The Effects of Design Elements on Users' Perceptions and Impressions of Privately Owned Public Spaces.

公開空地におけるランドスケープデザイン要素が
利用者の知覚と評価に及ぼす効果に関する研究

January 2017

OLAVO AVALONE NETO

Graduate School of Engineering

CHIBA UNIVERSITY

(千葉大学審査学位論文)

THE EFFECTS OF DESIGN ELEMENTS ON USERS' PERCEPTIONS AND IMPRESSIONS OF PRIVATELY OWNED PUBLIC SPACES.

公開空地におけるランドスケープデザイン要素が
利用者の知覚と評価に及ぼす効果に関する研究

January 2017

OLAVO AVALONE NETO

Graduate School of Engineering

CHIBA UNIVERSITY

THE EFFECTS OF DESIGN ELEMENTS ON USERS' PERCEPTIONS AND IMPRESSIONS OF PRIVATELY OWNED PUBLIC SPACES.

公開空地におけるランドスケープデザイン要素が
利用者の知覚と評価に及ぼす効果に関する研究

In partial fulfillment of the requirement for the
Degree of Ph.D. in Architecture.

Approved by:

Jun, Munakata, Dr. (Eng), Thesis Advisor.

Hiroaki Suzuki, Dr. (Eng), committee member.

Hideki Kobayashi, Dr. (Eng), committee member.

Martin Morris, Dr. (Eng), head of committee.

Kiminobu Sato, Dr. (Eng), committee member.

This thesis is dedicated to my parents,

Cristina Luiza Borchert and Olavo Avalone Filho,

For their love and values.

A scientist is never certain, we all know that.

We know that all our statements are approximate statements with different degrees of certainty. That, when a statement is made, the question is not whether is true or false, but rather how likely it is to be true or false.

(…)

We absolutely must leave room for doubt or there is no progress and there is no learning. There is no learning without having to pose a question and a question requires doubt.

—*Richard P. Feynman* —

in "The pleasure of finding things out"

DECLARATION

This dissertation is the result of my own work and includes nothing, which is the outcome of work done in collaboration except where specifically indicated in the text. It has not been previously submitted, in part or whole, to any university of institution for any degree, diploma, or other qualification.

Signed: ____

Date: ____

Olavo Avalone Neto M. Eng.

Chiba University, Japan.

ABSTRACT

Urban designers rely on the use of physical elements to create public spaces that will be friendly, lively, useful, attractive, and diverse, but there still a knowledge gap between how the manipulation of such elements will increase or decrease those characteristics, in users' perceptions.

This research identified which of those physical elements used by urban designers to create public spaces catches users' attention the most, divided them into subcategories related to how they are treated during the design phase and evaluated its effects on users.

On a first stage, immersive virtual environments were used to test each physical element to see how they affected users' perceptions and impressions of the built environment, how they affected their judgment about the environments suitability to develop specific activities and how they valued the environment as a whole, which was assessed by their willingness to stay and their willingness to pay for goods in the environment. How each physical element works with other elements to affect users (interactions) were also investigated.

Once the presence of an effect was confirmed, a second stage investigated the limits of that effect, identifying whether the relation between variables and the effects was linear (the more the better) or nonlinear (where increasing it to a certain point be beneficial but past that point is detrimental). The effects of environment scale and its interactions were also tested.

The users stated that the elements that caught their attention the most were: street furniture, greenery, buildings, sidewalk and overall space, with greenery being the most cited element.

Based on those results, the effects of tree cover ratio, seating ratio, bushes ratio, tree height and the interactions between tree cover ratio and tree height, tree cover ratio and seating ratio, tree height and seating ratio were tested, showing that seating ratio and tree cover ratio had the most effect, while tree height and bushes ratio had almost no effect (only 3 out of 23 evaluation scales). Interactions also were practically absent.

The second stage confirmed the effects observed and identified that seating ratio effect peaks between 3 and 5% of floor area, after which, its effects become detrimental. The effects of tree cover ratio were shown to have a continuous effect, although they diminish at higher ratios.

Results can aid urban designers to understand how their design decisions affect users and provide tools for evidence based design of public spaces.

Keywords: plaza design; design elements; seating ratio; tree cover ratio; bushes ratio; immersive virtual environment.

ACKNOWLEDGEMENTS

This work would not be possible without the help and support of several people during a long journey that started well before this research and to whom I owe more than a few words for their contributions, guidance, support, advice and patience.

First of all, my parents, Cristina Luiza Borchert and Olavo Avalone Filho, for imbuing in me the curiosity, critical thinking and the thirst for knowledge that lead me to become a scientist.

To my wife, Marianne Costa, for the constant support and advice, but also for enduring the years of mood swing and irritability whenever a deadline was close.

To my mentor and advisor, Dr. Eng. Jun Munakata whose guidance and advices made this work possible and who allowed me to find my questions in the field, even when it took me too long. His love for research is an inspiration.

To Prof. Sinwon Jeong for her friendship and all the support not only during this research, but during all my stay in Japan

To Yushi Yoshida and all the collaborators at Nikken Sekkei Research Institute for their interest and support with this research.

To Prof. Yosuke Yoshioka for making himself and his laboratory available during this project.

To Dr. Eng. Hiroaki Suzuki, Dr. Eng. Hideki Kobayashi, Dr. Eng. Martin Morris, Dr. Eng. Kiminobu Sato, for their interest, comments, support and feedback during the final push of this research.

To Saori Kihara for her interest and involvement in this research and the extensive help with translations to the Japanese language.

To Junichi Ishino for helping with the transcription of the interviews with Japanese urban designers.

To Ayano Komai, Emiko Kokubun, Homa Zakeri, Heki Kudo, Hiroaki Yoshida, Hugo Assis, Jhonatta Martins Leal, Kaori Asaka, Kentaro Inada, Kouhei Kurotaki, Kousei Kawamura, Kosuke Tanaka, Li Li, Manami Shiga, Masaki Hara, Minami Kashima, Nishi Daisuke, Nozomi Yamamuro, Omid Hashemi, Otani Seiki, Reika Yamakawa, Ryo Sekine, Ryosuke Shimoda, Sepideh Payami Azad, Shogo Ibaraki, Shun Kikuta, Suzuki Taku, Tomoko Kuze, Toshihito Saotome, Yuho Sugano, Yusuke Ebihara amongst so many others that helped early and later stages of the research such as preliminary surveys, data gathering, participants recruitment and testing. This research could not be done without their help.

At last, but not least, to my late grandmother Luiza Sihler Borchert, who always believed and supported me and whom I wish the most could share this moment with me.

This research could not be done without the support of the Ministry of Education, Culture, Sports, Science and Technology (MEXT).

Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND ACRONYMS

BR …………………………………………………………………………………………… Bushes Ratio.
CEM ………………………………………………………………………… Caption Evaluation Method.
CG ……………………………………………………………………………………… Computer Graphics.
CVM ……………………………………………………………………… Contingent Valuation Method.
FAR …………………………………………………………………………………………… Floor Area Ratio.
HMD ………………………………………………………………………………… Head Mounted Display.
IVE…………………………………………………………………………… Immersive Virtual Environment.
POPOS ……………………………………………………………… Privately Owned Publicly Open Space.
POPS ……………………………………………………………………… Privately Owned Public Space.
PPS ………………………………………………………………………………… Project for Public Spaces.
SDM ………………………………………………………………………… Semantic Differential Method.
SR……………………………………………………………………………………………… Seating Ratio.
TCR…………………………………………………………………………………………… Tree Cover Ratio.
TH ………………………………………………………………………………………………… Tree Height.
VE ……………………………………………………………………………………… Virtual Environment.
VR ………………………………………………………………………………………………… Virtual Reality.

List of Appendices

1 INTRODUCTION

What makes a good public space? This question, by itself, can be unfolded in a several other questions, such as good for whom?; to perform what activity?; what kind of public space? Or what is our definition of good?

Public spaces cannot be a "*one size fits all*" kind of environment and, even if designed for a single user, an environment will be better or worse, depending on his mood, intended activity, culture, company, the weather, and so on. Because of this, researchers have been tackling the question "*what does make a public space good?*" through several other questions that try to understand the relation between specific characteristics of the environment and a specific feeling of its users. Typical research questions in the field are: How trees/water/built environment/natural environment relate to the feeling of restoration/ stress reduction/preference/attractiveness/liveliness and so on.

There is, today, a fair body of knowledge about how different aspects of our built environment may affect the perception of specific aspects of the environment or its effects on specific emotions of the user to a point that is possible to draw some guidelines if the purpose is to improve one specific perception or emotion.

Unfortunately, this is not how public places are designed. An urban designer may say, for instance, that his intent to create a *relaxing* space, but only in the context of the activities he expects to be developed in it. As so, a relaxing space for reading does not correspond to a relaxing place to meet someone or talk. Users' behaviors vary between themselves and the same user's behavior varies when performing different activities, which makes it very difficult to infer solid design guidelines based on current research.

In a simple way, there is not sufficient research relating the physical elements that urban designers manipulate to the expected uses of such environments. Urban designers still have little to no evidence about the effects that specific design changes will have in the final use of the space.

The purpose of this research is to provide part of this knowledge. To understand how increasing or decreasing the amount of seating, tree cover and bushes can influence how people will perceive, feel and ultimately use the environment. We also explore the relationship of those elements with tree height and environment scale.

A qualitative exploratory method is adopted to identify which elements affect public space perception and impressions and a quantitative method is used to measure the scale of the effects.

At the end, it provides a clear comprehension of how the manipulation of each variable may improve or worsen users' perceptions and impressions of public spaces, their judgment of suitability for different activities, willingness to pay and willingness to stay in such environments.

Not all physical elements that may be manipulated in a design were tested, meaning that their effects and interactions with the variables tested in this study are still unknown. This research is also limited by its participants' socio-demographic and results may vary with other ethnical groups. Nonetheless, it provides a much needed data regarding the specific effects some decisions taken by designers will have on public space users.

2 REVIEW OF LITERATURE

2.1 The Production of Public Spaces

Public spaces permeate every aspect of our lives. They connect all places where human activities take place and provide a stage for social life to occur. In public spaces we consume information, goods, nature, meet others and socialize (Lefebvre, 19991). As such, public spaces ought to provide opportunities for discussion, encounters and deliberations as well as allow for the diverse views of the world (Németh, 2009).

Traditionally, all trades of goods and information was done in the public realm: from in the medieval square to the Spanish and Portuguese central square or the American main street, public life have been attached to public markets, squares, streets, ports and riversides. With an exponential degree of urbanization and densification of cities in the 20th century, space has gradually become a scarce good and the provision of public spaces by the government more unattainable. Nowadays streets are cities main public spaces and cities struggle to maintain its quality. Historical plazas and central squares have been maintained, but the provision of central, accessible parks, squares and plazas continue to become increasingly more difficult.

