Analysis on the physical and psychological influences of public open spaces on the urban streetscape

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1 INTRODUCTION

There exist various social mechanisms that support the creation and maintenance of a beautiful city, and it is necessary to undertake numerous endeavors to effectively carry out and manage these social mechanisms. Among these mechanisms, the urban streetscape, in particular, is representative of the image of a city and the quality of urban life. Therefore, there are many visual elements pertaining to urban streetscape and plenty of endeavors undertaken for its improvement.

After the Second World War, Japan displayed an interest in urban streetscapes, including the city skyline, view corridors, and landmarks. City policies have increased the number of regulations pertaining to urban streetscapes. However, the Japanese government had long focused on the economical efficiency and functionality, and as a result, some cities lost their diversity and cultural assets, which are characteristics of their being, "cities." Moreover, with the recent construction boom, the number of buildings in the inner cities of Japan has increased. This has led to several problems such as blocked view corridor, and the sense of feeling pressured by high-rise and high-density buildings.

In order to avoid the problem of the deterioration of urban streetscapes, many initiatives have suggested the implementation of legal tools such as the designation of view corridors, view points, and cityscape master plans. However, in order to secure these tools in advance, it is also necessary to consider public open spaces, as these are considered to be the 'pathways' of sights.

Hence, this study assumes that the non-existence of public open spaces is one of the key reasons for the deterioration of urban streetscapes. The study also measures the physical effects of public open spaces on the urban streetscapes and analyzes the relationship between the physical factors of urban streetscapes and the pedestrians' preferences regarding urban streetscapes. In other words, the aims of this study are as follow: (1) to ascertain the degree of physical influence that public open spaces have on urban streetscapes and (2) to investigate the relationship between public open spaces and pedestrians' preferences regarding urban streetscapes. Finally, it is hoped that this study will stimulate further investigation in this field in order to understand the possibility of enhancing urban streetscapes and effectively controlling streetscapes through the creation of suitable public open spaces.

2 LITERATURE REVIEW

With regard to pertinent literature on this subject, this study will review preceding theories on the “Landscape Law” of the Japanese government (2004) from the viewpoint of historical transition. This law was enacted very recently in order to preserve a favorable cityscape and enhance the image of the entire city. Further, the study will mention matters related to public open spaces- such as distributed conditions, arrangement, and design regulations- that can be found in Japan’s policy. Then, theories related to the methods of measuring the physical and psychological influences of urban streetscapes will be stated; these contain physical evaluation indicators that influence on urban streetscapes and psychological indicators for evaluating preferences regarding urban streetscapes.

2.1 Landscape Law

(1) Background of the law

Due to the exponential growth of urbanization after the Second World War, Japan concentrated all its efforts on the efficiency-centered development. However, instead of regional distinctiveness and creativity in urban space formation or an ideal image of the region, this efficiency-centered development often led to the creation of uniformly built or nondescript urban districts. However, with the advent of an era pursuing sustainability and quality of life, matters of public interest regarding favorable cityscapes have been raised[1] leading to the rapid development of machizukuri[2] across the country. Besides, local Japanese governments have dealt with the issue of local cityscapes independently, by enacting their own cityscape ordinances.

Japan was faced with construction booms- such as resort construction- due to the Tokyo Olympic in 1964, after which the local governments started enacting cityscape ordinances. In 1968, for the first time in Japan, the city of Kanazawa enacted the

[1] J. Okata, the decentralization system and Machizukuri Act, 2002

[2] In Japanese, machizukuri implies the act of community or town building. It refers to a variety of activities carried out by local residents, who work together or cooperate with the local government to transform the place they live in and conduct their daily business into a place that is attractive, pleasant to live in, and appropriate for the area.

Traditional Environment Conservation Ordinances to prevent the ruin of the historical environment, which was caused by the resort construction boom. In addition, the Cityscape Ordinance was enacted in Kyoto in 1972; until this time, these ordinances were typically enacted solely for the purpose of historical landscape preservation. However, after the enactment of the Cityscape Ordinance in Kobe in 1978, the application of these ordinances was extended from historical landscape preservation to the creation of cityscapes, and this trend of enacting cityscape ordinances spread across the local governments in Japan. In this manner, the Japanese government has very actively promoted the preservation and management of Japan's cityscapes, enacting cityscape ordinances in the form of local ordinances in nearly 500 local governments over a period of approximately 40 years.

However, these local ordinances were not sufficient to substantially regulate or control the local cityscapes, as the ordinances were only desirable devices and not practical ones. The characteristics of cityscapes in every local area were deteriorating or becoming increasingly similar. In order to solve these problems, the Landscape Law was finally enacted and promulgated in June 2004. This law was integrated with each local ordinance, such that the citizen or local governments provided support for the preservation and maintenance of their own local cityscapes.

(2) Characteristics of the Landscape Law

The Landscape Law has a total of 7 chapters and 107 clauses, and considers general rules, landscape planning, landscape district, landscape agreement, and landscape maintenance organizations. This law can be applied to both urban and rural areas. It can simultaneously reflect the unique characteristics of the cityscapes of each region with more compulsory power. NPOs and citizen can freely participate in proposing how this law can be enacted through various councils, such as the Landscape Agreement and Landscape Maintenance Organizations.

Japan has now reached the pinnacle of the discussion regarding how to manage the Landscape Law for the better landscape and how to encourage the revitalization of local regions by establishing ties with other industries such as tourist development and urban regeneration.

2.2 Public open spaces in Tokyo

(1) Outlines

In 1971, during the amendments of the Architectural Law, Tokyo introduced the "Planned Development Design System[3] (総合設計制度)" that centered on that regulation: thus, regulations for distinctive open space systems were imposed in each city. The Planned Development Design System refers to a new regulation system[4] that lightens some restrictions, for example, the floor space index restriction. This is done with official permission when a public open space is installed at the site of construction that has public access. The Planned Development Design System defines public open spaces as open spaces, both green spaces and hard "civic" spaces, to which there is public access, even though the land may not necessarily fall under public ownership.

