other is street structure in each city center. In addition, arcade, piazza, and street vendor are chosen as regional characteristics. The characteristics of this research are as follows:

- To measure pedestrian vibrancy and environmental factors in four city centers by field survey
- To identify the influence of pedestrian-friendly environment and the influence of vehicle-based environment on vibrancy
- To consider what kind of common structure is made among several environmental factors to make an area vibrant with pedestrians

Bibliography

Beirao, G., & Cabral, J. A. S. (2007). Understanding attitudes towards public transport and private car: A qualitative study. *Transport Policy*, *14*(6), 478-489.

Borgers, A., & Timmermans, H. (1986). A model of pedestrian route choice and demand for retail facilities within inner-city, *Geographical Analysis, 18*(2), 115-128.

Burchell, R, Downs, A., McCann, B., & Mukherji, S. (2005). *Sprawl costs: economic impacts of unchecked development*. Washington: Island Press.

Cervero, R., & Radisch, C. (1996). Travel choices in pedestrian versus automobile oriented neighbourhoods. *Transport Policy*, *3*, 127-141.

Crankshaw, N. (2008). *Creating Vibrant Public Spaces: Streetscape Design in Commercial and Historic Districts.* London: Island Press.

Rodriguez, D. A., & Joonwon, J. (2004). The relationship between non-motorized mode choice and the local physical environment. *Transportation Research Part D, 9.* 151-173.

Fujisawa, T., Aoyama, Y., Nakagawa, D., & Matsunaka, R. (2003). Benefit Estimation of the Pedestrian Space Improvement at an Urban Area. *Infrastructure Planning Review*, *20*, 191-197. (In Japanese).

Hamana, S., Nakagawa, D., Matsunaka, R., & Oba T. (2009). Study on the Effect of the Allocation of Road Space for Pedestrians on the Life of Shopping Malls: Based on Field Survey on 86 Shopping Malls in Kyoto City. *Journal of the City Planning Institute of Japan, 44*(3), 85-90. (In Japanese).

Hiller, B., & Iida, S. (2005). Network and psychological effects in urban movement. *Spatial Information Theory, 3693*, 475-490.

Jacobsen, P.L. (2003). Safety in numbers: more walkers and bicyclists. safer walking and bicycling, *Injury Prevention, 9*(3), 205-209.

Kitamura, H., Deguchi, A., Zhao, S., & Kurose N. (2005). Functional and spatial configuration of malls for attracting pedestrian activities, *Journal of Architecture and Planning. 70*, 145-152. (In Japanese).

Lee, D. (2008). Location of stores in the regional commercial area: A case study of Shimokitazawa. *Journal of architecture and planning, 73*(62), 619-624. (In Japanese).

Longstreth, R. (1997). City Center to Regional Mall Architecture, *the Automobile, and Retailing in Los Angeles, 1920–1950*. Cambridge MA: The MIT press.

Oba, T., & Nakagawa, D. (2009). A study on countermeasures for reducing the level of illegally parked bicycles in central shopping areas taking into consideration bicycle user's preference heterogeneity. *Infrastructure Planning Review, 27*. (in Japanese).

OECD Organization for Economic Co-operation and Development. (1998). *Safety of vulnerable road users*. DSTI/DOT/RTR/RS7(98)1/Final. Paris: OECD.

OECD Organization for Economic Co-operation and Development. (2011). *Summary Document: Pedestrian Safety, Urban Space and Health.* OECD. Paris.

Park, D., Nakagawa, D., Matsunaka, R., & Oba T. (2010). Study on the factors to make streets lively and brimming with people by field surveys on historic cities around the globe: Kyoto, Florence and Seoul, *Selected Proceedings of the 12th World Conference on Transport Research Society*. S1-01632, ISBN 978-989-96986-1-1.

Brambilla, R., & Longo, G. (1977). *For Pedestrians Only: Planning, Design and Management of Traffic-Free Zones.* New York: Whitney Library of Design.

Rundle, A., Roux, A. V. D., Freeman L. M., Miller, D., Neckerman, K. M., & Weiss, C. C. (2007). The Urban Built Environment and Obesity in New York City: A Multilevel Analysis, *American Journal of Health Promotion, 21*, 326-334.

European Cooperation in Science and Technology. (2010). *Pedestrian's Quality Needs* (PQN Final Report). Delft: WALK 21.

Topp, H.H. (1990). Traffic safety, usability and streetscape effects of new design principle for major urban roads, *Transportation*, *16*(4), 297-310.

Vandegrift, D., & Yoked, T. (2004). Obesity rates, income, and suburban sprawl: an analysis of US state. *Health & Place*, *10*, 221–229.

Yamamoto, T., Kitamura, S., Yoshii, T., & Kitamura, R. (2001). Analysis on Effects of

through traffic on pedestrian and bicycle traffic and observation of through traffic by ITS technology, *Infrastructure Planning Review*, *27*. (In Japanese).

Chapter 3 SURVEY CITIES AND RESEARCH METHOD

3.1 General introduction

Kyoto, Seoul, Beijing, and Florence are famous as historic cities where millions of tourists visit every year. Specifically, city centers are famous with people as a central area with a long history: Shijo and Gion in Kyoto, Myongdong and Insadong in Seoul, Wangfujing and Nanluoguxiang in Beijing, and Centro and Santacroce in Florence.
Policies for urban growth have been established in each city. As a global trend, the environment for pedestrians is more emphasized than for drivers. For example, a pedestrian zone has been implemented in the city centers. Moreover, various policies for pedestrians have also been put into effect. The survey method and the environmental factors surveyed in common for each city are firstly shown. This is to explain the relationship between vibrancy and environmental factors in Chapter 4.
In this chapter, the characters of survey areas in four cities are outlined, and various policies enforced in the present are shown for pedestrians in each city.

3.2 Surveyed city centers

3.2.1 Selection of city centers

The target city centers are the central areas of the cities which have good accessibility and are open to anyone. In each street, pedestrians may use the areas because shops with appropriate products are located within close range. As famous tourist cities, these areas are open to not only the people who come here every day but also visitors. Moreover, from the perspective of urban history, these cities are much older than other cities created recently through development and rapid growth. Through the long period of urban growth, these cities have been naturally formed including a wide range of people and cultures.
The central areas of these cities are basically rectangular. In particular, Shijo in Kyoto is strictly rectangular. The reason for the rectangle shape is that Kyoto was originally planned city. The survey area in Seoul is close to the rectangle shape. Florence has been developed as a city in the shape of a rectangle. However, it was established at the angle of almost forty five degrees in the direction of river Arno when it became an autonomous city as a commune in the 12 century. Therefore, there are streets running largely in two

directions. [2]

Kyoto, Seoul and Beijing are famous cities not only with a long history in Eastern Asia but also with a pedestrian-friendly policy like pedestrian zones. In addition, Florence can also be compared with them because it has along history with respect to street management with these same characteristics. [3]

3.2.2 Outline of survey areas in each city

The survey of city centers in Kyoto, Seoul, Beijing, and Florence were respectively conducted in November 2009, November 2008, November 2011, and July 2010.[4] The survey areas are each Shijo, Gion in Kyoto, Myongdong, Insadong in Seoul, Wangfujing, Nanluoguxiang in Beijing, and Centro, Santacroce in Florence.

The survey cities exist or existed as capital in their nation. With historical identity, they have done a lot of efforts for their original tradition. Together with these efforts, they also have commonly done a policy to encourage pedestrians and decrease motor vehicles such as pedestrian zone in central areas. Therefore, there is a tendency that a lot of citizens and tourists gather because they want to spend time enjoying many historical buildings and convenient amenities. Central areas have both characteristics of history and commerce. It means that there are a lot of pedestrians and motor vehicles although there are still narrow streets in central areas. With the importance of place, it is necessary to makes a good environment after identifying the relationship between pedestrian vibrancy and varioud street environment like store and parking. [5]

In Kyoto, Shijo and Gion are located between Kyoto station and Kyoto palace. They are respectively left and right in Figure 3. Shijo is surrounded by Sanjo-dori, Karasuma-dori, Kawaramachi-dori and Shijo-dori. And Gion is surrounded by Sanjo-dori, Kawabata-dori, Higashi-oji and Matsubara-dori.

Myongdong and Insadong are located between Seoul station and Gyeongbok palace. They are respectively down and up in Figure 4. Myongdong is surrounded by Eulji-ro, Namdaemun-ro, Samil-ro and Toegye-ro. And Insadong is surrounded by Yulgok-ro, Ujongkuk-ro and Samil-ro. [6]

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[2] Florence was built by the Romans. They settled and built city named Florentia, meaning prosperity, on the north side of the river Arno. They developed the city in the shape of the rectangle at the beginning period.

[3] Florence was famous for its "beautiful, wide, and straight" paved street, whose design had been regulated since the 14th century. (Kostof, 1993)

[4] Insadong of Seoul was surveyed again in April 2010.

[5] According to Matthew, C. *et al.* (2003), Europe introduced policies to protect historical areas as part of urban planning.

[6] Actually, we surveyed more area about Insadong, specifically southern part up to arterial road named as Jong-ro. However, the area had the atmosphere to be abolished and related content was checked in Hankyore Newspaper (2009.10.19). Therefore, this area is excluded in all analyses.

In Beijing, Wangfujing and Nanluoguxiang are located in near east of Beijing palace, or fobbiden city. We surveyed Wangfujing as northern part from Dongdan 3rd Alley Street. And Nanluoguxiang is surrounded by Gulou East Street and Di`anmen East Street in Figure 5.

In Florence, Centro and Santacroce are located in the southern east of Santa Maria Novella station along the river Arno. They are respectively left and right in Figure 6. Centro is surrounded by Via de Cenrretani, Via de Tornabuoni, Via de Giraldi and Lungarno degli Acciaiuoli. In addition, Santacroce is surrounded by Via G.B. Niccolini, Via de Giraldi, Viale della Giovine Italia and Lungarno della zecca vecchia.

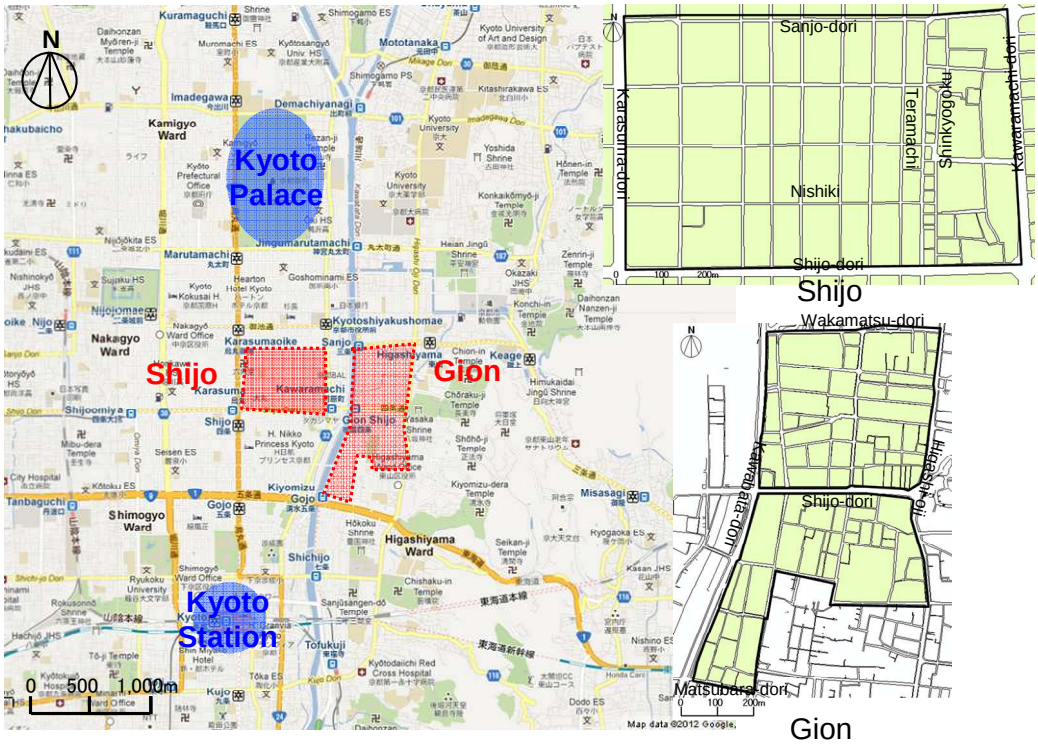


Figure 3 Location and figure of survey areas in Kyoto

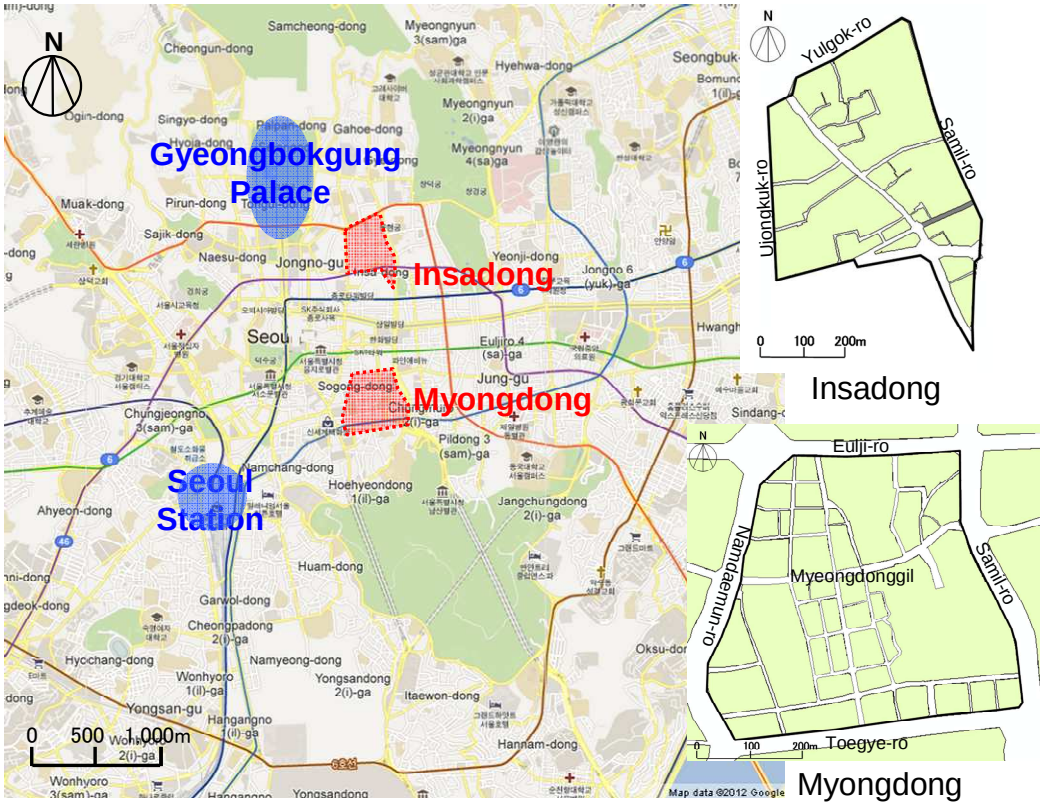


Figure 4 Location and figure of survey areas in Seoul

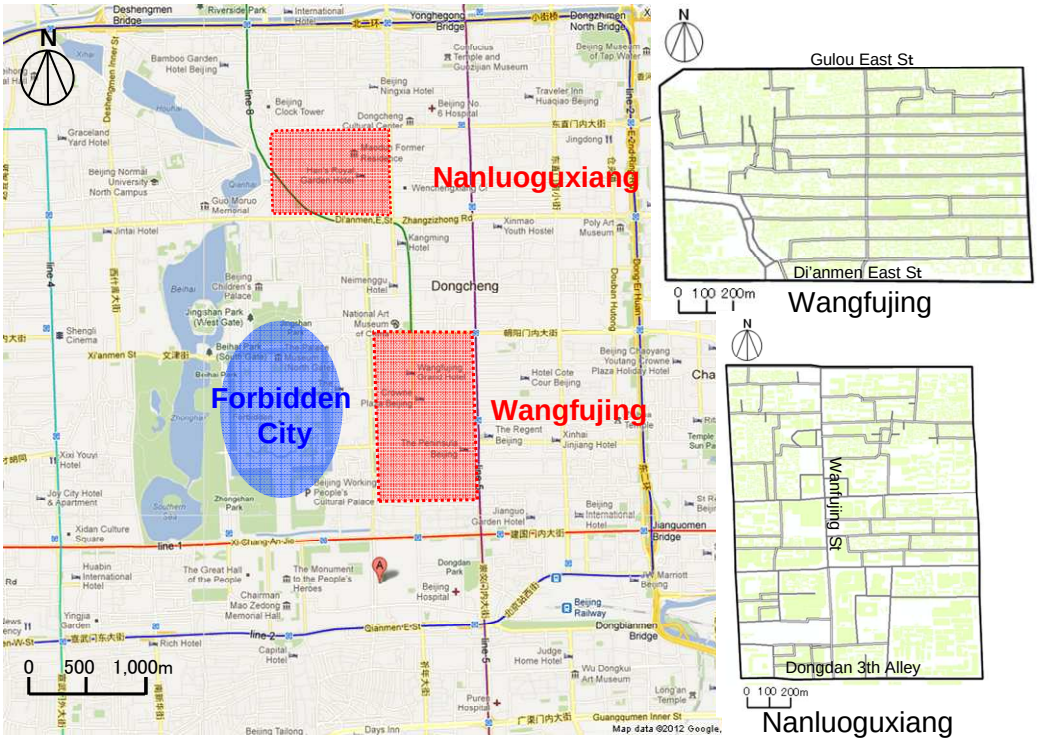


Figure 5 Location and figure of survey areas in Beijing

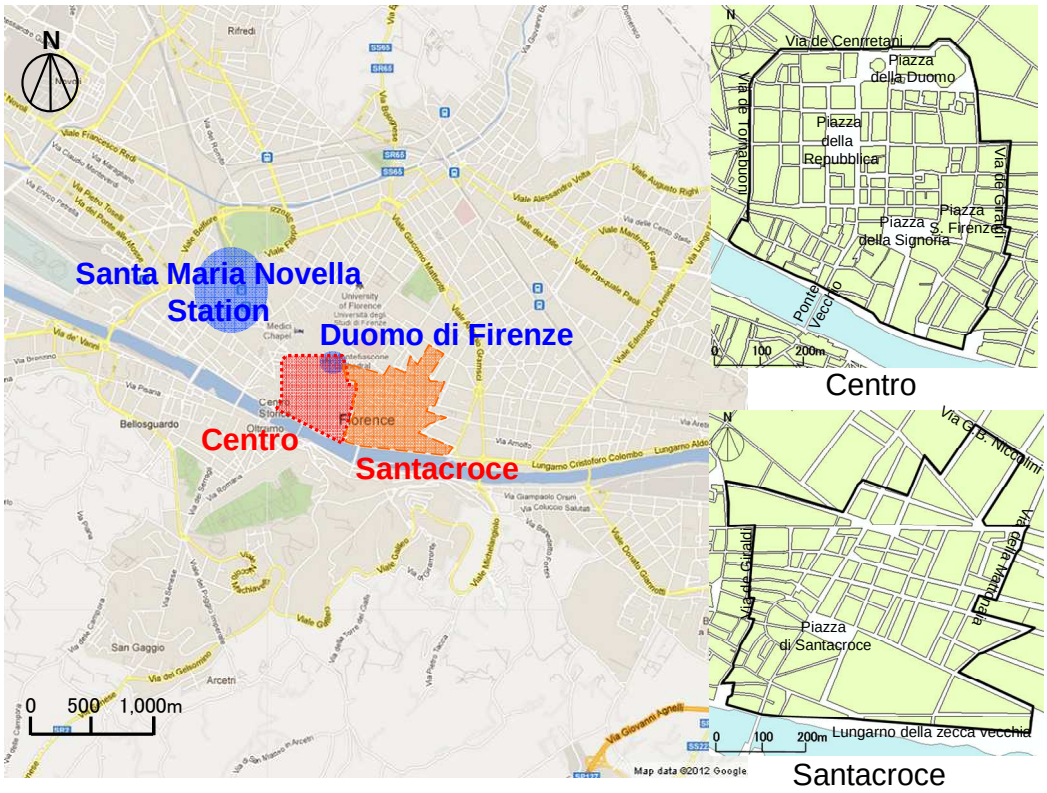


Figure 6 Location and figure of survey areas in Florence

3.3 Policies for pedestrian friendly environment in four cities

3.3.1 Kyoto

There have been policies to encourage citizens walking in Kyoto. First of all, the charter named as 'Arukumachi Kyoto' was made in 2010. In other words, it defines Kyoto as a walking town. And there is some range of prohibiting smoke in central area. It has been carried out since 2007. In addition, various action programs have been also introduced. For example, there is a policy to treat bicycles abandoned in city center.

- The charter of 'Walking town, Kyoto' [7]

Kyoto city established the charter of 'Kyoto, Walking town' (: Arukumachi Kyoto) in January 23, 2010. In this charter, walking is focused as the proper method of moving in Kyoto. The charter is purposed to make attractive town with humans as main part. The contents of the charter are like the following.

[7] Translation about the charter of 'Kyoto, Walking town' (http://www.city.kyoto.lg.jp/tokei/soshiki/9-5-0-0-0.html)

Figure 7 Advertisement for the charter of 'Walking town, Kyoto'

In our Kyoto, each of us does as a citizen,
1. Be thankful for the life with being healthy, human and eco-friendly, pleasant to walk
1. Create a vitalized town with pedestrian space and public transport
1. Make everyone visiting Kyoto to enjoy the attraction of walk

There is the same content in advertisement for the charter as shown in Figure 7.

- History of pedestrian zone

Table 2 illustrates that pedestrian zone has begun since 1972. However, pedestrian zone has been differently conducted by each shopping street as shown in Kyoto. Until 2000, the range of pedestrian zone has been expanded. The places are as follows.

Table 2 Shopping streets designated as pedestrian zone in Kyoto [8]

Shopping street	*Beginning year*	*Restriction hour on vehicle traffic*
Kyotonishiki	1972	From 7 a.m. to 8 p.m.
Teramachikyogoku	1975	From 10 a.m. to midnight
Shinkyogoku	1976	All day
Sanjo (meitengai)	1976	From 10 a.m. to midnight
Kawaramachi-takoyakushi	2000	From 1 p.m. to 5 p.m.

- Street of prohibiting smoke in central district of Kyoto

Since June 1st, 2007, the ban of smoking on street has been carried out in some parts of city center as the municipal ordinance. It is for the improvement of the public environment. Recently, the range of the smoking-ban area had been expanded since July 1st, 2010. The range of the area is like Figure 8.

[8] Quoted after modification in the part of Hamana (2011)

(Red: plan to be expanded, Yellow: current enforced)

Figure 8 Sign and advertisement for smoking-ban area in central area of Kyoto [9]

The range of the smoking-ban area was expanded from central district to areas around Kyoto station, Gion, and Temple Kiyomizu from February 1st, 2012.

3.3.2 Seoul

In Seoul, various policies have been made to encourage citizens walking. Since 1979, car-free zone, included in Myongdong, was carried. And the ordinance for walking right has been enforced since 1997. Business 'Seoul Road Renaissance' could be shown as one policy to improve the walking environment.

- History of car-free area and pedestrian zone

In Seoul, the policy of 'car-free streets' were conducted in the five places including Myongdong on every sunday since July 1979.[10] In Myongdong, the pedestrian zone was expanded since the middle of August 1987.[11] Recently, the pedestrian zone had been established, expanding to weekdays since May 16th in 2008 including time expansion from 11 a.m.-23 p.m. to 10 a.m.-23 p.m.[12] In addition, 'car-free streets' in Insadong has been conducted since April 13th in 1997. [13]

- Ordinance for the base of walking, Seoul

The ordinance (no. 3376) for walking has been conducted to make Seoul more walkable, since January 15th, 1997. Nowadays, several developed policies, related to this policy, have been carried out; encouragement of using bicycle, green spaces and so on. They are purported to make the city streets safe and walk able.

[9] http://www.city.kyoto.lg.jp/bunshi/page/0000027498.html
[10] Newspaper 'Donga', June 13th in 1979
[11] Newspaper 'Donga', August 15th in 1987
[12] Newspaper 'Seoul', May 16th in 2008
[13] Newspaper 'Donga', April 9th in 1987

- Seoul Road Renaissance

The business named 'Seoul Road Renaissance' has been implemented by administration. It is not only to make environment beautiful but to improve the street environment for safety and happiness of pedestrians. [14]

3.3.3 Beijing

- Historical and cultural preserves

In Beijing, there are 25 areas designated as historical and cultural preserves. According to Jeong (2008), their area is totally 1,038 ha. Plan was established to preserve the areas at the beginning of early 2001. Figure 9 illustrates that there are designated historical and cultural preserve in Nanluoguxiang.

- Increasing of parking fee

There was the increasing of basic parking fee from 2.5 to 7.5 Yuan per a half hour in inner city including Wangfujing area since the beginning of April in 2010. It is applied from 6 a.m. to 9 p.m. except for residential areas. [15]

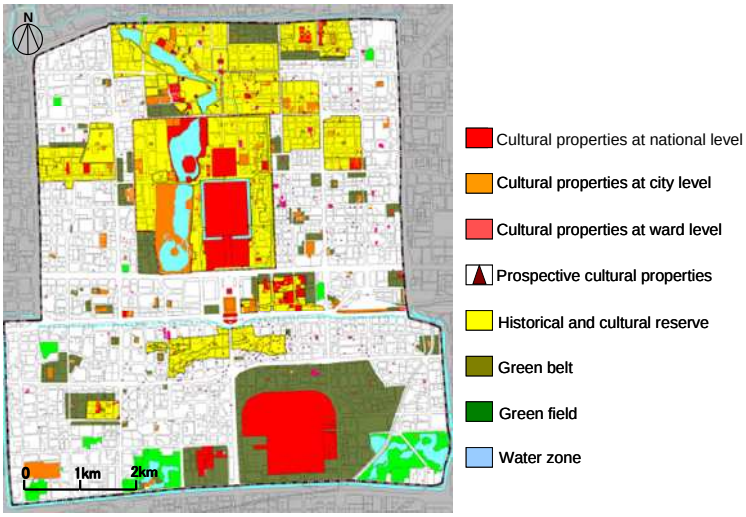


Figure 9 Distribution map of historical and cultural reserve in Beijing [16]

[14] http://transport.seoul.go.kr/index.html
[15] http://news.xinhuanet.com/fortune/2010-02/02/content_12917990.htm
[16] Modification of legend in the map (Jeong, 2008)

3.3.4 Florence

In the traffic policy of Florence, the effort could be seen from car to walking or public transportation. Above all, there is no public parking lot in central area of Florence. Moreover, the range of pedestrian zone was expanded to improve pedestrian utility; like Passo Duomo, even from 2008 to 2010. And the entry of vehicle into the city center is strictly limited by Zone Traffic Limit. In addition, bus routes were changed for pedestrian utility and preservation of historical cultural properties.

- Passo Duomo

Passo Duomo means new pedestrian zone around Duomo. Tourist attraction called Duomo where many buses passed was changed to the pedestrian zone since October 22, 2009 as shown in Figure 10. This change is purposed not only for historical cultural properties but also for the benefit of pedestrians like tourists.

To protect remains in Florence such as Passo Duomo, many bus routes have been changed on November 2, 2009. Figure 10 illustrates that there were the changes of ordinary bus routes. In the same way, sightseeing bus routes were also changed like Figure 11. This change is implemented not only for the protection of precious remains but also for pedestrians using central area.

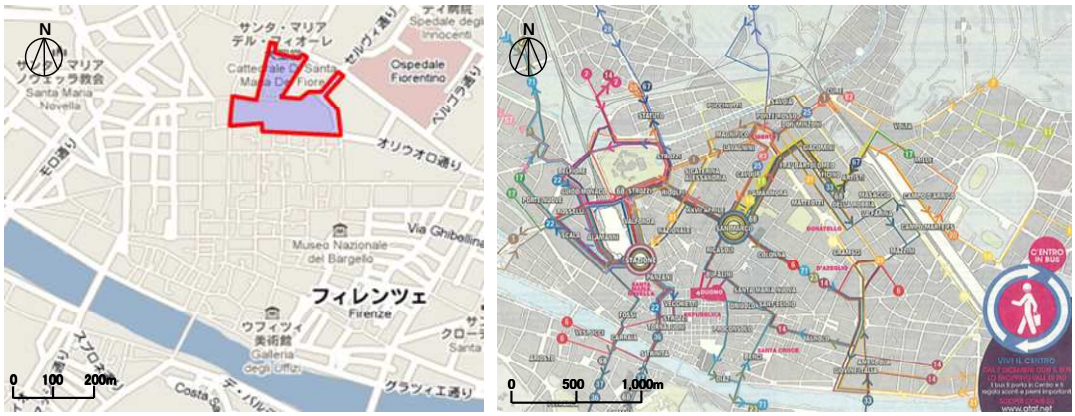
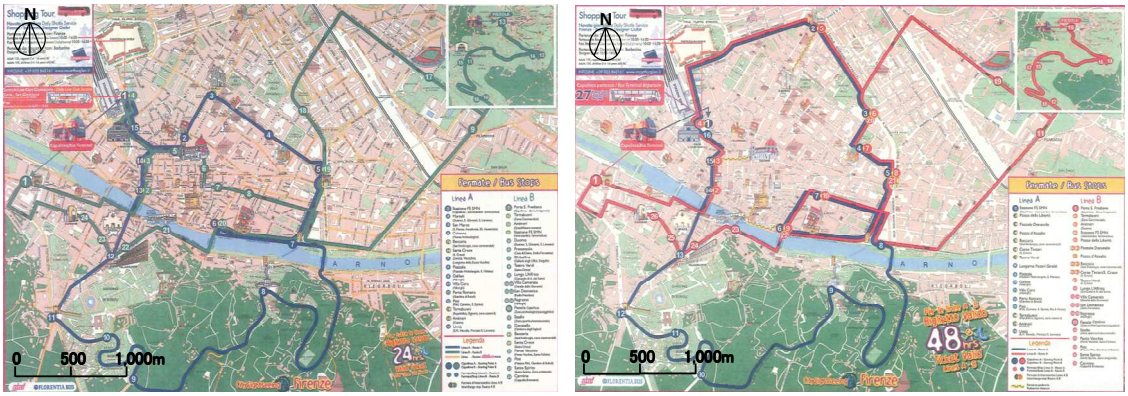


Figure 10 Passo Duomo and change of ordinary bus routes in Florence [17]

[17] http://news.comune.fi.it/muoversi (left map), http://www.ataf.net (right map)



Previous route, 2008 Current route, 2010

Figure 11 Change of sightseeing bus routes in Florence [18]

– Zone Traffic Limit to preserve the historical-central area of Florence

In the central area of Florence, driving is limited to registered vehicles of residents. It is called Zone Traffic Limit and it is divided into four kind of zone as shown in Figure 12. It had been implemented since December 11, 2009. As shown in Figure 13, there are the ZTL entry points: red T and blue T, and the various zones by letter which correspond to where residents can park. [19]

Figure 12 Map of ZTL in Florence [20]

[18] Source is the maps of ataf & Li-nea, 2008 and 2010

[19] For instance, the hotel must inform traffic police with license plate numbers when visitor stays with car.

[20] http://www.florence-on-line.com/maps-of-florence/florence-driving-map-ztl.htmlxcv

Figure 13 Sign board for no parking area by ZTL

3.4 Methods to measure vibrancy and environmental factors

All environmental factors and vibrancy are dealt in the unit of streets in this study. It is to seek the street environment for pedestrians gathering. The street as an institution is an equally critical subject. Beyond its regional and architectural identity, every street traditionally has an economic function and social significance. The street traditionally has important roles in a region. Traffic, the exchange of goods, social exchange and communication happen inseparably, being related to the physical form of the street.

Pedestrian vibrancy is regarded as an index of regional vitalization. It is made by a number of pedestrian on streets. Pedestrian vibrancy happens mainly in public places such as streets and parks.[21] To increase pedestrian vibrancy, it is necessary to make multiple pedestrian-friendly environments. Pedestrian vibrancy could mean pedestrians gathering influenced by street environment.

Basically, four pictures are taken on above a hundred of streets in each city, from 11 a.m. to 12 noon and from 1 p.m. to 4 p.m. only on weekdays and clear day. Then, average value of pedestrian number is calculated on each street. It is survey effort to collect more accurate data and reduce biased data.

In particular, it is excluded when the streets are outskirts and blocked such as cul-de-sacs of each area to avoid the effect of commute time and private use. [22] [23] [24] In

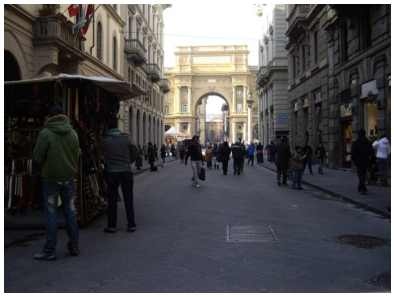
[21] According to Carmona *et al.* (2003, p.110), the 'public' in contemporary society means a universal construct that assumes a collective whole, while in reality the public is fragmented into marginalized groups, many of whom have no voice, position or representation in the public sphere.
[22] Crankshaw, N. (2008) shows the sidewalk along an arterial street could be threatening space.
[23] According to Matthew, C. *et al.* (2003), Cul-de-sacs has merits like providing quite and safe streets for residents. However, it could not be as public space in the point of weakness of connection and creating car dependence.
[24] According to Southworth and Ben-joseph (1997, pp.121-125), cul-de-sac has a lot of merits such as safety and local identify. However, it is excluded in this study because there are also a lot of demerits like lack of connection and growing dependence on motor vehicles.

addition, it is excluded if a street is multiple lanes divided for two-way, or included completely in building, or has no building on the side; in piazzas or beside river.

Area about each street is also required to measure vibrancy rate. Vibrancy rate is affected by not only pedestrian number but also area of a street, the information of area should be obtained for each street. It is found out by GIS file about central areas in each city. As a result, vibrancy rate is calculated by number of pedestrians per area of each street. It is shown in Figure 14. And vibrancy rate is defined as follows.