With a continuous pressure for densification of the city center, in 1961 the New York City government developed an interesting approach: they started to allow developers to build higher and a greater total building area than allowed by current legislation as long as they used part of the site to provide a public space to the city (Whyte, 1980; Smithsimon, 2008). By doing that the provision of public spaces in central, dense urban areas was ensured. This practice became known as increasing floor area ratio (FAR).

Since the 80's, as our cities continue to become more and more compact, FAR exchange have been widely adopted by different countries and the provision of public spaces suitable for a prolonged stay, have shifted from the government to the private sphere, (Banerjee, 2001; Langstraat, & Van Melik, 2013; Németh, 2009; De Magalhães & Trigo, 2016). Nowadays, most of those spaces that we understand as *public* in our city centers are a result of this policy and are known as privately owned public spaces (POPS) or, alternatively, as privately owned publicly open spaces (POPOS).

2.1.1 Public Spaces or Privately Owned Public Spaces

FAR exchange policies allow for the provision of publicly accessible spaces, but they still struggle to account for the quality of those spaces. This arises from the basic conflict between the cost of provision and benefits to be gained from the provision of public goods: in the social contract the private sector is responsible for the design, implementation and maintenance cost of the public space. While city governments hope to provide fully functional and truly public spaces, developers have all the incentives to create the most monotonous, cost effective and low maintenance spaces possible.

City governments try to ensure minimal quality through design directives, the most notorious being the directives of NYC that emerged from the study commissioned for William H. Whyte in the 1980's which established a minimal amount of seats, trees, retail space, lighting, access and maintenance. Most metropolises around the world have adopted some version of FAR exchange policies with their own directives to ensure good POPS.

Developers, on the other hand, may try to circumvent or deliver the bare minimum of those requirements while doing everything in their power to selectively inhibit actual use of the public space. Through the role of manager of the public space, developers have the capacity to coerce, inhibit or prohibit specific people, behaviors or activities to take part in the environment, making questionable the assertion that POPS are truly public spaces. For an in depth discussions about the publicness of POPS please refer to Banerjee (2001), Smithsimon (2008), Németh (2009) and De Magalhães & Trigo (2016).

In the midst of this struggle is the urban designer. A mediator in the conflict, the designers' vision is often aligned with the city governments' interests of good public spaces but he is paid by the developer, which have the power to revoke the designers' decision capabilities about the project at any time.

The spaces that arise from this struggle between developers and city government's interests are also distinct public spaces, apart from streets, city plazas or parks because not only their maintenance, character and identity are always interlaced with the private sphere, but they are directly affected by the sites main building – though its height, first floor usage, façade relationship with the open space and accepted/imposed behavioral conduct code.

Under the structure of privately managed space, civil activities such as leaflet distribution, public speeches, political discussions, as well as panhandling, sale of home-made goods, and other aspects of public life are commonly excluded from these environments, virtually making those spaces not public in the sense that the public affairs necessary for the notion of civic society cannot be freely discussed in them (Banerjee, 2001).

There is, however, another concept of public life that is our desire for social contact, relaxation, entertainment and leisure that does not necessarily require public spaces, but may be settled in "third places" such as bars, cafes, beauty salons, game courts, pool halls and the like. These, along with other convivial activities, reassert the role of the public realm. Attention should be given to the design for public life, rather than the design of public spaces (Banerjee, 2001).

Although somewhat questionable and imperfect spaces, POPS are still the principal way in which somewhat public spaces are produced in our metropolises and to ensure it allows for public life, two things are necessary: an evidence based design regulations and, secondly, more data about the effects of different design decisions to empower urban designers when arguing the merits of different proposals. Only then the pernicious effects of cost based design decisions and over control of the public sphere can be addressed.

2.1.1.1 POPS in Japan

In Japan, FAR bonus policies have been adopted since the 1980's through the Comprehensive Design System (Sogo Sekkei Seido) and supported by the Building Standard Act (Kenchiku Kijun Hou) (Akamine, Funahashi, Suzuki, Kita & Li, 2003; MLIT, 2003).

Table 2.1 – Tokyo POPS evaluation score.
source: Bureau of Urban Development of the Tokyo Metropolitan Government (2010). Translated by the author.

Evaluation topic	Detailed explanation	Evaluation levels	Score
Connectivity with surrounding greenery	The percentage of the greenery of parks, other POPS, streets, river beds, etc. that surrounds the site and that are connected and expanded through the POPS design.	A: 70% or more	25
		B: 60%~70%	20
		C: 50%~60%	15
		D: 50% or less	0
Diversity of tree species	The ratio of deciduous trees per total number of tall trees on site (including previously existing trees).	A: 50% or more	15
		B: 40%~50%	10
		C: 30%~40%	5
		D: 30% or less	0
Preservation and utilization of existing trees	The ratio of previous existing trees on site with height above 1.2m and with a trunk circumference of 60cm or more that were preserved or relocated inside the lot.	A: 50% or more	20
		B: 25%~50%	15
		C: 0%~25%	10
		D: 0%	0
Planting tall trees	The average tree height of tall trees (pre-existing tree included) that have the soil thickness necessary for full growth.	A: 7m or more	20
		B: 6m~7m	15
		C: 5m~6m	10
		D: 5m or less	0
Grass, water, etc. ground cover.	The ratio of grassed area or covered by water by total open area, with a minimum of $10m^2$.	A: 10% or more	10
		B: 5%~10%	8
		C: 0%~5%	5
		D: 0%	0
Greenery on the building.	The ratio of wall (facing the road, with height up to 20m), veranda or rooftop covered by greenery.	A: 15% or more	10
		B: 10%~15%	8
		C: 5%~10%	5
		D: 5% or less	0

Tokyo's legislation stipulates different quality degrees and categorizes the each POPS based on a points system that scores the environment based on the continuity with the surrounding greenery, diversity of tree species, preservation and utilization of existing trees, the height of the planted trees, amount of ground covered by grass, water or other greenery and amount of greenery on top of buildings (Table 2.1). POPS are classified into four quality categories: A (more than 80), B (61 to 80 points), C (40 to 60 points) or D (less than 40 points) with higher bonus FAR been awarded for better environments (1.3 for A, 1.2 for B, 1.1 for C and 1 for D) which means that an environment of quality "A" is awarded 30% more area than one of quality "D" (Bureau of Urban Development of Tokyo Metropolitan Government, 2010).

2.1.1.2 Designers' Approach to POPS Design in Japan

Iguchi (2011) interviewed 2 designers of one of the largest construction companies of Japan to probe the design process adopted by Landscape Architects and Urban Planners when design POPS in Japan. According to him, designers think that POPS should be livable places for the building users and the surrounding population; that to achieve this the use of greenery, flower beds and benches are necessary. Designers also stated that clients often request the design to be restrictive and/or to not induce users stay and that the desire of the client is ultimately fulfilled. A transcription of his results may be found in the Appendix section (Appendix 04).

Another study (Otani, Kitahara, Gotou & Kamia, 1991) interviewed the manager of 22 POPS in Nagoya city and found that POPS managers themselves almost (68%) did not use the environment. The few that used the POPS, did it at lunch time for activities such as eating and resting and using elements such as benches, sculptures, water fountains. Managers also reported (91%) that they felt that the protection of users was part of their job. Some managers (13.5%) did not know they space was a POPS and only 50% of them thought that some kind of event planning was suitable for the plaza. They also reported (72.7%) that the building workers did not frequently used the space.

Overall, POPS in Japan, as in other places, seems to focus its design on the buildings' users, reduced management requirements and the private initiative desires, resulting in somewhat restrictive environments with a more private than public aspect.

2.2 Public Space Design Elements

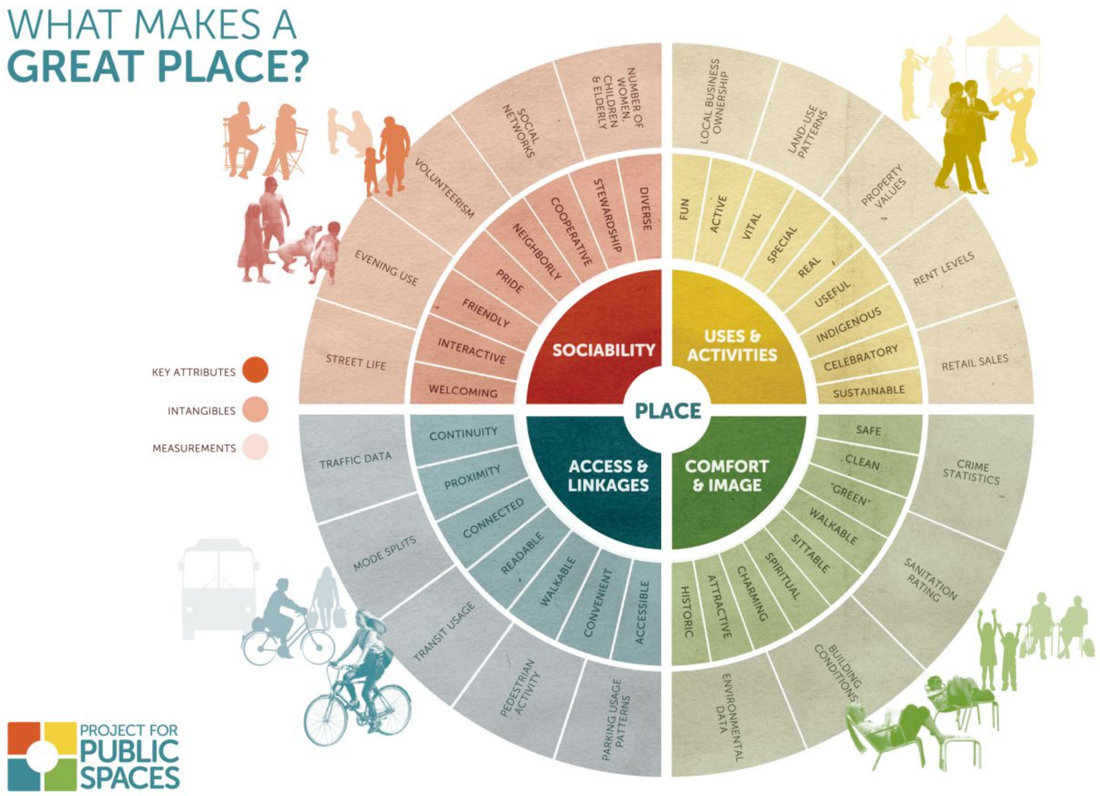


Figure 2.1 – PPS' Great Place Diagram
source: http://www.pps.org/reference/grplacefeat/

The design of public spaces combine specific elements into its creations in the same way that buildings can be broken down into different elements such as floors, walls, roofs, openings, etc. Although the narrative describing public spaces often include descriptions such as accessible, lively, social, attractive, neighborly and diverse, this can only be ultimately achieved through the manipulation of the actual physical elements that compose the environments, such as seats, vegetation, amenities, pavement, shops/stores, ramps, light posts and so on.