The characteristics of public open spaces include manner of use, space demarcation, and openness. Manner of use implies that public open spaces play an important role as "pedestrian spaces" that are more than just "empty spaces in the city." These spaces can be used freely by anybody, and so they include open areas (e.g., plazas, pedestrian ways and flower beds) and small facilities that can aid the use of open areas (e.g., telephone booths, comfort rooms). Regarding space demarcation, the regulation prescribes a minimum area (or width) for an open space. Openness demands that the open spaces are accessible, and prescribes the length of adjacent roads and the difference in elevation between a public open space and the road.

(2) Types

Public open spaces are divided into four types: pedestrian spaces (歩道状空地), passage spaces (貫通通路), atriums (アトリウム), public plazas (広場状空地) (Table 1).

Table 1 Types of public open spaces

Conditions \ Types	Pedestrian spaces	Passage spaces	Atriums	Public plazas
Use	People can use this space and pass through it at any time			
Width	More than 3m (effective width is more than 2m)	More than 3m (effective width is more than 2m)	More than 30m	Minimum of 4m
Area	-	-	-	More than 100m^2
Difference in elevation with roads	Not in principle.	-	-	Less than 3m
Others	The part of setback is included	Similar regulations with pedestrian space	Passage space set for skylight	Various regulations depending on the shape and size

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3 This term derived from the research of Atsushi, Nagaoka (長岡篤) et. al (2003).

4 Architectural Center of Japan, the Planned Development Design System based on the Architectura l Law, 1996

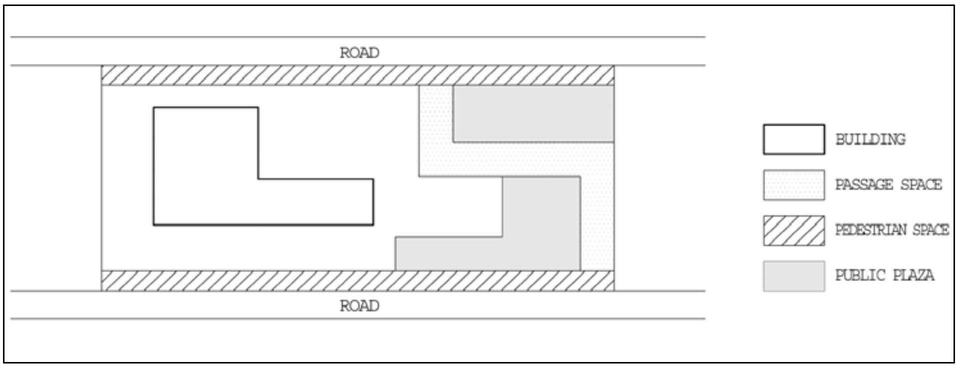


Figure 1 Types of public open spaces

(3) Benefits of urban streetscapes

Since public open spaces are essential to the quality of life downtown, providing opportunities for relief from steel and glass skyscrapers are essential, both psychologically and visually. In other words, public open spaces are extremely important in terms of providing relief to the eyesight in crowded urban spaces, which in turn implies mental rest. Given the generally high degree of development in urban Tokyo, these public open spaces do have numerous potential benefits and uses. Therefore, in order to enhance the urban environment, the Planned Development Design System of Japanese government should meticulously control not only the qualitative aspects of public open spaces but also their visual aspects.

2.3 Theories on measurement and evaluation

In order to estimate how public open spaces do work to create favorable urban streetscapes, this chapter will review some of the physical factors[5] that influence urban streetscapes. Further, before investigating the influence of the visual properties of urban streetscape on the people's preferences, it is necessary to address the question pertaining to the nature of people's psychological evaluations.

[5] By reviewing existing studies, the physical factors selected were those that were related to spatial scale and configuration and those that were similar to the fields dealt with in this study.

(1) Factors of physical influence

① Visual Accessibility

Visual accessibility implies the proportion of “landscape factors” in the entire composition of an image made by projection. This is frequently used to estimate the degree of changes needed in landscaping by measuring elements such as the sky, open spaces, roads, or buildings. Among these, the aspect of visual accessibility in public open spaces is significant because it contributes to the creation of favorable urban streetscapes by increasing the chance of being visible in the urban environment. In other words, the concept of visual accessibility can be defined as the opportunity and potential to enjoy open spaces in an urban area.

② Sky Blockage Ratio

The sky blockage ratio is defined as the “ratio of blocked sky volume to the total sky volume [6].” In 1982, a performance evaluation technique called “daylight evaluation” was introduced in Midtown Special District, New York. This technique determines the upper limit of the blocked sky ratio due to buildings by mixing two existing techniques- setback requirement and encroachment-compensating recess. This method can result in effective development with regard to density and can simultaneously achieve considerably more openness with regard to landscape management. This is because the daylight evaluation technique only controls the volume of blocked sky and relaxes restrictions on shape and scale.