Number of pedestrians
= (Number of pedestrians on the street in photo 1 + Number of pedestrians on the street in photo 2 and 3 + Number of pedestrians on the street in photo 4) / 3

Vibrancy rate (: persons / m² *100)
= Number of pedestrians / Area of one street unit * 100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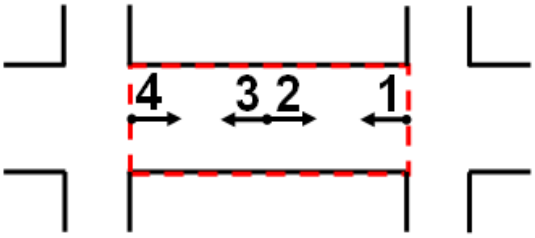

Figure 14 Method to measure vibrancy on street

In Table 3, there are environmental factors which are related to vibrancy. They are commonly surveyed in four cities are like Figure 15. Pedestrian zone and store are measured as typical pedestrian-friendly environmental factors. On the other hand, parking lot, parked car, parked motorbike and parked bicycle are measured representatively as vehicle-based environmental factors. Street shape and street connection are measured as environmental factor influencing vibrancy by street structure. In addition, arcade, street vendor and piazza are added as characteristic factors in each city.

Table 3 Environmental factors measured on the street

Variables	*Data type*	*Method*	*Supporting literatures*
Pedestrian zone	Dummy data	Map and photo	Park *et al.* (2010), Hamana *et al.* (2009)
Store	Numeric data	Photo	Fujisawa *et al.* (2003), Arima *et al.* (2008), Lee (2008)
Arcade or piazza or street vendor	Dummy data	Map and photo	Mcgarry (2008)
Parking lot, Parked car, Parked motorbike,	Numeric data	Photo	Loukopoulos *et al.* (2005), Yamamoto *et al.* (2001), Taniguchi and Fujii (2006)
Parking of bicycle	Numeric data	Photo	Oba and Nakagawa (2009), Taniguchi *et al.* (2009)
Street connection and shape	Dummy data	Map, photo and GIS file	Hiller and Iida (2005), Bogers and Timmermans (1986), Crane (1996)


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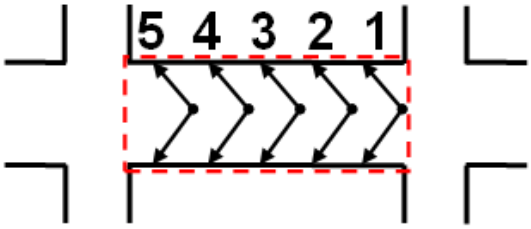

Figure 15 Method to measure environmental factors on street

3.5 Environmental factors surveyed on streets of four cities

In this study, surveys were conducted on the street. However, the concept of street is difficult to distinguish from road. They are sometimes used with the same meaning. Kostof (1993, p.277) indicates that the effect of the car tend to fragment urban areas. That is because of not a street but a road. Road is not for social aspect by pedestrians but for the flow of cars. In this study, a street is distinguished from a road. A road exists only for vehicle traffic. However, a street is regarded as a place where a diversity of human activity happens.

Street means the place where people do their various activities, such as walking, eating, working, shopping and so on, although road usually means the ground for passing. Therefore, the street is used for the background where vibrancy occurs, according to various factors in this study. And each following factor related to vibrancy is based on the street.

- Pedestrian zone

Pedestrian zone is made for the passage of pedestrians. It makes walking comfortable and makes easy for pedestrians to seek goods and services. It excludes automobile traffic with specific signs, obstacles and polices in regular daytime hours.

The term 'Pedestrian zone' was firstly used in European countries. Brambilla & Longo (1977, pp.8-9) showed several types of traffic-free zone; for example, pedestrian district, pedestrian streets, transitway, semimall and enclosed mall. Kärrholm (2012, p.41) indicates that the first modern central pedestrianisation of a street is said to be the 550 meter long Limberckerstrasse in Essen, Germany. It became a pedestrian zone in 1924. However, the large-scale and the most important pedestrian precinct in Europe could be Lijnbaan built in the center of Rotterdam.

In Kyoto, the pedestrian zone voluntarily began in central areas like Nishiki shopping street after February 1972. Regulation time is different in each area, but it is usually

from 10 a.m. to 9 p.m. There are currently areas such as Nishiki, Sanjo, and Teramachi carrying out the pedestrian zone in Shijo, however there is no pedestrian area in Gion.

In Seoul, the policy of 'car-free streets' had been carried out in five places including Myongdong since July 1979. Then, the pedestrian zone was expanded in Myongdong in 1987. Since 2008, the pedestrian zone was carried even on weekdays. In Insadong, a car-free street was created in 1997, but did not include weekdays until now.

Florence made the new pedestrian zone, named 'Passo Duomo', to protect historic sites around Duomo in October 2009. During the field survey in 2010, the pedestrian zone was further widened. Considering the situation for the pedestrian zones of the four cities in this study, a street is defined as a pedestrian zone when it is as follows.

1. It has a sign designating pedestrian zone as shown in Figure 16.
2. While it is located on the same street or avenue which a pedestrian zone (number 1 case), it is connected only to streets in two cases: a pedestrian zone (number 1 case) or a street less than 2m in width.
3. It is connected only to streets as defined in number 1 or 2.
4. It is less than 2m in width while it is connected to streets of number 1 or 2 or 3.
5. It is less than 2m in width while it is surrounded by streets of number 1 or 2 or 3.

Kyoto Seoul

Beijing Florence

Figure 16 Signs for the pedestrian zone in survey cities

- Store

A store could be the factor triggering people to gather in. When there are a lot of popular attractions to see, people are willing to come. Moreover, it automatically creates safety and attractiveness in the space as plenty of people come together. For this reason, the store is an important environmental factor on the street.

Concerning stores attracting pedestrians, they are classified and then their some parts are just adopted for the purposes of this study. The category of stores can be divided into three: a street-oriented shop, purposed-oriented store, and other.

Street-oriented stores influence unspecified numbers of pedestrians and are directly related to such factors as the structure and position of the street. For example, street-oriented stores could include the shops with open space and large exhibits such as antiques, art galleries, craft, costume, clothing, shoes, accessories and conveniences. However, purpose- oriented stores could be the shop serving a specific purpose, for example, business. Examples include restaurants, coffee shops, cafes, pubs and beauty salons. Finally, the other category includes the following: laundry shop, bank, hotel and others.

In addition, Choi (2003) classifies cultural properties by the conceptual contrast of the spatial and transpatial urban structure. In a spatial urban structure, pedestrians move by recognizing the structure, and stores are distributed by the spatial characteristics of cities. Otherwise, in a transpatial urban structure they are distributed regardless of such characters. This means an urban space where pedestrians move independent of spatial characteristics, and they are influenced by ex-spatial factors. The spatial urban structure is the area which is open to not only users but also strangers or visitors. A transpatial urban structure exists for the motive or profit of a specific group, excluding people who do not belong to the group. [25]

Street-oriented stores seriously consider their relationship with the character of their location, related to building and street. A retail store is a typical street-oriented store. In contrast, purpose-oriented stores focus on customers' clear purpose and the motivation of their visits. A restaurant and cafe are representative purpose-oriented stores. Therefore, retail stores are counted for store numbering, together with café and restaurant. [26]

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[25] Hillier and Hanson (1984) used the concepts of spatial and transpatial group to divide social groups into two categories. Spatial group is the group based on the spatial accessibility; in the realm of everyday life. On contrary, transpatial group is the group with the similarity of purposes of people regardless of space. On the other side, all groups have homogeneity or heterogeneity. The most important base to distinguish these two characters is whether it is open or close to all people.

[26] To make the definition of retail store accurate, it is referred from Industrial Classification in UN, North America, Korea and Japan, excluding street vendor or vending machine.

Figure 17 Arcade in Kyoto

- Arcade

Arcade means a group of arches in Italy. But it also means the arch-shape equipment on the roof of a walk way used by pedestrians to avoid rain or sunlight in Japan like Figure 17. In this study, arcade means the roof on the street of a mall, creating a pleasant shopping environment for pedestrians in commercial centers. Arcade is dealt with as an environmental factor because there is a large difference of pedestrian vibrancy according to whether or not there is an arcade on the street in Kyoto.

- Piazza

Giles-Corti et al. (2005) emphasize the importance of public open space. They showed that public open space made high degree of walking access in proportion to its attractiveness and size. Piazza or square is the representative one of public open spaces. Mcgarry (2008) indicates that the piazza in Italy has played an important role, like the Agora in Athens, or Forum in Rome. There are a lot of shops and cafes in the piazza of Florence. The piazza is a place with an important role in the daily life of citizens, even tourists. People come in and out together for many activities in the piazza because it provides the function of communicating. Piazza can be used as an environmental factor because there is a difference between the streets directly connected to the piazza, and those that are not.

Streets in Florence are connected by dozens of piazza. The piazza is a vibrant place in contrast to a square, which is planned as a silent and rectangular space. A large piazza is named a piazalle. A small piazza is also called the piazzetta. Therefore, a representative piazza is chosen with respect to size and name value.

Piazza della Repubblica is the piazza which has the longest history in Florence. Piazza della Signoria is the center of administration with Palazzo Vecchio. Figure 18 illustrates that vibrant atmosphere around the Piazza. Piazza di Santacroce is the central place with a variety of events and festivals. Piazza S. Firenze also has a central role with the

Figure 18 Vibrant atmosphere in Piazza della Signoria of Florence

large size. Piazza della Duomo is the most famous spot for foreign tourists. Piazza di Santacroce is famous for its central location. These five piazzas are chosen with respect to their size and name value as researched by literature, and for the field survey in this study.

- Street vendor

Street vendor means a vendor selling some items like a snack, drink and small souvenir on the street, especially in public places with a lot of people like Figure 19. Typically vendors must get permission from administrators. Actually, there are rarely street vendors with permission. There are few street vendors in Kyoto. And, they are almost all located on the vacant space of a piazza in the survey area of Florence.

There are relatively a lot more street vendors in Seoul, although there are few in Kyoto, Beijing and Florence. In Seoul, after the IMF economic crisis, there has been passive maintenance and enforcement of street vendors. Therefore, there are relatively many street vendors on the streets. They exist because there is the common sense among citizens that they provide earnings for the low-income class although they are usually illegal. However, it could be a factor to attract pedestrians. Therefore, a street vendor is considered to be one factor of the street in Seoul.

Figure 19 A street vendor in Seoul

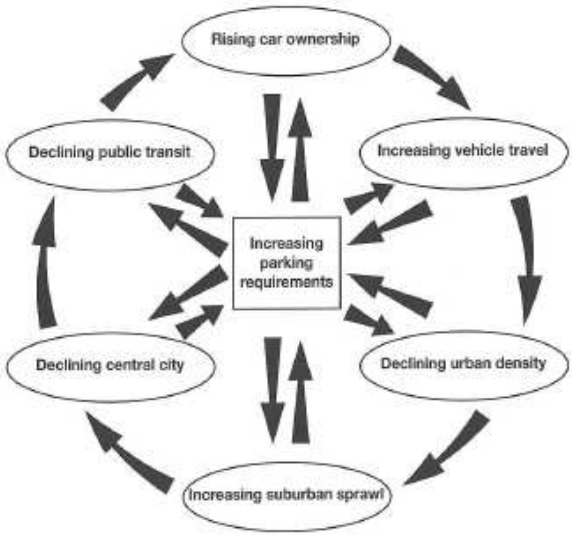


Figure 20 Street parking requirements accelerating urban sprawl

- Parking of car and motorbike

With the growth of motorization, streets have been transformed primarily to accommodate automobiles. It brings more vehicles into city centers and causes traffic congestion and environmental destruction. As the result, there are less pedestrians on streets of many cities, especially historic cities. It is because they could not coexist with increasing automobile traffic.

Crankshaw (2008) indicates that one of the most useful ideas for a historic downtown is to allow no parking in front of every store. This means parking is one index to spoil an area. Parked vehicles contribute to the elimination of pedestrian vibrancy in the central areas. Therefore, it is necessary to check parked vehicles in an area.

Shoup (2005, p.129) shows the linkage effect created by street parking requirement in a city center. In Figure 20, there is an explanation of how an increased street parking requirement destroys a city center and increases sprawl. In addition, Shoup (2005, pp.158-159) insists that street parking requirements especially harm the CBD with respect to the high density of space. The more cars are based on mobility, the less chance women, elderly people, and low income groups have access into a central area because they rely on walking and public transport.

There are definitions of parking according to the road traffic act in each country. The definitions by Japanese and Korean road traffic act are almost the same. And in the survey areas of two cities, any kind of parking is prohibited on the street. However, there is legal parking in the area of Beijing and Florence. But it could be an obstacle to

the flow of pedestrians. In Japan, road traffic act defines the parking and stopping of a vehicle like Figure 21.

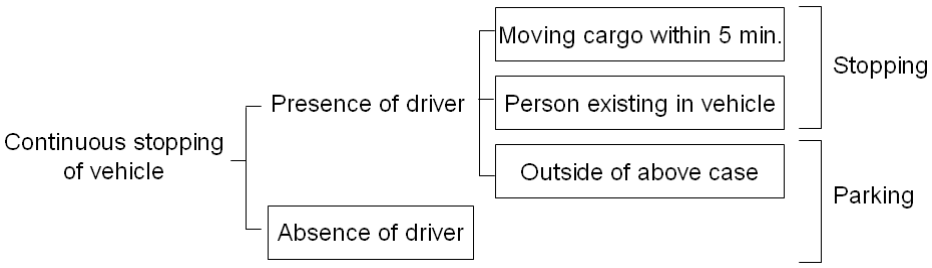


Figure 21 Concept of street parking in Japan

Definitions of parking and stopping are respectively written in the 18th and 19th clauses in Article 2 of Japanese road traffic act. Definition of parking is like following. Continuous stopping by reason of waiting for passengers, loading or unloading cargo and breakdown (except of the case of 1. stopping to get on or off and 2. less than five minutes stopping for loading and unloading of cargo), in addition to the condition of being unable to drive the vehicle immediately because of the absence of driver. In addition, stopping is the case except for parking as definition of stopping. [27]

In each country, parking is defined by the road traffic act. According to the road traffic act in Japan and Rep. of Korea, parking is the situation where a vehicle is stopped without a person. Therefore, based on Japanese and Korean cases in this study, parking is counted when a vehicle is stopped without a person or any sign.

- Parking of bicycle

The bicycle has two contradictory traits. The bicycle has to be the most nature-friendly vehicle and is more pedestrian-friendly than motor vehicles. Therefore, there are rules and exceptions about bicycle passing in each city. The vehicle must be able to coexist with pedestrians.

Nevertheless, the bicycle could be an obstacle to pedestrians. Specifically, parking a bicycle on street is usually popular owing to its convenience and cost. So it could potentially block the flow of pedestrians. For these reasons, there are exception clauses for bicycle passing in Japan and Korea. [28]

- Parking lot

[27] http://law.e-gov.go.jp/htmldata/S35/S35HO105.html

[28] There is exception of bicycle passing, in the 13th clauses of article 3. (http://law.e-gov.go.jp/htmldata/S35/S35HO105.html)

There are several kinds of parking lot such as surface lot and parking facility. They supply convenience for a minority of people. Therefore, Jacobs (1993) compared several environmental factors about excellent streets in western nations and resulted that characteristics of excellent streets is no large-scaled parking lot.

There are many kinds of parking lot system: timely or monthly parking lot, exclusive parking lot, parking lot for guest and others. A parking lot could have an influence on a pedestrian as the vehicle moves through the street. As the existence of a parking lot is regarded as the origin of vehicle-inflow, the number of parking lots is counted. In this study, either public or private parking lot is counted when it is available for many random drivers; however, an exclusive parking lot is not counted, such as a housing or company parking lot, because of its size, and survey time. A parking lot is counted when its entrance or exit exists in each street.

In survey area of Florence, there was no public parking lot, called parcheggio by the policy of Zone Traffic Limit. There are twelve public parking lots out of survey area in Florence.[29] There could be street parking for residents who have a permit card for parking in the survey area like Figure 22. There is no specific parking lot for parking and this could be checked by the sign contents in the vehicle. It is different from the parking system of Kyoto and Seoul because street parking is regarded as illegal parking. As a result, there is no parking lot in Florence in this study.

Figure 22 Permit card for parking in Florence

- Street shape and street connection

Street shape and street connection are also important environmental factors. Street topography makes one area vibrant by increasing accessibility and movement. Therefore, pedestrian vibrancy is affected by the street shape and street connection. Jacobs (1993) insists that opportunities to turn corners must be frequent in a street. Isolated and discrete street neighborhoods are not fit socially. In addition, there is a theory named

[29] http://www.firenzeparcheggi.it/index.php?option=com_joomap&Itemid=74

space syntax, in which the configuration of urban design influences a movement pattern like walking. Hiller (1996, p.161) showed that an important environmental index on pedestrians is the connection of the street. He explains it with the concept of integration. It is related to visual sense.

There are also researches which have dealt with community style. They show that there are different results, like choice of transportation or movement patterns, by comparing the different grid styles of a community. [30]

Shape and connection of streets were selected as design factors and treated importantly in several papers, although a common standard for the design factors was difficult to obtain for each city. They are also related to visual openness which gives people the sense of safety and convenience. In this study, street shape is defined as rectangular when one edge of the street is seen from the other edge. And street connection is defined as straight when there is no blocking at both edges along street flow.

Bibliography

Brambilla, R., & Longo, G. (1977). *For Pedestrians Only: Planning, Design and Management of Traffic-Free Zones.* New York: Whitney Library of Design.

Carmona, M., Heath, T., Oc, T., & Tiesdell, S. (2003). *Public places urban spaces: The dimension of urban design.* Burlington, MA: Elsevier.

Choi, Y. (2003). *Society and space*. Seoul: Sigongmunhwasa. (in Korean).

Crankshaw, N. (2008). *Creating Vibrant Public Spaces: Streetscape Design in Commercial and Historic Districts.* London: Island Press.

Giles-Corti, B., Broomhall, M. H., Knuiman, M., Collins, C., Douglas, K., Ng, K., Lange, A., & Donovan, R. J. (2005). Increasing walking: how important is distance to, attractiveness, and size of public open space?. *American Journal of Preventive Medicine, 28*(2S2). 169-176.

Hamana, S. (2011). *Study on factors on shopping street to make vibrancy in point of the management of pedestrian space and the location of parking lot*. (Master dissertation). Retrieved from Kyoto University. (In Japanese).

Hiller, B. (1996). *Space is the machine.* Cambridge: Cambridge University Press.

[30] The arguments for straight streets are at least as old as the Renaissance.
1. The straight street promotes public order by doing away the nooks and crannies of irregular neighborhoods, and thwarting the temptation to obstruct passage or to shield insurrection behind barricades.
2. The straight street has a practical superiority, in that it connects two points directly and so speeds up communication.
3. The straight street can direct the social and practical advantages it possesses into a discourse of ideology, and with a suitable coding of architecture and decoration it can impart a powerful representational message.

Hillier, B., & Hanson, J. (1984). *The Social Logic of Space.* Cambridge University Press: Cambridge.

Jacobs, A. (1993). *Great streets.* Cambridge, Mass: MIT Press.

Jeong, Seok. (2008). A study on the conservation policy for the historic city in Beijing, China - Focused on 'the conservation plan for the historic city of Beijing (2003)'. *Seoul Urban Research, 9*(4), 165-183. (In Korean).

Kärrholm, M. (2012). *Retailising Space: Architecture, Retail and the Territorialisation of Public Space.* Burlington, VT: Ashgate Publishing Company.

Kostof, S. (1993). *The city shaped: urban patterns and meanings through history.* London: Bulfinch.

Mcgarry, L. (2008). *The Piazzas of Florence: Mapping a Renaissance Spirit.* Pier 9: Murdoch Books

Southworth, M., & Ben-Joseph, E. (1997). *Street and the shaping of towns and cities*, New York: Mcgraw Hill.

Shoup, D. (2005).*The high cost of free parking.* Chicago, IL: American Planning Association.

Chapter 4 RELATIONSHIP BETWEEN PEDESTRIAN VIBRANCY AND ENVIRONMENTAL FACTORS ON STREET

4.1 General introduction

In this chapter, conditions are shown about vibrancy rate, pedestrian zone, and three kinds of parked vehicle in each area. The relationships between vibrancy rate and several environmental factors on the street are shown by t-test.
Survey conditions are respectively dealt with the relationship between vibrancy rate and each environmental factor in survey areas. Then, the results of t-test are shown with respect to whether environmental factors are present or absent.

4.2 Surveyed results in each area

- Shijo, Kyoto
The survey of Shijo was conducted in November 2009. Shijo is the central area located between Kyoto station and Kyoto palace and is a famous commercial area. Sanjo dori is included in the survey area because it is a street used by both pedestrians and vehicles on a one-sided lane, although the outskirt of the survey area is excluded.
The pedestrian zone is set on or around the Teramachi-dori, Shikyogoku-dori and Nishiki-dori. The vibrancy rate tends to be high around the same street. The highest vibrancy is focused on the Teramachi, Shikyogoku and Nishiki streets and the second highest vibrancy is scattered on the center of the horizontal axis related to the pedestrian zone. The area with a high degree of vibrancy is overlapped with the pedestrian zone in most parts.
The parking of cars is located almost on the center of the vertical axis, except for a pedestrian zone such as Nishiki, Teramachi, and Shikyogoku. The parking of motorbikes is similar to the car parking. They have a tendency to be in contrast to the pedestrian zone.
In addition, the parking of bicycles is scattered on all streets of Shijo with high degree. This is considered to result from two reasons: first, there are a lot of bicycle users in Kyoto and second, a bicycle is a vehicle with a pedestrian-oriented character.

As a result in Shijo, the pedestrian zone and the street with high vibrant degree are almost the same streets. And this shows the clear distinction between the pedestrian zone and parking of car and motorbike.

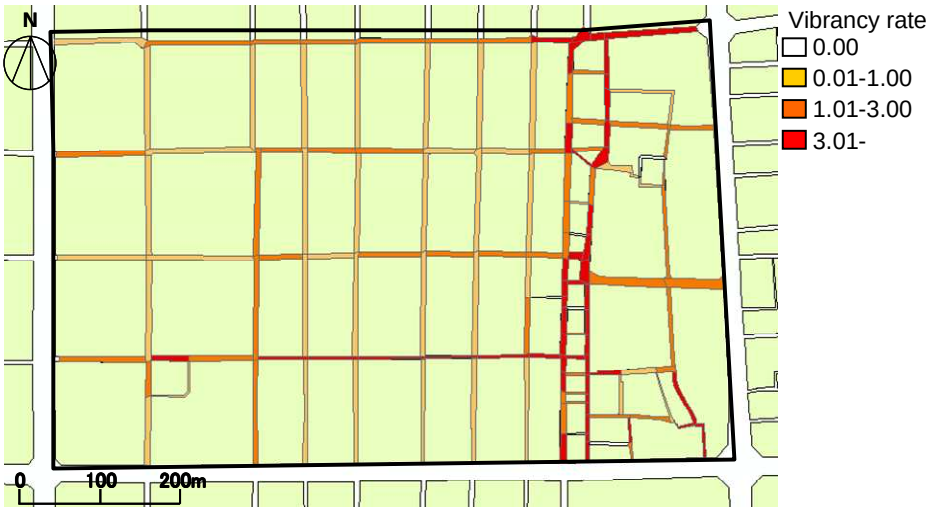


Figure 23 Distribution of vibrancy rate in Shijo

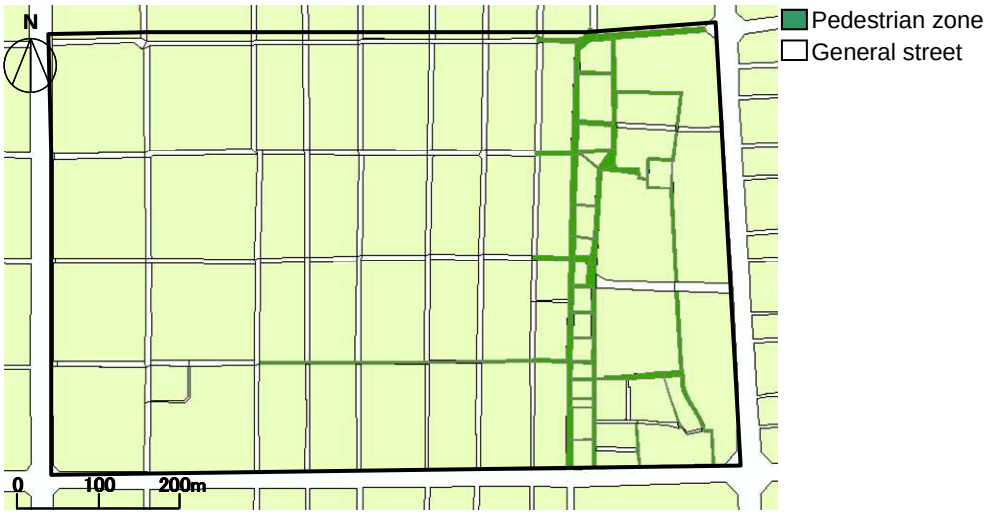


Figure 24 Distribution of pedestrian zone in Shijo [31]

[31] As previously shown in Table 2 (p.18), vehicle traffic is restricted as pedestrian zone from 1 p.m. to 5 p.m. in streets named Kawaramachi-takoyakushi. It is identified by field survey that the part of street on the north of Kawaramachi-takoyakushi is applied as pedestrian zone during same time. We surveyed totally 3 street units from 11 a.m. to noon, which are.applied as pedestrian zone from 1 p.m. to 5 p.m. Therefore, these three street units are analyzed as not pedestrian zone but general street in this study.

Figure 25 Distribution of parked car in Shijo

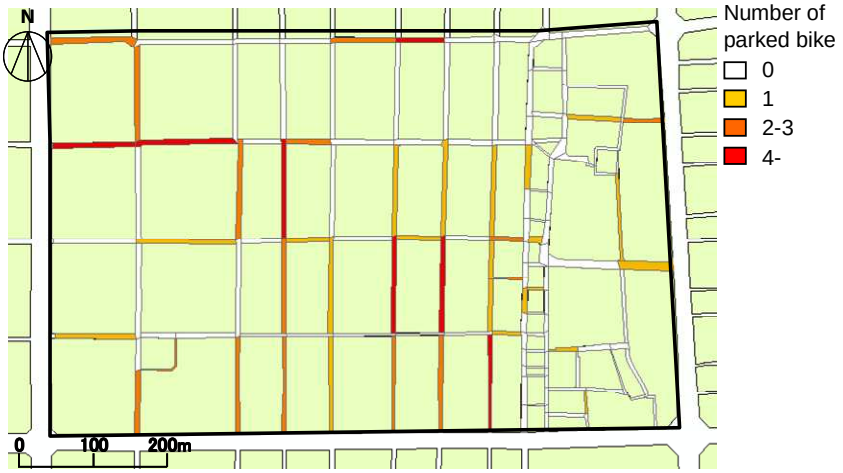


Figure 26 Distribution of parked motorbike in Shijo

Figure 27 Distribution of parked bicycle in Shijo

- Gion, Kyoto

The survey of Gion was also conducted in November 2009. Gion is located on the eastern side of Shijo.[32] Some streets in border are included in the survey area because they are used together with pedestrian and vehicles as one-sided lane although arterial roads on the outskirt of survey area are excluded. In addition, there is no pedestrian zone on Gion. On the streets of central axis in southern area, there is the relatively higher vibrancy rate. But it is evenly distributed around all streets of Gion.

The parking of cars is almost located in the direction of horizontal axis on the north part. It is similar on the case of motorbike. But on the southern side, there is rarely the parking of car and motorbike. In addition, the parking of bicycles exists around almost all streets. It is also considered to come from two same reasons of Shijo: a lot of bicycle users and pedestrian-oriented character

As a result, there are relatively less similar patterns between the streets with high vibrancy and the streets with parking of vehicles. And there are relatively less distinctions between high vibrancy and each parked vehicle. It could come from the relatively low rate of vibrancy and parking.

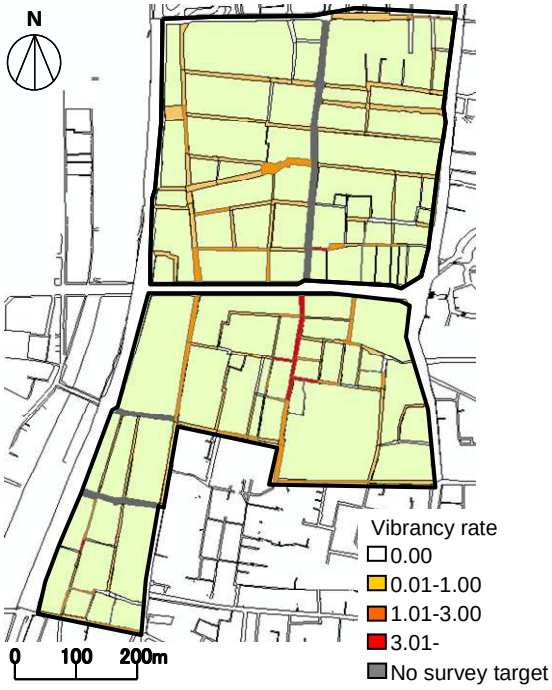


Figure 28 Distribution of vibrancy rate in Gion

[32] The shape of survey area is not close to rectangle. It is to control the area with similar character and area.

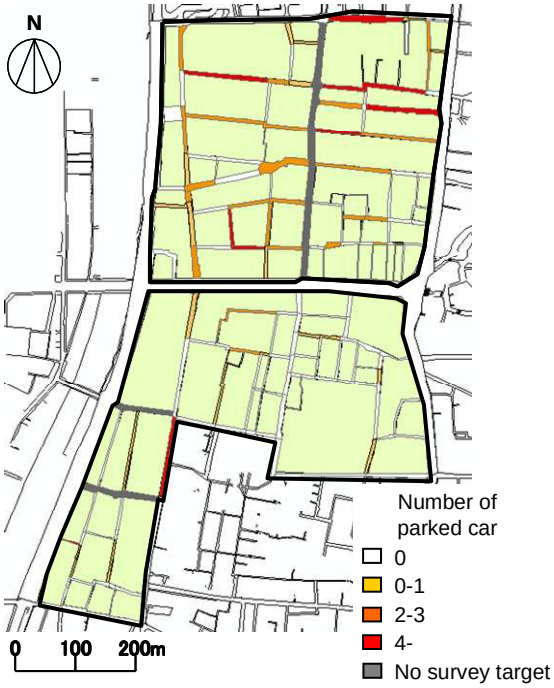


Figure 29 Distribution of parked car in Gion

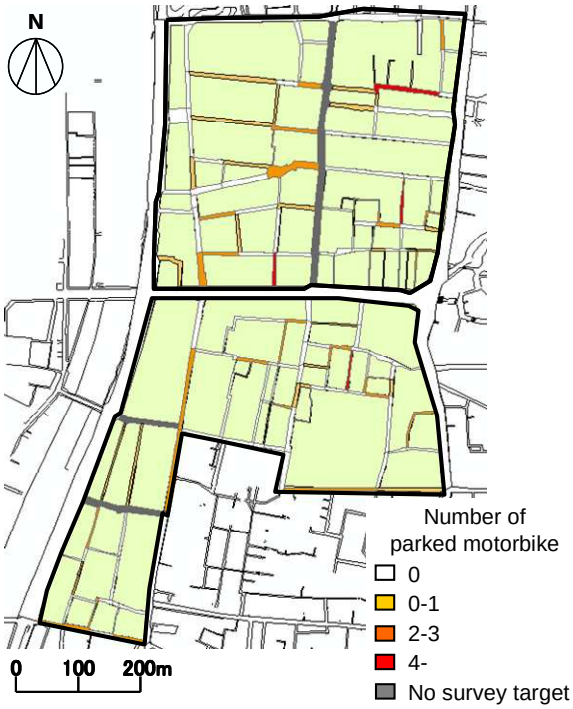


Figure 30 Distribution of parked motorbike in Gion

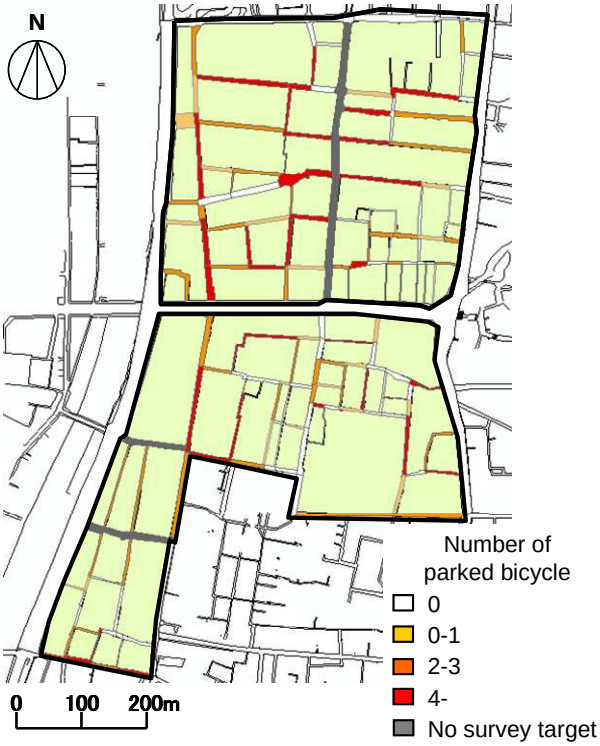


Figure 31 Distribution of parked bicycle in Gion

- Myongdong, Seoul

Myongdong was surveyed in November 2008. Myongdong is famous for the central area of commerce. It is located on the east part between Seoul station and Gyeongbok palace. All these roads of outskirts in Myongdong are excluded because they are each over-two lane only for vehicles.

In myongdong, vibrancy rate is relatively higher as the center of horizontal and vertical axis in the middle of the area. And pedestrian zone is set around the cross of horizontal and vertical axis in the middle. Specifically, the streets with the highest vibrancy rate are overlapped with the pedestrian zone.