Research into public space design and improvement commonly identifies and categorizes aspects of public space design in a holistic way, such as the "Project for Public Spaces" (PPS) Great Place chart (Figure 2.1 above) which divides the desired attributes to public spaces into several intangible aspects on 4 categories. For public spaces with less than 5 acres (20.000m^2), Project for Public Spaces (2009) suggest that this intangibles can be achieved through the use of specific physical elements such as the use of curb cuts, extensions, smooth paving surface, signage, transit stops and bicycle racks for accessibility and design considerations such as use of water fountains or temporary public art installations as focal points, creation of small and intimate areas, flexible open spaces, triangulation of elements, landscaping, variety of seating options and interactive public art.

Other researchers have focused on the design of specific public spaces such as neighborhood streets. Mehta (2007) analyses the neighborhood commercial street characteristics that support social behavior (Figure 2.2) for which he proposes that social behavior is supported by physical characteristics such as generous sidewalks, ample seating, ample street furniture, tree cover, other landscape elements as well as a well designed border or street front with permeable, personalized facades and diverse commercial activity.

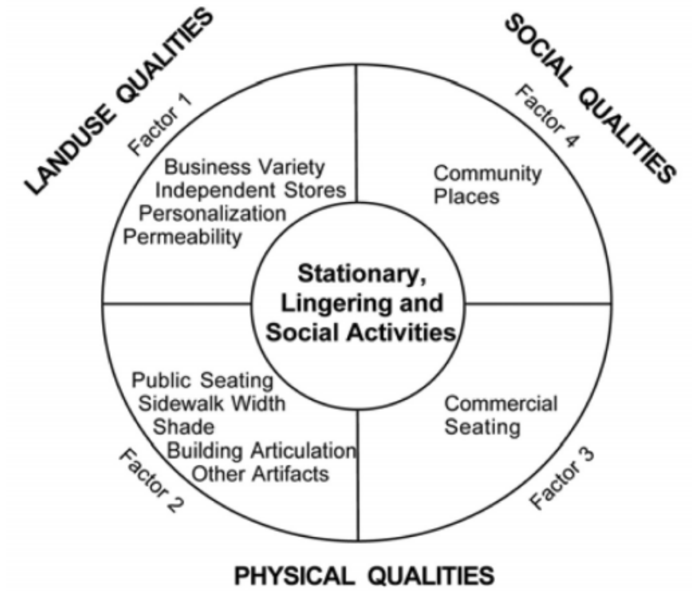


Figure 2.2 – Mehta's Characteristics of neighborhood commercial streets.

source: Mehta (2007)

Based on previous research into public space design (Mehta, 2007; Project for Public Spaces, 2009; Iguchi, 2011) is possible to propose the structure in which different aspects of public space design are considered and how they affect human-environment interaction (Figure 2.3). The physical elements that compose the design may be further divided and classified as amenities, street furniture, trees, bushes, hedges,ground cover, paving, spatial form, boundaries and accesses, amongst others and the diagram may be expanded as needed. As such, although some guidelines commonly proposed and adopted may be self explanatory, such as "the use of curb cuts" or "curb extensions" for accessibility, other guidelines are broad and ambiguous, such as "landscaping" or "intimate areas" and further research into how those elements affect POPS users is needed. This research analyses which physical elements manipulated by designers to compose public spaces were more readily perceived by public space users, and therefore are likely to have a bigger effect. After surveying users and designers, the research was focused on three main elements: tree cover, bushes and seating. Previous research on the use and perception of these elements are discussed below.

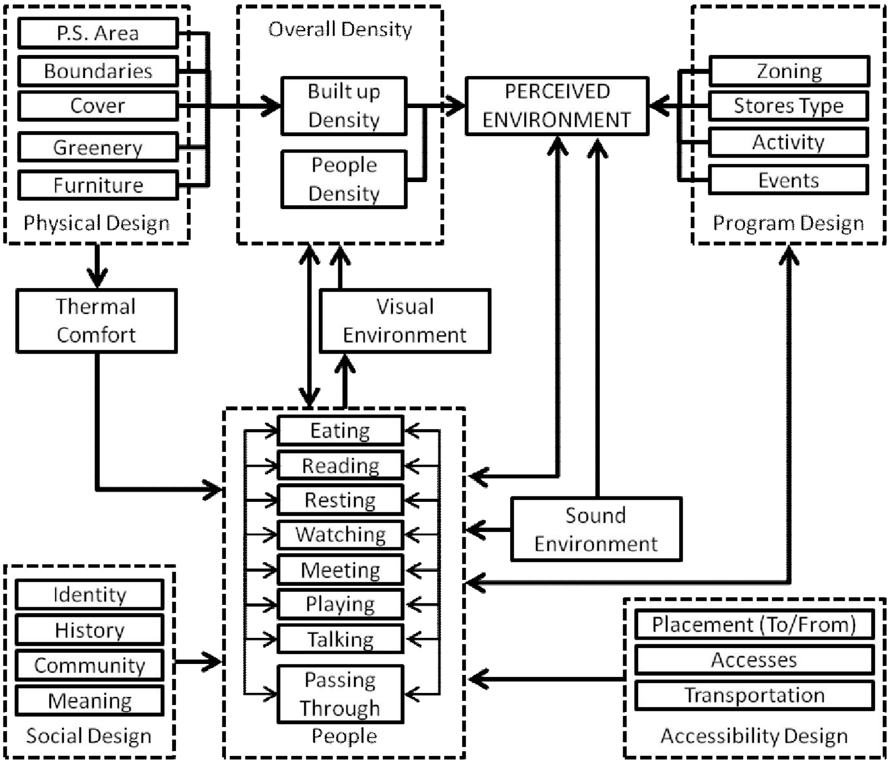


Figure 2.3 – Public Space Design Structure

2.2.1 Seats

Seats are a structural component of public spaces and the most basic element necessary to stay to occur (Gehl, 2011). Several prolonged activities such as rest, eat/drink, stay and talk requires seats or are facilitated by it. While all sittable surfaces in a public space may be interpreted as seats, they are commonly classified into primary (chairs, benches, stools, etc.) and secondary seats (stairs, steps, planter walls, etc.) with primary seats being generally preferred and secondary seats filling the demand for extra seating when it is necessary (Gehl, 2011).

Seats are selected considering other occupants (Hall, 1990; Whyte, 1980), spatial distribution (Gehl, 2011), seat characteristics (Gehl, 2011; Avalone Neto & Munakata, 2015) and, moreover, based on the activity intended (Li, Chen, Hibino, Koyama & Zheng, 2009; Hayashi & Ohno, 1995; Ohno, Soeda, Kondo, Hashimoto & Sato, 2006; Avalone Neto & Munakata, 2015).

The mere presence of seats can improve visitability (Whyte, 1980) and this effect is amplified by other elements such as sculptures (Abdulkarim & Nasar, 2013). Mehta (2007) finds that seats are crucial for street activity with commercial seating alone accounting for 11.5% of the variance present in his samples.

Whyte (1980) suggested that POPS should have at least a 30cm of 40cm wide bench for each 2.80m^2 of plaza area. In other words, he suggested that 4.37% of the plaza area ratio should be of sittable area. This number is, however, based on observations with no reported statistical analysis or relation between seats and users' perception of the environment.

It is widely accepted that seats are a key element to the design of social and vibrant public spaces and that ample range of seating should be widely provided (Mehta, 2007: Project for Public Spaces, 2009) but, although seats are seen as positive design element, there is no reason to assume that the more seats in an environment the better: at some point, the positive impressions caused by the presence of seats will deteriorate as they start to be perceived more as an obstruction than street furniture. This effect should be also conditioned by the scale of the environment.

2.2.2 Trees

Trees resonate with our primal subconscious, with our idea of a fertile, providing environment and, as so, they provide relief from, as well as aesthetic beauty to, our built environment (Orians & Heerwagen, 1992). Our preferences for landscapes are likely shaped by millennia of interactions with the natural environment in which we evolved to prefer those elements more helpful to our survival (Kellert & Wilson 1993).

Whether we are preconditioned by evolution to prefer fertile and providing environments (Orians & Heerwagen, 1992; Kellert & Wilson 1993) or those environments which allow us to find shelter or escape if necessary (Appleton, 1975), there are no doubt that people positively respond to trees and other natural elements.

Trees also have a symbolic value, representing permanence, stability, trustworthiness, fertility, generosity (Altman, 1993 *in* Summit & Sommer, 1999) and are metaphorically represented with roots, trunk and branch representing the infernal, earthly and heavenly domains (Fuller, 1988 *in* Summit & Sommer, 1999).

In urban design, trees are used to provide a sense of comfort, create a specific micro-climate, provide shade, scenery, for its colors, flowers, fruits or smells and the designer may have to consider the tree amounts, sizes, species, combinations and maintenance amongst other variables.

The amount of trees in the urban environment can have an effect on the users' propensity to develop activities such as rest, stay, meet or wait on the environment (Tanaka & Kikata, 2008; Hsieh & Lee, 2010; Jiang, Larsen, Deal & Sullivan, 2015) and its mere presence can positively affect urban plaza perception, city image, shopping atmosphere, cleanliness, worth of stay, willingness to visit and revisit urban squares (Raskovic & Decker, 2015). In public housing courtyards it increases opportunities for social interactions and attract larger and more age mixed groups of peoples (Coley, Kuo & Sullivan, 1997).

In streetscapes they mitigate oppressiveness (Asgarzadeh, Lusk, Koga & Hirate, 2012), and the amount of tree cover have being positively correlated with street preference of residential areas (Jiang, Larsen, Deal & Sullivan, 2015), shorter market period and higher house prices (Donovan & Butry, 2010), higher land prices (Ishikawa & Fukushige, 2012), a reduced risk of negative mental outcomes such as depression (Taylor, Wheeler, & White, 2015) and with reducing heat-related ambulance calls (Graham, Vanos, Kenny & Brown, 2016).