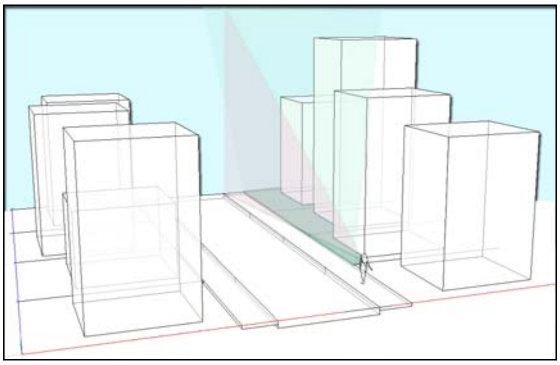


Figure 2 Visual Accessibility of the sky, buildings, and public open spaces

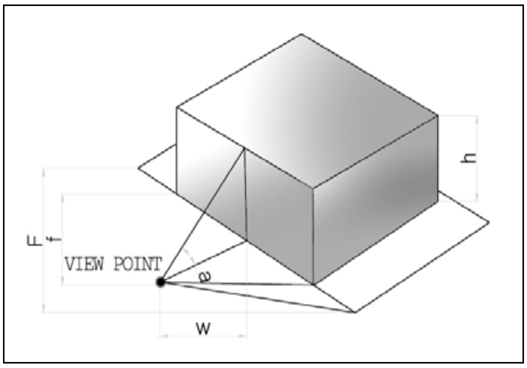


Figure 3 Sky blockage ratio

[6] Y.B. Jang, S.R. Lee, A Mathematical Approach for Calculating Sky Blockage Ratio, Journal of Korean Planners Association, v. 36 n.5, 2001

Table 2 Physical factors

Physical Factors		Contents	Formula
Sky Blockage Ratio		Vertical Blockage Ratio X Horizontal Blockage Ratio	$\frac{\tan^{-1}(h/w)}{90} \times \frac{\tan^{-1}(f/2w)}{\tan^{-1}(f/2wa)}$
Visual Accessibility	VA of the sky	the Proportion of Visibility of the Sky to the whole area of projected plane	$\frac{VAsky_i}{VAtotal_i}$
	VA of Buildings	the Proportion of Visibility of the Buildings to the whole area of projected plane	$\frac{VAbuild_i}{VAtotal_i}$
	VA of Public Open Space	the Proportion of Visibility of the Public Open Spaces to the whole area of projected plane	$\frac{VApos_i}{VAtotal_i}$

(2) Psychological factors of evaluation: Preference evaluation by SD

The urban streetscape is an important element that determines the image of a city. As stated by Kevin Lynch, "a street as a pathway is a predominant element of the image of a city for almost all people, so people can observe the city while passing along the street."[7] Therefore, since urban streetscapes represent the intrinsic meaning of a city, it is significant to ascertain people's preferences regarding these streetscapes.

In order to evaluate the people's preferences, the semantic differential method (SD) was used; this is the most popular way to acquire preferential information from a user's verbal responses[8]. Based on their subjective criteria, users evaluate their senses or moods within the scales provided using paired adjectives. The data collected by SD are usually made to undergo some multivariate analyses, like the principal component analysis (PCA), and some components or factors underlying the verbal responses are extracted as abstract concepts. Due to the simplicity of SD and that fact that it includes extensive analyzing software, including multivariate analyses, SD is considered to be the most basic method for acquiring preferential information.

However, a large amount of data must be collected for processing because of the statistical requirements of multivariate analyses. Therefore, these evaluations must generally be conducted on a large number of people (a few hundred) or on one person repeatedly (a few dozen). In the case of estimation using a large number of people, individual differences or errors among subjects usually increase. Thus,

[7] Kevin Lynch, The Image of city, Cambridge: the MIT Press, 1960
[8] S. Nagasawa, "Present State and Issues of Kansei Engineering", Journal of Japan Society for Fuzzy Theory and Systems, Vol. 10, No. 4, pp. 647-661, 1998.

dealing with individual data as a relative value within whole averages cannot be helped. In the case of estimation using one person repeatedly, that person's personal criteria for estimation would tend to change over a long time period of time. Thus, errors within subjects usually occur. Therefore, the axes evolved by processes such as described above tend to be vague and abstract. In this case, it is difficult to apply SD results to produce direct improvement.

3 RESEARCH DESIGN

With regard to the methodology, the main part of this chapter is outlined as follows. First, the study area was selected; this area is one in which the characteristics of public open spaces can be easily obtained. After understanding some general information pertaining to the study area, data was collected in order to grasp the present conditions of this area; this data includes basic plans, maps of the area as well as photographs. Subsequently, the values of the physical influence factors were measured by a simulation model that was created from the maps and photographs. Further, based on SD, a survey of people's preferences regarding urban streetscapes was carried. After arranging these physical and psychological data, a factor analysis and a correlation analysis were carried out between the preference of urban streetscape with / without public open spaces and physical factors of influence through SPSS. A linear regression analysis was also performed between physical factors of influence and people's preferences at certain selected locations.

3.1 Outlines of the study area

(1) Selection of the study area: Otemachi-Marunouchi-Yurakucho area

The study area is located in Chiyoda Ward, in the center of the Tokyo Metropolitan Area; historically, it has been the representative business district for Japanese cities. Remarkably, the Planned Development Design System is being applied for the entire urban streetscape in this ward, which contains regulations for public open spaces, and that is the reason for choosing this area. Considering this area as a case study, this chapter examines its characteristics- in particular, the legislative system for spatial continuity with regulations for public open spaces.

Figure 4 Location of Chiyoda ward

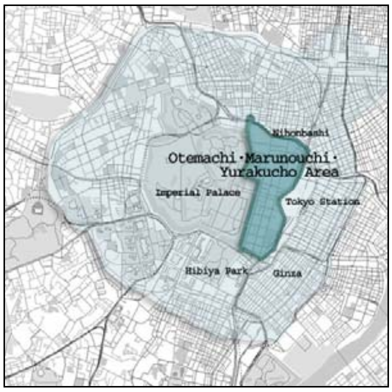


Figure 5 Chiyoda ward

① Basic information

The study area- Otemachi-Marunouchi-Yurakucho area (大手町·丸の内·有楽町地区; OMY area)- includes approximately 120 ha of the "Redevelopment Inducement District of Tokyo Station Area (東京駅周辺の再開発誘導地区)" and Otemachi blocks 1-3, 1-4. This area falls under the "Readjustment, Development and Conservation Principle of UPA·UCA in TMA[9] (東京都市計画市街化区域および市街化調整区域の整備、開発又は保全の方針)" regulation of November 1986; in March 2000, the "OMY Area Machizukuri Guideline (大手町·丸の内·有楽町まちづくりガイドライン)" was adopted. Through these devices, this area aims to function as the amenities business core (ABC), which means the city center with multiple functions, and to create a new urban streetscape through various regulations such as height regulations and a public open space network system. The main objects of this study comprise 40 completed buildings and their public open spaces.