The parking of car is dispersed around on all areas. The parking of motorbike is similar to the parking of car. But it is relatively low on the pedestrian zone. In addition, the parking of bicycle is rare in Myongdong. It is because it is not easy to move in or out of Myongdong because of the disconnection by arterial lane.

As the result of Myongdong, there is almost overlapped tendency between pedestrian zone and the street with high vibrant degree. And there is difference between pedestrian zone and parking of motorbike.

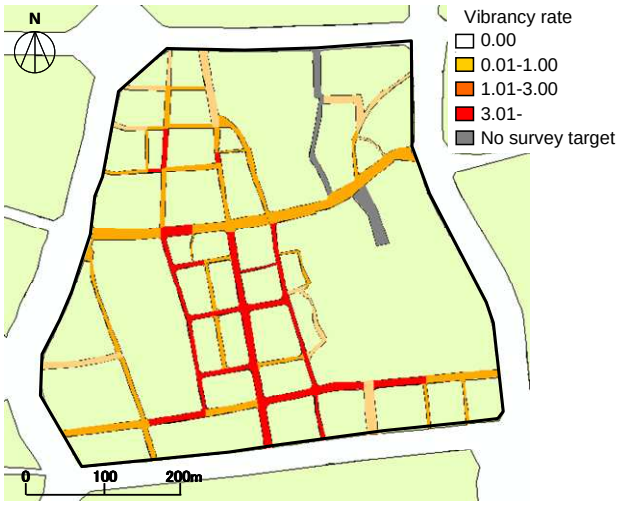


Figure 32 Distribution of vibrancy rate in Myongdong

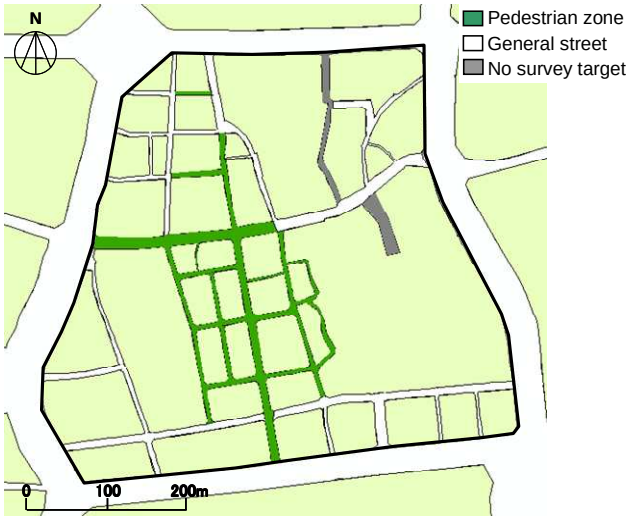


Figure 33 Distribution of pedestrian zone in Myongdong

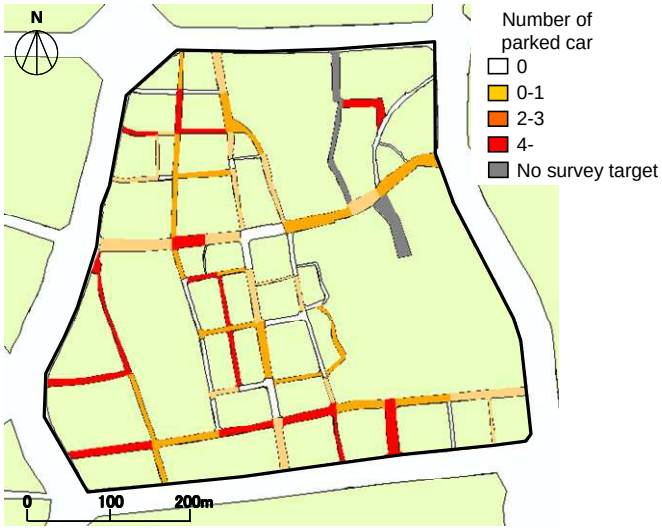


Figure 34 Distribution of parked car in Myongdong

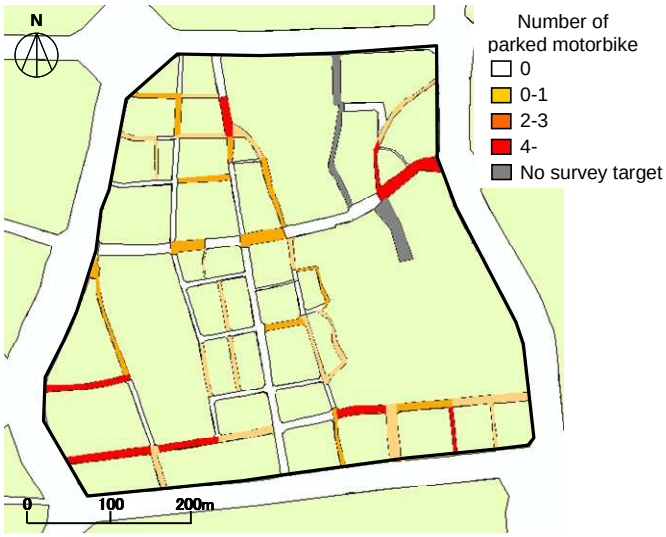


Figure 35 Distribution of parked motorbike in Myongdong

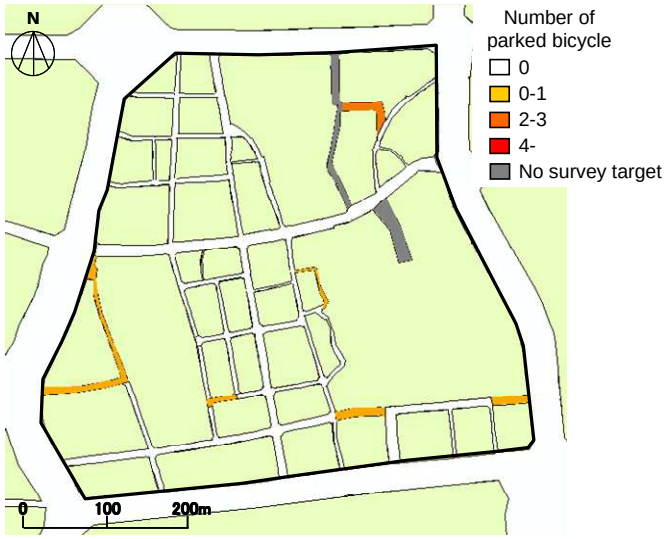


Figure 36 Distribution of parked bicycle in Myongdong

- Insadong, Seoul

The survey of Insadong was conducted in April 2010. Insadong are also located on the northern part of Myongdong. All these roads in Insadong are also excluded because they are each over-two lane only for vehicles like Myondong.

Car-free road is carried out on every weekend in Insadong. However, there has been no pedestrian zone until now.[33] Centered on horizontal and vertical axis of the middle, there is the high vibrancy rate. In particular, it is higher on the vertical axis. In addition, it is high on the part of southern west.

[33] Car-free road is carried out on every weekend in Insadong. However, there is no pedestrian zone until now.

A lot of parked cars are located along horizon axis of the area. This condition is overlapped on the street with high vibrancy in some cases. In addition, the parking of motorbike and bicycle are located along horizontal axis. But these parking have low degree of destiny. They could be not required because of difficulty to move in or out of Insadong by the disconnection.

As a result, there is weak contrast between vibrancy and the parking of car. And there is also distinction between vibrancy and the parking of motorbike and bicycle although they are not in the majority.

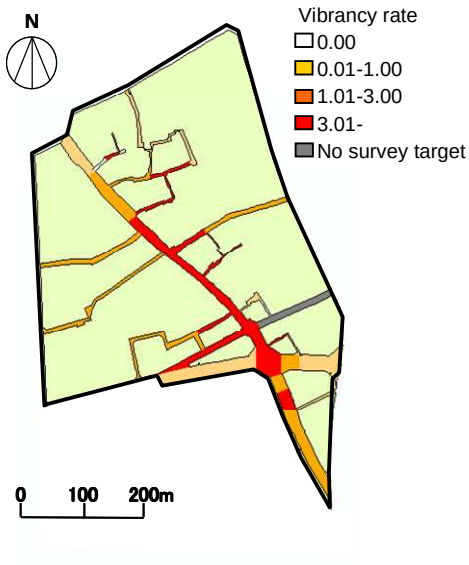


Figure 37 Distribution of vibrancy rate in Insadong

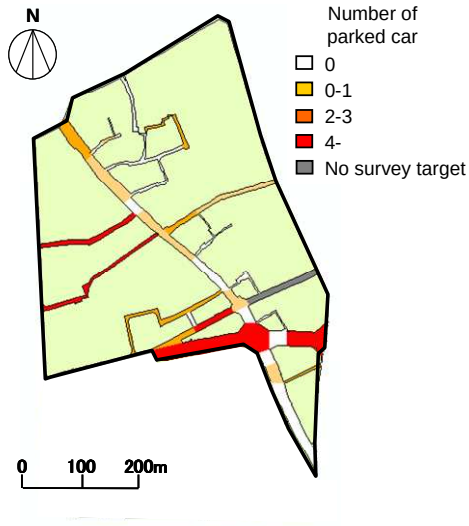


Figure 38 Distribution of parked car in Insadong

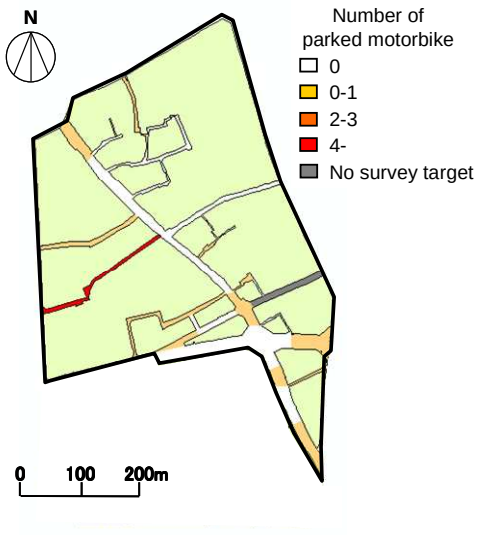


Figure 39 Distribution of parked motorbike in Insadong

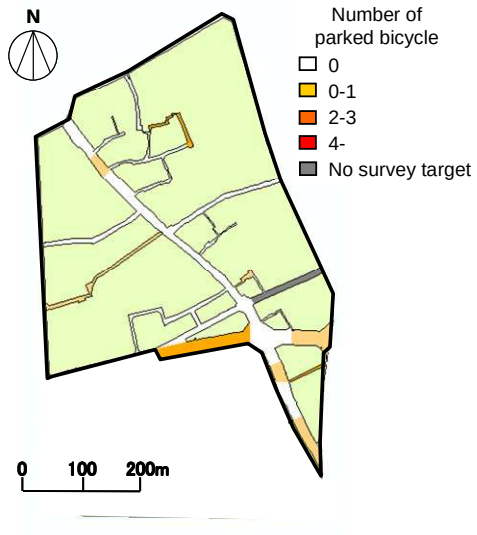


Figure 40 Distribution of parked bicycle in Insadong

- Wangfujing, Beijing

Wangfujing was surveyed in November 2011. Wangfujing is famous for the central area of commerce. It is located on the near east part between Beijing palace. In the survey period, a lot of places of Wangfujing are under construction, specifically southern part. Therefore, there was difficulty to survey this area and get relatively less street units than other survey areas as seen below figures.

In Wangfujing, vibrancy rate is relatively higher in the southwest and northeast area. Pedestrian zone and traditional market is located in the southern west area. In

particular, the street with the highest vibrancy rate is overlapped with the pedestrian zone. And there is school zone in the northern east area. There are many students with their parents. The parking of vehicles is dispersed around on all areas. It could be the result from the policy of parking in Wangfujing. There are some facilities for parking. However, parking on the ground is usual in this area. As the result, there is high pedestrian vibrancy on pedestrian zone and traditional market. Parking of vehicle is dispersed except the areas.

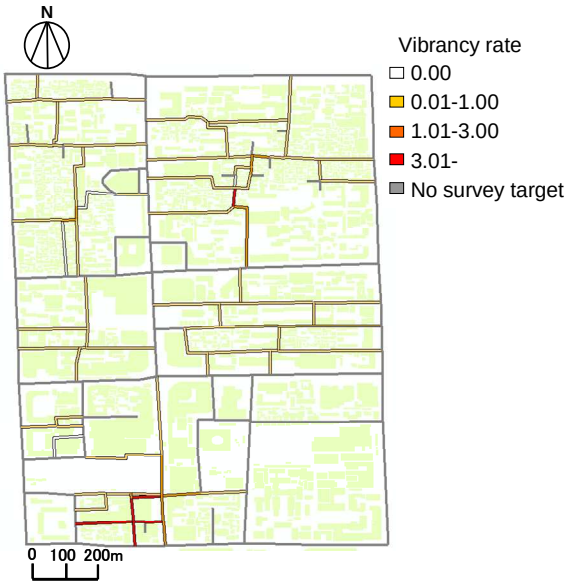


Figure 41 Distribution of vibrancy rate in Wangfujing

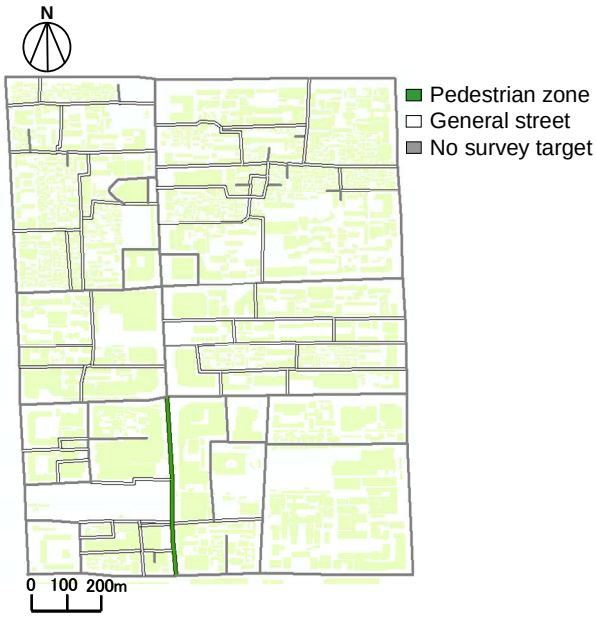


Figure 42 Distribution of pedestrian zone in Wangfujing

Figure 43 Distribution of parked car in Wangfujing

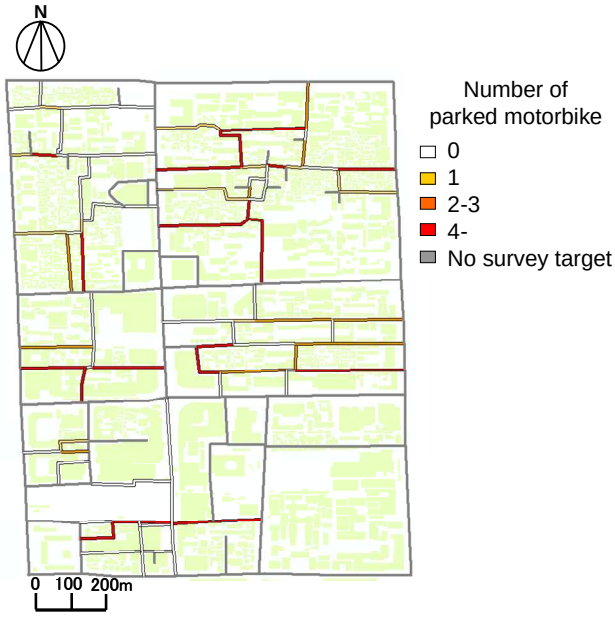


Figure 44 Distribution of parked motorbike in Wangfujing

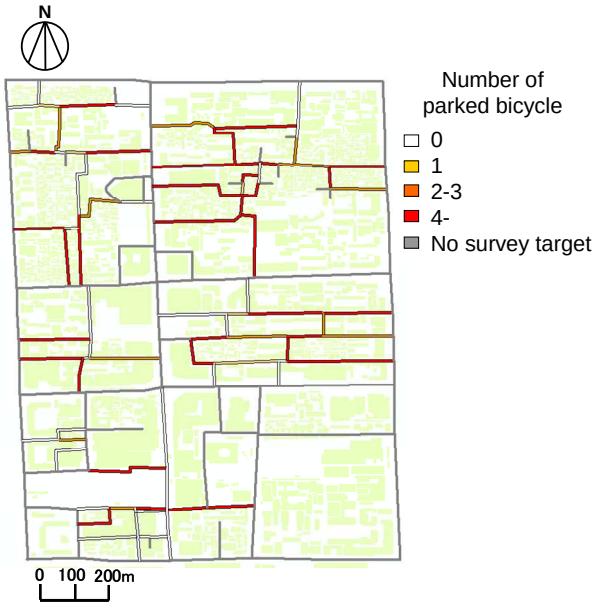


Figure 45 Distribution of parked bicycle in Wangfujing

- Nanluoguxiang, Beijing

The survey of Nanluoguxiang was also conducted in November 2011. It is located on the near northern east part between Beijing palace. It has recently been one of the most favorite places in Beijing because it is consisted of many Chinese traditional building, named Hutong.

Centered on vertical axis of the middle, there is Nanluogu lane. A lot of pedestrians walk and do shopping there. However, until now, there has not been system or facility for pedestrian such as pedestrian zone. And there are mostly resident people in the horizontal edge part of the area.

A lot of vehicles are parked along horizontal streets. Specifically, a lot of cars were parked on the streets. In addition, lots of motorbikes and bicycles are also parked there. It could be the result of residential characteristics.

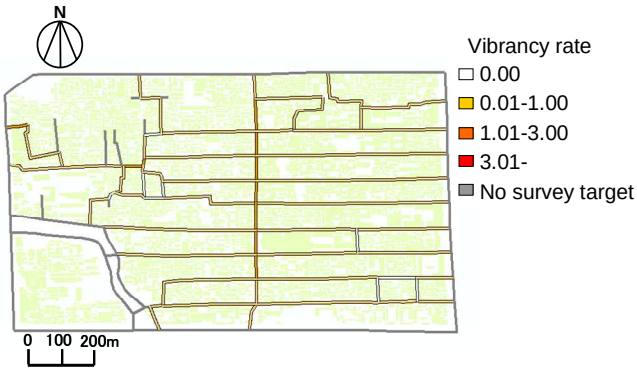


Figure 46 Distribution of vibrancy rate in Nanluoguxinag

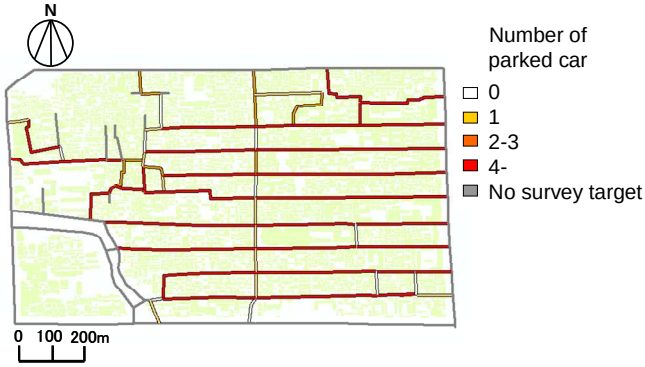


Figure 47 Distribution of parked car in Nanluoguxinag

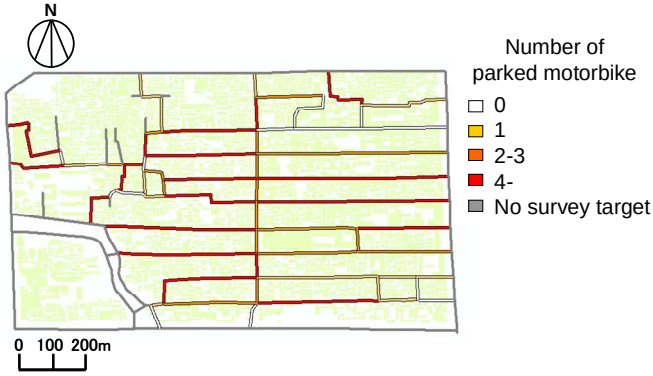


Figure 48 Distribution of parked motorbike in Nanluoguxinag

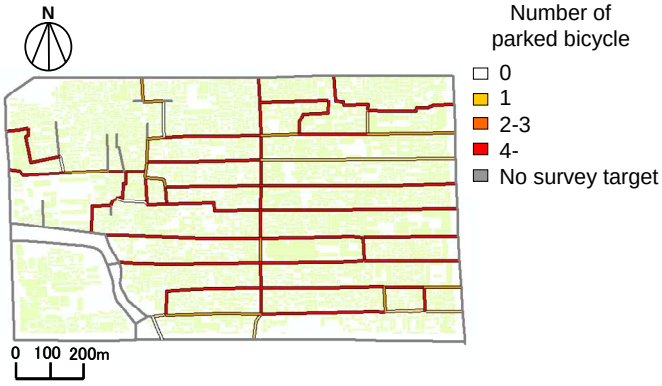


Figure 49 Distribution of parked bicycle in Nanluoguxinag

- Centro, Florence

Centro was surveyed in July 2010. Centro is located along River Arno and on the southern east of Santa Maria Novella station. The some parts in east road of outskirt and all south roads are excluded in the survey area because the roads are over two lanes only for vehicles or blocked by river.

There are Piazzas which play a main role as the center of daily life in Florence; Piazza della Repubblica, Piazza della Signoria, Piazza S. Firenze and Piazza della Duomo. And pedestrian zone is set on almost street of Centro with these piazzas as the center. The vibrancy rate is high the streets connected to each piazzas. And high vibrancy is overlapped to pedestrian zone in most streets.

The parking of car is rare in Centro by ZTL although there is some residential parking. However, the parking of motorbike is dispersed on a lot of street regardless of pedestrian zone. It tends to be in contrast to vibrancy rate. Additionally, the parking of bicycle is also scattered in a lot of streets. It means like Shijo that there are a lot of bicycle users together with the policy of bicycle as pedestrian-oriented device.

As the result, almost streets with high vibrancy are overlapped on pedestrian zone. But it is not clear that there is contrast between pedestrian zone and three kind of parking although they are fewer on the streets with high vibrancy.

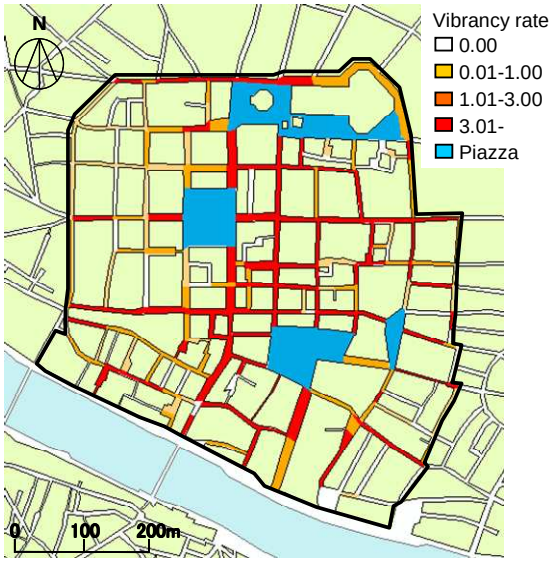


Figure 50 Distribution of vibrancy rate in Centro

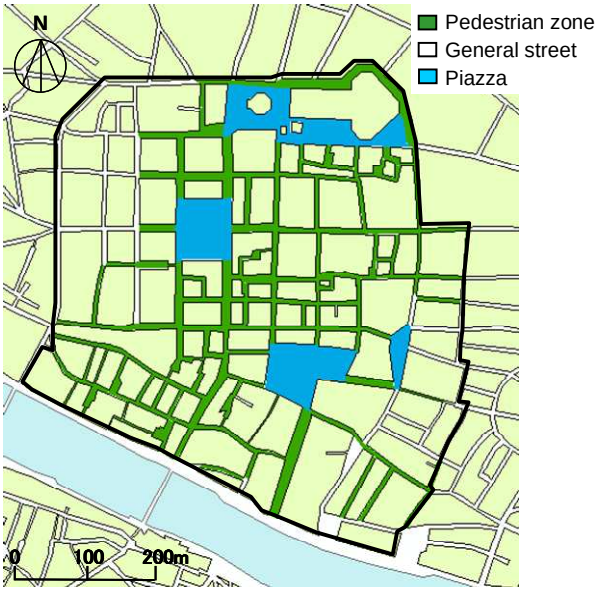


Figure 51 Distribution of pedestrian zone in Centro

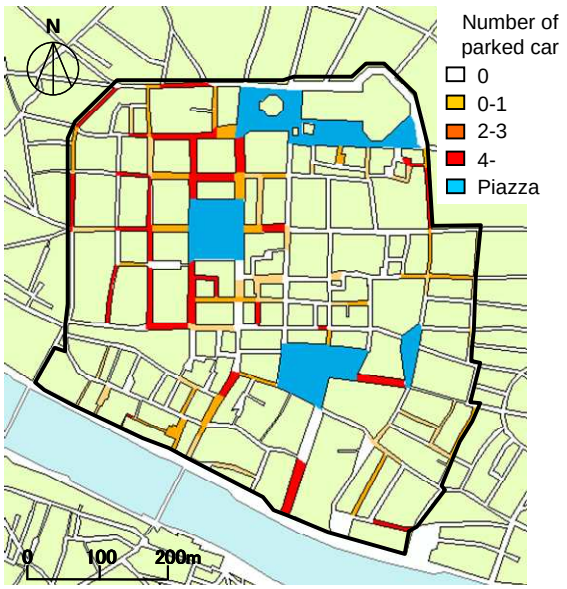


Figure 52 Distribution of parked car in Centro

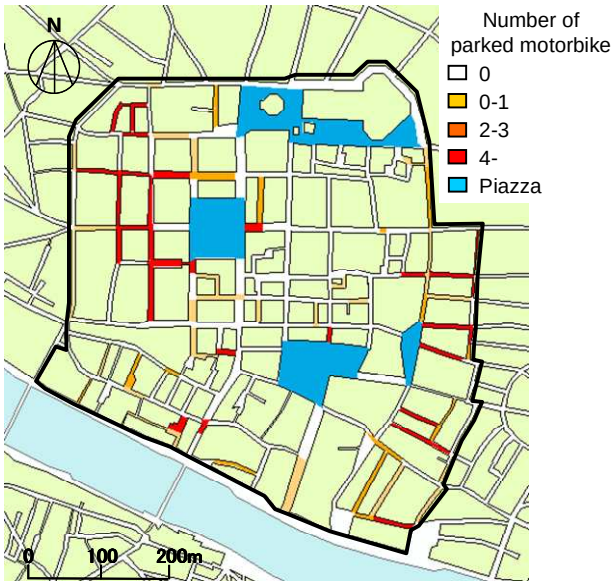


Figure 53 Distribution of parked motorbike in Centro

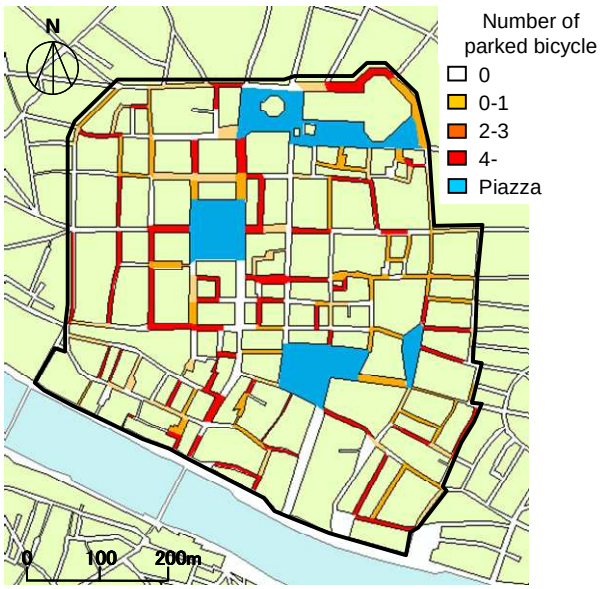


Figure 54 Distribution of parked bicycle in Centro

- Santacroce, Florence

The survey of Santacroce was also conducted in July 2010. Santacroce is directly connected to the east of Centro along River Arno. The some parts in north and east road of outskirt and all south roads are excluded in the survey area because of same reasons of Centro.

The vibrancy rate is high on the pedestrian zone together with around Piazza di

Santacroce. Pedestrian zone in Santacroce is not connected to Piazza santacroce and scattered as disconnected. Anyway, high vibrancy is almost entirely overlapped to pedestrian zone.

The parked vehicles are overlapped on pedestrian zone in Santacroce.[34] In addition, the parking of bicycle is also scattered regardless of pedestrian zone. There are almost same tendency between pedestrian zone and street with high vibrancy rate. But it is relatively distinct that there is rare contrast between pedestrian zone and parking of car and motorbike.

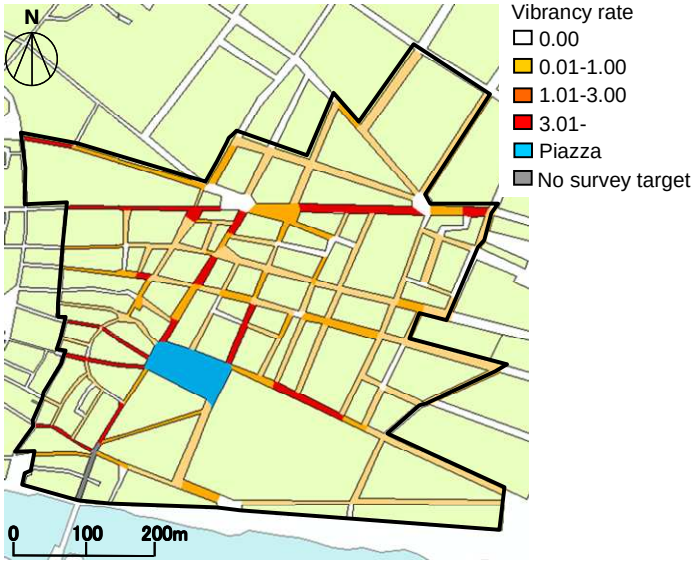


Figure 55 Distribution of vibrancy rate in Santacroce

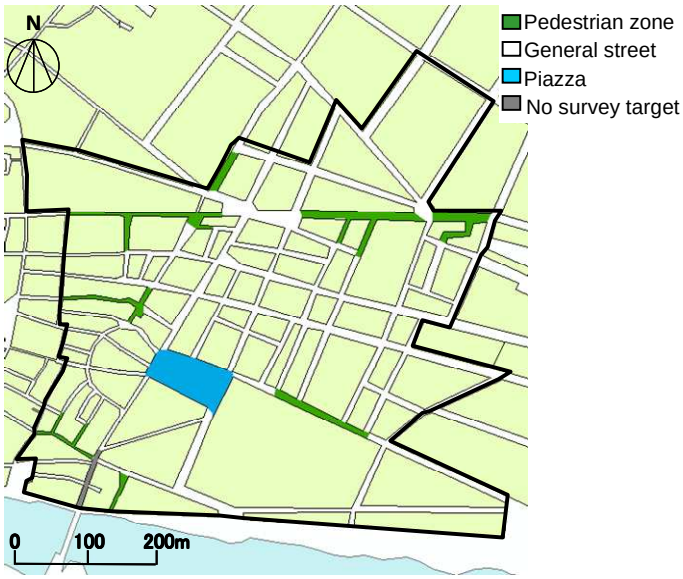


Figure 56 Distribution of pedestrian zone in Santacroce

[34] It could originate from the difference of ZTL as shown in Figure 10.

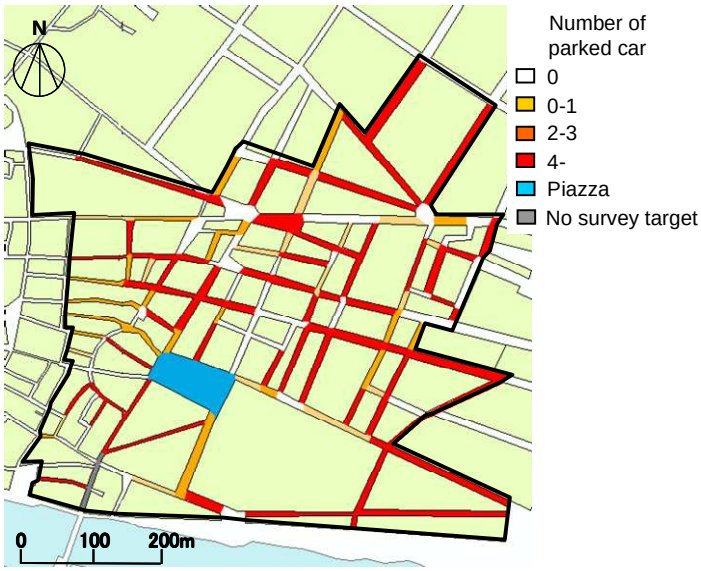


Figure 57 Distribution of parked car in Santacroce

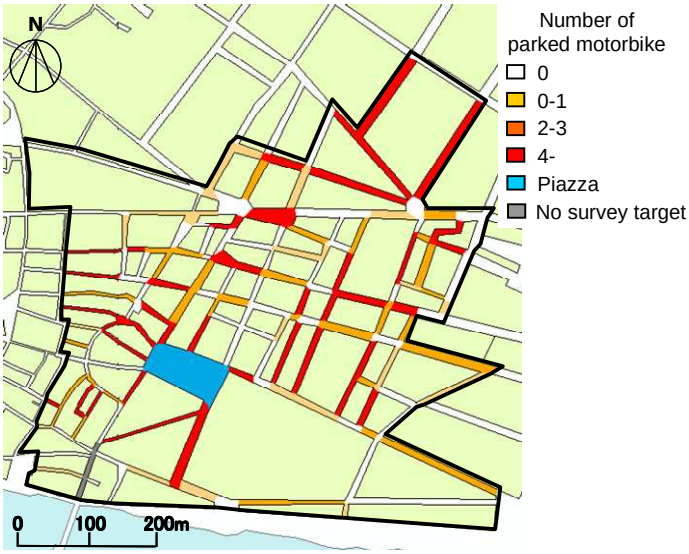


Figure 58 Distribution of parked motorbike in Santacroce

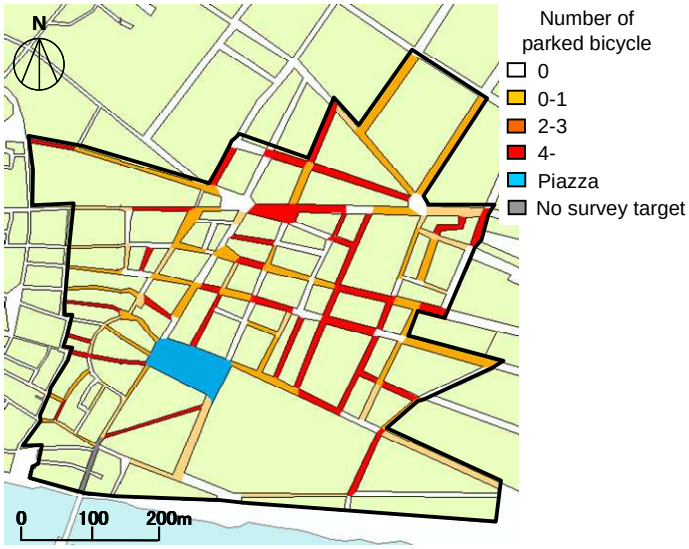


Figure 59 Distribution of parked bicycle in Santacroce

- Increase of pedestrian zone in Centro of Florence

By field survey in 2008 and 2010, it was found that the pedestrian zone had been further increase by new 21 street units in Centro. New pedestrian zone had been designated from November 2008 to July 2010. It included Passo Duomo as shown in Figure 60.