Aesthetically, deciduous trees are preferred over Conifers (Gerstenberg & Hofmann, 2016), broad canopies over narrow ones (Sommer & Summit, 1996; Sommer, 1997; Summit & Sommer, 1999; Lohr & Pearson Mims, 2006), dense canopy over sparse ones (Gerstenberg & Hofmann, 2016; Lohr & Pearson-Mins, 2006; Nelson, Johnson, Strong, Rudakewich, 2001) and a high crown size to trunk ratio is preferred (Gerstenberg & Hofmann, 2016; Sommer & Summit, 1995; Summit & Sommer, 1999).

Preference for tree form is conditioned by context with tree shape and height being matched to its context in suburban and city environments and taller trees being preferred in undeveloped settings (Summit & Sommer, 1999). In streetscapes, trees planted on both sides of the street were preferred over trees in the middle which were still considered better than no trees at all (Ng, Chau, Powell & Leung, 2015).

Increasing the amount of trees improves general preference of streets, with the most improvement occurring between 0 and 10% of tree ratio as measured in site plan or between 0 and 20% as measured from panorama pictures. Effects' magnitude diminishes as tree ratio increases up to 60% (Jiang, Larsen, Deal and Sullivan 2015). In public courtyards of residential buildings, higher tree ratio also yielded higher preference and safety ratings up to 22 trees per acre (Kuo, Bacaicoa & Sullivan, 1998).

Although increasing tree coverage will improve preference, improvement seems to plateau at higher densities and designers have to be able to justify how a high tree cover ratio will improve users' experiences or compromise in favor of a lower implementation/maintenance cost since the costs associated with tree establishment and maintenance are directly related to the amount of trees planted (Dwyer, McPherson, Schroeder & Rowntree, 1992). Additionally, it is not clear that users' judgment of plazas will follow the same preference curve as streetscapes, residential courtyards or a different pattern.

2.2.3 Bushes, shrubs and flower beds

Greenery such as bushes, shrubs and flowers are most studied regarding species selection or spatial organization. This may be due to the fact that greenery is most commonly used in urban design as a greenery mass or composition. None of the less, there is little research that investigates the effects different amounts of this kind of greenery have on users in public spaces.

Instead, bushes, shrubs and flowers are commonly studied under landscape preference and are commonly assessed using the *landscape preference matrix* method (Kaplan & Kaplan, 1989). The theory assumes that landscape preference is dependent on the human need to extract information from the environment to properly function in it. Kaplan & Kaplan (1989) suggests that preference for landscapes is conditioned by their informational needs (understanding and exploration) and the information's availability (immediate or inferred/predicted). Regarding informational needs, understanding relates to our need to make sense of the environment while exploration relates to our need for novelty and the possibility for improvement and growth. Exploration is what will allow one to gain experience and start to understand things that were previously confusing.

Information availability relates to the aspects readily available (clear, understandable visual information) and those that require inference (partially obscured areas, or configurations that invites to imagine hidden aspects of the scene).

The combination of these two domains provides four different scales for landscape assessment: coherence, legibility, complexity and mystery (Table 2.2).

Table 2.2 – Kaplan&Kaplan's (1989) Landscape Preference Matrix

	UNDERSTANDING	EXPLORATION
IMMEDIATE	Coherence	Complexity
INFERED/PREDICTED	Legibility	Mystery

Coherence entails the organization of a given setting with areas organized into few distinct regions of having repeating elements, themes or textures being more coherent than those with several distinct and/or contrasting areas or textures (Kaplan & Kaplan, 1989). Characteristics that allow a landscape to be perceived as a unity with focused attention are responsible for the landscapes coherence. Coherence degree also positively affects landscape preference when measured through plant organization (whether they were arranged in a formal, clustered or scattered manner) with clustered arrangements being preferred over formal ones and scattered arrangements being preferred overall (Kuper, 2017).

Complexity entails the amount of things or richness of a landscape or how much there is to see and reflect upon. It can be measured through attributes such as amount, distinct colors, textures, shapes, or physical dimensions of elements such as foliage, flowers, paths, topography and structures (Kaplan & Kaplan, 1989). Higher levels of landscape complexity have been linked to landscape preference when it was measured through the number of unique plant species (Kuper, 2017).

Legibility is how well an environment can be understood and remembered. It is how well structured the environment is amongst different element. An environment with good legibility allows one to move through it forward and backwards, as they are predictable with identifiable objects that can be easily interpreted.

Mystery refers to the promise of opportunities not readily apparent from the start. It is the promise that there is something further into the scene (Kaplan & Kaplan, 1989).

Within these four parameters, Kaplan & Kaplan suggest that landscape preference requires an average degree of coherence and complexity but higher degrees of legibility and mystery. In other words, while high degrees of coherence and complexity are not necessary, some degree is otherwise users will not engage with the scene. Increasing legibility and mystery, on the other hand, will increase landscape preference.

Beyond preference, views of outdoor, natural environments have been shown to influence peoples' psychological well-being, reduce stress (Ulrich, 1979) and improve recovery speed of hospital patients (Ulrich, 1984) and increasing the amount of bushes, shrubs and/or flower beds may improve psychological states (Ulrich, 1981), and allow for human biodiversity interactions (Palliwoda, Kowarik & von der Lippe, 2017).

2.2.4 Environment Size, Area or Scale

It may look intuitive that larger open spaces will be preferred over smaller ones even if it is just because larger environments may afford a wider range of activities - such as soccer matches but Kaplan, R. (1985a) found that the environment size in itself played only a minor role in residents' satisfaction and that opportunity to grow plants, access to nearby trees, places to take walks and well-landscaped grounds were much more related to neighborhood satisfaction.

In another study, Talbot and Kaplan (1986) investigated the relationship between urban open area preference and environment size to find no correlation between real or perceived size and environment preference. Subsequent studies (Bardwell, 1985 *in Kaplan & Kaplan, 1989*; Talbot, Bardwell and Kaplan, 1987) searched a larger range of outdoor areas just to find similar results, although they found that too small (such as 1m strip front yards) or too big spaces (huge straps of lawn with little to no development) will be negatively seen.

Large undeveloped open spaces have received negative preference ratings in other several studies (Talbot & Kaplan, 1984; Washburne & Wall, 1980; Kaplan, R., 1985a) while other studies have suggested that an open space does not need to be small to be highly preferred and that a space with many smaller regions is preferred over one large space (Kaplan, R., 1980)

An environment perception of its size does not depend only on its sheer area, but also in its surroundings. Instead of merely analyzing users' perceptions of environmental size, the effects of environment size and the effects of the surroundings are commonly assessed through three scales: enclosure, spaciousness and oppression. These scales are particularly important in urban settings such as POPS and streets where the impact of high rise buildings has to be factored in the environment perception.

Enclosure refers to the physical barriers posed by the surroundings and increasing blocking features, whether they block vision or motion, they will increase the sense of enclosure (Stamps, 2001).

Spaciousness, also referred as openness, refers to the feeling of how open the environment is perceived. It positively correlates to sheer floor area (Stamps & Krishnan, 2006; Stamps, 2007) and lack of occlusion (Stamps 2007), and it negatively correlates to the percentage of floor area obstructed (Imamoglu, 2000; Stamps & Krishnan 2006, Stamps 2007) and boundary height (Coeterier, 1994 *in Stamps & Krishnan 2006*). Cities with open views and scenery elicited better preference ratings (Nasar, 1990).

Oppression is generally understood as the opposite of spaciousness/openness. All three terms are closely related to environment size, enclosure type and height and, although an environment may be fairly large, the height of the surrounding buildings may cause it to be perceived as highly oppressive, enclosed and with low openness.

2.2.5 Other elements

There are other elements that have the potential to significantly affect users' behavior, but that, due to the scope of this research, ended up not included in the analysis. The most significant of those elements may be water.

Waterscapes consistently receive higher preference ratings. In natural settings, waterscapes provide information about potential opportunities and people are willing to pay higher rent for water view (Kaplan & Kaplan, 1989). In public open spaces, waterscapes increase the number of visitors (Chen, Liu, Xie & Marusic, 2016). Elements that contain water, such as fountains, ponds or streams are commonly used in public space design as a focal point (Project for Public Spaces, 2009).

Grass cover and hedges also deserve further investigation, but have not been included in this study past the exploratory part of this study. As a design element, grass cover, bushes, hedges and trees are distinct elements that may be used for very distinct purposes but they are, unfortunately, commonly bundled together in landscape preference research. While each element offers different characteristics of the environment, research that considers every element as *greenery* or *landscape* does not allow for the understanding of the individual effects. This research focused strictly on bushes and trees because of feasibility purposes since testing every element would require a timeframe outside the scope of this research.

The characteristics of the surrounding enclosure also have the possibility to significantly affect users' perceptions. The boundaries of the public space may provide for its liveliness with openings, commerce and other facilities or may reject it creating a solid border between public/private. Public spaces' boundaries may affect them through its height, material, permeability and use.

According to Project for Public Spaces (2009), facades should blur the boundaries between private and public sphere, allowing for a more seamless transition and inducing social behavior. The activity being developed in the environments facing public spaces also have a great impact and social inducing activities such as retail, cafes, bookstores, small shops are preferred over social deterrent one such as blank walls/facades, office space or banking.

Mehta (2007) also states that the relationship between the boundaries and the street are essential for its liveliness, and that street front with high levels of permeability, business variety, independent stores and personalization of signs and store fronts are conducive to stationary, lingering and social activities (Figure 2.2).

The possibilities for further investigations into the elements enumerated in this segment are discussed in Chapter 10.

3 METHODOLOGY

Due to Public Spaces complexity, any analysis that tries to assess the effects of any one aspect of the built environment in users' perception is unable to assert if such effect is due to the observed or due to some other, confounding variable.

To assess how design elements configuration influence user perception one must adopt a method that eliminate those confounding variables while still allowing for dependent variables to be manipulated.

The best approach would be to design and build a series of Privately Owned Public Spaces and evaluate its usage while changing design patterns through a long period of time. This, of course, is impractical because it requires too much time, money and manpower, while still being restricted to specific sites and the public that is able to use it.

Case studies, although useful for preliminary investigations, are not a viable alternative because there are no two different sites that are only different in their design and variables cannot be freely manipulated.

Because of the conflict between the different levels of experiment control and mundane realism obtained through experiments done in real settings and those done through virtual settings, this research used a mixed approach of real and virtual environment evaluations. The first stage of the research assessed how the environments are perceived in real settings, which was then followed by an '*on site*' survey and the evaluation of virtual versions of those sites, which allowed to evaluate whether those variables were perceived the same way in the real and virtual settings, for the assessment scales being adopted.