Figure 6 Main Buildings[10] in OMY Area

[9] UPA: urbanization promotion area, UCA: urbanization control area, TMA: Tokyo metropolitan area
[10] Refer to Mitsubishi Office Information(三菱地所オフィス情報) Site, http://office.mec.co.jp

Otemachi Building
-Completion:1958
-Height:31m(9F)
-Lot Area:10496
-Floor Area:111272

Otemachi First Square
-Completion:1998
-Height:105m(23F)
-Lot Area:11042
-Floor Area:144016

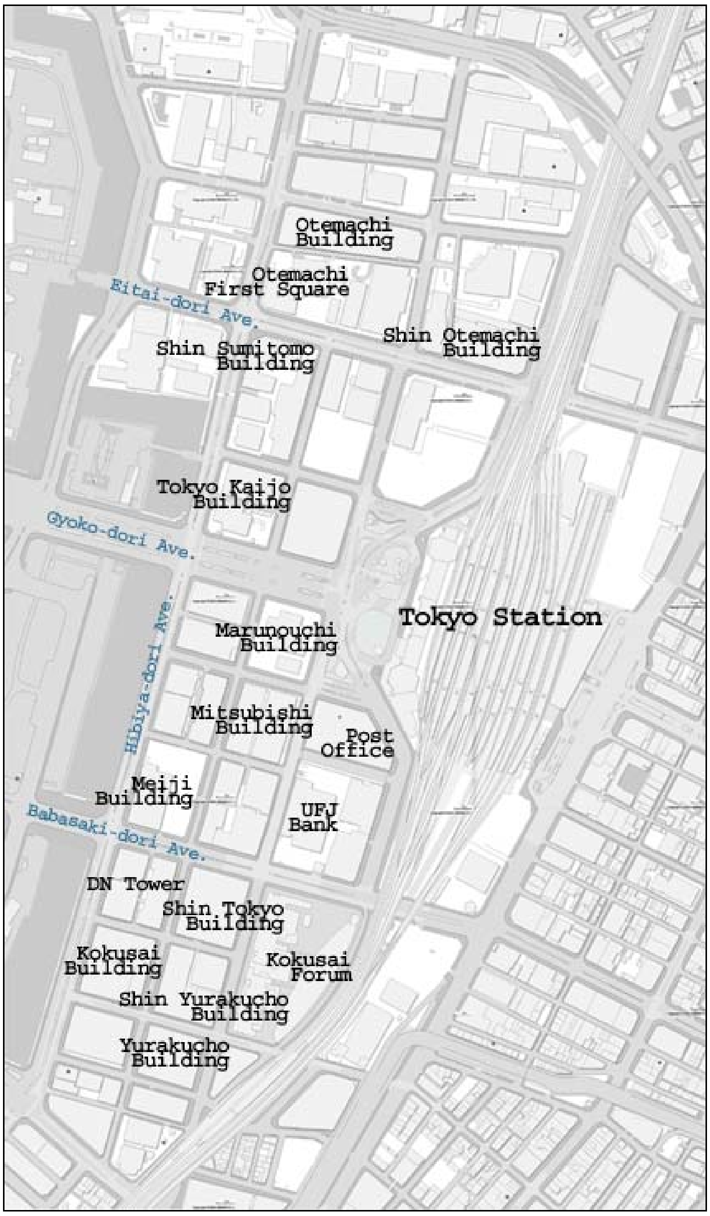
Tokyo Kaijo Building
-Completion:1974
-Height:m108(25F)
-Lot Area:10149
-Floor Area:63120

Meiji Building
-Completion:2004
-Height:135m(30F)
-Lot Area:11346
-Floor Area:148727

DN Tower
-Completion:1995
-Height:114m(21F)
-Lot Area:7438
-Floor Area:97966

Shin Tokyo Building
-Completion:1963
-Height:31m(9F)
-Lot Area:9126
-Floor Area:106004

Kokusai Building
-Completion:1966
-Height:31m(9F)
-Lot Area:5623
-Floor Area:76918



Shin Otemachi Building
-Completion:1958
-Height:34m(10F)
-Lot Area:8530
-Floor Area:88785

Marunouchi Building
-Completion:2003
-Height:180m(37F)
-Lot Area:10029
-Floor Area:159907

Mitsubishi Building
-Completion:1973
-Height:59m(15F)
-Lot Area:5739
-Floor Area:62906

Tokyo Central Post Office
-Completion:1931
-Height:20m(5F)

Kokusai Forum
-Completion:1997
-Height:40m(11F)
-Lot Area:
-Floor Area:145077

Shin Yurakucho Building
-Completion:1967
-Height:38m(14F)
-Lot Area:7233
-Floor Area:83688

Yurakucho Building
-Completion:1966
-Height:38m(11F)
-Lot Area:3551
-Floor Area:42159

② Techniques regarding urban streetscape maintenance

Three techniques to conserve and improve the urban streetscape in this area are suggested. First, the height of the lower part of the building is set as 31 m, and the height regulations of the total height of the buildings are 100/150/200 m. It makes this area unify the skyline and success historicity. Second, special districts are assigned to maintain the urban streetscape through the conservation of historical structures. Third, the wall-lines of buildings and the uses of lower parts in this district are also designated in order to revitalize the streets and create a dynamic urban streetscape.