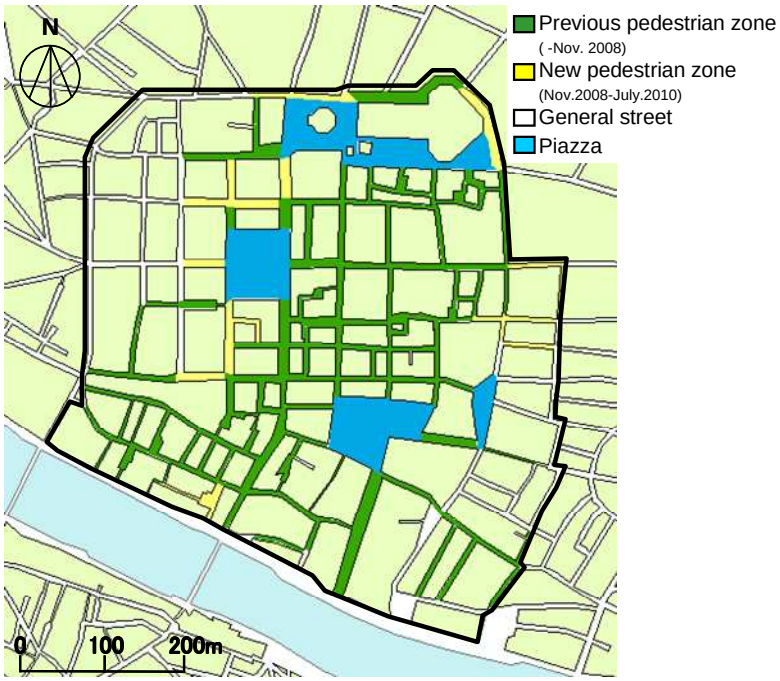


Figure 60 Increase of Pedestrian zone in Centro

Table 4 Difference of vibrancy rates on general street and pedestrian zone in Centro, 2008 and 2010

Year	*November 2008*		*July 2010*	
Street	*General street*	*Pedestrian zone*	*General street*	*Pedestrian zone*
Vibrancy rate	0.903	2.539	2.355	6.173
Standard deviation	0.832	3.053	3.997	7.115
Observed value	72	154	51	175
t-value	4.464		3.663	
p-value	0.000		0.001	

Table 4 illustrates that there are the differences of vibrancy rates on pedestrian zone and general street. Each vibrancy rate on both general street and pedestrian zone in 2010 is higher than in 2008. It could be seasonal reason because survey in 2010 was made in July when it is closer to tourist season than November. However, vibrancy rate on pedestrian zone was significantly higher than on general street in 2008 and 2010.
21 street units had been newly designated as pedestrian zone from November 2008 to July 2010. In Table 5, there is difference of increased vibrancy rate about general street and previous pedestrian zone and new pedestrian zone between 2008 and 2010. The increase rate is respectively 2.643, 2.564, and 3.953. There is certainly the difference of the rates on new pedestrian zone. That means there could be influence on pedestrian vibrancy in 21 street units after they were newly designated as pedestrian zone.

Table 5 Difference of vibrancy rate on general street, previous pedestrian zone and new pedestrian zone in Centro, 2008 and 2010

Street	*General street, 2010 (2008)*	*Previous pedestrian zone, 2010 (2008)*	*General Street, 2010 (2008)*	*New pedestrian zone, 2010 (2008)*	*Previous pedestrian zone, 2010 (2008)*	*New pedestrian zone, 2010 (2008)*
Vibrancy rate	2.355	6.511	2.355	3.692	6.511	3.692
	(0.891)	(2.539)	(0.891)	(0.934)	(2.539)	(0.934)
Standard	3.997	7.302	3.997	5.023	7.302	5.023
Deviation	(0.825)	(3.053)	(0.825)	(0.871)	(3.053)	(0.871)
Observed Value	51	154	51	21	154	21
t-value	3.872	(6.064)	1.195	(0.199)	1.712	(5.163)
P-value	0.001	(0.000)	0.672	(0.843)	0.052	(0.000)

In 2010, vibrancy rate is 3.692 on new pedestrian zone although it is 6.511 on previous pedestrian zone. In other words, vibrancy rate on new pedestrian zone is about two times lower than vibrancy rate on previous pedestrian zone with significance. It could mean that previous pedestrian zone with older history attract pedestrians more than new pedestrian zone. It also means it takes enough time to do a role as pedestrian zone.

- Increase of vibrancy after establishing Passo Duomo

As a part of new pedestrian zone in Florence, Passo Duomo was also newly designated as pedestrian zone. Within Passo Duomo, vehicle traffics have been prevented for not only protecting Duomo but also pedestrian comfort.

Figure 61 illustrates one sample about before and after Passo Duomo. As seen in the picture before establishing Passo Duomo, the street is full of parked car, contrast to rare pedestrians. But there are full of pedestrians in picture 1 or 2 after establishing Passo Duomo. It could be proved that the policy like pedestrians zone has the power to change the urban atmosphere.

Picture before establishing Passo Duomo

(3p.m. November 26th 2008)

(→: direction of photographing, □ : Passo Duomo)

Picture 1 after establishing Passo Duomo

(2p.m. July 19th 2010)

Picture 2 after establishing Passo Duomo

(2p.m. July 19th 2010)

Figure 61 Pictures before and after establishing Passo Duomo

This result can be meaningful when the estimate is analyzed about the change between 'before and after'. After conversion into pedestrian zone, the number of pedestrians visibly increased around Duomo. After Passo Duomo, there were a lot of visitations of family units with children, people in terrace and bench and artisan activity.

4.3 Comparison of vibrancy according to environmental factors on street

Table 6 illustrates that total distance of street and total number of pedestrians in each area. In addition, the number of photograph is shown in
Table **7**. Total distance of street in Shijo, Gion, Centro, Santacroce are similar; each about 10,000m. That means that the width of streets is also similar. However, in the case of Myongdong, total distance of street is almost half of Gion.

Table 6 Street distance and number of pedestrians in survey areas

City-area	*Total distance of surveyed streets (m)*	*Total number of pedestrians (persons)*
Kyoto-Shijo	8,693	910
Kyoto-Gion	9,799	269
Seoul-Myongdong	5,076	753
Seoul-Insadong	2,204	271
Beijing-Wangfujing	10,583	870
Beijing-Nanluoguxiang	10,999	231
Florence-centro	9,076	1,648
Florence-Santacroce	10,064	466

Table 7 Number of photograph for vibrancy and environmental factors in survey areas

City-area	*Photo for vibrancy*	*Photo for environmental factors*
Kyoto-Shijo	572	2,678
Kyoto-Gion	613	1,565
Seoul-Myongdong	306	1,812
Seoul-Insadong	194	1,201
Beijing-Wangfujing	368	1,254
Beijing-Nanluoguxiang	307	1,358
Florence-Centro	920	3,078
Florence-Santacroce	624	2,713

In this study, independent two-sample t-test is used to verify the difference of vibrancy and its significance according to whether there is or not an environmental factor on street. T test can be calculated as follows:

If the variance of each population X, Y is same ($\because \sigma^2{}_X = \sigma^2{}_Y$), the common variance of population can be estimated like equation (4.1).

$$S_p{}^2 = \frac{(n_X - 1)s_X{}^2 - (n_Y - 1)s_Y{}^2}{n_X + n_Y - 2} \tag{4.1}$$

The statistic of standardized $\overline{X} - \overline{Y}$ has the t-distribution with the degree of freedom of '$n_X + n_Y - 2$'. The difference of two population means can be verified in small sample like equation (4.2) and (4.3).

Firstly, when each variance is same,

$$t = \frac{\overline{X} - \overline{Y}}{S_p\sqrt{\frac{1}{n_X} + \frac{1}{n_Y}}} \qquad \sim t(n_X + n_Y - 2) \tag{4.2}$$

Secondly, when each variance is different,

$$t = -\frac{\overline{X} - \overline{Y}}{\sqrt{\frac{S_1{}^2}{n_X} + \frac{S_2{}^2}{n_Y}}} \qquad \sim t\left(\frac{(S_1{}^2/n_X + S_2{}^2/n_Y)^2}{\frac{(S_1{}^2/n_X)^2}{n_X - 1} + \frac{(S_2{}^2/n_Y)^2}{n_Y - 1}}\right) \tag{4.3}$$

Where $\overline{X}$ is the average of group X, $\overline{Y}$ is the average of group Y,

S_p is the standard deviation of the sum of two group X and Y,

n_X is the sample size of group X, n_Y is the sample size of group Y,

- Null hypothesis $H0$: $\mu_X = \mu_Y$
- Test statistic: $t = \dfrac{\overline{X} - \overline{Y}}{\sqrt{\dfrac{(n_X - 1)s_X{}^2 - (n_Y - 1)s_Y{}^2}{n_X + n_Y - 2}\left(\dfrac{1}{n_X} - \dfrac{1}{n_Y}\right)}}$
- Rejection region:
  1. $t \geq t_a(n_X + n_Y - 2)$, in the case of $H_1 : \mu_X > \mu_X$
  2. $t \leq -t_a(n_X + n_Y - 2)$, in the case of $H_1 : \mu_X < \mu_X$
  3. $|t| \geq t_{a/2}(n_X + n_Y - 2)$, in the case of $H_1 : \mu_X \neq \mu_X$

- The difference of vibrancy rate as a function of pedestrian zone

A pedestrian zone is commonly allocated in survey cities. The main purpose of pedestrian zone is to revitalize the old city center by providing utility such as safety and pleasure to citizens. In this paragraph, there is the difference as a function of pedestrian zone in several areas.

In Table 8, the proportion of the pedestrian zone in Myongdong of Seoul, Shijo of Kyoto and Centro of Florence are respectively fifty percent or over. Compared with them, there are only four streets as a pedestrian zone in Wangfujing of Beijing. However, they are a prominently large size as they are restricted in Wangfujing by a Chinese police officer.

Table 8 Number of streets designated as pedestrian zone in survey areas

City	*Area*	*Pedestrian zone*	*General street*	*Total*	*T-value (P-value)*
Kyoto	Shijo	78	65	143	7.744 (0.000)
	Gion	0	163	163	-
	total	78	228	306	8.201 (0.000)
Seoul	Myongdong	39	39	78	4.932 (0.000)
	Insadong	0	46	46	-
	total	39	85	124	3.934 (0.000)
Beijing	Wangfujing	4	86	90	0.414 (0.680)
	Nanluoguxiang	0	66	66	-
	total	4	152	156	0.741 (0.460)
Florence	Centro	175	51	226	4.918 (0.000)
	Santacroce	26	130	156	2.598 (0.014)
	total	201	181	382	7.645 (0.000)

The difference of vibrancy rate between the pedestrian zone and general street is clearly distinguished in each area. Specifically in Figure 62, the difference is respectively about five times and four times in Kyoto and Florence. As seen in the figure, there is no pedestrian zone in Gion of Kyoto, Insadong of Seoul, and Nanluoguxiang of Beijing. The difference of vibrancy rate on between pedestrian zone and general street is clearly distinguished in each area. It is same tendency in the four cities.

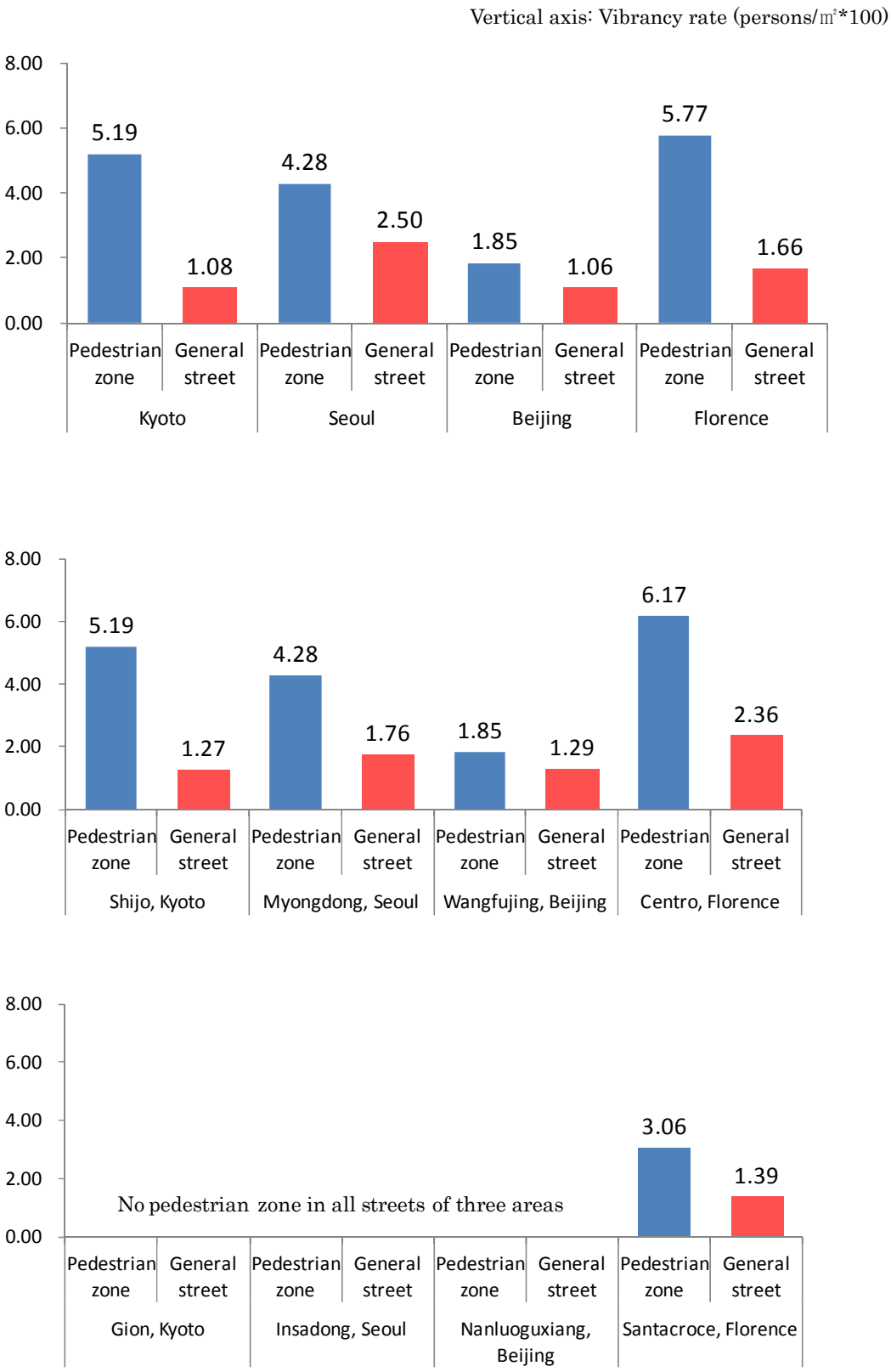


Figure 62 Difference of vibrancy rate as a function of pedestrian zone

- The difference of vibrancy rate as a function of store

Seen in Table 9, there is no street without a store in Insadong. This is actually the result of reducing the southern part of Insadong. Almost all streets in Shijo and Myongdong have a store. In contrast, there are more streets without a store in Gion and Nanluoguxiang. That could be related to the characteristics of each area. Gion and Nanluoguxiang have more residential characteristics than other areas.

Table 9 Number of streets with store in survey areas

City	*Area*	*Street with store*	*Street without store*	*Total*	*T-value (P-value)*
Kyoto	Shijo	138	5	143	1.280 (0.203)
	Gion	30	133	163	0.920 (0.359)
	total	168	138	306	5.945 (0.000)
Seoul	Myongdong	76	2	78	1.443 (0.153)
	Insadong	46	0	46	-
	total	122	2	124	1.515 (0.132)
Beijing	Wangfujing	45	45	90	1.690 (0.095)
	Nanluoguxiang	27	39	66	4.419 (0.000)
	total	72	84	156	2.566 (0.011)
Florence	Centro	186	40	226	2.475 (0.014)
	Santacroce	116	40	156	5.376 (0.000)
	total	302	80	382	4.962 (0.000)

The difference of vibrancy rate among the streets with or without stores is clearly distinguished in each area of Kyoto, Seoul, Beijing and Florence in Figure 63. As a result, there is a higher vibrancy rate when a store exists on streets in all cases. Specifically, the difference is about four, five, and six times in Nanluoguxiang, Snatacroce, and Myongdong.

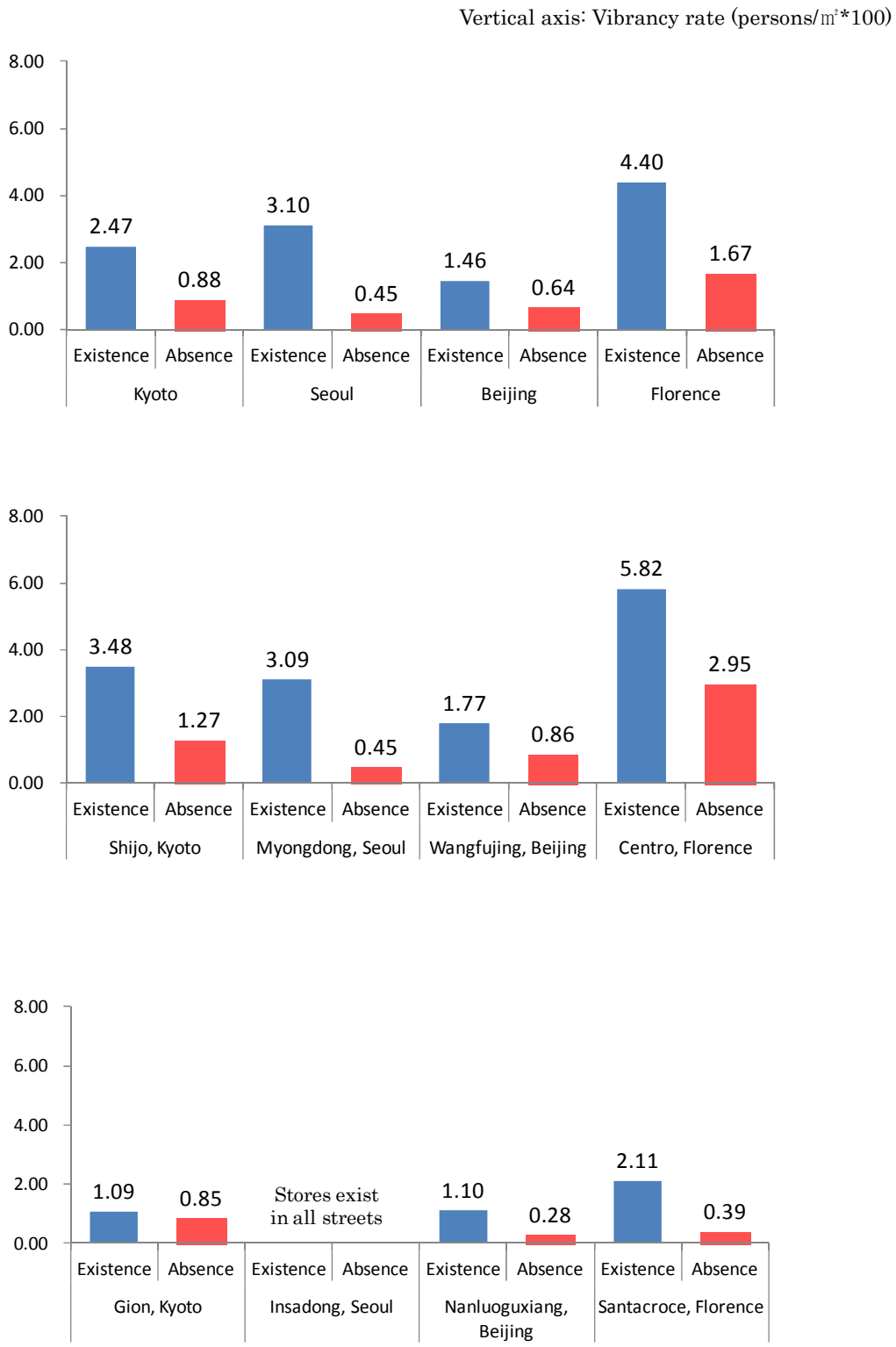


Figure 63 Difference of vibrancy rate as a function of store

- The difference of vibrancy rate as a function of parking lot

There are usually a lot of parking lots in survey cities. The main purpose of parking lot is for the comfort to walk less to arrive in the purposed place in city center. Nevertheless there have been policies try to remove parking lot out of a city center, there have still been parking lots.

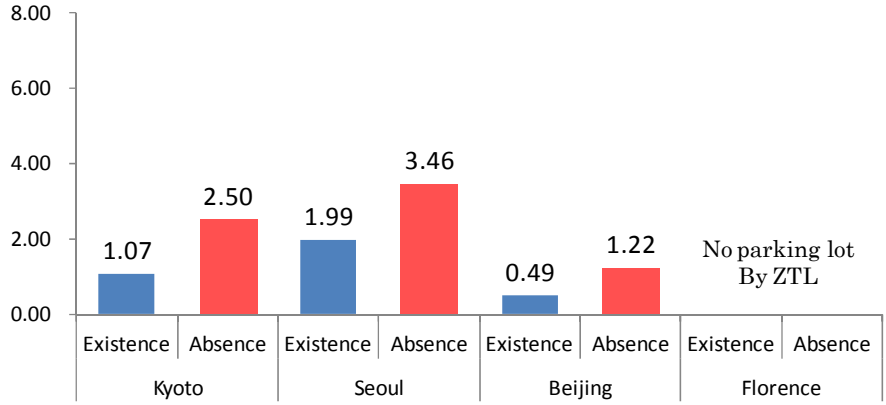
In survey area of Florence, there is no public parking lot and no operation of private parking lot during survey time by Zone Traffic Limit. Actually, residents of the area could park on the street although nonresidents are strictly restricted for parking in central area of Florence. Therefore, parking lot is not dealt in Florence.

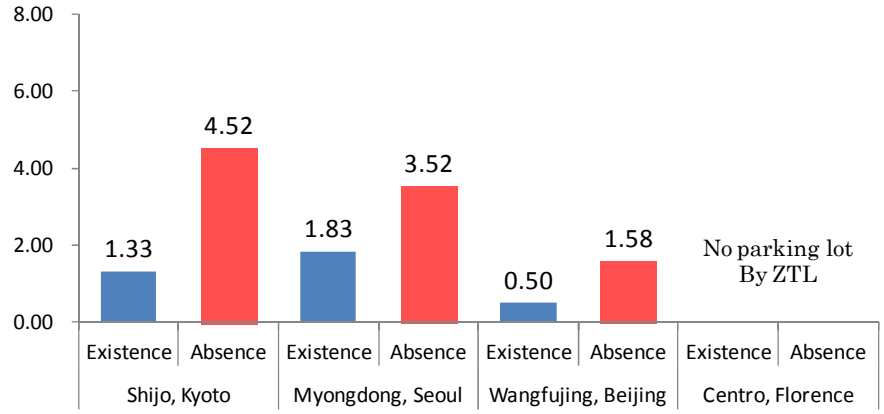
In Table 10, the rate of parking lot in Shijo, Myongdong, and Wangfujing is respectively higher than Gion, Insadong, Nanluoguxiang. The vibrancy by a function of parking lot is clearly different in Kyoto, Beijing and Seoul. Specifically in Shijo, the difference of vibrancy rate on function by parking lot is over three times in Figure 64.

Table 10 Number of streets with parking lot in survey areas

City	*Area*	*Street with parking lot*	*Street without parking lot*	*Total*	*T-value (P-value)*
Kyoto	Shijo	50	93	143	6.828 (0.000)
	Gion	30	133	163	2.533 (0.012)
	total	80	226	306	5.602 (0.000)
Seoul	Myongdong	23	55	78	3.797 (0.000)
	Insadong	11	35	46	1.339 (0.187)
	total	34	90	124	4.135 (0.000)
Beijing	Wangfujing	22	68	90	2.913 (0.005)
	Nanluoguxiang	8	58	66	0.937 (0.352)
	total	30	126	156	3.336 (0.001)
Florence	Centro	0	226	226	-
	Santacroce	0	156	156	-
	total	0	382	382	-

Vertical axis: Vibrancy rate (persons/㎡*100)





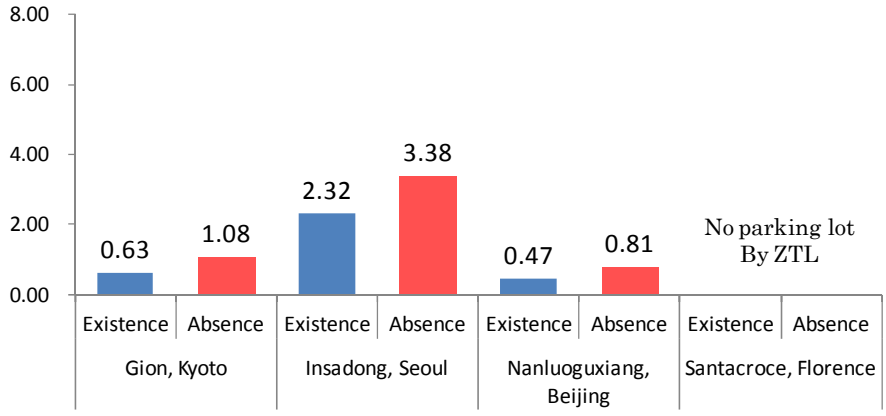


Figure 64 Difference of vibrancy rate as a function of parking lot

- The difference of vibrancy rate as a function of three kinds of parked vehicles

In each city, there are the difference of vibrancy rate as a function of parked vehicles; car, motorbike and bicycle. The vibrancy rate on the street with parked vehicles is generally lower than the street without parked vehicles, regardless of car, motorbike and bicycle. In

Table 11-13, there are tables showing conditions about parked vehicles in survey areas. The rate of street with parked car is higher in Myongdong, Nanluoguxiang and Santacroce than in Insadong, Wangfujing and Centro. Concerning parked motorbike, it could be similar to parked car.

There are more streets with parked bicycle than without in each area of Kyoto, Beijing and Florence. This is because bicycle is small and easy to move and park. However, there is less parking of bicycle in Seoul. It is certain because two survey areas in Seoul are isolated as being surrounded by arterial roads with over six lanes.

Table 11 Number of streets with parked car in survey areas

City	*Area*	*Street with parked car*	*Street without parked car*	*Total*	*T-value (P-value)*
Kyoto	Shijo	40	103	143	7.560 (0.000)
	Gion	54	109	163	3.055 (0.003)
	total	94	212	306	7.504 (0.000)
Seoul	Myongdong	55	23	78	1.941 (0.063)
	Insadong	22	24	46	0.428 (0.671)
	total	77	47	124	2.004 (0.049)
Beijing	Wangfujing	70	20	90	2.950 (0.008)
	Nanluoguxiang	56	10	66	1.479 (0.144)
	total	126	30	156	3.013 (0.005)
Florence	Centro	99	127	226	4.086 (0.000)
	Santacroce	109	47	156	1.678 (0.098)
	total	208	174	382	5.290 (0.000)

Table 12 Number of streets with parked motorbike in survey areas

City	*Area*	*Street with parked motorbike*	*Street without parked motorbike*	*Total*	*T-value (P-value)*
Kyoto	Shijo	43	100	143	4.742 (0.000)
	Gion	65	98	163	1.253 (0.212)
	total	108	198	306	5.003 (0.000)
Seoul	Myongdong	39	39	78	3.331 (0.002)
	Insadong	15	31	46	2.098 (0.042)
	total	54	70	124	4.250 (0.000)
Beijing	Wangfujing	45	45	90	1.656 (0.102)
	Nanluoguxiang	52	14	66	0.927 (0.358)
	total	108	198	156	1.629 (0.107)
Florence	Centro	80	146	226	4.183 (0.000)
	Santacroce	96	60	156	1.966 (0.052)
	total	176	206	382	6.037 (0.000)

Table 13 Number of streets with parked bicycle in survey areas

City	*Area*	*Street with parked bicycle*	*Street without parked bicycle*	*Total*	*T-value (P-value)*
Kyoto	Shijo	106	37	143	5.597 (0.000)
	Gion	109	54	163	1.289 (0.202)
	total	215	91	306	4.165 (0.000)
Seoul	Myongdong	7	71	78	0.911 (0.365)
	Insadong	9	37	46	5.012 (0.000)
	total	16	108	124	2.600 (0.010)
Beijing	Wangfujing	54	36	90	2.098 (0.041)
	Nanluoguxiang	62	4	66	0.658 (0.513)
	total	116	40	156	2.139 (0.038)
Florence	Centro	139	87	226	2.003 (0.046)
	Santacroce	106	50	156	0.225 (0.822)
	total	245	137	382	2.143 (0.033)

As seen in Figure 65, vibrancy rate is commonly higher on streets with parked vehicle than without in each city. In Figure 66, vibrancy rate is higher on streets with parked

vehicle than without in each area of Kyoto and Seoul. It is same in Wangfujing of Beijing. However, there is reverse result in parked motorbike and bicycle in Nanluoguxinag of Beijing. About difference of vibrancy rate as a function of parked bicycle, there is not significant because there are parked bicycle in almost streets in Nanluoguxing. Whereas, parked motorbike have similar tendency of presence or absence according to store. Store is an important factor about vibrancy. Its existence or absence makes a large difference of vibrancy. This could be one reason to be higher vibrant on street with parked motorbike in Nanluoguxiang.