The last part of the research used virtual environments to freely change the design in different public spaces and assess the effects of different design elements on users' perceptions.

This mixed approach is useful because it has the benefits of yielding results from real settings in the preliminary stage while being able to control for confounding variables at a later stage and allow for the method validation for the specific measurement scales being used.

3.1 Instruments

For this research several surveys were used. This chapter describes the various instruments adopted and the methods in which the environments were evaluated.

3.1.1 Caption Evaluation Method (CEM)

Caption Evaluation Method (CEM) survey consists of asking participants to freely move in the environment with a camera and photograph elements that catch their attention or judge remarkable. The participant will then take note about why that particular scene caught his attention with a subtitle for each picture. Later, each picture is attached to an evaluation card that in which the participants describe (characteristic) the pictures scenery or elements and the reason (impression) it caught their attention (Koga, Taka, Munakata, Kojima, Hirate & Yasuoka, 1999).

In the present research, when CEM was adopted, the evaluation was made under the following structure: ○○is, ○○because○○; where“○○”was the element, characteristic and impression respectively (Figure 3.1). Participants were also asked to classify each scene as positive, negative or unclear.

File Name: ________________________ This place/thing was (positive / unclear / negative)

(________________________) is (________________________) because (________________________)

(________________________) is (________________________) because (________________________)

(________________________) is (________________________) because (________________________)

Figure 3.1 – Evaluation sheet adopted

This method allows eliciting participants to choose and point out elements in the environment that relate to them, rather than to evaluate elements relevant to the researcher. It also allows for the possibility of participants to detail relationships between elements and their perception as well as emotional outcomes which may elicit descriptions and insights to the built environment that would not arrive if the elements were chosen by the researcher to be analyzed.

Possible restrictions to the method are that data gathering involves lengthy sessions with participants on site and may require coordination of larger groups and sites or may lead to small sample sizes (Naoi, Yamada, Iijima & Kumazawa, 2011).

3.1.2 Semantic differential Method (SDM)

The semantic differential method consists of a pair of antonyms adjectives that comprise an evaluative dimension. Each pair is the extreme of a 7 point evaluation scale and participants select which point along the scale, they identify as the correspondent to their evaluation (Krosnick, Judd & Witternbrink, 2005). The scales are commonly labeled “extremely agree”, “agree”, “somewhat agree” or “neither” at each point to clarify its correspondence and values are typically coded 1, 2, 3, 4, 5, 6 and 7 from negative to positive statement although the coding -3, -2, -1, 0, +1 +2 +3 are also common.

This method requires that the participant assess his attitude toward the object and quantify it on each measurement scale and choose the point in the scale which corresponds to that assessment. For this to work as a methodological tool, four requirements must be met: each evaluative dimension must cover the whole continuum; scale must appear to be ordinal with a comprehensive order from one end to the other of the spectrum; each participant must understand the meaning of each point in the scale and all participants must agree on their interpretation of each scale and the research must know the meaning of that interpretation (Krosnick Judd & Witternbrink, 2005) which makes the preparation of the evaluation scales of great importance.

Although other evaluation scales may be used to elicit participants' attitudes towards the space, such as Thurstone's equal-appearing intervals or Likert's summated rating method, this study chosen to make use of SDM because it offers a relatively easy method to administer with good reliability (Krosnick Judd & Witternbrink, 2005) while allowing for a clear distinction between positive/neutral and positive/negative scales (e.g.: not bright/ bright and dark/bright) and consequently a finer nuance to participants responses using fewer evaluation scales.

The method also has the advantage of already being widely used in people-environment research as well as for the evaluation of plazas and POPS (Kakutani, 2005; Fujita & Ito, 2006; Tanaka & Kikata, 2008; Tsuchida & Tsumita, 2005).

3.1.3 An alternative to Contingent Valuation Method (CVM)

Contingent Valuation consist of a method where participants are asked to consider a hypothetical scenario where the provision of the good in question – normally something intangible, such as air quality, access to goods, services or landscapes – is related to a monetary contribution from the participant. The participant is then asked the range of that contribution in which he/she will be willing to pay to maintain/gain/preserve the access to such good. The purpose of this method is to associate a monetary value to non monetary benefits (Ready, Berger & Blomquist, 1997).

In a preliminary study, a specific CVM question regarding the value of the public space was tested with the intention of relate a monetary value to different design alternatives. The questionnaire asked the following:

> "*The following question asks you to assign a contribution/donation for the public space. Although no money will be charged from you (this is a hypothetical question), we ask that you consider the worth of this public space to you and answer the following truthfully, as if you would actually have to pay such a sum.*
>
> *Suppose that you are working at company "A", which is located in the building of this site. At the present moment, the fee collected from tenants to maintain this plaza is not enough and the building owner wants to clear the plaza and leave it as a sidewalk, just with pavement. To preserve the plaza, company "A" is considering to assume the administrative expenses and ask its employees to contribute to pay the expenses through a small deduction in salary*.
>
> *Q1: When considering that you will have to pay such a contribution, how much would you be willing to pay? Please think of the question as if you are a 1st year employee, with a $2,000 salary and that the contribution will be deducted from your salary once every month for 2 years"* (Answer varied from $0 to $50 or more). Questions 2 and 3 related to the reasoning behind question 1.

The question structure with the disclaimer and the scenario description was too long and the necessity of anchor all participants in the same salary base led participants find the questionnaire too confusing. We choose to adopt, instead, two scales that represent an unconscious evaluation people constantly make when interacting with the environment: *time* and *money*.

When people decide to spend time in a place, they are validating it as a useful place that answers to their necessities: people leave uncomfortable places (whether they are pubs, restaurants or plazas) and prolong their stay in comfortable ones. Therefore, their *willingness to stay* may stand as a representation of their satisfaction with the built environment.

Another obvious way people approve or disapprove an environment is through their *willingness to pay* for the use of such built environment, since it is assumed that a commodity price includes the places benefits, people expect to pay more in better located or fancier places. In fact, they justify that to themselves when they choose to pay more for any comparable product and usually express that in phrases such as "*the price of the experience*".

Therefore, we choose to ask participants how much they would be willing to pay for a cup of coffee served from a food truck to be consumed in that public space as a mean to evaluate the public space aggregated value (willingness to pay), and how long would they be willing to stay in that environment (willingness to stay). The specific questions were:

Willingness to pay: *A Food Truck parks in this area and you decide to buy something to consume here. What is the highest amount you would be willing to pay for a cup of coffee/tea?* (Answer varied from $0 to $10 or more).

Willingness to stay: *How long would you like to spend here?* (Answer varied from 0min to 2hours or more).

3.1.4 Questionnaire adopted

Table 3.1 – Measurement Scales Adopted for the Experiments

		Measurement	Scale
1	Activities	Suitability for stay	Unsuitable – suitable
2		Suitability for eat/drink	Unsuitable – suitable
3		Suitability for rest	Unsuitable – suitable
4		Suitability for wait	Unsuitable – suitable
5		Suitability for read	Unsuitable – suitable
6	Impressions	Appeal	Not appealing – appealing
7		Interestingness	Not interesting – interesting
8		Enclosure	Do not feel enclosed – feel enclosed
9		Atmosphere	Gloomy – cheerful
10		Relaxation	Not relaxing – relaxing
11		Openness	Not open – open
12		Oppression	Do not feel oppressed – feel oppressed
13		Liveliness	Not lively – lively
14		Diversity	Uniform – diverse
15	Perceptions	Size	Small – large
16		Greenery amount	Too little greenery – a lot of greenery
17		Greenery placement	Badly placed – well placed
18		Seat amount	Too little seats – a lot of seats
19		Seat placement	Badly placed – well placed
20		Seat design	Badly designed – well designed
21		View	Bad view – good view
22		Willingness to Pay	0, 100, 200, 300, 400, 500, 600, 1000 ien or more
23		Willingness to Stay	0m, 5m, 10m, 15m, 30m, 1 hour, 2hours or more

This research utilized the same questionnaire throughout all different experiments, with the exception of the first part (identification of physical elements) which used data from previous research and thus adopted slightly different questionnaire.

The questionnaire consisted of 21 questions as a 7 point semantic differential scale followed by 2 multiple choice questions (Table 3.1). It was presented to the participants on their smart phones when ministered *on site* and on paper form otherwise. They were instructed to check both sides of each scale before answering it. The form used and an English translation of it may be found in the Appendix section.

When the questionnaire was ministered, participants were instructed with the following instructions:

> "*Please freely spend around 5min in this plaza or until you feel that it is enough. After that, please open the questionnaire and answer the questions. There is no need to over think and an intuitive answer works just fine*"

3.2 Methods

To assess the specific effects of physical elements on users' perceptions a survey method that allow for the control of extraneous variables was necessary. While case studies allow for the evaluation of a specific setting, real physical environments do not allow for easy changes in the environment. Research of environmental preference has long relied on simulation methods to create variation in its stimuli. Although environments may be simulated through simple elevation of perspective drawings (Stamps, 1993; Stamps, 2003), photograph manipulation (Kaplan, R., 1985b; Stamps, 1990; Stamps, 1993; Downes, & Lange, 2015), architectural models (Matsumoto, Kanazawa & Kito, 2012; Mochinaga & Ishida, 2013), computer generated images (Avalone Neto & Munakata, 2015) or computer generated environments (Jansen-Osmann & Berendt, 2002), the term virtual reality (VR) or virtual environments (VE) have being used to describe as different things as computer generated images (Avalone Neto & Munakata, 2015), walkthrough routines/videos (Bishop, Ye, & Karadaglis, 2001) and game-like virtual environments that allow for free movement inside the modeled environment (Patterson, Darbani, Rezaei, Zacharias, & Yazdizadeh, 2017).

The way a participant experience the environment has also significantly varied as technology develops. While early research used still frames on paper (Stamps, 1993; Stamps, 2003), other researchers used still frames projected on a surface or flat screen (Avalone Neto & Munakata, 2015; Lindquist, Lange & Kang, 2016), to 360° still frames projected on a curved surface or seen on a screen (Ohno, Soeda, Kondo, Hashimoto, & Sato, 2006), 360° still frames viewed through HMD (Jackson & Cormack, 2010), virtual environments that allow exploration presented on a screen (Jansen-Osmann & Berendt, 2002; Patterson, Darbani, Rezaei, Zacharias, & Yazdizadeh, 2017), virtual environments that allow exploration presented on a projected surface (Ryu, Hashimoto, Sato, Soeda & Ohno, 2007) and virtual environments that allow exploration presented on HMDs (Fernandez-Palacios, Morabito & Remondino, 2016).