(2) Guidelines for public open space and its current situation

The guidelines for public open spaces which were included in the 'OMY area machizukuri guideline' can be summarized as follows:

Table 3 Guidelines for public open spaces

Stage 1 Indication of Direction	- Maintenance of mixed use spaces - Network of pedestrian spaces - Formation of interchanging places - Improvement of street spaces - Consideration of natural environment			
	Continuity	Integration	Network	Entireness
Stage 2 Principles	- arranging public open spaces along the roads	- concentrating public open spaces at the intersections	- networking pedestrian spaces - networking natural elements - networking parking systems	- improving the infrastructure - maintaining on-the-ground/ underground plazas
Stage 3 Institutionalization	- designating the distance of wall retreats	- inducing concentrative arrangement of plazas	- installing a pass-through - linking on-the-ground and underground spaces - securing green zones along the road	- improving underground passages
Stage 4 Application and Mitigation	- mitigating the public space regulation by setbacks	- mitigating the inner public space regulation	- giving bonuses for green zone conservation - giving bonuses for infrastructure maintenance	- giving bonuses for infrastructure maintenance
Analysis	- The maintenance process is to secure the integration and characteristics of each block - A quantity-based evaluation is changed to a quality-based evaluation			

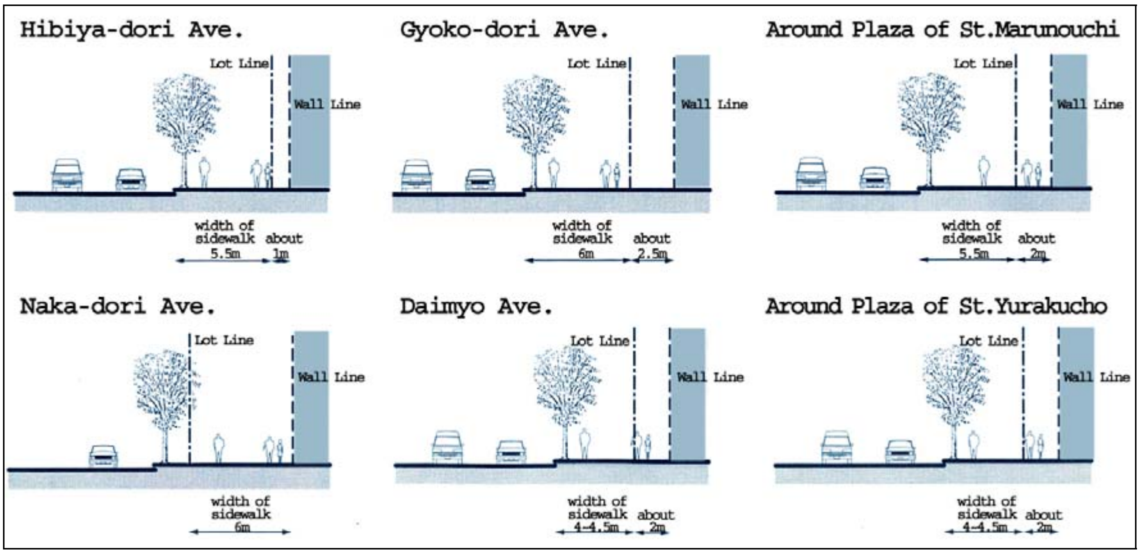


Figure 7 Designation of wall lines

Also, the current situation of public open spaces in the study area is as follows:

Figure 8 Public open spaces along Hibiya-dori Ave.

Figure 9 Public open spaces along Naka-dori Ave.

3.2 Simulation and Measurement of Physical Data

(1) Simulation of Study Area

From Z-Professional 3 digital maps (ZENRIN)[11] of the study area, a simulation was constructed to obtain physical and psychological data using AutoCAD LT 2000 and 3DStudio MAX 5.0 programs. With the exceptions of the 1st, 2nd, and 3rd floors, which were set to 3 m, the floor height was set to 4 m. Assumed that the main observers were pedestrians, the cameras used for renderings were positioned on the sidewalk, 170 cm from the ground level; the size and incident angle of the lens was set[12] at 50 mm - closest to the human eyesight. The view distance of the camera was set to 200 m, which represented the short-range view of the visibility range[13]. In the rendering process, variable elements that could affect preference were eliminated, for instance, large signboards, cars, and humans, as well as street furniture such as telephone poles and trees.

From among 200 rendering images, 100 were created from the original data and the other 100 were created from altered data. Set-back lines for ensuring public open spaces were removed and buildings were built at the lot lines in the altered data, which meant the spaces for public open spaces were removed, in order to measure the effect of public open spaces on urban streetscapes. Among them, 10 locations were chosen as following process. First, images were classified according to the directions of sight (North-South, East-West) as well as the widths of adjacent roads. Further, 10 representative locations were selected, so that 20 images were obtained. These 20 images were used to measure physical indicators as well as to survey the preference test in chapter 3.3.

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[11] It is software produced by Geo Technical Laboratory Co., Ltd., and more information can be found at http://www.zenrin.co.jp.
[12] The angle of view of this lens is 47°; it is called a "standard lens" because of its similarity to the human eye.
[13] Buildings are individually recognized within the range of 200 m (芦原, 1993).