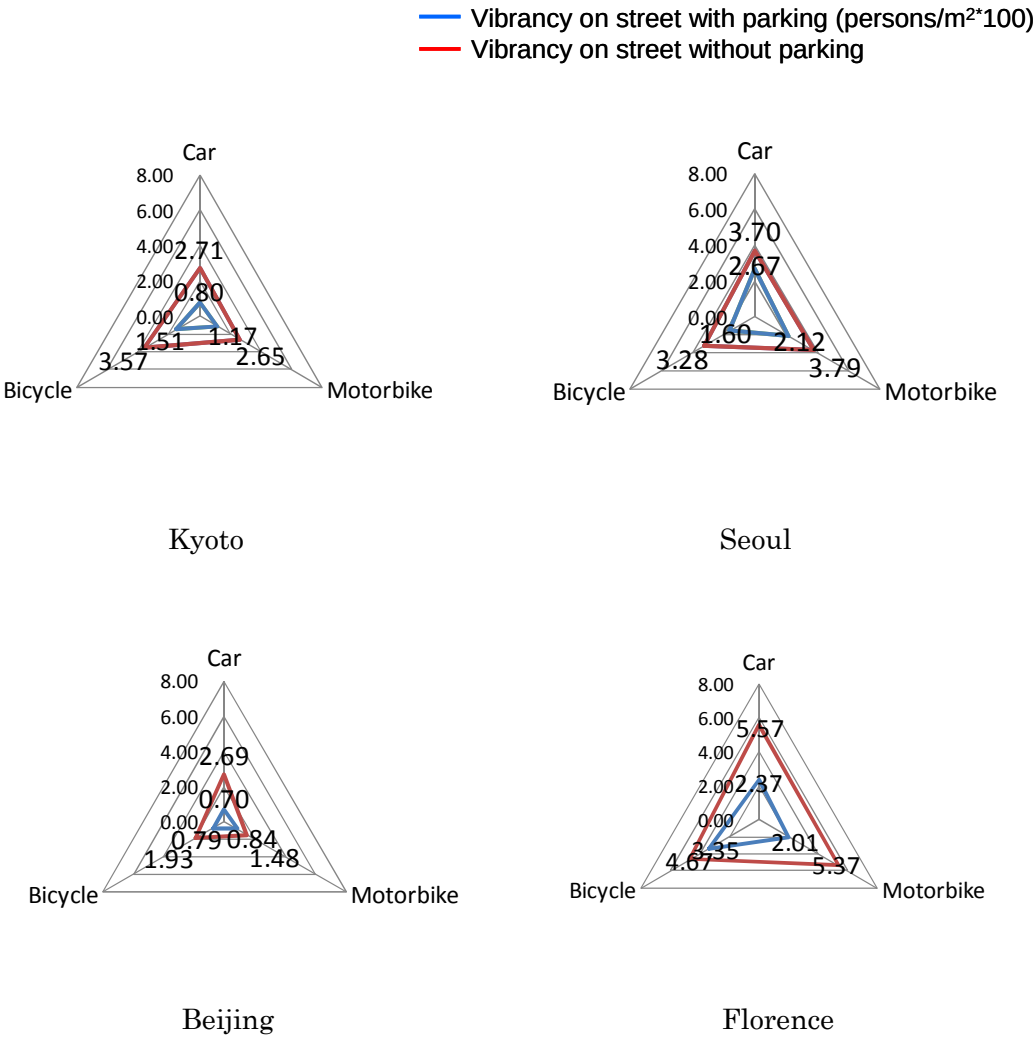


Figure 65 Difference of vibrancy rate as a function of parked car, parked motorbike and parked bicycle in survey cities

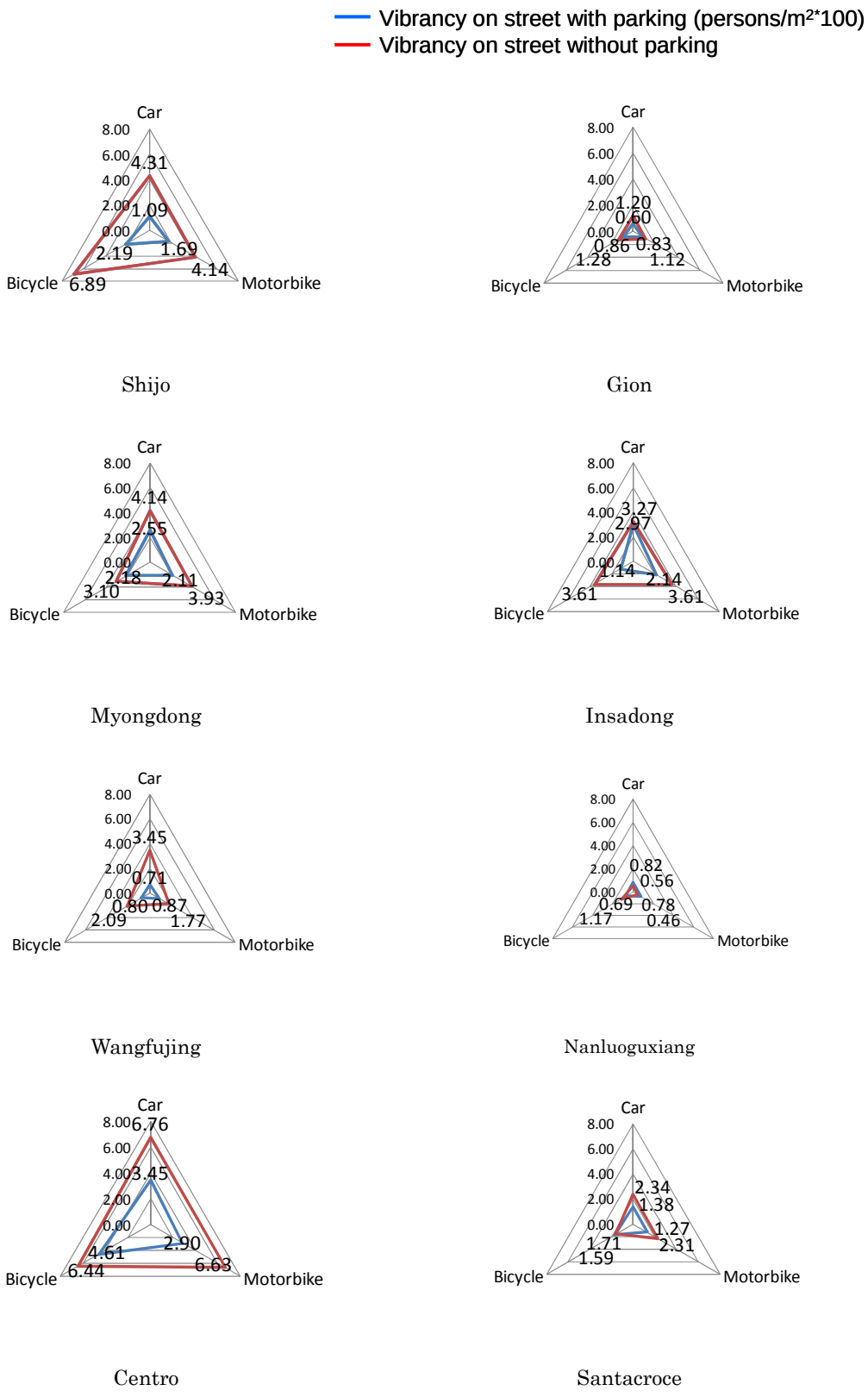


Figure 66 Difference of vibrancy rate as a function of parked car, parked motorbike and parked bicycle in survey areas

- The difference of vibrancy rate as a function of arcade

As seen in Table 14, there are arcades only in Shijo. In Figure 67, it could be seen that there is the definite difference; about six times between vibrancy rate on streets with or without arcade. It is certain that arcade gives positive impact on vibrancy rate.

Table 14 Number of streets with arcade in Kyoto

City	*Area*	*Street with arcade*	*Street without arcade*	*Total*	*T-value (P-value)*
Kyoto	Shijo	45	98	143	8.472 (0.000)
	Gion	0	163	163	-
	total	45	261	306	9.173 (0.000)

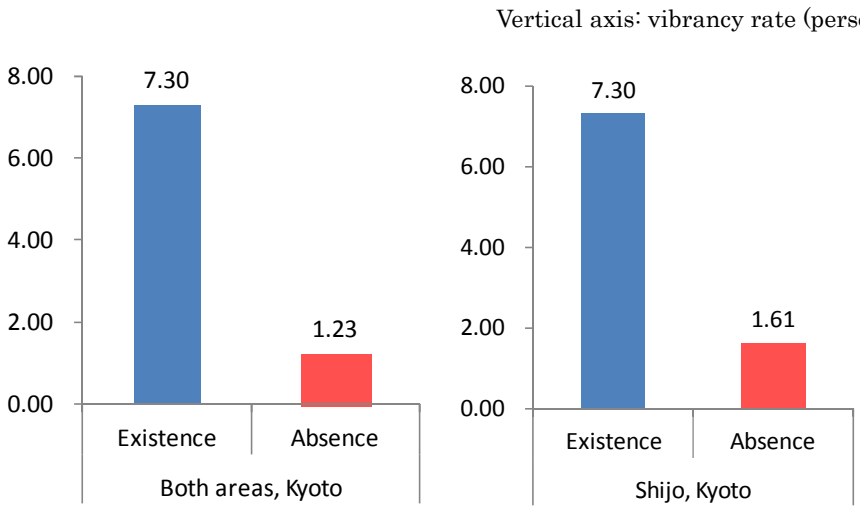


Figure 67 Difference of vibrancy rate as a function of arcade

- The difference of vibrancy rate as a function of street vendor

In Seoul, the street vendor could be considered one character on the street of survey areas. As seen in Table 15 and Figure 68, there is higher vibrancy rate on streets with street vendors than without.

Table 15 Number of streets with street vendor in Seoul

City	*Area*	*Street with street vendor*	*Street without street vendor*	*Total*	*T-value (P-value)*
Seoul	Myongdong	27	51	78	0.685 (0.495)
	Insadong	3	43	46	0.164 (0.871)
	total	30	94	124	0.501 (0.617)

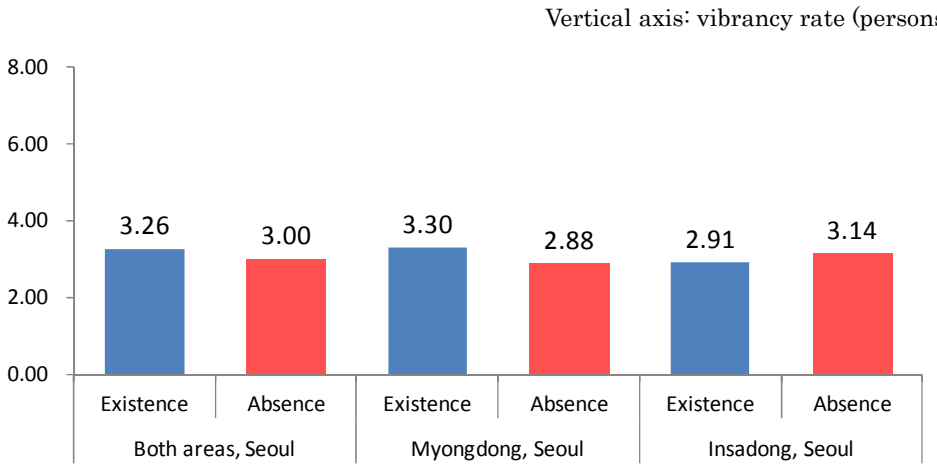


Figure 68 Difference of vibrancy rate as a function of street vendor

- The difference of vibrancy rate as a function of piazza

Piazza plays an important role in daily life for citizens or visitors in Florence. In Table 16, there is the number of street connected directly to piazza. As piazza could be considered as a characteristic on the street, there is a difference between vibrancy rate on streets connected to piazza or not like Figure 69.

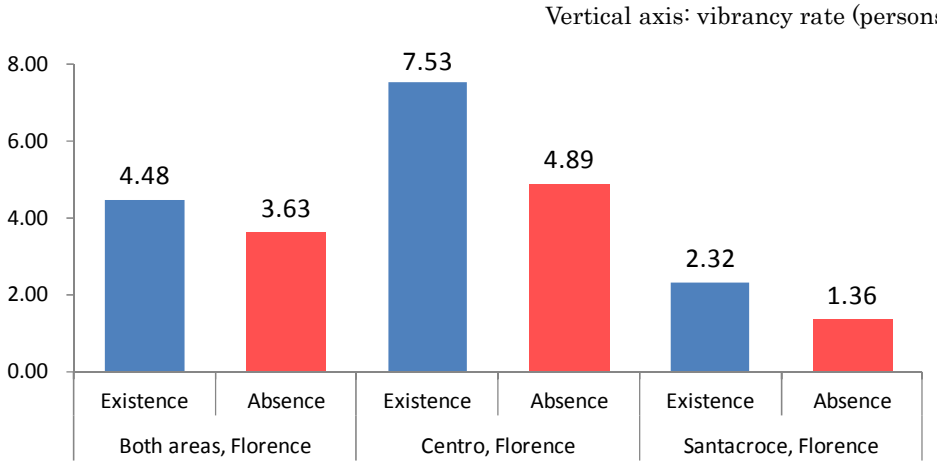


Figure 69 Difference of vibrancy rate as a function of connection to piazza

Table 16 Number of streets connected to piazza in Florence

City	*Area*	*Street connected to piazza*	*Street not connected to piazza*	*Total*	*T-value (P-value)*
Florence	Centro	36	190	226	2.180 (0.030)
	Santacroce	51	105	156	1.647 (0.104)
	total	87	295	382	1.196 (0.232)

- The difference of vibrancy rate as a function of street connection

In Table 17, the rate of straight connection on street tends to be more than not straight, except for Insadong. In the point of street connection, straight connection makes more pedestrian vibrancy than not-straight. This is considered important in the point of street design.

In Figure 70, there are about double differences of vibrancy rate on street with straight or not-straight connection in Beijing and Florence. In Kyoto, there is over three times difference of vibrancy rate on street with straight or not-straight connection. In common, there are definitely differences in all areas.

Table 17 Number of streets straightly connected on the both edges in survey areas

City	*Area*	*Straightly connected street*	*Not straightly connected street*	*Total*	*T-value (P-value)*
Kyoto	Shijo	114	29	143	4.871 (0.000)
	Gion	88	75	163	2.913 (0.004)
	total	202	104	306	6.900 (0.000)
Seoul	Myongdong	58	20	78	1.287 (0.202)
	Insadong	20	26	46	0.969 (0.338)
	total	78	46	124	1.460 (0.147)
Beijing	Wangfujing	61	29	90	0.811 (0.419)
	Nanluoguxiang	41	25	66	3.759 (0.000)
	total	102	54	156	1.748 (0.082)
Florence	Centro	155	71	226	3.420 (0.001)
	Santacroce	109	47	156	4.780 (0.000)
	total	264	118	382	4.304 (0.000)

Vertical axis: vibrancy rate (persons/㎡*100)

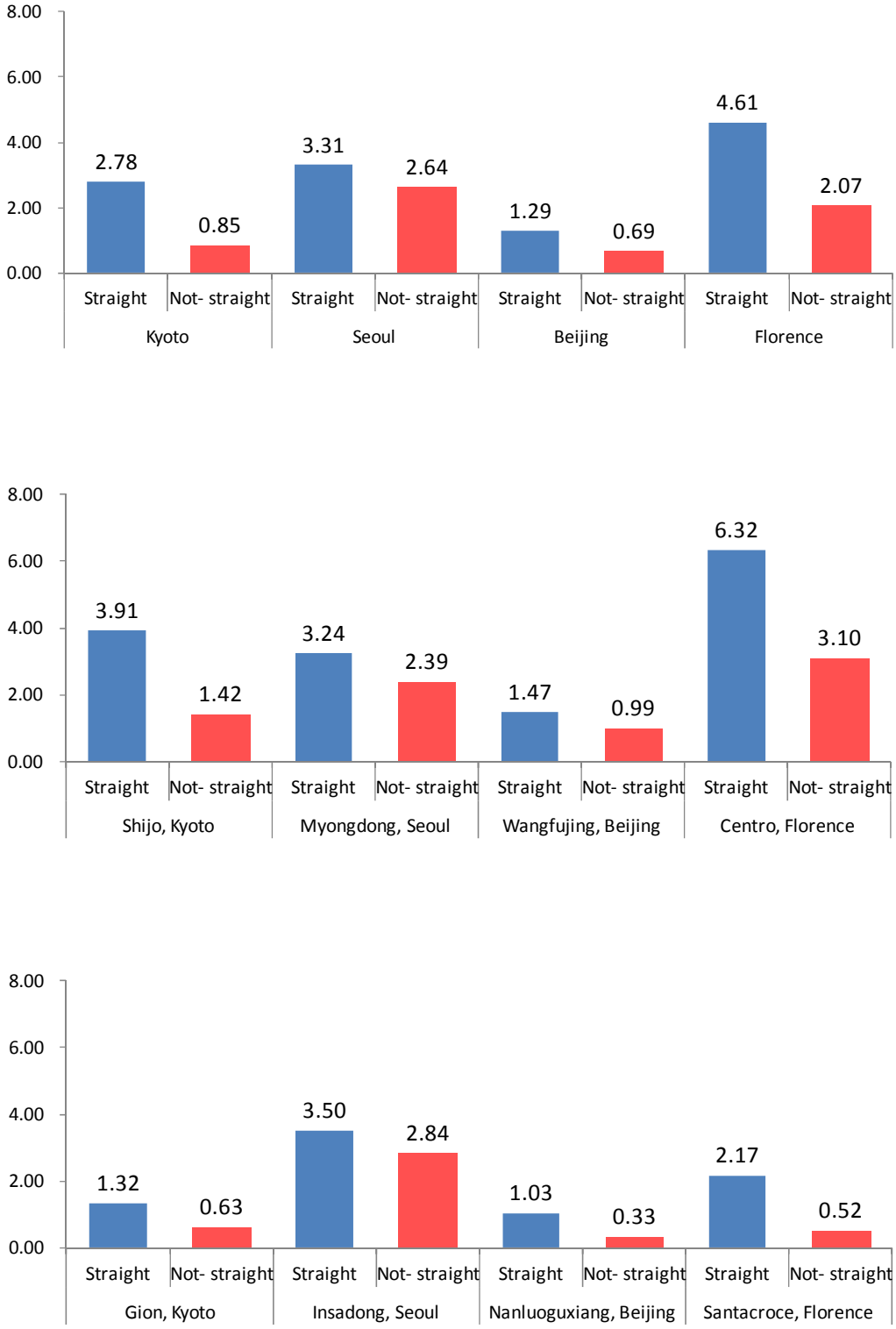


Figure 70 Difference of vibrancy rate as a function of street connection

- The difference of vibrancy rate as a function of street shape

In Table 18, the rate of street with rectangular shape is more than curve in each area. In Figure 71, there are about four times differences between vibrancy rate on rectangular street or curve in Beijing and Florence. Moreover, there is difference about five times in Kyoto. There are definitely vibrancy rate on rectangular street higher than curve in all cities and areas. This is one important character in street design.

Table 18 Number of streets with rectangular shape in survey areas

City	*Area*	*Rectangular street*	*Curve street*	*Total*	*T-value (P-value)*
Kyoto	Shijo	138	5	143	6.498 (0.000)
	Gion	153	10	163	1.164 (0.246)
	total	291	15	306	7.448 (0.000)
Seoul	Myongdong	73	5	78	1.747 (0.085)
	Insadong	32	14	46	0.800 (0.428)
	total	105	19	124	1.486 (0.140)
Beijing	Wangfujing	75	15	90	1.338 (0.184)
	Nanluoguxiang	53	13	66	4.729 (0.000)
	total	128	28	156	4.051 (0.000)
Florence	Centro	213	13	226	7.693 (0.000)
	Santacroce	149	7	156	0.547 (0.585)
	total	362	20	382	6.378 (0.000)

Vertical axis: vibrancy rate (persons/㎡*100)

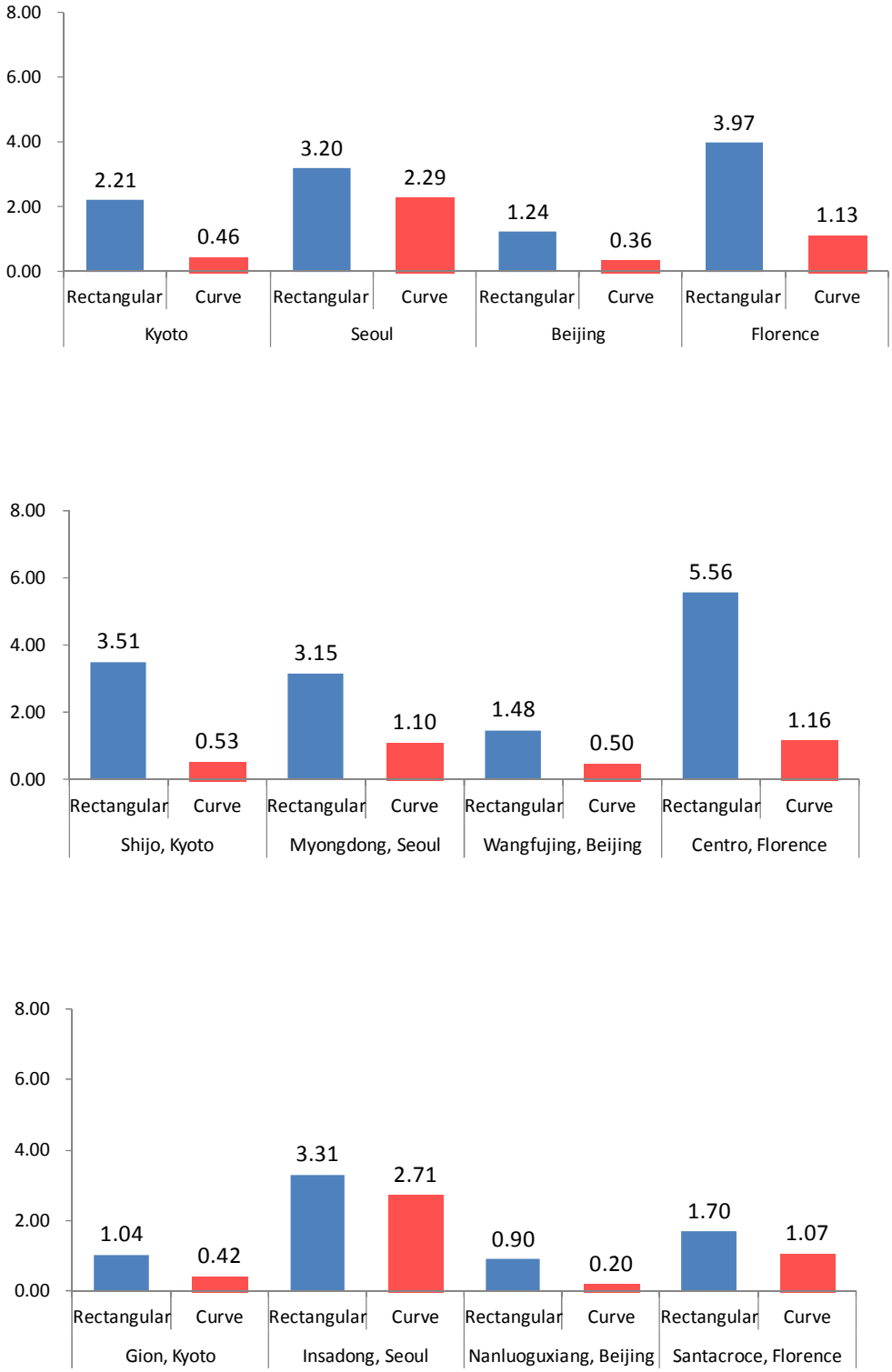


Figure 71 Difference of vibrancy rate as a function of street shape

4.4 Concluding remarks

In four surveyed city centers, pedestrian vibrancy has the significant tendency to be higher on streets with particular environmental factors. Vibrancy rate is higher on streets with store and pedestrian zone. In addition, vibrancy rate is also higher on streets with rectangular shape and straight connection. In contrast, vibrancy rate is lower on streets with parking lot and parked car. This means each environmental factor could be respectively a factor which helps pedestrians walk in the mode of safety, convenience and pleasure, or a factor which gives pedestrians in the mode of un-safety, inconvenience and displeasure.

For almost cases, there is strong tendency that vibrancy rate is higher or lower on a specific environmental factor. Although there are some cases which are different from total tendency, all of them are not significant. As the result of t-test, there is significance for above 60 percent of all cases.

Pedestrian zone, store, arcade, piazza, straight connection and rectangular shape are positively related to vibrancy rate; however, parking lot and parked car are negatively related to vibrancy rate in common of all survey areas and cities. Parked motorbike and parked bicycle are negatively related in most survey areas. Vibrancy rate could be expected higher or lower according to whether certain environmental factors exist on each street.

Chapter 5 FORMULATION OF VIBRANCY BY APPLICATION OF MULTIPLE REGRESSION WITH CATEGORICAL DATA ON STREET ENVIRONMENT

5.1 General introduction

In Chapter 4, it is shown that there are relationships between vibrancy and each environmental factor on street. Pedestrian vibrancy is higher on streets with store and pedestrian zone while it is usually lower on streets with parking lot and parked vehicles. However, it is respectively dealt with each environmental factor. Therefore, it is necessary to reveal the comprehensive relationship among vibrancy and its related environmental factors on street.

Quantification method type one is used to distinguish how much the existence or non-existence of each factor simultaneously has an impact on vibrancy. This is because quantification method type one is a kind of multiple regression with the explanatory variables as dummy. After Hayashi, C. (1974) made public the methodology of quantification, quantification theory type one has been the one of most recognized methods as a kind of multiple regression model. Tanaka, Y. (1979) also shows that Hayashi's quantification theory type one is the first and most recognized method as ordinal logistic regression.

Park et al. (2010) proved that there are patterns between pedestrian vibrancy and environmental factors by the results of the quantification method type one. In addition, Hamana et al. (2009) suggested that the relation between pedestrians and the allocation of street space like public transportation is surveyed. 86 shopping malls in Kyoto were researched to analyze the effect of the allocation of street space for pedestrians. However, the unit of research is not the street. Moreover, parking distribution is not considered. The environmental factors surveyed in four cities are as follows. [35]

[35] The origin of quantification theory is the theory of predictions by L. Guttman. Then, the original theory was developed in the late 1940s and the early 1950s, by Hayashi, C. (1974). It is widely applied, especially in marketing, advertising, media, polls, in the field of behavioral science and social studies.

Table 19 Environmental factors surveyed in four cities

City	*Environmental factors*
Kyoto	Parking lot, Parked car, Parked motorbike, Parked bicycle, Pedestrian zone, Arcade, Store, Street shape, Street connection (In Gion, there is no pedestrian zone and arcade)
Seoul	Parking lot, Parked car, Parked motorbike, Parked bicycle, Pedestrian zone, Store, street vendor, Street shape, Street connection (In Insadong, there is no pedestrian zone)
Beijing	Parking lot, Parked car, Parked motorbike, Parked bicycle, Pedestrian zone, Store, Street shape, Street connection (In Nanluoguxiang, there is no pedestrian zone)
Florence	Parked car, Parked motorbike, Parked bicycle, Pedestrian zone, Piazza, Store, Street shape, Street connection

Table 19 illustrates environmental factors in four cities. The vibrancy rate is used as a dependent variable with environmental factors as independent variables. To distinguish the impact on vibrancy rate according to the existence or non-existence of each environmental factors, quantification method type one is used. In other words, it is to estimates numeric score from a set of categories. It is like following.

$$t_{i(j1)} + t_{i(j2)} + \cdots + t_{i(jc_j)} = \sum_{k=1}^{c_j} t_{i(jk)} = 1 \qquad (i=1,\ldots,\text{N, and } j=1,\ldots,\text{p}) \qquad (5.1)$$

In equation (5.1),

where i is item: in other words, environmental factor,

k is category,

j is qualitative variable

p is the size of qualitative variable,

c_j is the number of categories about qualitative variable j

$t_{i(jk)} = 1$ means that item i responds to category k of qualitative variable j.

And $t_{i(jk)} = 0$ means that item i does not respond to category k of qualitative variable j.

The dependent variable must depend on one of the categories for each item.

In equation (5.2), predictive value (: $\hat{y}_i$) is the sum of categories which item *i* responds to. In equation (5.3), Q means the residual sum of squares. In quantification method type one, each category value is obtained to minimize Q.

$$\hat{y}_i = t_{i(11)}x_{11} + t_{i(12)}x_{12} \ \ldots + t_{i(pc_p)}x_{pc_p} = \sum_{j=1}^{p}\sum_{k=1}^{c_j} t_{i(jk)}x_{jk} \qquad (5.2)$$

$$Q = \sum_{i=1}^{N}(y_i - \hat{y}_i)^2 = \sum_{i=1}^{N}\left(y_i - \sum_{j=1}^{p}\sum_{k=1}^{c_j} t_{i(jk)}x_{jk}\right)^2 \qquad (5.3)$$

5.2 Result of quantification method type one in four cities

5.2.1 Kyoto

- Shijo

The range of category score means the degree of influence on vibrancy rate. As a result of Table 20, arcade has the highest influence on vibrancy rate as it has the widest rage among the surveyed environmental factors. And parked bicycle also has high impact.

Figure 72 illustrates that parking lots, parked car, parked motorbike, and parked bicycle have negative category scores. On the other hand, pedestrian zone, arcade, store, straight connection and rectangular street shape have positive category scores. In particular, category score is highly positive on the street with an arcade or without parked bicycle. In contrast, the category score of curved street shape is the most negative.

In Shijo, there are negative impacts on vibrancy rate when parking lot and three kinds of parked vehicles exist. In contrast, there are positive impacts when the other factors exist such as pedestrian zone, arcade and store.

(R=0.751)

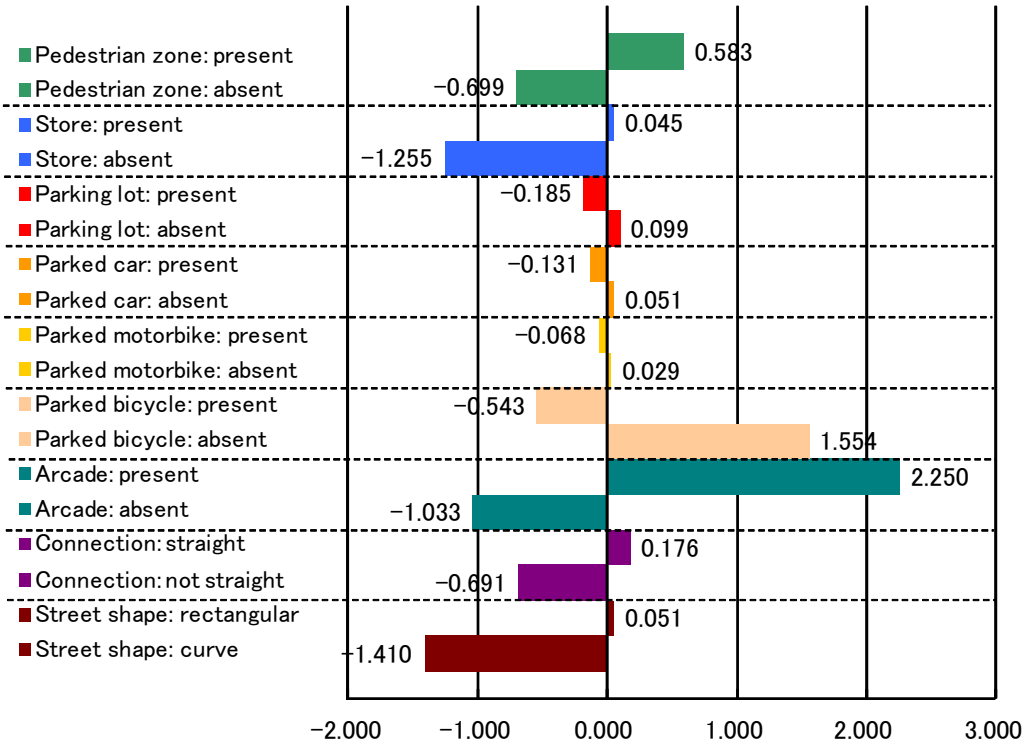


Figure 72 Category scores of quantification in Shijo

Table 20 Results of quantification according to category of items in Shijo

(Vibrancy rate: persons/㎡*100)

Item	*Category*	*Sample size*	*Average of vibrancy rate*	*Category score*	*Range of category score*
Pedestrian zone	Absent	65	1.265	-0.699	1.282
	Exist	78	5.188	0.583	
Store	Absent	5	1.267	-1.255	1.300
	Exist	138	3.483	0.045	
Parking lot	Absent	93	4.521	0.099	0.284
	Exist	50	1.329	-0.185	
Parked car	Absent	103	4.306	0.051	0.182
	Exist	40	1.086	-0.131	
Parked motorbike	Absent	100	4.144	0.029	0.097
	Exist	43	1.687	-0.068	
Parked bicycle	Absent	37	6.894	1.554	2.097
	Exist	106	2.187	-0.543	
Arcade	Absent	98	1.614	-1.033	3.283
	Exist	45	7.305	2.250	
Street connection	Not- straight	29	1.417	-0.691	0.867
	straight	114	3.911	0.176	
Street shape	Curve	5	0.528	-1.410	1.461
	Rectangular	138	3.509	0.051	

- Gion

According to Table 21, street connection has the highest influence on vibrancy rate as it has the widest rage of category score. Parked car also has a high influence, similar to straight connection.

In Figure 73, store and straight connection have positive category scores. However, there are negative category scores when parking lot and three kinds of parked vehicles exist. In particular, category score is very high as 0.287 when street is straightly connected. In contrast, parked car, not straight street connection and curved street shape have highly negative category score.

In Gion, there are negative impacts on vibrancy rate when parking lot and three kinds of parked vehicles exist in contrast to store. This is same as the result of Shijo. However, the coefficient of determination is the lowest among all areas in four cities as 0.320. It could be the result of relatively scattered vibrancy distribution on all surveyed streets in Gion.

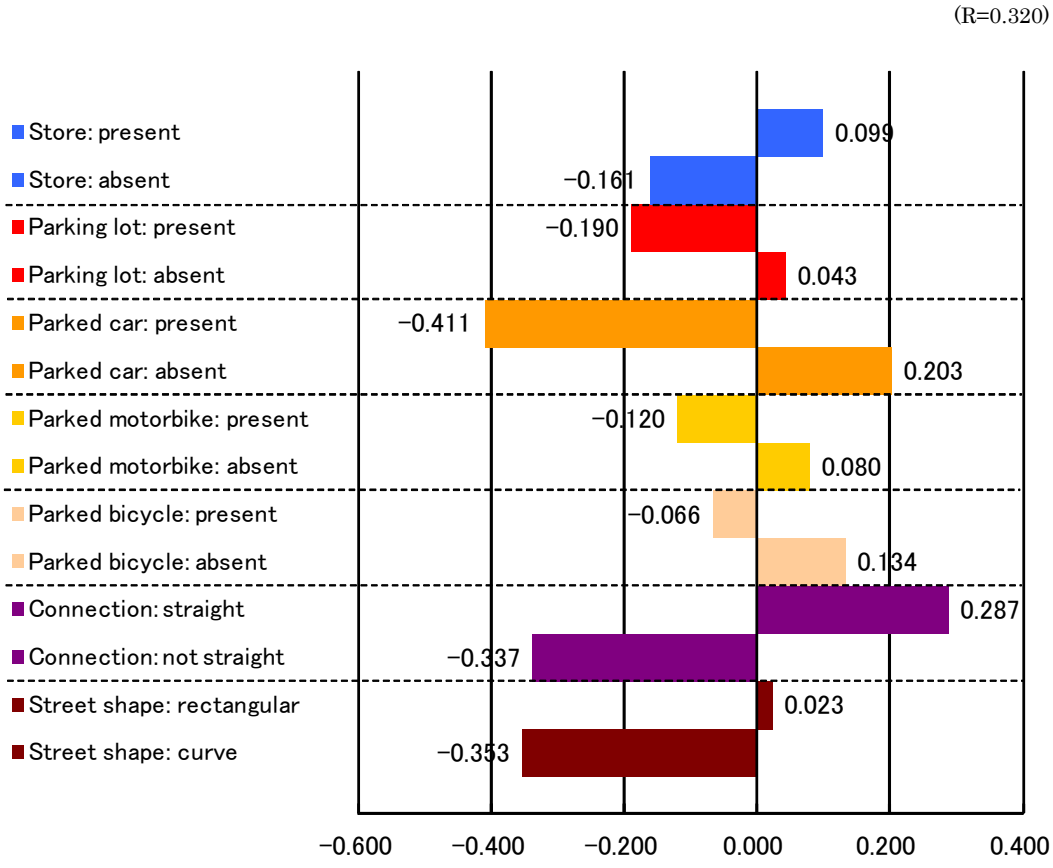


Figure 73 Category scores of quantification in Gion

Table 21 Results of quantification according to category of items in Gion

(Vibrancy rate: persons/㎡*100)

Item	*Category*	*Sample size*	*Average of vibrancy rate*	*Category score*	*Range of category score*
Store	Absent	62	0.852	-0.161	0.260
	Exist	101	1.091	0.099	
Parking lot	Absent	133	1.084	0.043	0.233
	Exist	30	0.630	-0.190	
Parked car	Absent	109	1.201	0.203	0.614
	Exist	54	0.595	-0.411	
Parked motorbike	Absent	98	1.116	0.080	0.200
	Exist	65	0.826	-0.120	
Parked bicycle	Absent	54	1.285	0.134	0.200
	Exist	109	0.860	-0.066	
Street connection	Not- straight	75	0.627	-0.337	0.625
	straight	88	1.319	0.287	
Street shape	Curve	10	0.425	-0.353	0.376
	Rectangular	153	1.038	0.023	

- Both areas of Kyoto

As shown in Table 22, arcade has the highest influence on vibrancy rate as it has the widest rage of category score. In Figure 74, pedestrian zone and absence of parked bicycle on the street have positive category scores. However, the presence of an arcade has dominant high category score.