VR or VE may be defined as "synthetic sensory information that leads to perceptions of environments and their contents as if they were not synthetic" (Blascovich, Loomis, Beall, Swinth, Hoyt & Bailenson, 2002, p. 105) while Immersive Virtual Environments (IVE) is an environment that perceptually surrounds the individual in an interaction that provides a continuous stream of stimuli (Witmer & Singer, 1998).

The values in adopting this methodology as well as the limitations are discussed below.

3.2.1 VR and IVE in Architectural research

Virtual environments have been used in architectural research for some time since they avoid the constraints of the real world, allow control of extraneous variables, enable easy spatial variability, and to control the number, position and nature of physical elements present in the environment (Jansen-Osmann & Berendt, 2002).

Studies have found real and virtual environments to be highly correlated in open public space settings such as plazas (Ohno, Soeda, Kondo, Hashimoto, & Sato, 2006). Experiments using desktops and virtual environments have been shown to yield similar results even for activities such as distance judgment (Jansen-Osmann & Berendt, 2002), personal space (Wilcox, Allison, Elfassy & Grelik, 2003), seat selection (Ohno, Soeda, Kondo, Hashimoto, & Sato, 2006) and seat choice (Avalone Neto & Munakata, 2015).

The evaluation of computer generated environments is a valid research tool, yielding similar results to real settings (Stamps, 1990; Lange, 2001). Although real settings are the most reliable method they allow for no experimental control as virtual settings allow for a high level of experimental control at the cost of mundane realism. There is, therefore, a tradeoff between experimental control and mundane realism, which is directly affected by the method chosen (Blascovich, Loomis, Beall, Swinth, Hoyt & Bailenson, 2002).

An observational survey, for instance, is high on mundane realism, but low on control and an architectural model evaluation may be considered high in control but low in mundane realism (scenario A in Figure 3.2). With the development of better computer graphics (CG) tools that allows for the modeling of whole city sections, as well as the increasing disponibility of HMD, we are able to create stimuli that have high control and high mundane realism (scenario C in Figure 3.2).

Since high experimental control was needed, this research chosen to use IVE with head movement tracking to show the stimuli.

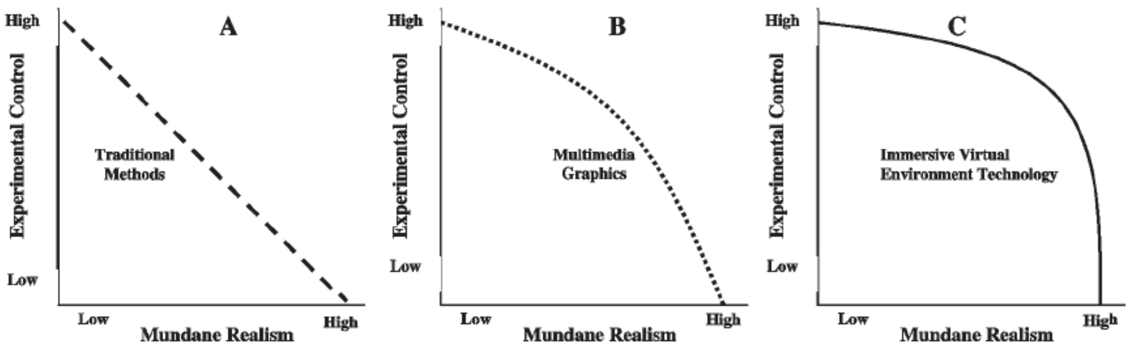


Figure 3.2 – Experimental control vs. Mundane realism tradeoff.

source: Blascovish et al, 2002.

3.2.2 Experiments structure

The present research purpose was to identify the elements that most affect users' perceptions and impressions of POPS and evaluate how those elements affect different perceptions, impressions and propensity to develop specific activities. For that purpose, the first stage of the research was to identify the elements most perceived for which we used an *on site* survey. On a second stage, we analyzed whether the sheer amount (quantity) of each element is responsible or if the effect comes mainly from other characteristics of each element (quality). Once the effects presence was identified, a third stage of the research investigated the extent of the effect of each element and created logistic curves to be used as design tools. A diagram of the research structure can be seen in Figure 3.3 below.

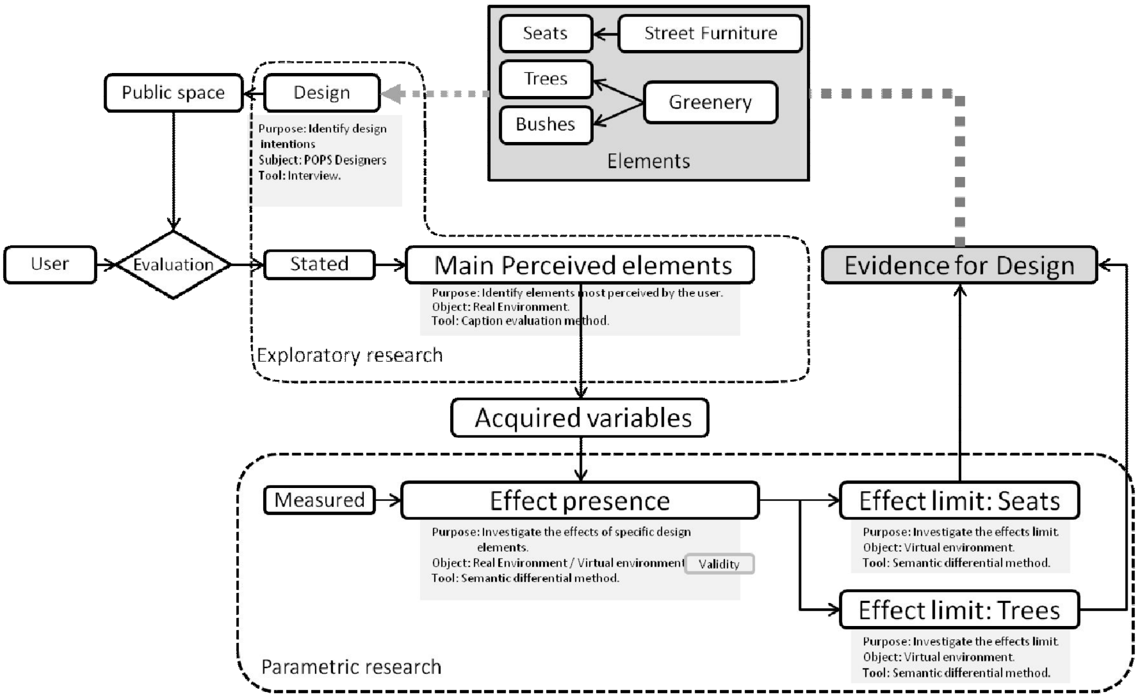


Figure 3.3 – Research Outline

4 Designers' Approach to POPS Design

Between the potential for fully public and social spaces and the reality of its private development and management, POPS are becoming the majority of our city centers' "public" squares and designers are in a position to negotiate between the private and public's interest.

Previous research (Banerjee, 2001; Smithsimon, 2008; Németh, 2009 and De Magalhães & Trigo, 2016) have explored how designers and managers perceive, produce and manage POPS, while Iguchi (2011) and Otani, Kitahara, Gotou & Kamia (1991) have conducted interviews with designers and POPS managers in Japan. With the exception of Iguchi (2011), the focus of previous research is on the publicness of POPS rather than on the design process. Since only the interview with two Japanese designers was available (Iguchi, 2011), further interviews with POPS designers were conducted to better understand the creation and production of privately owned public spaces.

Interviews were conducted as an exploratory approach (Figure 3.3) to understand which aspects are considered and valued by designers in the creation of POPS, which are common design intentions and how that translates into design directives and physical design of the environment.

4.1 Questionnaire

A questionnaire was developed to try to elicit designers to explain their design process without priming for an answer. The questions were purposefully ambiguous at first and more specific at the end. Designers were encouraged to freely talk, as much as they wished to explain their views without constant prompting from the interviewer. The interviewer did follow up questions to induce further thinking in the design process if the interviewee was stuck for an answer, unwilling to respond or did not understand the question.

Interviews were conducted between November and December 2016 and took, on average, 40min per interview. Three designers, two from company A and a university professor, formerly affiliated with company B, were interviewed. The transcriptions of the interviews (in Japanese) can be found in the Appendix section. The translation of the questions and the summary of answers are discussed below. The questionnaire included demographic information such as gender, age, profession, company affiliation, practice and teaching experience but, because the sample is too small, they are omitted here. They are, however, provided in the appendix section for future analysis of gender, practice and teaching experience effects.

The questionnaire was composed of ten questions that elicited designers to describe their design process, the relation between user and environment, specify which physical design elements they used, how design intentions translate into the physical aspects of the environment, how those elements are quantified, their willingness to use data and develop evidence-based design, their perception of POPS publicness and the effects of cultural differences on the design. The questions with the summarized answers are shown below.

Q1: Please describe the general steps you would take to design a privately open public space:

> **Designer 01**: Site Context (train station location, movement lines, car lane width, stores, demographics, information about greenery species); history (local history and culture); buildings usage and characteristics; laws and regulations (greenery ratio, accessibility, POPS area). On the design itself: plaza concept (greenery, liveliness, open/close, purpose); relation to the building's ground level; relation with neighboring sites; zoning; movement lines; main access and building entrance; behavioral design; clients' needs and wants; color Scheme.

> **Designer 02**: Site Context analysis; design theme; design Concept; uses; zoning and programming; environment structure (open/close, etc.).

> **Designer 03**: I look into the POPS placement and shape, its relation with the surrounding city blocks and the flow of people coming from to and from it. Based on what I think people will do in that specific environment I see if a green space is more suitable or a semi enclosed plaza.

Q2: What aspects of the user you have to consider to design it? (Please, be as specific as you can).

> **Designer 01**: It is not about knowing. I design based on the imagined user needs. For instance, the desired grouping of users, can be designed through benches sizes (fitted for 1, 2 or more) and placement, allowing or restricting the gathering of larger groups.

> **Designer 02**: Demographic distribution (office workers, store employees, residents); age distribution, presence/absence of kids; presence/absence of foreigners/tourist; It is also useful to know how revenue will be made to keep the environment and if there is a management system in place.

> **Designer 03**: I don't think it is necessary to know a lot about the users. If everyone can use the environment I am content.

Q3: What are the basic elements needed for urban design (i.e.: physical elements that will be used/designed)?

> **Designer 01**: Greenery; paving; installations (benches, illumination, walls, bicycle parking).

> **Designer 02**: Benches, Grass, paving, walls, stairs, greenery.

> **Designer 03**: benches, tables, greenery and lighting.

Q4: How do you quantify each of those elements (e.g.: quantity, density, visual aspect, gut feeling, etc.)?