Figure 10 2D from ZENRIN map

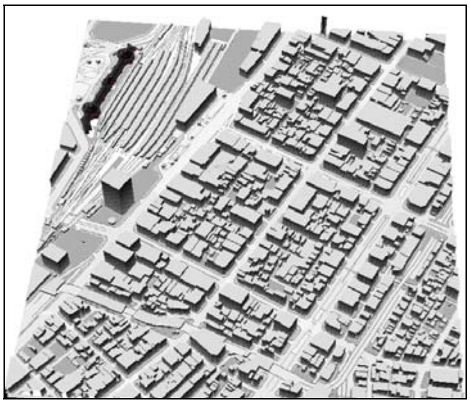

Figure 11 3D from ZENRIN map

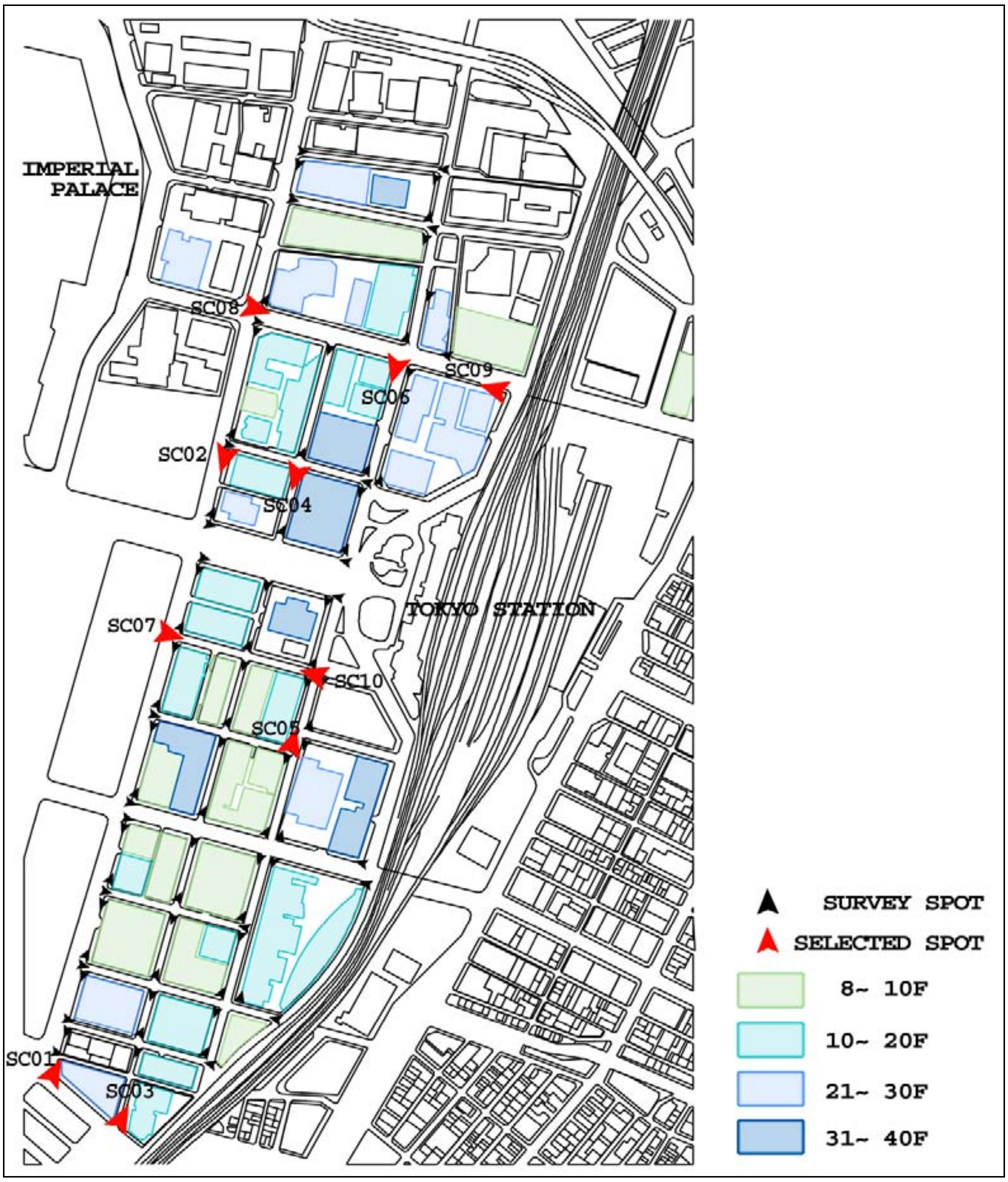

Figure 12 Survey spots and selected spots

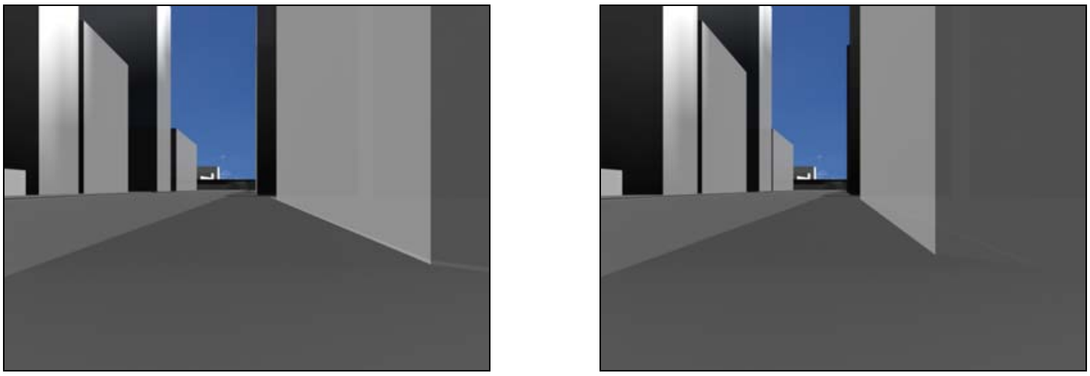

Figure 13 with/without public open space[14]

(2) Measurement of physical data

The visual accessibility (VA) and sky blockage ratio (SBR) were measured through 2D and 3D simulations that were constructed in advance, according to the formulas addressed in Chapter 2. The result is as follows.