In both areas of Kyoto, there are negative impacts on vibrancy rate when parking lot and three kinds of parked vehicles are present on streets. And there are positive impacts when pedestrian zone, arcade and store exist on streets. Additionally, there are also positive impacts when street connection and street shape are respectively straight and rectangular. They all have the same tendency in both areas and each area of Kyoto.

(R=0.737)

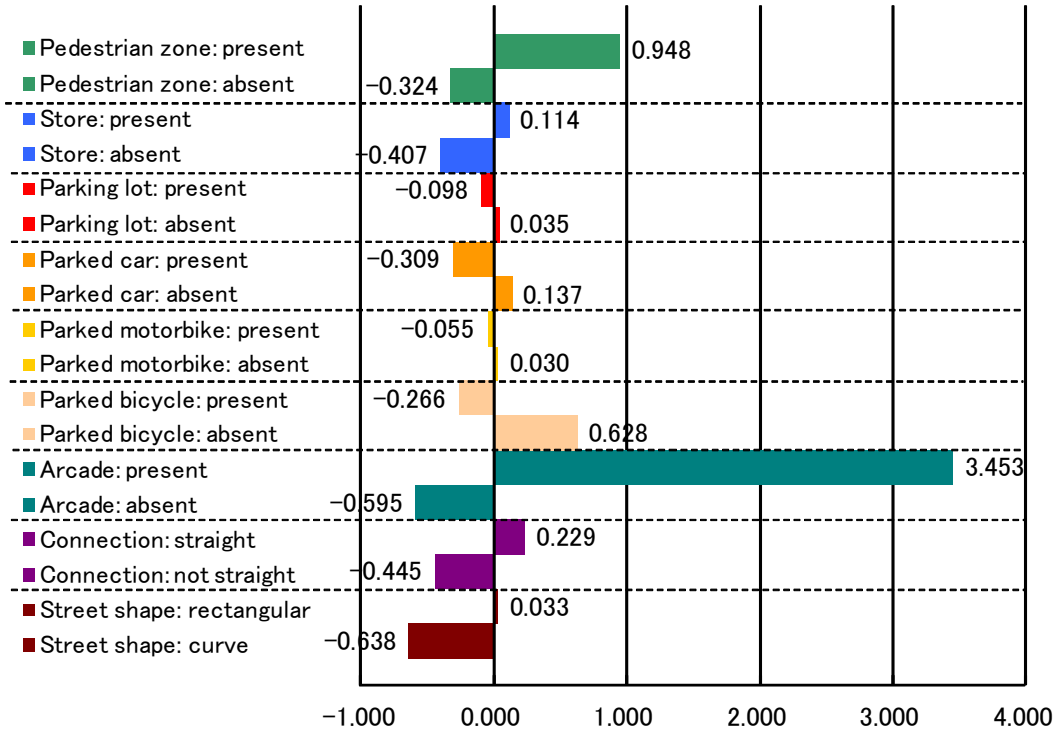


Figure 74 Category scores of quantification in both areas of Kyoto

Table 22 Results of quantification according to category of items in both areas of Kyoto

(Vibrancy rate: persons/㎡*100)

Item	*Category*	*Sample size*	*Average of vibrancy rate*	*Category score*	*Range of category score*
Pedestrian zone	Absent	228	1.076	-0.324	1.273
	Exist	78	5.188	0.948	
Store	Absent	67	0.883	-0.407	0.521
	Exist	239	2.472	0.114	
Parking lot	Absent	226	2.499	0.035	0.133
	Exist	80	1.067	-0.098	
Parked car	Absent	212	2.710	0.137	0.446
	Exist	94	0.804	-0.309	
Parked motorbike	Absent	198	2.645	0.030	0.085
	Exist	108	1.169	-0.055	
Parked bicycle	Absent	91	3.565	0.628	0.894
	Exist	215	1.514	-0.266	
Arcade	Absent	261	1.231	-0.595	4.048
	Exist	45	7.305	3.453	
Street connection	Not- straight	104	0.847	-0.445	0.674
	straight	202	2.782	0.229	
Street shape	Curve	15	0.459	-0.638	0.671
	Rectangular	291	2.210	0.033	

5.2.2 Seoul

- Myongdong

As seen in range of category of Table 23, street shape has the highest influence on vibrancy rate as it has the widest rage of category score. And pedestrian zone also has respectively high influence.

Figure 75 illustrates that parked car and parked motorbike have negative category scores. And pedestrian zone, store, straight street connection and rectangular street shape have positive category scores. Specifically, curve-shaped street, street without store have highly negative category scores.

In Myongdong, there are negative impacts on vibrancy rate when parked car and parked motorbike exist. However, parking lot and parked bicycle have positive impacts although they have relatively a little value.

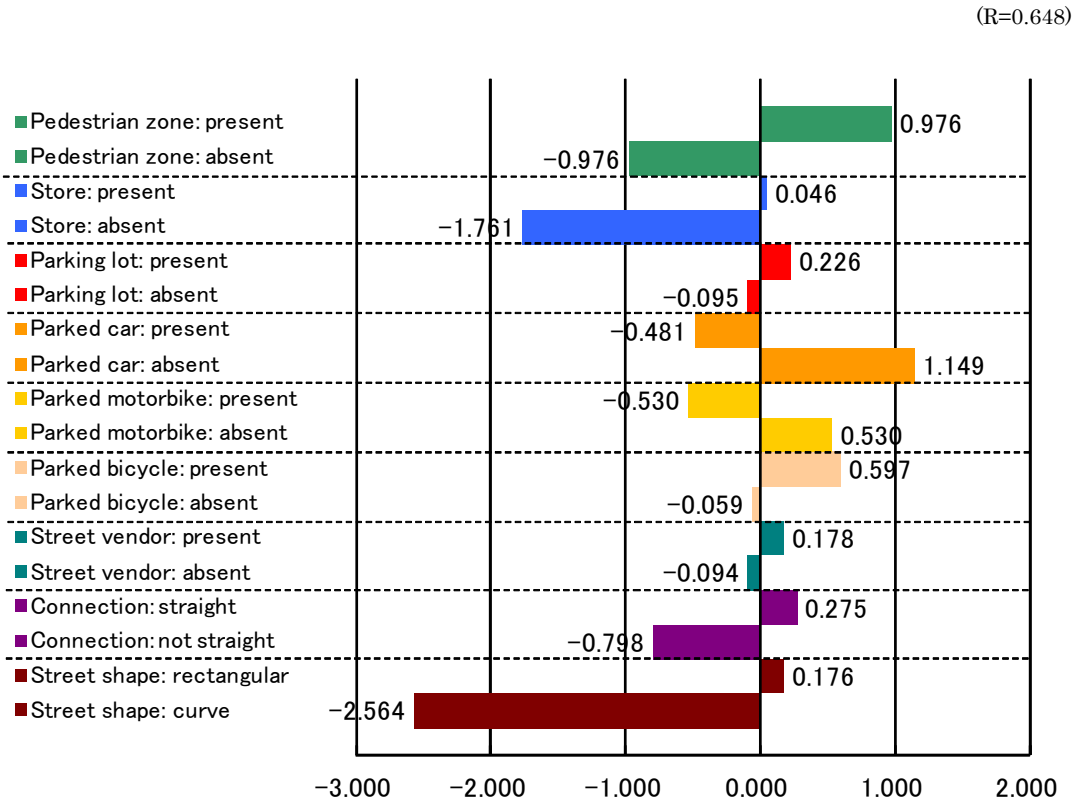


Figure 75 Category scores of quantification in Myongdong

Table 23 Results of quantification according to category of items in Myongdong

(Vibrancy rate: persons/㎡*100)

Item	*Category*	*Sample size*	*Average of vibrancy rate*	*Category score*	*Range of category score*
Pedestrian zone	Absent	39	1.763	-0.976	1.951
	Exist	39	4.279	0.976	
Store	Absent	2	0.452	-1.761	1.808
	Exist	76	3.089	0.046	
Parking lot	Absent	55	3.517	-0.095	0.321
	Exist	23	1.835	0.226	
Parked car	Absent	23	4.144	1.149	1.630
	Exist	55	2.552	-0.481	
Parked motorbike	Absent	39	3.933	0.530	1.060
	Exist	39	2.110	-0.530	
Parked bicycle	Absent	71	3.105	-0.059	0.656
	Exist	7	2.176	0.597	
Street vendor	Absent	51	2.876	-0.094	0.272
	Exist	27	3.296	0.178	
Street connection	Not- straight	20	2.386	-0.798	1.074
	straight	58	3.240	0.275	
Street shape	Curve	5	1.104	-2.564	2.740
	Rectangular	73	3.153	0.176	

- Insadong

In Insadong, it is impossible that store is included in analysis because store is located in any surveyed street unit. According to Table 24, presence of parked bicycle has the highest influence on vibrancy rate as it has the widest rage of category score. And Figure 76 illustrates that presence of parking lot has negative category score. Store and straight connection have positive category score. And parking lot, parked motor bike, and parked bicycle have negative category scores.

In Insadong, three results are different from expectation. It is shown that absence of street vendor, presence of parked car, and curved street shape have the positive category scores respectively. Curved street shape and absence of street vendor have positive category scores although their differences are respectively in below 10 percent of total sample size or a little value. However, concerning positive category score for presence of parked car, it could be one reason that there is relatively high possibility of streets with parked car in central 18 streets among total 46 streets, as each 67 and 48 percents. It could mean that there is high tendency to be many parked cars on central streets with a lot of store.

(R=0.521)

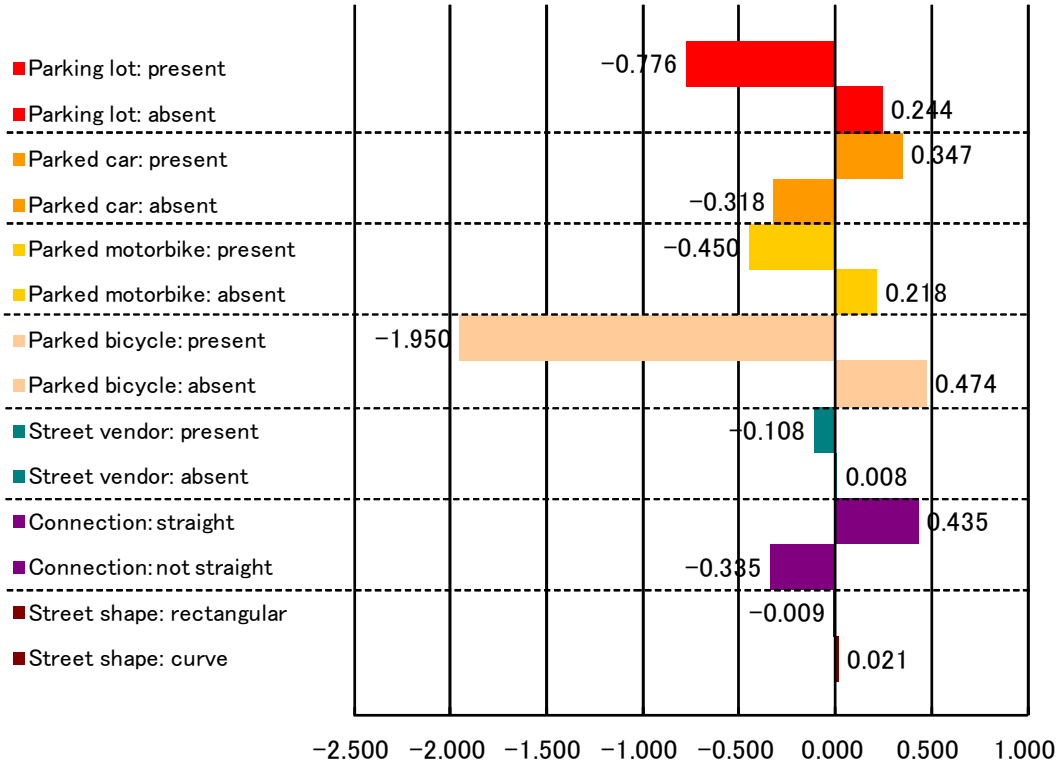


Figure 76 Category scores of quantification in Insadong

Table 24 Results of quantification according to category of items in Insadong

(Vibrancy rate: persons/㎡*100)

Item	*Category*	*Sample size*	*Average of vibrancy rate*	*Category score*	*Range of category score*
Parking lot	Absent	35	3.381	0.244	1.019
	Exist	11	2.319	-0.776	
Parked car	Absent	24	3.268	-0.318	0.666
	Exist	22	2.972	0.347	
Parked motorbike	Absent	31	3.607	0.218	0.668
	Exist	15	2.135	-0.450	
Parked bicycle	Absent	37	3.609	0.474	2.424
	Exist	9	1.145	-1.950	
Street vendor	Absent	43	3.142	0.008	0.115
	Exist	3	2.914	-0.108	
Street connection	Not- straight	26	2.837	-0.335	0.770
	straight	20	3.503	0.435	
Street shape	Curve	14	2.713	0.021	0.030
	Rectangular	32	3.308	-0.009	

- Both areas in Seoul

In Table 25, store has the highest influence on vibrancy rate as it has the widest rage of category score. Specially, category score is highly low when store is absent. In Figure 77, it is shown that absence of store has a negative category score. Pedestrian zone has highly positive category score.

In both areas of Seoul, parking lot and three kinds of parked vehicle have negative impacts on vibrancy rate. And pedestrian zone, store, straight street connection and rectangular street shape have positive impacts. However, street vendor has a negative impact although it has a little value.

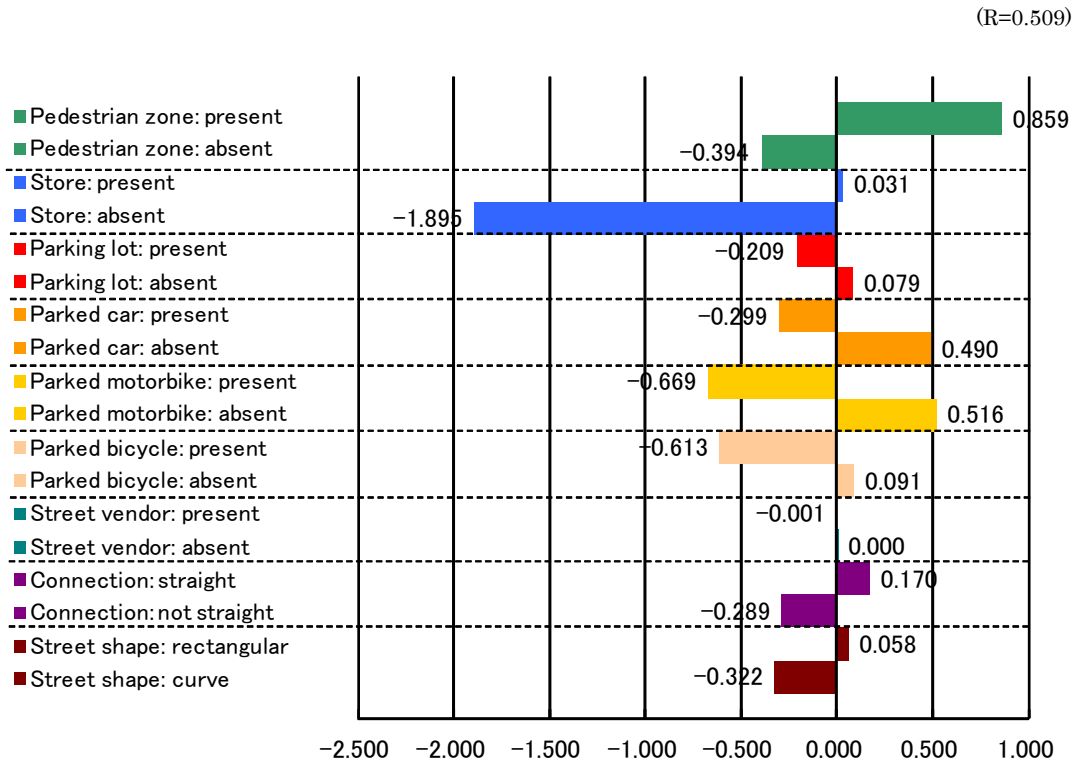


Figure 77 Category scores of quantification in both areas of Seoul

Table 25 Results of quantification according to category of items in both areas of Seoul

(Vibrancy rate: persons/㎡*100)

Item	*Category*	*Sample size*	*Average of vibrancy rate*	*Category score*	*Range of category score*
Pedestrian zone	Absent	85	2.501	-0.394	1.253
	Exist	39	4.279	0.859	
Store	Absent	2	0.452	-1.895	1.926
	Exist	122	3.103	0.031	
Parking lot	Absent	90	3.464	0.079	0.288
	Exist	34	1.991	-0.209	
Parked car	Absent	47	3.697	0.490	0.789
	Exist	77	2.672	-0.299	
Parked motorbike	Absent	70	3.788	0.516	1.185
	Exist	54	2.117	-0.669	
Parked bicycle	Absent	108	3.277	0.091	0.704
	Exist	16	1.596	-0.613	
Street vendor	Absent	94	2.998	0.000	0.001
	Exist	30	3.257	-0.001	
Street connection	Not- straight	46	2.641	-0.289	0.459
	straight	78	3.308	0.170	
Street shape	Curve	19	2.290	-0.322	0.381
	Rectangular	105	3.200	0.058	

5.2.3 Beijing

- Wangfujing

In Wangfujing, some streets are designated as pedestrian zone. However, the result could not be gained because other environmental factors are all in the same condition. Therefore, the analysis is conducted except for pedestrian zone as one factor.

In Table 26, parked car has the highest influence on vibrancy rate as it has the widest rage of category score. In Figure 78, absence of parked car has prominently positive category score. And there are also high category scores in case of absence of parked car and curve street shape.

As a result, parking lot, parked car, and parked bicycle have negative impacts on vibrancy rate. And store, straight street connection and rectangular street shape positively influence vibrancy rate. However, parked motorbike has positive impact on vibrancy rate although it has relatively a little value.

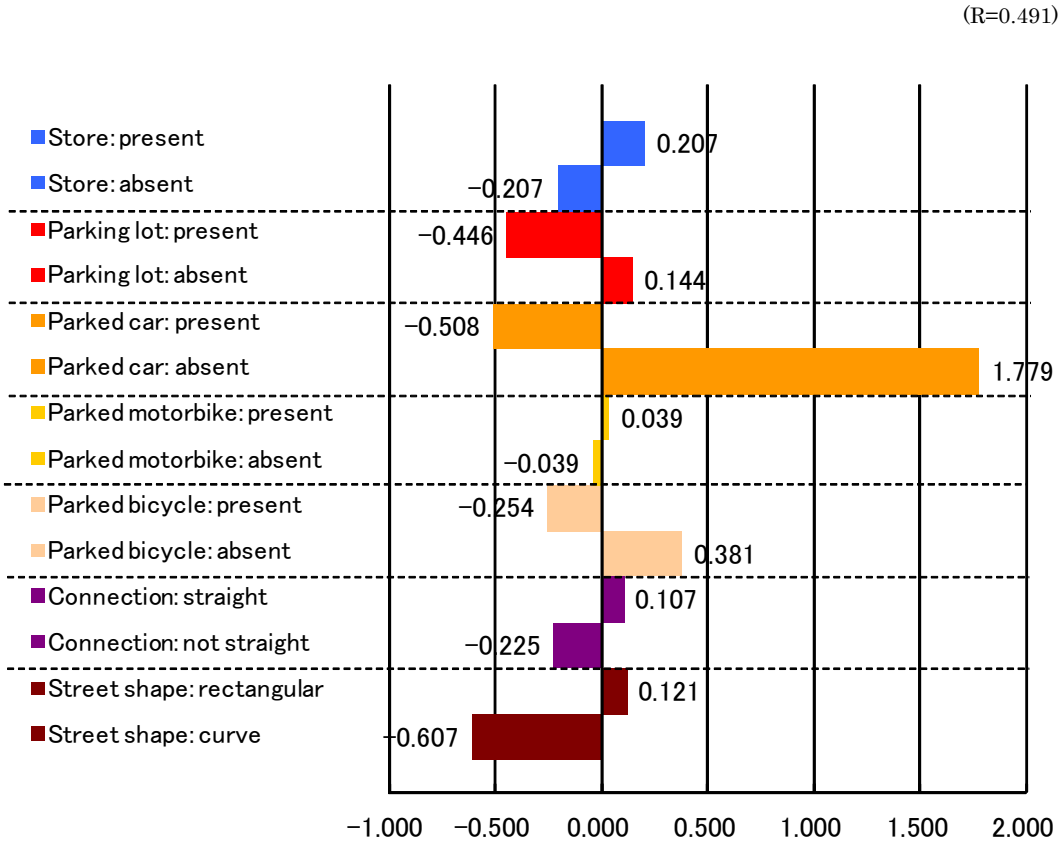


Figure 78 Category scores of quantification in Wangfujing

Table 26 Results of quantification according to category of items in Wangfujing

(Vibrancy rate: persons/㎡*100)

Item	*Category*	*Sample size*	*Average of vibrancy rate*	*Category score*	*Range of category score*
Store	Absent	45	0.858	-0.207	0.414
	Exist	45	1.775	0.207	
Parking lot	Absent	68	1.580	0.144	0.590
	Exist	22	0.503	-0.446	
Parked car	Absent	20	3.452	1.779	2.288
	Exist	70	0.706	-0.508	
Parked motorbike	Absent	45	1.765	-0.039	0.077
	Exist	45	0.867	0.039	
Parked bicycle	Absent	36	2.088	0.381	0.635
	Exist	54	0.802	-0.254	
Street connection	Not- straight	29	0.993	-0.225	0.332
	straight	61	1.470	0.107	
Street shape	Curve	15	0.501	-0.607	0.729
	Rectangular	75	1.479	0.121	

- Nanluoguxiang

As shown in Table 27, store has the highest influence on vibrancy rate as it has the widest rage of category score. Parked car, parking lot, and street connection have highly positive category scores.

In Figure 79, parking lot, parked car, and parked bicycle have negative impact on vibrancy rate. And store, straight street connection and rectangular street shape positively influence. However, parked motorbike has positive impact although it has relatively a little value. It is the same result as Wangfujing.

(R=0.623)

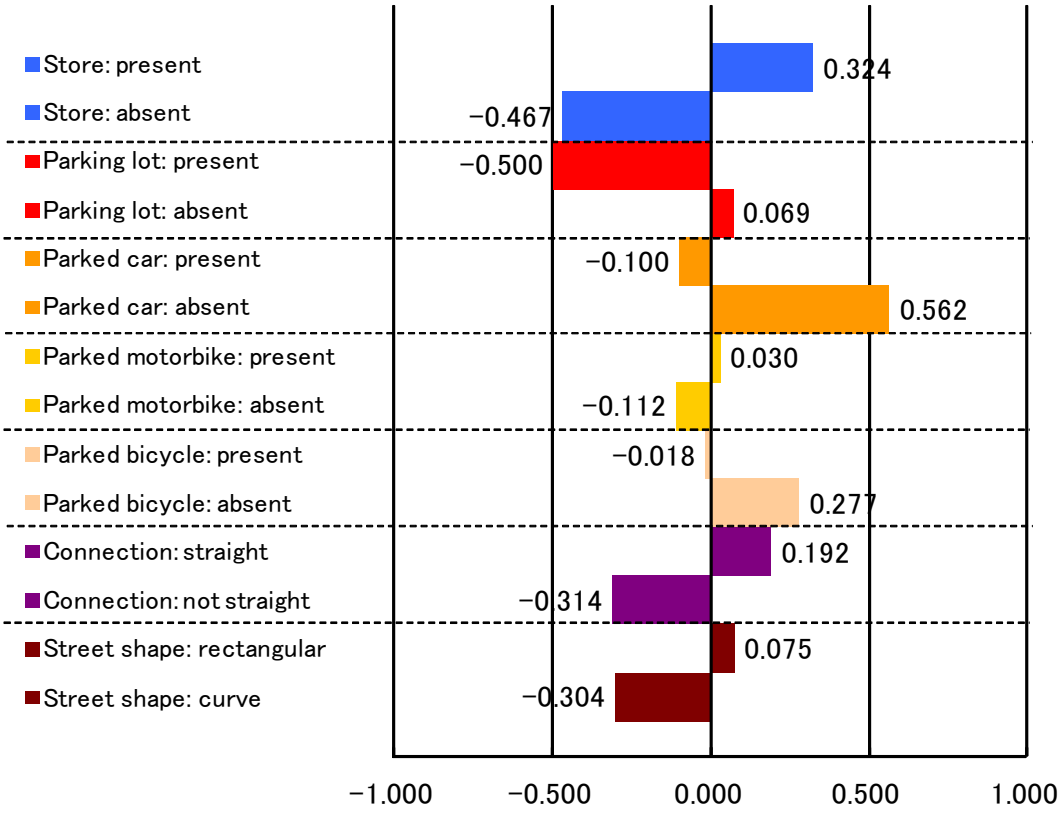


Figure 79 Category scores of quantification in Nanluoguxiang

Table 27 Results of quantification according to category of items in Nanluoguxiang

(Vibrancy rate: persons/㎡*100)

Item	*Category*	*Sample size*	*Average of vibrancy rate*	*Category score*	*Range of category score*
Store	Absent	27	0.284	-0.467	0.791
	Exist	39	1.097	0.324	
Parking lot	Absent	58	0.805	0.069	0.569
	Exist	8	0.470	-0.500	
Parked car	Absent	10	1.169	0.562	0.662
	Exist	56	0.692	-0.100	
Parked motorbike	Absent	14	0.555	-0.112	0.142
	Exist	52	0.821	0.030	
Parked bicycle	Absent	4	0.463	0.277	0.295
	Exist	62	0.784	-0.018	
Street connection	Not- straight	25	0.328	-0.314	0.506
	straight	41	1.031	0.192	
Street shape	Curve	13	0.204	-0.304	0.379
	Rectangular	53	0.902	0.075	

- Both areas of Beijing

In Table 28, it is shown parked car has the highest influence on vibrancy rate as it has the widest rage of category score. In Figure 80, it is shown that parking lots, parked vehicles have negative category score. On the other hand, store, straight connection and rectangular shape have positive category scores. In particular, category score is highly positive on street without parked car. Parking lot and absence of store have negative category scores.

As the result of both areas in Beijing, there are negative impacts on vibrancy rate when parking lot and three kinds of parked vehicle exist. In contrast, there are positive impacts when the other factors exist such as pedestrian zone and store.

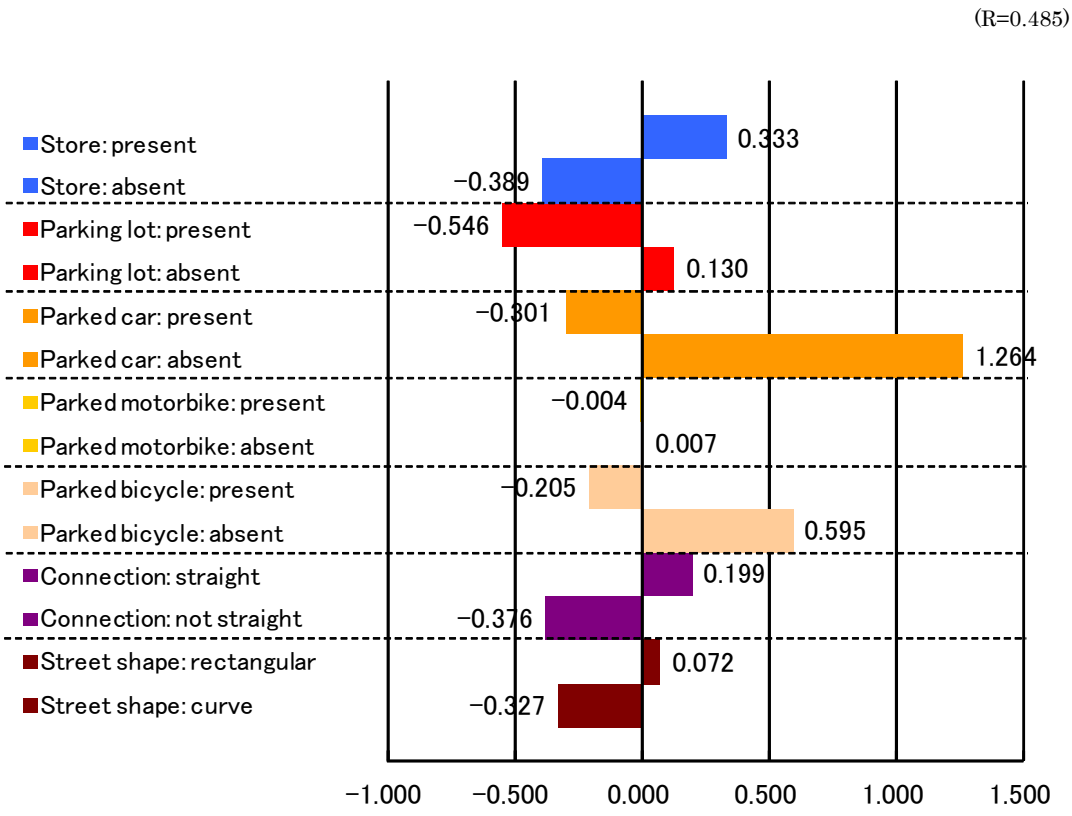


Figure 80 Category scores of quantification in both areas of Beijing

Table 28 Results of quantification according to category of items in both areas of Beijing

(Vibrancy rate: persons/㎡*100)

Item	*Category*	*Sample size*	*Average of vibrancy rate*	*Category score*	*Range of category score*
Store	Absent	72	0.643	-0.389	0.722
	Exist	84	1.460	0.333	
Parking lot	Absent	126	1.223	0.130	0.676
	Exist	30	0.494	-0.546	
Parked car	Absent	30	2.691	1.264	1.566
	Exist	126	0.700	-0.301	
Parked motorbike	Absent	59	1.478	0.007	0.010
	Exist	97	0.842	-0.004	
Parked bicycle	Absent	40	1.926	0.595	0.800
	Exist	116	0.792	-0.205	
Street connection	Not- straight	54	0.685	-0.376	0.574
	straight	102	1.293	0.199	
Street shape	Curve	28	0.364	-0.327	0.399
	Rectangular	128	1.240	0.072	

5.2.4 Florence

- Centro

As a result of Table 29, street shape has the highest influence on vibrancy rate as it has the widest rage of category score. And pedestrian zone and parked car also have high impact. In Figure 81, it is shown that parked car, parked motorbike, and parked bicycle have negative category scores. On the other hand, pedestrian zone, piazza, store, straight street connection and rectangular street shape have positive category scores. Specifically for curved street shape, it has the high prominently negative category score. In Centro, there are negative impacts on vibrancy rate when three kinds of parked vehicles exist. In contrast, there are positive impacts when the other factors exist such as pedestrian zone, piazza and store.

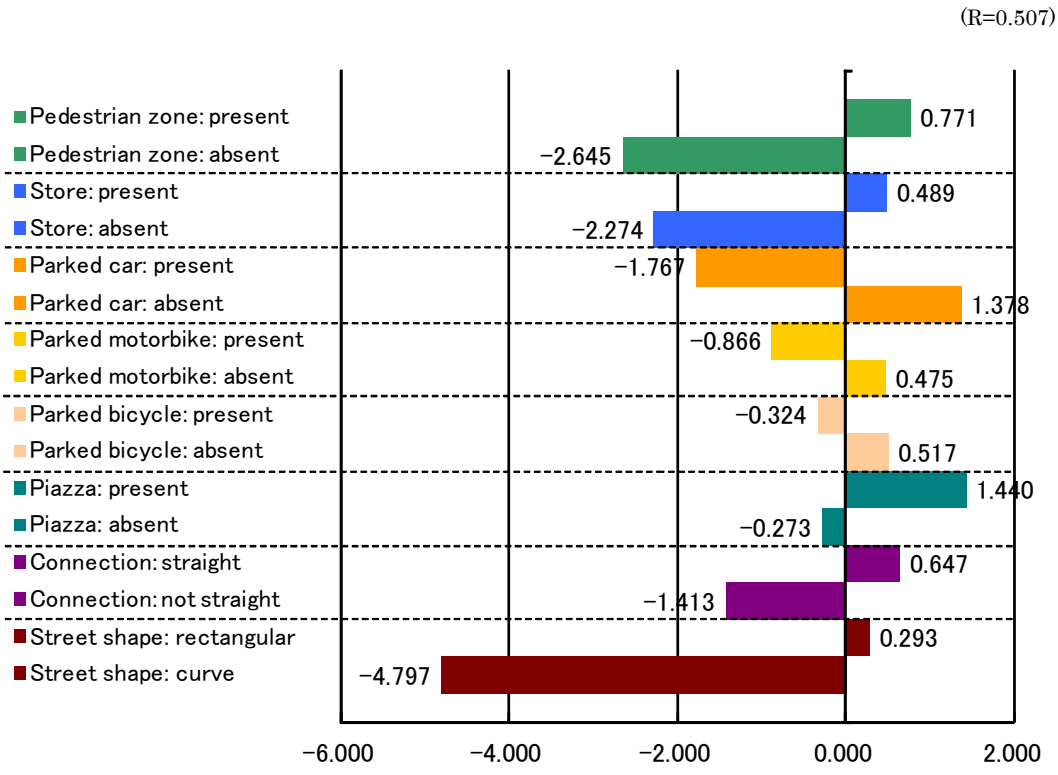


Figure 81 Category scores of quantification in Centro

Table 29 Results of quantification according to category of items in Centro

(Vibrancy rate: persons/㎡*100)

Item	*Category*	*Sample size*	*Average of vibrancy rate*	*Category score*	*Range of category score*
Pedestrian zone	Absent	51	2.355	-2.645	3.415
	Exist	175	6.172	0.771	
Store	Absent	40	2.949	-2.274	2.763
	Exist	186	5.819	0.489	
Parked car	Absent	127	6.764	1.378	3.145
	Exist	99	3.447	-1.767	
Parked motorbike	Absent	146	6.630	0.475	1.341
	Exist	80	2.904	-0.866	
Parked bicycle	Absent	87	6.437	0.517	0.841
	Exist	139	4.607	-0.324	
Piazza	Absent	190	4.890	-0.273	1.713
	Exist	36	7.533	1.440	
Street connection	Not- straight	71	3.102	-1.413	2.060
	straight	155	6.323	0.647	
Street shape	Curve	13	1.165	-4.797	5.090
	Rectangular	213	5.564	0.293	

- Santacroce

In Table 30, store has the highest influence on vibrancy rate as it has the widest rage of category score. And pedestrian zone and street connection also have high impact. In Figure 82, pedestrian zone, arcade, store and straight street connection positive category scores. In particular, pedestrian zone has highly positive category score.