> **Designer 01**: Greenery is defined by the legislation through floor area ratio; pavement by visual aspect and installations through their suitable amount (gut feeling).

Designer 02: The amount of greenery is defined by the legislation (ratio). Other elements are intuitively measured.

Designer 03: Visual aspect and my judgment as a designer.

Q5: What data do you consider useful to POPS design? How is that data is useful?

Designer 01: pedestrian flow, traffic flow and data about the surrounding greenery.

Designer 02: background of the site and surrounding area; cultural and historical data and information; site form and how the stores in the building are attracting customers and which is the target customers.

Designer 03: The amount of people that will use the environment, user variation during the day and night periods, data about wind direction and speed and air temperature during the year. With that kind of data it is easier to build a meaningful place.

Q6: Do you consider the design of POPS as being different from the design of other public spaces such as parks and plazas?

Designer 01: They have the same basic approach, but parks and plazas are open to everyone. POPS are a more private space since they have to provide value for the developer/company.

Designer 02: I design it as they are the same, but parks and plazas are much more open to the public. Because POPS have owners, they have a big effect on how the space is designed. From the start, it is impossible to ignore the owner's wishes, which make the POPS different from other public environments.

Designer 03: They are the same. Same design process and use.

Q7: How do you design the first design proposals? Do you process the requirements internally before committing it to paper (Black Box) or do you process the design requirements through successive, incremental drawings (White or Clear box).

Designer 01: White box. I organize my ideas and design variations using diagrams. I often come up not with one, but two or three different proposals.

Designer 02: Black box at first, but once the first proposal is ready, white box.

Designer 03: I start drawing and decide things while drawing. White box.

Q8. Would you design a POPS on a different country similar to the ones you design in Japan? If not, what information do you consider necessary to design POPS in countries other than Japan?

Designer 01: Is different. The regulation in Japan is more severe. It is very specific and detailed. In China, if the developer has leverage, he can force his will on a top down decision style. Information about culture and history is useful.

Designer 02: Other countries have a deeper consciousness about the social value of POPS. In the Japanese system, POPS are only seen as a way to increase floor area ratio, while other countries have a deeper understanding of the social value and contribution POPS provide.

Designer 03: They are basically the same. I like to know if there are cultural differences or differences in the way they use public spaces.

Q9: Regarding differences in design of POPS in different countries, what design elements would you use to address differences in public space usage or cultural differences?

Designer 01: It does not change. The design process and approach are the same, just the way the process is biased that changes.

Designer 02: I use different elements according to the cultural behavior (such as increasing grassed areas in places where people are used to sunbathe in the grass), but the design is the same overall.

Designer 03: There is no change regarding the physical elements used in projects inside or outside Japan.

Q10: Is there any important aspect of POPS design that you feel should have been addressed, but was neglected in this questionnaire?

Designer 01: I keep thinking more and more that feedback is necessary. I also think that we should change the way we address urban space design from landscape design to public space design.

Designer 02: There is not.

Designer 03: The presence of POPS and other public spaces in high density areas are extremely important. I also feel that its distribution in the urban fabric and shape are important.

4.2 Discussion

To design POPS, designers consider the overall context: site surroundings, place's history, laws and regulations and define the plaza design based on the concept, context and layout, as shown in Figure 4.1 below. Although there are several design aspects being quoted (e.g.: stores, local history, building characteristics, liveliness, behavior design) they are often intangible and vague. There is little relation between which design decisions correspond to actual design intangibles being quoted. For example, how user demographics actually affect a project? What is used to design the space as lively? How the behavior is designed?

Regarding users, answers were vague and generic. Users seem to be considered in a general way without actual considerations for different age, social or ethnical groups. Although two out of the three designers did say that they consider users' needs and demographics, it has not translated into design decisions at any time in their speeches, neither in specific statements or generic ones such as Gehl's (2011) statement that public spaces should be designed for the very young and the old so that they will attend the needs of all.

From the physical elements used to design POPS, benches, greenery and paving were the most cited elements and illumination, bicycle racks, grass, walls, tables and stairs were cited in a smaller degree. From those, greenery is quantified by ratio because of the Japanese legislation requirements while other elements are quantified by visual aspect or intuition.

Data normally used to aid POPS design include pedestrian and traffic flow, demographic distribution, historic and cultural background and surrounding greenery (required by legislation). One designer out of three also included wind direction and speed and air temperature. No data regarding physical elements quantification or placement were cited. When specifically asked whether they used any rule to quantify or place physical elements on POPS only the legislation about the minimum greenery ratio was quoted.

Although designers stated that they use the same approach to POPS design as they would use to design other public spaces such as parks or public plazas, they recognize the intrinsic difference in the spaces publicness degree due to the fact that POPS have owners. Designers also sounded as being resigned to comply with the owners/developers wishes foremost and above all, even if that required decreasing the public value of the plazas. The designers view is that POPS plazas should add value to the building first and to the public second which agrees with Iguchi (2011).

Cultural differences are mainly reflected in the development process and clear cultural differences, such as the habit of seating on the grass or the incorporation of local symbols into the design but with the overall space structure being the same. More than physical design differences, cultural differences seem to affect the creation or consolidation of the meaning of the public space.

The necessity to comply with owners desires even if it means going against the common good and actively make the space less public seem to drive POPS designers. The public plaza that is acquired by the government in exchange for FAR is still seen by developers and designers as private property and, as so, they are a product commissioned by the owner.

Since FAR exchange policies often relegate the management and maintenance of the POPS to the building administration, it is difficult to break the perception of ownership in the publics' and owners' minds. This has been, and may continue to be, POPS biggest failing and challenge, and may only be mitigated by furthering our knowledge of what makes POPS livable, accessible and useful so that those aspects may be incorporated into POPS creation and legislation.

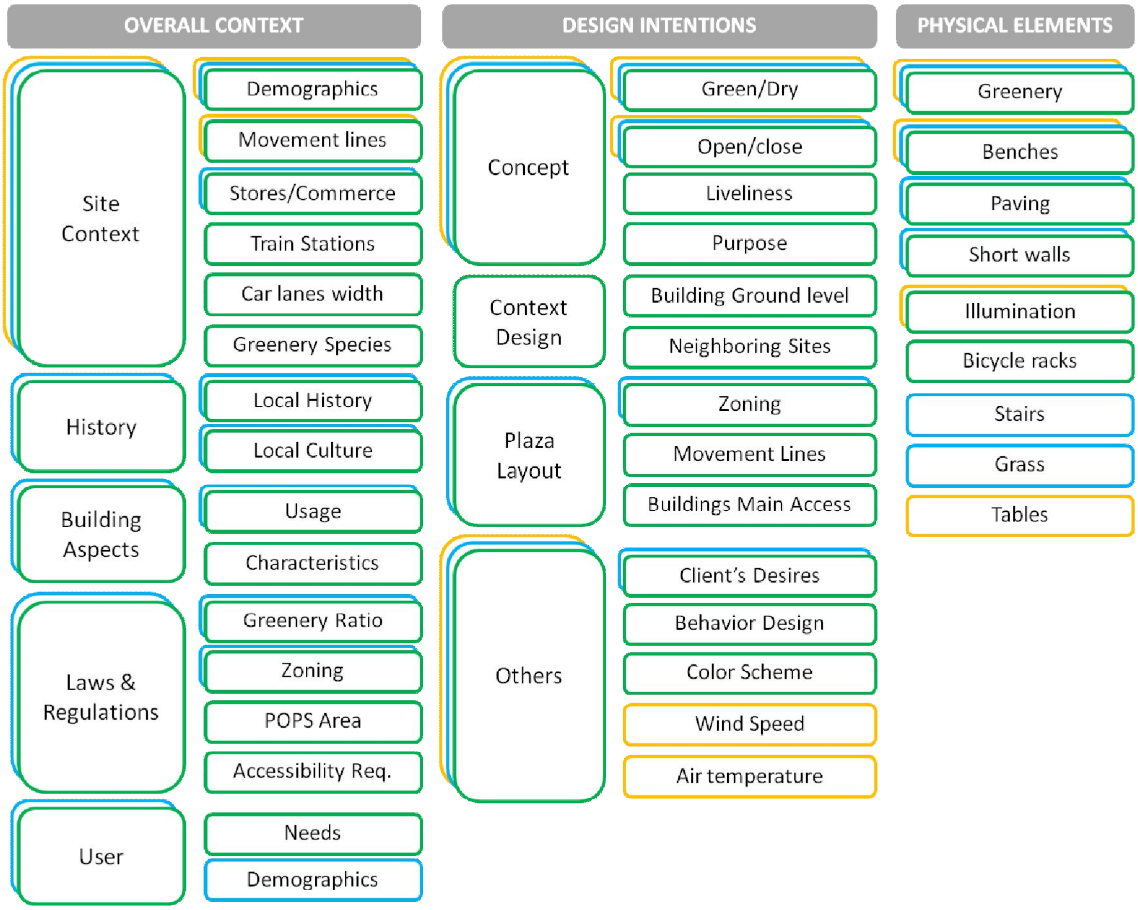


Figure 4.1 – POPS design process as stated by designers.
* different colors denote entries by different subjects.

5 Physical Elements Identification

To evaluate the effects of design elements on users' impressions, a first assessment of which variables have the most effect is necessary. Previous research (Nakata, 2010) explored the subject through the evaluation of 12 POPS in the central area of Tokyo with a lot area larger than 3000m^2 and constructed after 1990. Data was gathered during four days in October and November 2010 from 12:30 to 17:30, in either sunny or partially cloudy days and questionnaires were collected from a total of 30 participants (23 males and 7 females) that visited, on average, four of the 12 sites, with an average of 10 participants per site and a total of 120 sites observations.

Nakata's (2010) research used a caption evaluation method (CEM) survey to identify which physical elements commonly found in POPS are selected, how they are evaluated and which impressions are evoked on users. Based on users' responses to different environments, a structural relation between physical elements, element characteristics and impressions was constructed. Participants could take and evaluate as many pictures as they wished and write as many entries per picture as they deemed necessary and a total of 1494 entries were made. Elements were classified into 11 macro categories composed of 64 smaller ones (Table 5.1); characteristics into 10 macro categories composed of 40 smaller ones (Table 5.2) and impressions into 9 macro categories composed of 45 smaller ones (Table 5.3).

According to Nakata's (2010) data, greenery was the most quoted element, with 256 entries (E) (77% positive (P), 13% negative (N) and 10% indifferent (I)) followed by Sidewalk (138 E, 61% P, 31% N and 8% I), Space (117 E, 42% P, 40% N, 18 I), Street Furniture (113 E, 51% P, 43% N, 6% I) and Building (80 E, 40% P, 42% N, 18% I) as shown in Table 5.1.