Table 4 Values of physical factors

	S.B.R.	VAofsky	VAofBuild	VAofPOS		S.B.R.	VAofsky	VAofBuild	VAofPOS
SC01	0.010	0.250	0.320	0.368	SC01´	0.012	0.233	0.334	0.370
SC02	0.009	0.256	0.267	0.413	SC02´	0.010	0.251	0.286	0.399
SC03	0.014	0.043	0.506	0.091	SC03´	0.015	0.039	0.513	0.092
SC04	0.014	0.069	0.459	0.053	SC04´	0.014	0.049	0.494	0.043
SC05	0.012	0.159	0.376	0.421	SC05´	0.013	0.149	0.419	0.384
SC06	0.014	0.060	0.474	0.419	SC06´	0.015	0.041	0.530	0.383
SC07	0.011	0.064	0.453	0.049	SC07´	0.012	0.079	0.499	0.028
SC08	0.013	0.075	0.472	0.378	SC08´	0.013	0.062	0.520	0.344
SC09	0.010	0.075	0.451	0.345	SC09´	0.011	0.060	0.498	0.309
SC10	0.013	0.063	0.459	0.007	SC10´	0.014	0.059	0.459	0.005

*Build = Building, POS = public open spaces

3.3 Survey of psychological data

In order to analyze the psychological responses to how the urban streetscape is affected by public open spaces, data on people's visual preferences were collected by

[14] For example, these two simulations of Figure 13 show the same location, and each of them represents the streetscape with original public open spaces and with lessened or removed public open spaces.

the questionnaire after watching 20 simulations of 10 locations randomly. Visual preferences were investigated by semantic differential method, which uses seven scales of paired adjectives. In this study, 49 paired adjectives were selected by scanning existing studies[15] on urban streetscapes. From among these, 23 paired adjectives were selected through a preliminary test; adjectives that were difficult to apply to this study were excluded. The survey consisted of two performances– the general people-oriented performance and the experts-oriented performance– that was because, general pedestrians are the most important users and spectators of urban streetscape, but in the other hand, few of them are recognizing the importance of urban streetscape, so that the comparative study is needed through investigating the opinions of the 'recognizing group'. The first investigation was performed at the study area from p.m. 1:00 to p.m. 5:00 on June 4, 2006, with pedestrians who were residing in the study area (e.g., the group of general people-oriented.) Each investigation was taken approximately 20~30 minutes on one questionnaire; the second performance was conducted with graduate students at the Urban Engineering Department in the University of Tokyo, from June 7 – 14, 2006 (e.g., the group of experts-oriented.) Totally, 58 available responses were obtained from 38 general people-oriented questionnaires and from 20 expert-oriented questionnaires.

3.4 Analysis

(1) Factor analysis

This analysis was performed in order to discover simple patterns from among the patterns of relationships for visual preferences, particularly, to discover if visual preferences can be explained largely in terms of a much smaller number of factors[16]. As a result of the factor analysis on total groups to collectivize the 23 paired adjectives, three factors were converged stably in five iterations of rotation. The percentages of variance for each of the three factors were 50.60%, 26.11%, and 16.63%, respectively; thus, these three factors accounted for approximately 93.34% of this model. Based on size, factors 1, 2, and 3 were referred to as openness factor, variety factor, and balance factor, respectively. The calculation was done using the SPSS 14.0 version. The result is as follows.

[15] Yim (1991), Zube (1975), Joo (2003)
[16] Richard B. Darlington (1990)

Table 5 Result of factor analysis

Paired Adjectives	Factor 1	Factor 2	Factor 3
	Openness Factor	Variety Factor	Balanced Factor
Empty-Crowded	0.990	0.009	0.034
Opened-Closed	0.981	0.143	0.039
Pleasant-Stuffy	0.977	0.114	0.093
Broad-Narrow	0.966	0.205	-0.022
Bright-Dark	0.950	0.271	0.075
Neat-Dismal	0.947	0.269	0.096
Light-Heavy	0.942	0.287	0.049
Cheerful-Gloomy	0.900	0.384	0.058
Arranged-In a mess	0.762	-0.218	0.566
Active-Inactive	0.085	0.942	-0.009
Rhythmical-Flat	-0.054	0.939	0.116
Heterogeneous-Homogeneous	0.104	0.918	-0.287
Friendly-Unfriendly	0.208	0.902	0.129
Fun-Boring	0.397	0.882	-0.123
Various-Monotonous	0.290	0.840	-0.420
Unique-Ordinary	0.600	0.711	-0.209
Natural-Artificial	0.555	0.673	0.072
Concentrated-Dispersed	0.444	0.586	0.533
Stable-Unstable	0.074	0.115	0.950
Regular-Irregular	-0.085	-0.235	0.945
Systematic-Unsystematic	0.339	-0.165	0.916
Balanced-Out of balance	-0.311	0.303	0.861
Calm-Exciting	0.295	-0.277	0.861

(2) Correlation analysis

The correlation analysis was used to ascertain whether the physical variables were related to the three preference factors. The factor score coefficient matrix from the former factor analysis of each group was used to obtain each factor scores that would be applied to the correlation analysis. Further, this analysis was used in conjunction with a regression analysis to measure how well the physical factors could affect the three preference factors. The calculation was done on each group and also total group using the SPSS 14.0 version. The results are as follows.

Table 6 Result of correlation analysis (general people-oriented)

	Factor 1 (Openness)		Factor 2 (Variety)		Factor 3 (Balance)	
	Peason Cor.	Sig.(2tailed)	Peason Cor.	Sig.(2tailed)	Peason Cor.	Sig.(2tailed)
S.B.R	-0.785(**)	0.000	0.260	0.200	-0.123	0.550
VA. of sky	0.864(**)	0.000	-0.231	0.257	0.010	0.963
VA of Build	-0.838(**)	0.000	0.252	0.215	-0.031	0.881
VA of POS	0.445(*)	0.000	0.000	0.998	-0.105	0.609

**.Correlation is significant at the 0.01 level (2-tailed)
*.Correlation is significant at the 0.01 level (1-tailed)

Table 7 Result of correlation analysis (experts-oriented)