In Santacroce, there are negative impacts on vibrancy rate when parked car and parked motorbike exist. In contrast, there are positive impacts when the other factors exist such as pedestrian zone, piazza and store. However, parked bicycle has positive impact although it has relatively a little value.

(R=0.489)

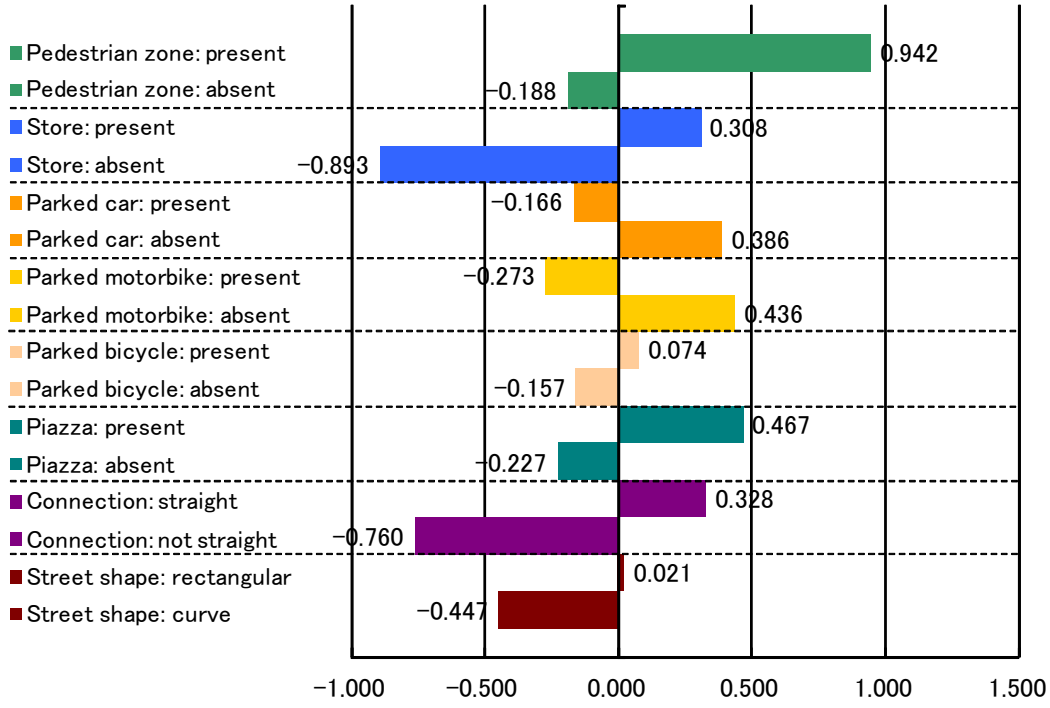


Figure 82 Category scores of quantification in Santacroce

Table 30 Results of quantification according to category of items in Santacroce

(Vibrancy rate: persons/㎡*100)

Item	*Category*	*Sample size*	*Average of vibrancy rate*	*Category score*	*Range of category score*
Pedestrian zone	Absent	130	1.393	-0.188	1.131
	Exist	26	3.059	0.942	
Store	Absent	40	0.387	-0.893	1.201
	Exist	116	2.113	0.308	
Parked car	Absent	47	2.337	0.386	0.552
	Exist	109	1.383	-0.166	
Parked motorbike	Absent	60	2.310	0.436	0.709
	Exist	96	1.270	-0.273	
Parked bicycle	Absent	50	1.593	-0.157	0.231
	Exist	106	1.707	0.074	
Piazza	Absent	105	1.356	-0.227	0.693
	Exist	51	2.318	0.467	
Street connection	Not- straight	47	0.515	-0.760	1.087
	straight	109	2.168	0.328	
Street shape	Curve	7	1.074	-0.447	0.468
	Rectangular	149	1.698	0.021	

- Both areas of Florence

As the result of both areas in Table 31, pedestrian zone has the highest influence on vibrancy rate as it has the widest rage of category score. And curve shape also has high impact. In Figure 83, it is shown that parked car, parked motorbike and parked bicycle have negative category score. On the other hand, pedestrian zone, piazza, store, straight street connection and rectangular street shape have positive category score. Specifically for curved street shape, there is the highly negative category score.

In both areas of Florence, there are negative impacts on vibrancy rate when three kinds of parked vehicles exist. In contrast, there are positive impacts when the other factors exist such as pedestrian zone, piazza and store.

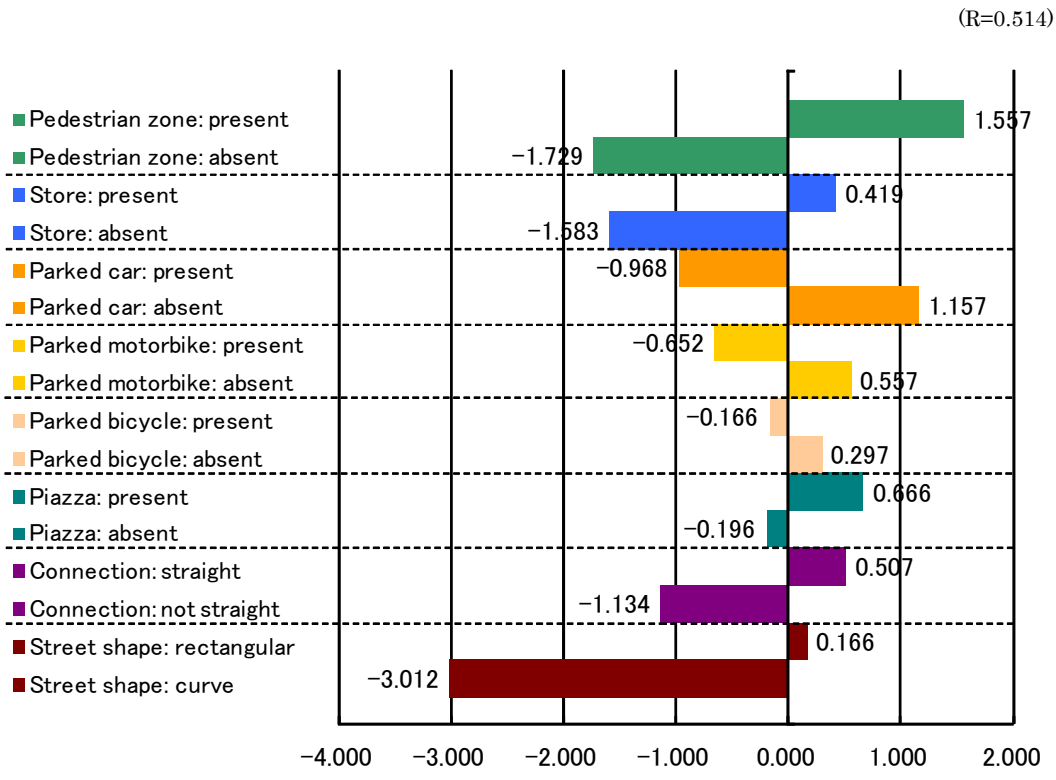


Figure 83 Category scores of quantification in both areas of Florence

Table 31 Results of quantification according to category of items in both areas of Florence

(Vibrancy rate: persons/㎡*100)

Item	*Category*	*Sample size*	*Average of vibrancy rate*	*Category score*	*Range of category score*
Pedestrian zone	Absent	181	1.664	-1.729	3.286
	Exist	201	5.770	1.557	
Store	Absent	80	1.668	-1.583	2.003
	Exist	302	4.395	0.419	
Parked car	Absent	174	5.568	1.157	2.124
	Exist	208	2.365	-0.968	
Parked motorbike	Absent	206	5.372	0.557	1.209
	Exist	176	2.013	-0.652	
Parked bicycle	Absent	137	4.669	0.297	0.463
	Exist	245	3.352	-0.166	
Piazza	Absent	295	3.632	-0.196	0.862
	Exist	87	4.476	0.666	
Street connection	Not- straight	118	2.072	-1.134	1.640
	straight	264	4.608	0.507	
Street shape	Curve	20	1.133	-3.012	3.178
	Rectangular	362	3.973	0.166	

5.3 Concluding remarks

It is important for pedestrian vibrancy what kind of environmental factors exist or not on street. It is because pedestrians are concentrated or dispersed in specific parts of an area according to the distribution of environmental factors. In survey cities, various factors were compared to distinguish whether they are comprehensively related to pedestrian vibrancy by quantification method type one.

In Kyoto, parking lot and parked vehicles have negative impact on vibrancy and pedestrian zone, arcade and store have positive impact. It is same in each area. In particular, the degree of influence is high when pedestrian zone and arcade exist. In Seoul, with respect to whether parking lots and parked vehicles are present or absent, there are high impact. In addition, pedestrian zone and curve street shape also have high impact. Particularly, the result of Insadong is different from general tendency.

In Beijing, parking lot and parked bicycle have negative impact on vibrancy although store has positive impact. Specially, absence of parked car is highly related to vibrancy. However, parked motorbike has positive impact in Wangfujing and Naluoguxiang although it has relatively a little value. In Florence, parked vehicles usually have negative impact. Parked bicycle is relatively less related among parked vehicle. In Santacroce, it has positive impact although it has a little value. However, pedestrian zone, piazza and store have positive impact.

As a result, pedestrian zones and stores generally had positive category scores. In addition, rectangular shape and straight connection of street also had positive category scores. In contrast, parking lot and parked vehicles usually have negative category scores in each city. These results mean that pedestrian-friendly environments are important to make an area vibrant together with ordered street structure, in contrast to a vehicle-centered environment.

Bibliography

Hayashi, C. (1974). *The methodology of quantification*. Tokyo: Toyokeizai. (In Japanese).

Hamana, S., Nakagawa, D., Matsunaka, R., & Oba, T. (2009). Study on the Effect of the Allocation of Road Space for Pedestrians on the Life of Shopping Malls: Based on Field Survey on 86 Shopping Malls in Kyoto City. *Journal of the City Planning Institute of Japan, 44*(3), 85-90.

Kitamura, H., Deguchi, A., Zhao, S., & Kurose, N. (2005). Functional and spatial configuration of malls for attracting pedestrian activities. *Journal of Architecture*

and Planning, 70, 145-152.

Park, D., Nakagawa, D., Matsunaka, R., & Oba, T. (2010). Study on the factors to make streets lively and brimming with people by field surveys on historic cities around the globe: Kyoto, Florence and Seoul. pp G1-02273-13. *Selected Proceedings of the 12th World Conference on Transport Research Society*. ISBN 978-989-96986-1-1.

Tanaka, Y. (1979). Review of the methods of quantification. *Environmental Health Perspectives, 32*, 113-123.

Chapter 6 STRUCTURAL RELATIONSHIP OF VIBRANCY AND ENVIRONMENTAL FACTORS ON STREET

6.1 General introduction

Environmental factors such as pedestrian zone and store have a positive influence. In contrast, environmental factors like parked vehicles and parking lot have negative influence. It means that various environmental factors have common characteristics in the point of the influence on vibrancy. Therefore, various measured variables can be grouped into a few latent variables. Moreover, the results of analyses in previous chapters are originated from the difference between the existence and non-existence of each factor on the street. However, it is necessary to compare the amount of each factor to analyze the influence on vibrancy.

The result is made about the multiple regression with categorical data of environments on street in Chapter 5. In this chapter, various factors are grouped into a latent variable with common characteristics in the point of the influence on vibrancy. Then, the relationship between vibrancy and the latent variables can be clarified. Structural equation modeling is suitable as the method for this solution. [36]

There are direct effects and indirect effects on the latent variable in structural equation modeling. The direct effect means the effect which is directly made from one variable to the other variable. The indirect effect means the effect which is indirectly made by parameter. The total effect to a latent variable is the sum of the two effects.

Pedestrian friendly environment is important to vitalize an area. Arima et al. (2008) surveyed several environmental factors on shopping streets to examine whether they stimulate pedestrian activities. In this study, it is proved that car traffic, arcades and the location of a store have an influence on the design of a store, and in addition, openness is important in triggering pedestrian purchasing decisions. There was another survey by Taniguchi and Fujii. (2006). Concerning controlling vehicle-traffic, shop owners are found to give a negative opinion on any car restriction to benefit pedestrians. However, as a result, their attitude regarding car restriction was changed after they knew that above ninety percent of pedestrians prefer a shopping environment having car restriction as potential shoppers.

[36] There are statistics methodology; LISREL, EQS, AMOS. AMOS has advantage to be easy to use the program on the base of graphics. In this study, AMOS is used as the statistics tool.

In this model, it is supposed that pedestrian comfort has an impact on the existence of parking and vibrancy, and the existence of parking has an impact on only vibrancy. Carmona et al (2003, pp.165-166) indicates that comfort is indispensable for good public spaces. It helps impact on people to stay longer in a public space. Therefore, comfort is one of important indexes for pedestrian vibrancy.

It is also supposed that the existence of parking has an impact only on vibrancy. Shoup (2005, pp.584-585) shows that several damages of parking requirement. Parking requirement makes worse air quality, walking environment, and energy consumption. As a result of its interaction, there is no benefit for the public. Moreover, it is proved that there is reverse relationship between parked vehicles and pedestrian gathering.

Illegal parking destroys the convenience of a pedestrian street environment and affects the vitality of an area. There has been research done on the influence of vehicle use on pedestrians. Nakamura et al. (2004) paid attention to parking lots as one reason for the decline in local city centers. They showed the reverse relationship between shopping floors and parking lots. To demonstrate the negative psychological influence of the car on pedestrians, an interview survey in shopping centers was conducted by Taniguchi et al. (2009). The pedestrians' opinions were measured to compare with indexes for walking. The existence of car and bicycle had a negative impact on walking, directly and indirectly. Loukopoulos et al. (2005) suggested that public attitudes on several situations related to traffic differ as a consequence of individual travel demand management measures such as prohibition, road pricing and individual marketing. Hatori et al. (2009) tired to reduce illegal parked bicycle by campaign. They proved that it could reduce the illegal parked bicycle by psychological effect.

6.2 Overview of structural equation model and hypothesis

- The characteristics of Structural Equation Modeling

Structural equation modeling is a kind of multivariate data analysis. It is the statistical method to analyze the relationship between various factors with the observed data. In particular, the structural relationship can be simultaneously estimated.

The character of Structural equation modeling is as follows. First, it is possible to verify the causal relationship between latent variables after introducing latent variables. Second, it is easy to make a model of causal structure by setting the causal relationship between latent variables. Third, it can be widely used in the form of a multivariate data analysis.

- Index of fitness

In structural equation modeling, a hypothesis is not guaranteed because it is made only by the researcher. Therefore, what you just configured to express the nature of the data is not enough. Consequently, it is necessary to check whether the model is fit to data or not, after estimating parameter. In this study, verification of the fitness of model is attempted with the indexes in Table 32.

Table 32 Index of fitness in Structural Equation Model

Index of fitness	*Contents*
χ^2 statistic (Chi-squared test)	When there are enough samples, the model of null hypothesis is correct. χ^2 is distributed with the degree of freedom in the χ^2 distribution. $\chi^2 = (N-1) f_{ML} \qquad df = \frac{1}{2} n(n+1) - p$ *N: the number of samples, n: the number of observed variables* *p: the number of estimated parameters* χ^2 is determined as follow: $\chi^2 . \chi^2 (df, \alpha) \Rightarrow$ Model is rejected $\chi^2 \leqq \chi^2 (df, \alpha) \Rightarrow$ Model is not rejected There is weak point that χ^2 statistic is sensitively influenced by the number of samples.
GFI (Goodness of fit index)	$\mathrm{GFI} = 1 - \frac{\mathrm{tr}((\Sigma(\hat{\boldsymbol{\theta}})^{-1}(\mathbf{S} - \Sigma(\hat{\boldsymbol{\theta}})))^2)}{\mathrm{tr}(\Sigma(\hat{\boldsymbol{\theta}})^{-1}\mathbf{S})^2)} \qquad \mathrm{tr}((A)^2) = tr(AA')$ The value ranges from 0 to 1. A model is considered as good model when the GFI is higher than 0.9. However, There is weak point that the index is better in the condition that the degree of freedom is less.
AGFI (Adjusted goodness of fit index)	$\mathrm{AGFI} = 1 - \frac{n(n+1)}{2df}(1 - \mathrm{GFI})$ AGFI is the index which is modified in the weak point of GFI about the degree of freedom. The value ranges from 0 to 1. A model is considered as good model when it is higher than 0.9 like GFI.
RMSEA (Root Mean Square Error of Approximation)	$\mathrm{RMSEA} = \sqrt{\max\left(\frac{f_{ML}}{df} - \frac{1}{N-1}, 0\right)}$ f_{ML}*: fitness of the maximum likelihood* RMSEA is the index to show the gap between the real distribution and the model distribution per one degree of freedom. When it is not higher than 0.1, the model is considered not bad.

- Latent variable and measured variable

The variables consist of observed variable, latent variable, exogenous variable, endogenous variable and error variable in the structural equation model like Table 33. Observed variable is the variable which is directly observed and related to latent variable. Latent variable is indirectly measured because it is not directly observed or measured. Exogenous variable is the variable having an impact on other variables and endogenous variable is the variable influenced by other variables. Error variable consists of measurement error and structure error.

The structural equation model has the character of priori control. This is because the model is analyzed after the hypothesis is set by the researcher. The latent variables are set from the observed variables by the researcher. Therefore, there must be a model setting before the analysis.

This modeling is to clarify the relationship between each factor and vibrancy. Some factors have similar characteristics on vibrancy. Therefore, environmental factors are grouped into two latent variables: pedestrian comfort and existence of parking.

Pedestrian zone, store, arcade or piazza can be categorized to pedestrian comfort because they give pleasure, safety and convenience of walking to pedestrians. But street vendor is not included because it could be an obstacle to a pedestrian. And all factors related to parking are categorized to the existence of parking. Their category is as follows.

Table 33 Latent variables and measured variables in structural equation model

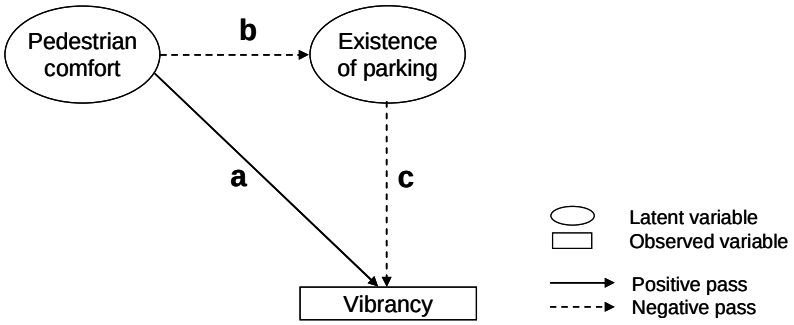
Latent variable	*Measured variables*
Pedestrian comfort	Pedestrian zone, Store, Arcade or Piazza
Existence of parking	Parking lot, Parked car, Parked motorbike, Parked bicycle
Absent of latent variable	Street shape, Street connection, Street vendor

- Hypothesis related to vibrancy and latent variables

The total effect on vibrancy is the sum of the direct effect and the indirect effect in Figure 84. In this hypothesis, the standardized total effect on vibrancy is the sum of the standardized direct effect and standardized indirect effect. It can be expressed like the following: Standardized Total Effect = Standardized Direct Effect (a) + Standardized Indirect Effect (b*c)

Pedestrian comfort usually has a longer history than the existence of parking. The reverse influence is not possible because the existence of parking is a temporary or relatively short-term situation. Therefore, the total effect from pedestrian comfort to

vibrancy can make sense.



From Pedestrian comfort to Vibrancy: Std. TE = Std. DE (a) + Std. IE (b*c)

Figure 84 Hypothesis related to vibrancy and latent variables in survey cities

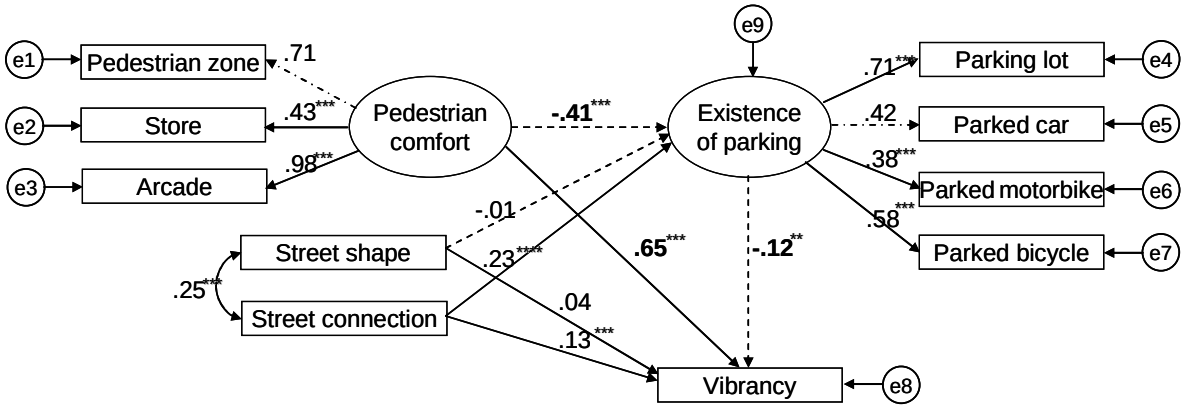
6.3 Structural equation models in four cities

6.3.1 Kyoto

In Figure 85, the fit index and the significance of model are good: χ^2=145.638, DF=31, GFI=0.917, AGFI=0.853, RMSEA=0.110. The pass from pedestrian comfort to vibrancy is positive. And both passes, from pedestrian comfort to existence of parking and from existence of parking to vibrancy, are negative in common.

Pedestrian comfort gives a positive impact on vibrancy, and additionally, a negative impact on the existence of parking. The relation of pedestrian comfort and its observed variables have high significance. Arcade and pedestrian are highly related to pedestrian comfort. Concerning the existence of parking, parking lot is highly related. In addition, street connection and street shape have positive influences on vibrancy with good significance.

The standardized total effect from pedestrian comfort to vibrancy is 0.70. The direct effect of pedestrian comfort is high as the direct effect and indirect effect are relatively 0.65, 0.05



Vibrancy: Std TE(0.70)= Std DE(0.65)+ Std IE(0.05)

χ2 test		GFI	AGFI	RMSEA
χ2	DF			
145.638	31	0.917	0.853	0.110

*: P <.01, **: P <.05, ***: P <.1

Positive pass
Negative pass
Pass in limitation of non-standardized coefficient as 1

Latent variable
Observed variable

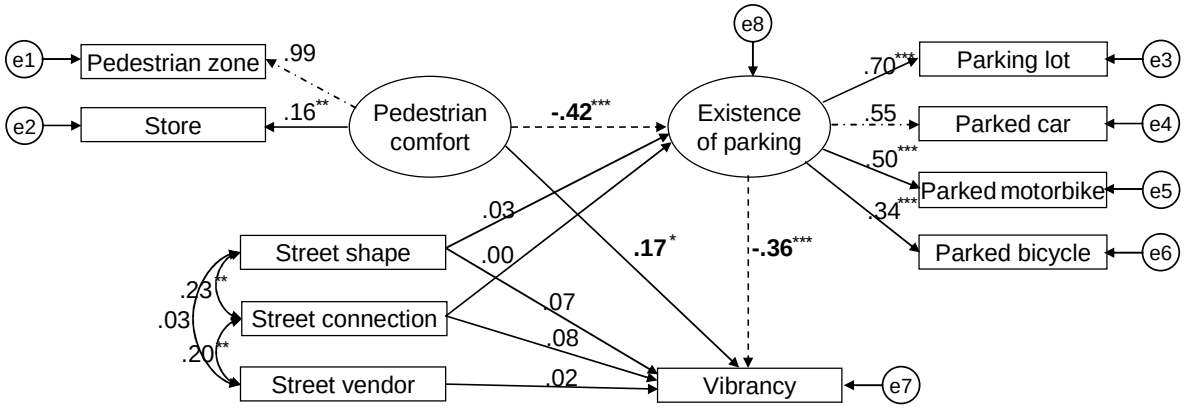
Figure 85 Structural Equation Model in Kyoto

6.3.2 Seoul

In Figure 86, the fit index and the significance of model are good: χ^2=80.37, DF=28, GFI=0.913, AGFI=0.828, RMSEA=0.112. The pass from pedestrian comfort to vibrancy is positive. And both passes, from pedestrian comfort to existence of parking and from existence of parking to vibrancy, are negative in common.

Pedestrian comfort gives positive impact on vibrancy, additionally negative impact on existence of parking. The relation of pedestrian comfort and store has high significance. Pedestrian are highly related to pedestrian comfort. Concerning existence of parking, parking lot is highly related. On the other hand, parking of bicycle is in low influence. In addition, street shape and street connection have a little positive influence on vibrancy and existence of parking in common. However, all of them are in low significance. In addition, the pass from street vendor to existence of parking is reduced to increase the significance of the pass from pedestrian comfort to vibrancy.

The standardized total effect from pedestrian comfort to vibrancy is 0.32. The direct effect of pedestrian comfort is high as direct effect and indirect effect are relatively 0.17, 0.15.



Vibrancy: Std TE(0.32)= Std DE(0.17)+ Std IE(0.15)

χ 2 test		GFI	AGFI	RMSEA
χ 2	DF			
80.37	28	0.913	0.828	0.112

*: P <.01, **: P <.05, ***: P <.1

Positive pass
Negative pass
Pass in limitation of non-standardized coefficient as 1

Latent variable
Observed variable

Figure 86 Structural Equation Model in Seoul

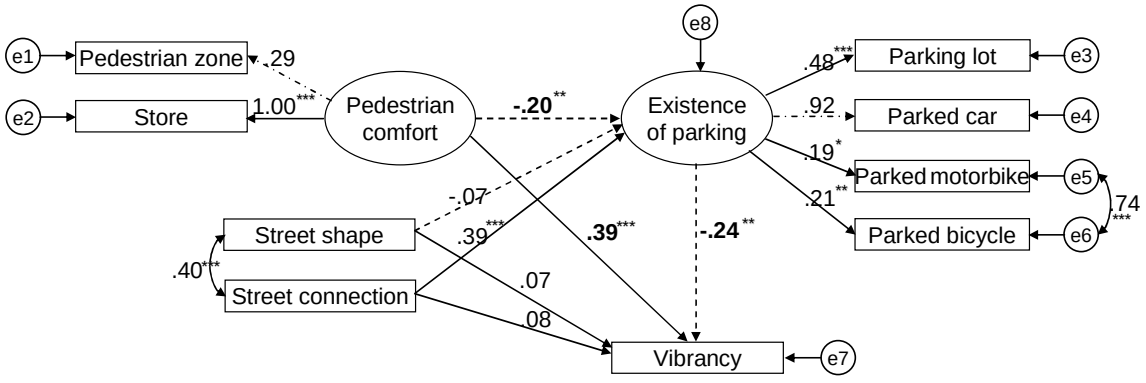
6.3.3 Beijing

Different from other cities, the model in Beijing is modified by setting the covariance of parked motorbike and parked bicycle. It is because there is high modification index between two variables. In addition, there are a lot of mopeds treated as motorbikes as the intermediate form of motorbike and bicycle. We decided to make covariance between two variables because it is logically reasonable. Different from models in other cities, there is high degree of covariance between parked motorbike and parked bicycle.

In Figure 87, the fit index and the significance of model are excellent: χ^2=54.245, DF=22, GFI=0.931, AGFI=0.860, RMSEA=0.097. The pass from pedestrian comfort to vibrancy is positive. Both passes, from pedestrian comfort to existence of parking and from existence of parking to vibrancy, are negative in common.

Pedestrian comfort gives positive impact on vibrancy, additionally negative impact on existence of parking. The relation of pedestrian comfort and related observed variables has high significance. Store is highly related to pedestrian comfort. Concerning existence of parking, parked car is highly related. Parked motorbike and parked bicycle are related in low degree. In addition, street connection has positive influence on existence of parking with significance. In addition, not only the covariance between parked motorbike and bicycle but also the covariance between street shape and street connection are commonly high in good significance.

The standardized total effect from pedestrian comfort to vibrancy is 0.44. The direct effect of pedestrian comfort is high as direct effect and indirect effect are relatively 0.39, 0.05.



Vibrancy: Std TE(0.44)= Std DE(0.39)+ Std IE(0.05)

χ 2 test		GFI	AGFI	RMSEA
χ 2	DF			
54.245	22	0.931	0.860	0.097

*: P <.01, **: P <.05, ***: P <.1

Positive pass
Negative pass
Pass in limitation of non-standardized coefficient as 1

Latent variable
Observed variable

Figure 87 Structural Equation Model in Beijing

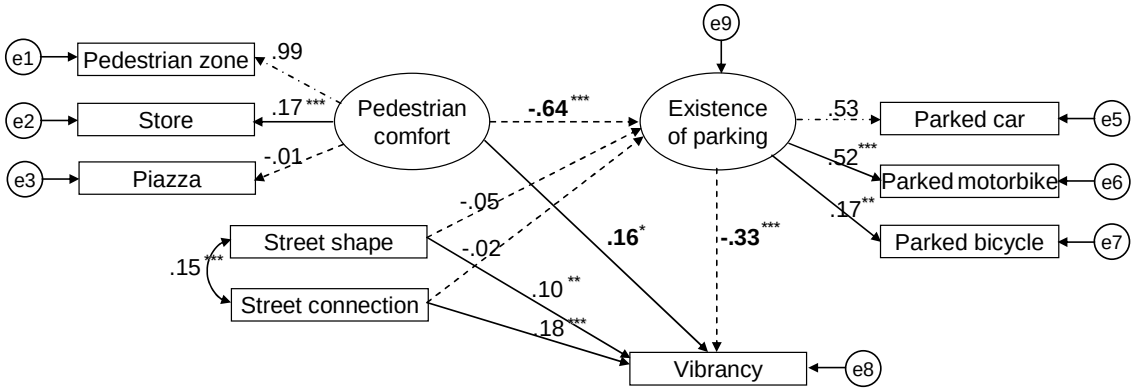
6.3.4 Florence

In Figure 88, the fit index and the significance of model are good: χ^2=112.354, DF=23, GFI=0.944, AGFI=0.890, RMSEA=0.101. The pass from pedestrian comfort to vibrancy is positive. And both passes, from pedestrian comfort to existence of parking and from existence of parking to vibrancy, are negative in common.

Pedestrian comfort gives positive impact on vibrancy, additionally negative impact on existence of parking. Pedestrian zone and store are positively related to pedestrian comfort. The pass from pedestrian comfort to piazza is not positive; however, it is not significant.

Pedestrian zone is overwhelmingly related to pedestrian comfort comparing other factors. Concerning existence of parking, parked car and parked motorbike are highly related. In addition, street shape and street connection have positive influence on vibrancy with significance. In contrast, street shape and street connection have negative influence on existence of parking without significance.

The standardized total effect from pedestrian comfort to vibrancy is 0.36. The indirect effect of pedestrian comfort is higher as direct effect and indirect effect are relatively 0.16, 0.20.



Vibrancy: Std TE(0.36)= Std DE(0.16)+ Std IE(0.20)

χ2 test		GFI	AGFI	RMSEA
χ2	DF			
112.354	23	0.944	0.890	0.101

*: P <.01, **: P <.05, ***: P <.1

Positive pass
Negative pass
Pass in limitation of non-standardized coefficient as 1

Latent variable
Observed variable

Figure 88 Structural Equation Model in Florence

In four cities, the results are usually good in the significance of model and the fit index. There are also good significances between each latent variable and vibrancy. Consequently, total effect from pedestrian comfort to vibrancy could be obtained in all four cities.

Table 34 shows feasibility of the hypothesis about total effect in four cities. Factor structures could verify the hypothesis in four surveyed cities. And there are common results. Pass is positive from pedestrian comfort to vibrancy although passes are reversely negative from pedestrian comfort to existence of parking and from existence of parking to vibrancy. Consequently, both direct and indirect effects are positive. In addition, direct effect is higher than indirect effect in three cities except for Florence.

Table 34 Total effects in four cities

City	*Pass**	*Direct Effect ***	*Significance (p-value < 0.10)*	*Indirect Effect ***	***Total Effect *****
Kyoto	PC → EP	- 0.41	Accept		
	EP → V	- 0.12	Accept		
	PC → V	**0.65**	Accept	**0.05**	**0.70**
Seoul	PC → EP	- 0.42	Accept		
	EP → V	- 0.36	Accept		
	PC → V	**0.17**	Accept	**0.15**	**0.32**
Beijing	PC → EP	- 0.20	Accept		
	EP → V	- 0.24	Accept		
	PC → V	**0.39**	Accept	**0.05**	**0.44**
Florence	PC → EP	- 0.64	Accept		
	EP → V	- 0.33	Accept		
	PC → V	**0.16**	Accept	**0.20**	**0.36**

* PC: Pedestrian comfort, EP: Existence of parking, V: vibrancy

** Effect is gained by the standardized coefficient of pass.

6.4 Concluding remarks

In common of structural equation model about four cities, pedestrian comfort has not only a positive effect on pedestrian vibrancy but also a negative effect on existence of parking. In addition, existence of parking also has a negative effect on pedestrian vibrancy.

Each effect between pedestrian comfort or vibrancy or existence of parking in four cities has significance in common. There are generally high values in passes between parking lot or parked car and existence of parking with significance while there are the low values in the passes between parked motorbike or bicycle and existence of parking. In addition, the value and significance of street shape are relatively low.

Bibliography

Arima, T., Oki, K., Deguchi, A., & Sakai, T. (2008). The relationship between the action trigger elements and pedestrian's activities on shopping streets: the commercial environment to stimulate the five senses and pedestrian's activities (no.1). *Journal of Architecture and Planning, 73*(623), 177-182.

Carmona, M., Heath, T., Oc, T., & Tiesdell, S. (2003). *Public places urban spaces: The dimension of urban design.* Burlington, MA: Elsevier.

Ewing, R., & Cervero, R. (2010). Travel and the built environment, *Journal of the American Planning Association. 76*(3), 265-294.

Hatori, T., Mikiya, S., & Fujii, S. (2009). An Examination on the Effects of Measures for Reducing the Illegal Bicycle Parking by Psychological Strategy: A Case Study on Toritsu-daigaku Station, Tokyu Corporation. *Infrastructure Planning Review, 26*(4), 797-805.

Loukopoulos, P., Jakobsson, C., Garling, T., Schneider, C.M., & Fujii, S. (2005). Public Attitudes towards Policy Measures for Reducing Private Car Use: evidence from a study in Sweden. *Environmental Science & Policy*, *8*(1), 57-66.

Nakamura, K., Aoyama, Y., Nakagawa, D., & Karatani, Y. (2004). A study on the analysis about the effect of the central area's regeneration measure considering the behavior of parking lots locating. *Journal of the city planning institute of Japan, 9*(3), 811-816.

Park, D., Nakagawa, D., Matsunaka, R., & Oba, T. (2012). Structural Relationship about Pedestrian Vibrancy and Street Environment in Central Areas of Kyoto, Seoul, Beijing and Florence. *International Journal of Urban Science*, *16*(2),

187-202.

Shoup, D. (2005). *The high cost of free parking.* Chicago, IL: American Planning Association.

Taniguchi, A., & Fujii, S. (2006). An analysis of attitude change of shop keepers toward car restriction in shopping area - a psychological effect of provision of pedestrian survey data in Jiyuugaoka shopping area -. *Journal of the City Planning Institute of Japan*, *41*(3), 115-120.

Taniguchi, A., Kagawa, T., & Fujii, S. (2009). An analysis of psychological effects of car traffic of pedestrian in shopping area. *Journal of JSCE, 65*(3), 329-335. (In Japanese).

Chapter 7 Comparison of central commercial areas and traditional areas

7.1 General introduction

During the process of modernization, old areas have been transformed into what have been termed new towns. Development in old city centers tends to occur without preservation efforts because there is a misunderstanding that only the new will attract people. However, pedestrians gather in older areas because people have increasingly recognized the importance of such areas and their traditional characteristics. However, few studies have focused on which environmental factors are important for development and how factor structures operate.

In Chapter 6, the results are made for structural equation model in four cities. In structural equation model about four cities, pedestrian comfort has not only a positive effect on pedestrian vibrancy but also a negative effect on existence of parking. In addition, existence of parking also has a negative effect on pedestrian vibrancy. They are all significant. However, there is difference according to an area in even a same city. Each area in a city is divided into central commercial and traditional area.

Both central commercial and traditional areas with high vibrancy can be identified based on certain common factors. Thus, understanding these factors is essential to revitalize characterized areas and to create vibrant and sustainable areas. In addition, there are some differences related to creating vibrancy between the two kinds of areas. Our research focuses on common points and different points of environmental factors for high vibrancy as the first step to regenerating central commercial areas and traditional areas according to their character.

To find common and different characteristics according to areas, we surveyed two areas in each city that are famous for their traditional or commercial features. The three cities in East Asia are Kyoto in Japan, Seoul in the Republic of Korea, and Beijing in China. We created two groupings and compared the cities in terms of these groupings. The first of these were the regions of Shijo, Myongdong and Wangfujing. They are all well known as central commercial areas with high buildings and a pedestrian zone. The other grouping contained Gion, Insadong and Nanluoguxiang. These areas are traditional areas with cultural characteristics such as preserved architecture. As Peter (2005) points out, there are traditional architectures in three cities of East Asia such as

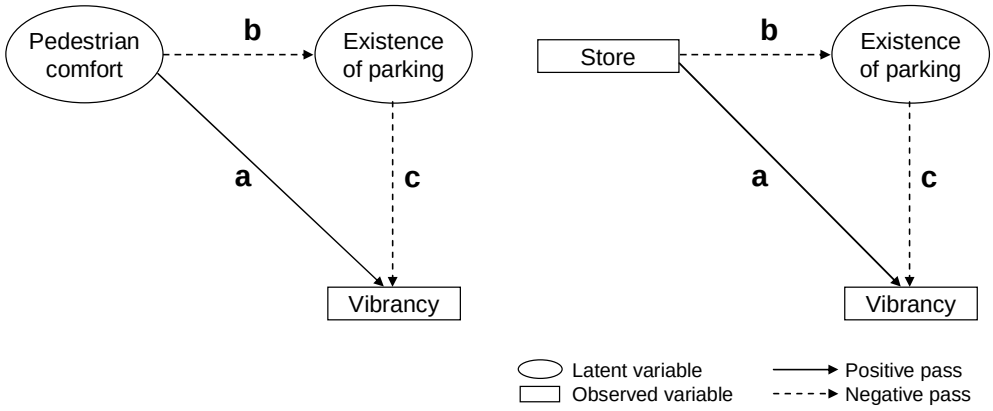
kyomachiya in Kyoto, hanok in Seoul, and Hutong in Beijing. They make an area's own characteristics and attract people.

The factor structures in Shijo and Myongdong were analyzed by Park et al. (2012) together with Centro of Florence. However, the each area could not be compared because traditional areas were not dealt in the study. In addition, Centro could not be distinct from Santacroce because they are just next to each other and pedestrian zone are designated in all of both areas. Therefore, each area in only three cities of East Asia is analyzed except for Florence

7.2 Comparison of central commercial areas and traditional areas in three cities of East Asia

- Hypothesis related to vibrancy and latent variables

The total effect on vibrancy is the sum of the direct effect and the indirect effect in Figure 89. This hypothesis in central commercial area is same as the model in Chapter 6. However, store in traditional area takes place on the same position of factor structure by substituting for pedestrian comfort of central commercial area. It is because there is only store as a factor of pedestrian comfort in traditional area, without pedestrian zone or arcade or piazza.



From Pedestrian comfort to Vibrancy: Std. TE = Std. DE (a) + Std. IE (b*c)

Figure 89 Hypothesis in central commercial area and traditional area

7.2.1 Characteristics of central commercial areas

In Shijo, Figure 90 illustrates that the fit index of the model is not too bad: χ^2 is 122.616, DF is 31, GFI is 0.862, AGFI is 0.756, and RMSEA is 0.144. All passes among latent variables and vibrancy are in good significance. Therefore, the total effect from pedestrian comfort to vibrancy could be obtained. The direct pass from pedestrian comfort to vibrancy is positive as 0.52. Both indirect passes, from pedestrian comfort to existence of parking and from existence of parking to vibrancy, are relatively negative as -0.67, -0.26. In the result, the standardized total effect is 0.69 as the sum of direct effect and indirect effect.

All observed variables have good significance in each latent variable. Arcade and pedestrian zone have high estimates. Parking lot, parked car, and parked motorbike are related in influential order for existence of parking. This is the same as the result of Myongdong. In addition, street connection has positive influence on the existence of parking. However, the coefficient and significance of street shape is low.

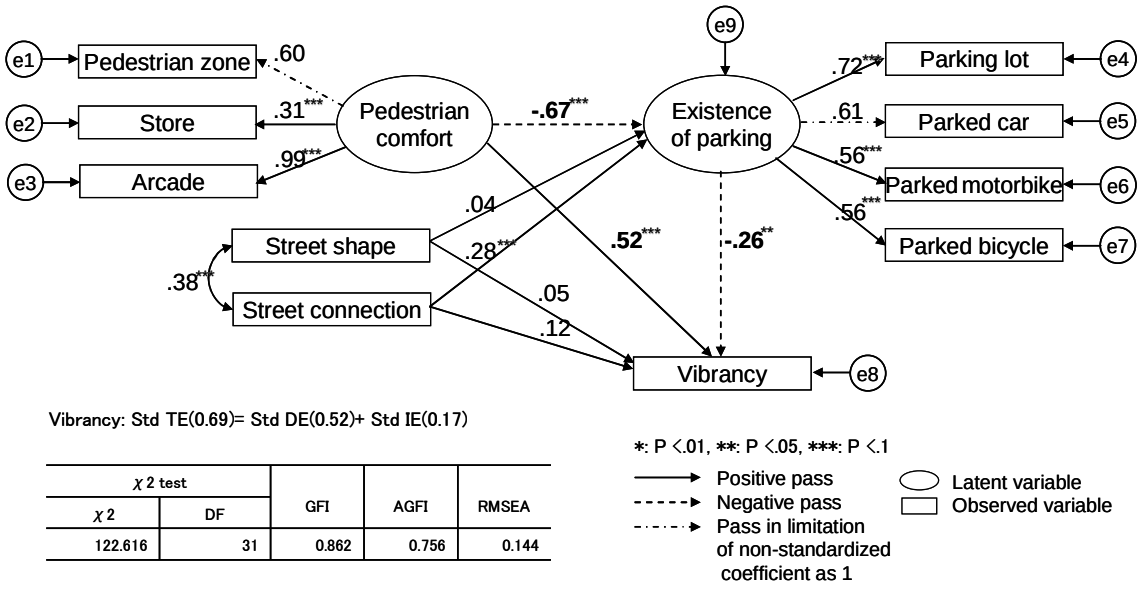


Figure 90 Structural Equation Models in Shijo, Kyoto

In Myongdong, the fit index of the model is excellent: χ^2 is 35.474, DF is 27, GFI is 0.921, AGFI is 0.839, and RMSEA is 0.064 as shown in Figure 91. The pass from pedestrian comfort to vibrancy is positive with significance. The pass from pedestrian comfort to existence of parking is negative as -0.70. However, there is low significance on the pass from existence of parking to vibrancy. Therefore, indirect effect could not be obtained.

The structural equation model is modified by setting the covariance of store and parked car. This is a trial to get total effect because there is a high modification index between the two variables. However, the result is almost the same as the previous model. As a result, the total effect could not be obtained. This could have resulted from an interference effect like the following. In the model, there is low value and low significance concerning store. On the other hand, street connection has negative influence on existence of parking, while street vendor has positive influence on existence of parking.

And pedestrian zone are highly related. Concerning existence of parking, parking lot, parked car, parked motorbike and parked bicycle are related in influential order. Existence of parking and related each observed variable are related in high significance. In addition, street shape has positive influence on vibrancy.

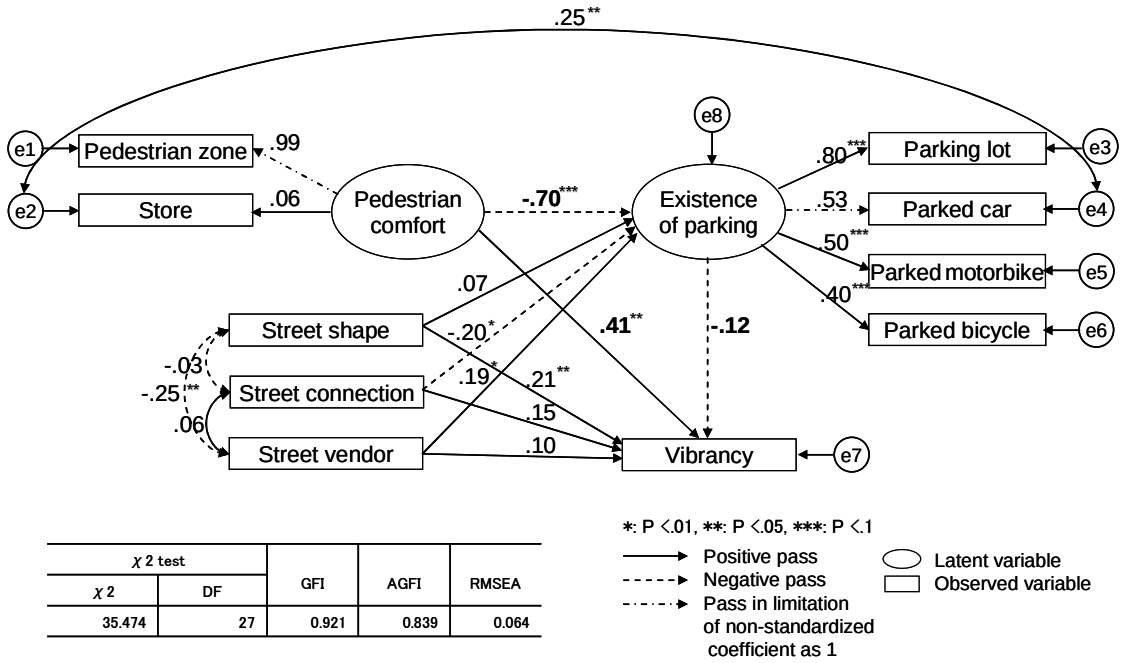


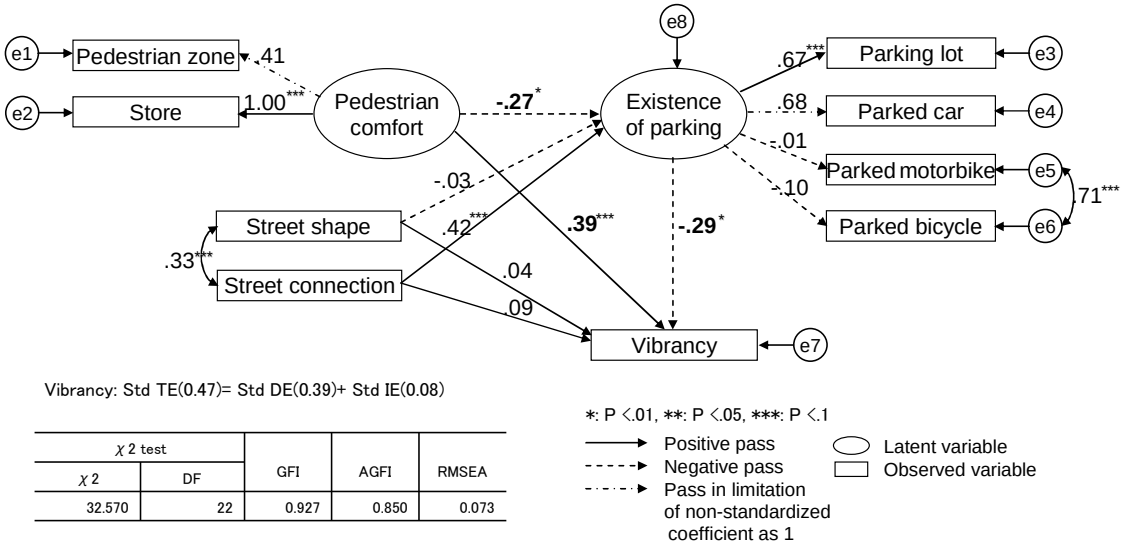
Figure 91 Structural Equation Models in Myongdong, Seoul

In Wangfujing, Figure 92 illustrates that the fit index of model is excellent: χ^2 is 32.570, DF is 22, GFI is 0.927, AGFI is 0.850, and RMSEA is 0.073. All passes among latent variables and vibrancy are in good significance. Consequently, the total effect from pedestrian comfort to vibrancy could be obtained. The direct pass from pedestrian comfort to vibrancy is positive as 0.39. Both indirect passes, from pedestrian comfort to existence of parking and from existence of parking to vibrancy, are relatively negative as -0.27, -0.29. In the result, the standardized total effect is 0.47 as sum of direct effect and

indirect effect.

Different from other central commercial areas, the model in Wangfujing is modified by setting the covariance of parked motorbike and parked bicycle. This is because there is high modification index between two variables which is same as the model in both areas of Beijing

All observed variables have good significance concerning pedestrian comfort. Pass, from pedestrian comfort to store, has prominently high estimates. Parking lot and pared car are negatively related to existence of parking. However, parked motorbike and parked bicycle are positively related to existence of parking although they are all without significance. In addition, street connection has positive influence on existence of parking.



χ2 test		GFI	AGFI	RMSEA
χ2	DF			
32.570	22	0.927	0.850	0.073

Figure 92 Structural Equation Models in Wangfujing, Beijing

Table 35 shows the feasibility of the hypothesis about the total effect in three central commercial areas. In Shijo and Wangfujing, factor structures could verify the hypothesis. However, Myongdong could not verify it because of a low significant pass. In central commercial area, there are common results. Pass is significantly positive from pedestrian comfort to vibrancy in three areas. And pass coefficients are negative from pedestrian comfort to existence of parking. They are same from existence of parking to vibrancy but in low significant. Direct effects are positive in three areas and they are higher than indirect effect in Shijo and Wangfujing.

Table 35 Total effects in central commercial areas

Area	*Pass**	*Direct Effect ***	*Significance (p-value < 0.10)*	*Indirect Effect ***	***Total Effect *****
Shijo	PC → EP	- 0.67	Accept		
	EP → V	- 0.26	Accept		
	PC → V	**0.52**	Accept	**0.17**	**0.69**
Myongdong	PC → EP	- 0.70	Accept		
	EP → V	- 0.12	Reject		
	PC → V	**0.41**	Accept	**-**	**-**
Wangfujing	PC → EP	- 0.27	Accept		
	EP → V	- 0.29	Accept		
	PC → V	**0.39**	Accept	**0.08**	**0.47**

* PC: Pedestrian comfort, EP: Existence of parking, V: vibrancy

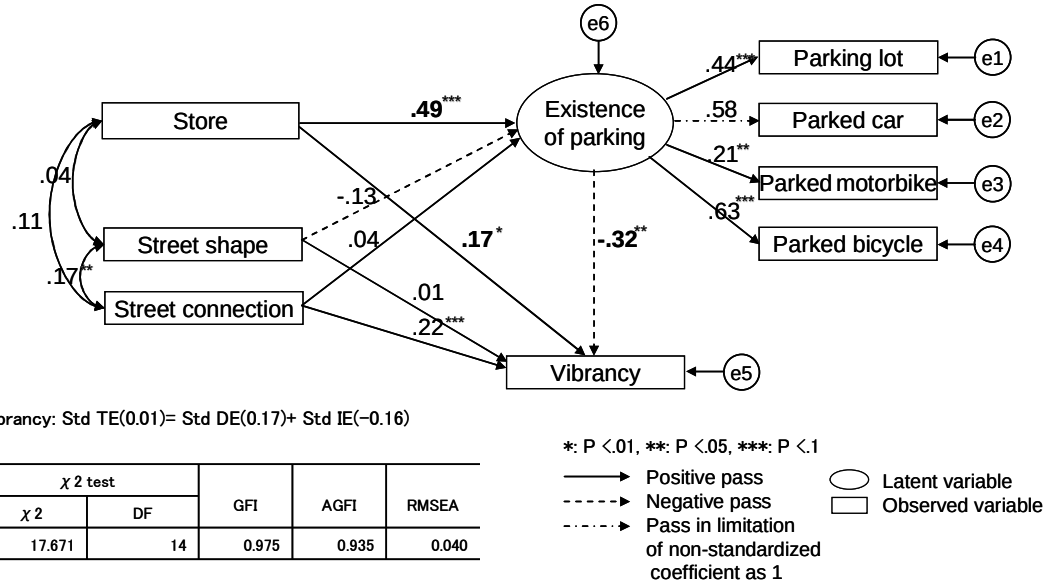
** Effect is gained by the standardized coefficient of pass.

7.2.2 Characteristics of traditional areas

For three traditional areas, only store is related to pedestrian comfort because there is no pedestrian zone or arcade. That is a clear distinction between the central commercial areas and traditional areas. Therefore, cases with only store in pedestrian comfort can be checked in traditional areas.

In Gion, the fit index of the model is excellent: χ^2 is 17.671, DF is 14, GFI is 0.975, GFI is 0.935, and RMSEA is 0.040 as shown in Figure 93. The pass from store to existence of parking is positive. This is the important point which is different from the results of Indadong and Nanluoguxiang. This is only one case that store could give a positive impact on existence of parking if there is no pedestrian zone. As a result, only store could influence on vibrancy not only negatively but also positively. The standardized total effect from store to vibrancy is 0.01; direct effect and indirect effect are relatively 0.17, -0.16.

All observed variables have good significance concerning existence of parking. Parked bicycle and parked car have high values. In addition, street connection has positive influence on vibrancy.



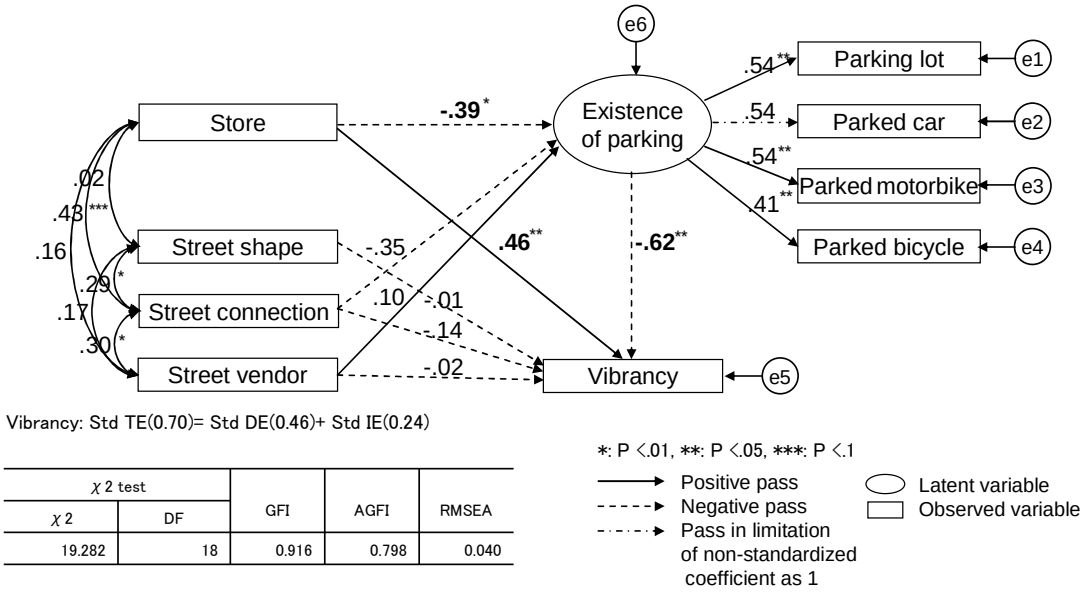
χ 2 test		GFI	AGFI	RMSEA
χ 2	DF			
17.671	14	0.975	0.935	0.040

Figure 93 Structural Equation Models in Gion, Kyoto

In Insadong, Figure 94 illustrates the fit index of the model is excellent: χ^2 is 19.282, DF is 18, GFI is 0.916, GFI is 0.798, and RMSEA is 0.040. The pass from street shape to existence of parking is reduced to increase the significance of the pass from store to

existence of parking. The pass from store to existence of parking is negative. This is different from the result of Gion. It means that store could give not only positive impact but also negative impact on existence of parking as one factor of pedestrian comfort. The standardized total effect of vibrancy received from store to vibrancy is 0.70; direct effect and indirect effect are relatively 0.46, 0.24.

All observed variables have good significance concerning existence of parking. Parking lot, parked car, and parked motorbike have almost same values. In addition, street shape, street connection, and street vendor have negative influence on vibrancy without significance.



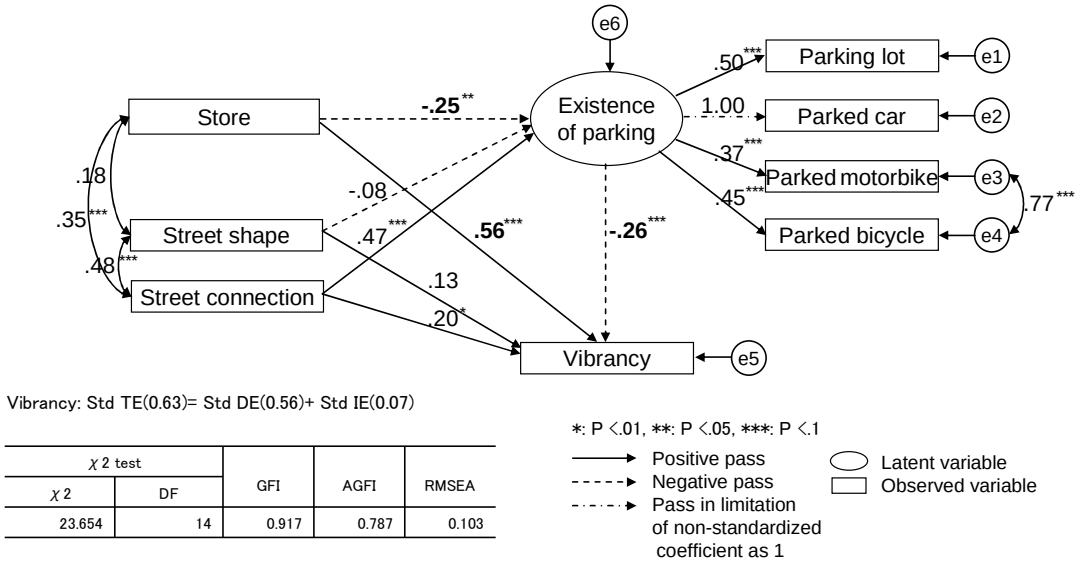
χ 2 test		GFI	AGFI	RMSEA
χ 2	DF			
19.282	18	0.916	0.798	0.040

Figure 94 Structural Equation Models in Insadong, Seoul

The fit index of the model in Nanluoguxiang is good: χ^2 is 23.654, DF is 14, GFI is 0.917, AGFI is 0.787, and RMSEA is 0.103 as shown in Figure 95. And the pass from store to existence of parking is negative. This is same as the result of Insadong. The standardized total effect from store to vibrancy is 0.63; direct effect and indirect effect are relatively 0.56, 0.07.

Different from other traditional areas, the model in Nanluoguxiang is modified by setting the covariance of parked motorbike and parked bicycle. This is because there is high modification index between two variables which is same as the model in Wangfujing.

All observed variables have good significance concerning existence of parking. Parked car has almost the highest value. In addition, street shape and street connection have positive influence on vibrancy with significance.



χ 2 test		GFI	AGFI	RMSEA
χ 2	DF			
23.654	14	0.917	0.787	0.103

Figure 95 Structural Equation Models in Nanluoguxiang, Beijing

Table 36 shows feasibility of the hypothesis about total effect in traditional area. In the traditional areas, there are also common results. Pass is positive from store to vibrancy. Reversely, it is negative from existence of parking to vibrancy. However, there is different result from hypothesis. In Gion, indirect effect is negative. It means pass could be not only positive but also negative from store to existence of parking in factor structures of traditional areas. And total effects are commonly positive.

Table 36 Total effects in traditional areas

Area	*Pass**	*Direct Effect ***	*Significance (p-value < 0.10)*	*Indirect Effect ***	***Total Effect *****
Gion	S → EP	0.49	Accept		
	EP → V	- 0.32	Accept		
	S → V	**0.17**	Accept	**-0.16**	**0.01**
Insadong	S → EP	- 0.39	Accept		
	EP → V	- 0.62	Accept		
	S → V	**0.46**	Accept	**0.24**	**0.70**
Nanluoguxiang	S → EP	- 0.25	Accept		
	EP → V	- 0.26	Accept		
	S → V	**0.56**	Accept	**0.07**	**0.63**

* S: Store, EP: Existence of parking, V: vibrancy

** Effect is gained by the standardized coefficient of pass.

7.3 Concluding remarks

In central commercial areas and traditional areas of three cities in East Asia, the significance and the fit index of models are usually good. Therefore, total effect from pedestrian comfort to vibrancy could be obtained in five areas except for Myongdong.

In each area of Kyoto, there are results that the pass from pedestrian comfort (or store) to existence parking respectively has the absolute value higher than the passes from each latent variable (or store) to vibrancy. In Gion, the indirect effect is negative because there is negative pass from store to existence of parking. This result shows that only store could give positive impact on existence of parking. It means that only store could not perform a same function of pedestrian comfort because it makes the positive effect on existence of parking.

In Myongdong and Insadong of Seoul, there were results that a pass among vibrancy and latent variable (or store) had low significance in each area. Eventually in Myongdong, total effect could not be obtained because the pass from existence of parking to vibrancy has low significance regardless of setting covariance between store and parked car. However, total effect could be obtained in Insadong by modification of model.

In wangfujing and Nanluoguxiang of Beijing, there are results that the pass from pedestrian comfort (or store) to vibrancy respectively has the value higher than the other passes among pedestrian comfort (or store), existence of parking and vibrancy. This makes direct effect very higher than indirect effect in each area of Beijing. These results are all in significance.

In structural equation models of central commercial areas, pedestrian comfort has not only a positive effect on pedestrian vibrancy but also a negative effect on existence of parking with significance in common. These results are same as the results in Chapter 6. The results of total effects in three central commercial areas are same except for Myongdong. It is because there is the low significance of the pass from existence of parking to vibrancy in Myongdong.

In the models of traditional areas, there are common results that the pass is positive from store to vibrancy although it is negative from existence of parking to vibrancy. Same as models in central commercial areas, the pass from store to existence of parking is negative in Insadong and Nanluoguxiang. However, there are different results that it is positive in Gion. Total effect is commonly positive in all three traditional areas, same as central commercial areas.

As a result of central commercial areas, the passes among each latent variable and

vibrancy is same as hypothesis although a pass is not significant in Myongdong. However, concerning traditional areas, it was found that nothing but store could influences existence of parking not negatively but positively. It means that only store could not function as same as pedestrian comfort. It could be the result from no existence of pedestrian zone or arcade. The findings of this study show that pedestrian-oriented development is crucial to attract pedestrian vibrancy.

Bibliography

Park, D., Nakagawa, D., Matsunaka, R., & Oba, T. (2012). FACTOR STRUCTURE WHICH MAKES STREETS VIBRANT WITH PEOPLE —BASED ON FIELD SURVEY OF KYOTO, SEOUL AND FLORENCE. *Journal of JSCE*, *68*(5), 513-522. (In Japanese).

Peter G.R. (2005). *East Asia Modern: Shaping the Contemporary City.* London: Cromwell Press.

Chapter 8 Conclusion

8.1 Significance of this study

Urban issues such as sustainability and regeneration are significant themes which people are becoming aware of in the modern age. There have been a lot of attempted policies to solve them. However, they seem to be problems which are difficult to solve, until now.

Pedestrian vibrancy in itself is regarded as one of the best solutions. Although it is simple, it is difficult to create spontaneously and sustainably. Therefore, it is quite important to create an environment to bring about voluntary walking by citizens. There are some common factors in the pedestrian-friendly environment.

In Chapter 1, the background and scopes of this study were introduced together with research objectives. Then, literature about research on vibrancy and environmental factors were reviewed in Chapter 2. In Chapter 3, characteristics and current policies in survey cities were introduced. Research methodologies and an explanation about environmental factors were added.

In Chapter 4, the results of survey and t-test for each area were made. Pedestrian zone and store made vibrancy rate higher with rectangular street shape and straight street connection in all areas. In contrast, parking lots and parked car made vibrancy rate lower in all areas. The arcade in Kyoto, street vendor in Seoul and piazza in Florence had a role in influencing the vibrancy rate as the characteristic factor in each city.

In Chapter 5, the relationship among vibrancy and environmental factors on street are illustrated by the quantification method type one. The existence of pedestrian zones and stores had a highly positive influence. In contrast, parked vehicles and parking lot negatively influenced on vibrancy. This is a common feature in four cities.

In Chapter 6, structural equation models were made in four cities. In factor structure, pedestrian comfort including a pedestrian zone has both a positive impact on vibrancy and a negative impact on existence of parking. Pedestrian comfort gives not only direct effect but also indirect effect on vibrancy through the negative effect on existence of parking. It is a common feature in four cities.

Finally in Chapter 7, the survey areas were divided into central commercial areas and traditional areas in three cities of East Asia. In structural equation model about central commercial areas, pedestrian comfort has not only a positive effect on pedestrian vibrancy but also a negative effect on existence of parking. However, in structural

equation models of traditional areas, only store could have not only negative but also positive effect on existence of parking while only store has not a positive effect on pedestrian vibrancy. This shows the importance of a pedestrian zone to manage environments for pedestrians.
Managing the parking situation is important. Moreover, the management of pedestrian comfort is also important. It is because pedestrian comfort has not only a direct impact but also an indirect impact on pedestrian vibrancy throughout the impact on parking situation.

8.2 Recommendation for future work

This research shows that several environmental factors are related to pedestrian vibrancy. However, there are limits in this research. First, more samples in other areas and cities are required in the future for a more accurate result because only four cities were surveyed. In addition, the survey on pedestrian vibrancy in commute time or pedestrian path could make the research more meaningful. Then, there are other factors and characteristics regarding environment in a city center. They are not considered in this research survey. There could be a relationship between vibrancy and these other environmental factors.
Finally, the psychological effect on pedestrian vibrancy can not be overlooked. There must be a distinction of vibrancy according to psychological factors. Understanding the impact of psychological effect on decisions regarding a path of movement could help making the relationship between pedestrian vibrancy and environmental factors clearer.