	Factor 1 (Openness)		Factor 2 (Variety)		Factor 3 (Balance)	
	Peason Cor.	Sig.(2tailed)	Peason Cor.	Sig.(2tailed)	Peason Cor.	Sig.(2tailed)
S.B.R	-0.791(**)	0.000	0.383	0.053	-0.125	0.543
VA. of sky	0.878(**)	0.000	-0.336	0.093	-0.125	0.542
VA of Build	-0.811(**)	0.000	0.433(*)	0.027	0.112	0.587
VA of POS	0.513(**)	0.007	-0.302	0.134	-0.208	0.308

**.Correlation is significant at the 0.01 level (2-tailed)
*.Correlation is significant at the 0.01 level (1-tailed)

Table 8 Result of correlation analysis (total)

	Factor 1 (Openness)		Factor 2 (Variety)		Factor 3 (Balance)	
	Peason Cor.	Sig.(2tailed)	Peason Cor.	Sig.(2tailed)	Peason Cor.	Sig.(2tailed)
S.B.R	-0.797(**)	0.000	0.406(*)	0.040	-0.085	0.681
VA. of sky	0.876(**)	0.000	-0.368	0.064	-0.100	0.626
VA of Build	-0.838(**)	0.000	0.405(*)	0.040	0.079	0.700
VA of POS	0.485(*)	0.012	-0.176	0.390	-0.188	0.358

**.Correlation is significant at the 0.01 level (2-tailed)
*.Correlation is significant at the 0.01 level (1-tailed)

The results revealed that physical factors such as the sky blockage ratio, visual accessibility of the sky, buildings, and public open spaces significantly influenced the sense of preference for the aspect of “openness” of the urban streetscape. In other words, the sky blockage ratio and visual accessibility must be secured in order to improve the urban streetscape with regard to openness. Also, the result of experts-oriented revealed that visual accessibility of buildings influenced the sense of preference for the aspect of “variety” of the urban streetscape. On the other hand, these physical factors were not significant to judge preference with regard to the factors of “variety” and “balance” for the general people. This implies that other factors must be also considered in order to improve people’s sentiments toward urban streetscapes.

(3) Multiple regression analysis

The physical factors and the three derived preference variables were analyzed through a multiple regression analysis to identify which physical factor is important and how important that particular factor is in influencing preference. Three multiple regression analyses on three preference variables were performed for each group and the total group by setting the physical factors as independent variables and setting each preference variable as dependent variable. Independency was diagnosed by Durbin-Watson diagnostics, and factors having multicollinearity were excluded. Further, the stepwise method was used to input the variables. This calculation was also done using the SPSS 14.0 version. The results are as follows[17].

Table 9 Result of regression analysis (General people-Factor 1)

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	1.396	0.134	-	10.414	0.000
VA of sky	10.224	1.114	0.884	9.177	0.000
VA of POS	0.004	0.002	0.208	2.157	0.042

F=70.420, r^2=0.791, R^2=0.738, Durbin-Watson= 0.802
Predictors: (Constant), VA of sky, VA of POS Excluded variables: VA of building, SBR
Dependent variable: Factor 1

Table 10 Result of regression analysis (Experts-Factor 1)

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	2.902	0.132	-	21.923	0.000
VA of sky	10.045	1.116	0.878	8.996	0.000

F= 80.924, r^2=0.771, R^2=0.761, Durbin-Watson= 1.322
Predictors: (Constant), VA of sky Excluded variables: VA of building, SBR, VA of POS

[17] The results of regression analysis for following groups were excluded: for general people on factor 2, 3, for experts on factor3, and for total group on factor 2, 3.

Dependent variable: Factor 1

Table 11 Result of regression analysis (Experts-Factor 2)

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	4.288	0.469	-	9.134	0.000
VA of build	2.420	1.029	0.433	2.351	0.027

F= 5.530, r^2=0.187, R^2=0.153, Durbin-Watson= 2.030
Predictors: (Constant), VA of building Excluded variables: VA of sky, SBR, VA of POS
Dependent variable: Factor 2

Table 12 Result of regression analysis (Total-Factor 1)

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	1.797	0.128	-	13.989	0.000
VA of sky	9.642	1.084	0.876	8.899	0.000

F= 79.193, r^2=0.767, R^2=0.758, Durbin-Watson= 1.056
Predictors: (Constant), VA of sky Excluded variables: VA of building, SBR, VA of POS
Dependent variable: Factor 1

As results, visual accessibility of the sky had a very significant influence on the preference of general people, experts, and total group for the aspect of openness of the urban streetscape. Also, visual accessibility of buildings had a significant influence on the preference of experts for the aspect of variety of the urban streetscape, as well as that of public open spaces on the preference of general people for the aspect of openness, but all the physical factors for the balance variables were meaningless. The meaning of this result is that the more the visual accessibility of the sky and public open spaces secured, the more will be the preference for the aspect of openness of the urban streetscape.

4 SUMMARY

In general, the urban streetscape is representative of the image of the city and the quality of urban life; therefore, considerable endeavors have been undertaken for streetscape improvement. This study carried out several analyses assuming that the non-existence of public open spaces is one of the reasons for the deterioration of urban streetscapes.

Regarding the methodology, first, the study region was selected as Otemachi-Marunouchi-Yurakucho area in Minato ward, Tokyo. Values of the physical characteristics of 100 locations were measured by a simulation model that was developed in this study. Further, a survey on people's preferences regarding streetscapes in each region was carried out using semantic differential method. After collecting data, a factor analysis of the preferences and a correlation analysis and a linear regression analysis were carried out between the physical factors and psychological elements.

As a result of the factor analysis, three factors were obtained referred to as openness factor, variety factor, and balance factor, respectively. Further, correlation analyses and regression analyses revealed that physical factors, particularly visual accessibility of public open spaces and the sky, influenced the sense of preference for the aspect of "openness" and "variety" of the urban streetscape significantly. It implies that, in order to improve the urban streetscape with regard to openness and variety, visual accessibility of public open spaces and the sky must be secured.

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