The characteristics of elements most quoted by participants, shape had 190 entries (62% P, 17% N, 21% I) followed by presence/absence (164 E, 54% P, 29% N, 17% I), space composition (100 E, 55% P, 30% N, 15% I), vegetation (93 E, 90% P, 5% N, 5% I), view (83 E, 73% P, 17% N, 10% I), placement (81 E, 57% P, 30% N, 13% I), amusement/variety (77 E, 43% P, 40% N, 17% I) and aesthetics (70 E, 80% P, 16% N, 4% I) as shown in Table 5.2.

Table 5.1 Elements extracted from the CEM Survey. Source: adapted from Nakata, 2010.

Macro	Medium
Objects	Things
	Street Furniture
	A.C. Machinery
	Surveillance Cam.
	Artwork
	Information board
Place Or Environ.	Gate
	Semi-outdoor
	Overall Space
	Garden
	Space
	Lot
	Rest Area
	Smoking Place
	Entrance
	Approach
Pathway	Sidewalk
	Street
Ground Surface	Pavement
	Terrain
Living Things	Animals
	Interpersonal Comp.
Natural Environ.	Greenery
	Water Element
	Nature
Sensory Component	Ambiance
	Light contrast
	Smell
	Sense of Scale
	Sound
Building And Environ.	Pilotis
	Elevator
	Toilet
	Wood Deck
	Slope
	Handrail
	Train Station
	Car Parking
	Bicycle Parking
	Bridge
	Fence
	Eaves (Roof)
	Pillar
	Stores
	Roof
	Building
	Temple/Shine
	Surrounding Bld.
	Partition (boundary)
	Gradient
	Wall
	Flower Bed
	Stairs (steps)
Landscape	View
	Emptiness
	Tree Shade
	Scenery
	Shadow
Design Elements	Design
	Material
	Color
Vehicles	Train
	Car
	Bicycle

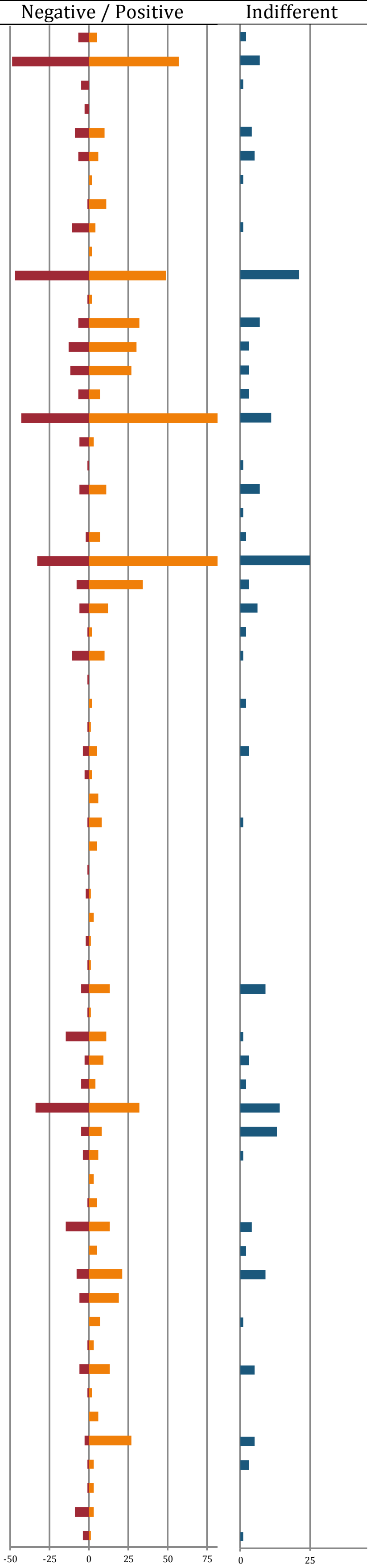
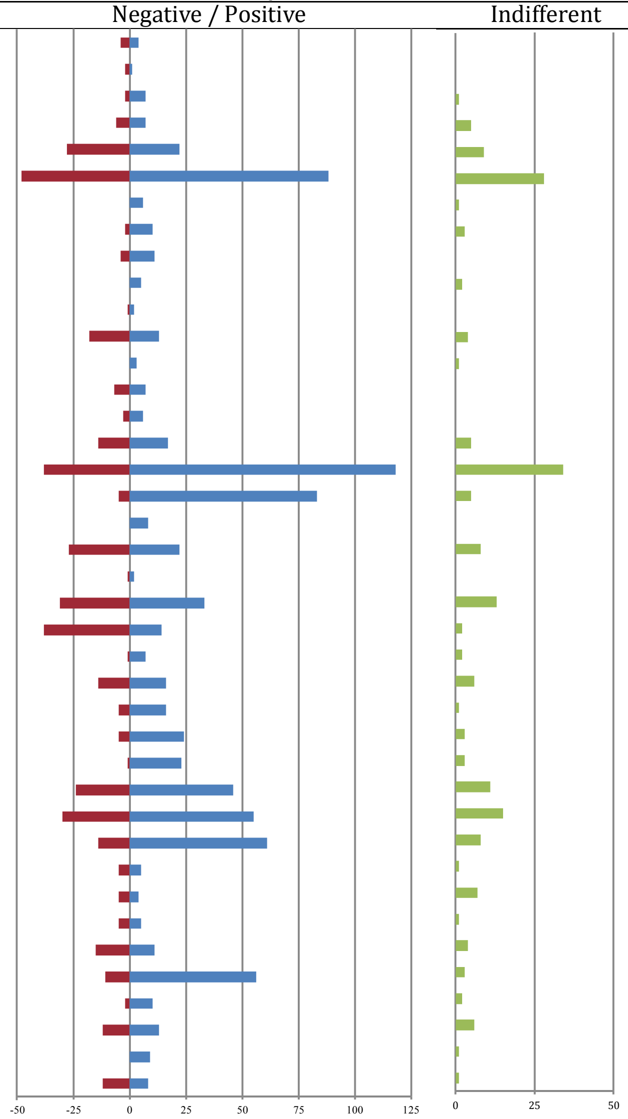


Table 5.2 Characteristics extracted from the CEM Survey. Source: adapted from Nakata, 2010.

Macro	Medium
History	History
	New and Old
State Of Things	Good or Bad
	Appearance
	Quantity
	Presence
Perception	Reflex; Permeability
	Scenery
	Shadow
Personal Relations	Use; Openness
	Interpersonal Comp.
	Managem. Maintain.
	Smoking
	Safety
Condition	Balance
	Harmony
	Shape
Nature Intake	Vegetation
	Nature
Novelty Unexpected	Attraction
	Liveliness
	Amusing, variety
Five Senses	Light
	Recollection
	Feeling
	Sound, Smell
Spatial Relations	Path
	Continuity
	Placement
	Space
	Line of Sight
	Boundary
	Distance
	Depth
	Approach
Design Elements	Aesthetics
	Design
	Material
	Refinement
	Color



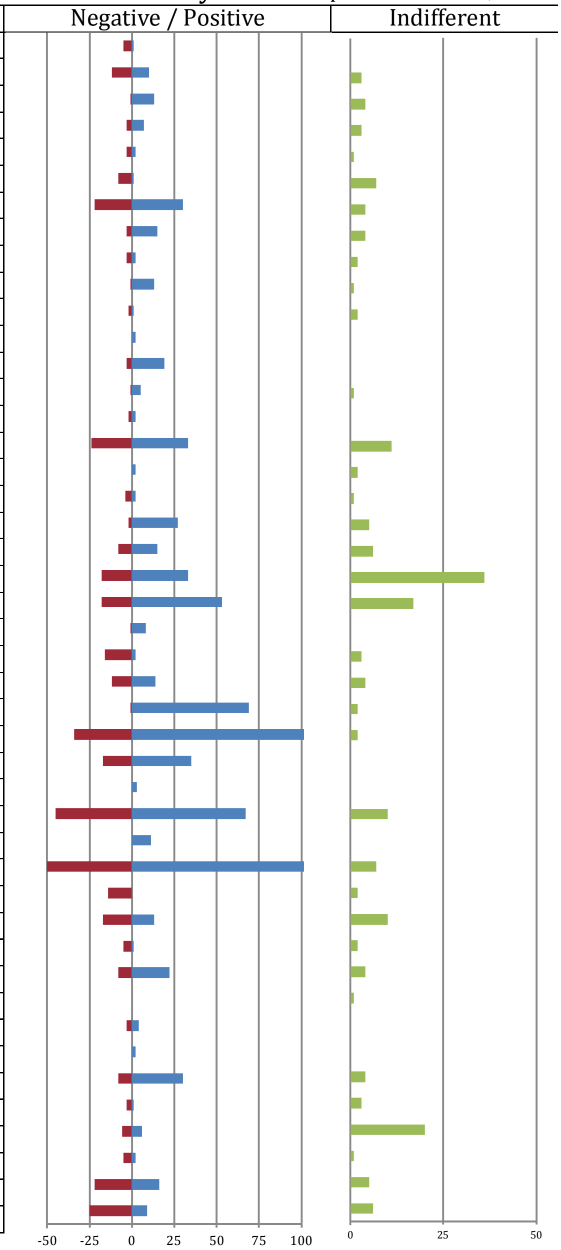
Comfort was the most cited impression (191 E, 68% P, 29% N, 3% I) and like/dislike (162 E, 78% P, 21% N, 1% I) followed by restfulness (122 E, 55% P, 37% N, 8% I), entertainment (88 E, 60% P, 20% N, 20% I), space aspiration (87 E, 38% P, 21% N, 41% I), goodness (72 E, 96% P, 1% N, 3% I), usage (68 E, 49% P, 35% N, 16% I), people walking (56 E, 54% P, 39% N, 7% I) and pleasantness (52 E, 67% P, 33% N) as shown in Table 5.3.

The overwhelming majority of answers identifying elements that trigger users' attention points to tangible physical elements that compose the built environment (i.e. Greenery, sidewalk, street furniture and building) or to the intangible that is the sum of those elements (i.e.: space). Those five categories alone, account for 704 entries (47%) of the 1494 gathered in the survey.

Between the characteristics, shape of the environment or things (12.7%) and the presence or absence of elements were the most cited (11%) and three (placement, space composition and view) of the nine categories of spatial relation account for a combined 17.7% of entries (264 E), while vegetation accounts for 6.2% of entries.

Table 5.3 Impressions extracted from the CEM Survey. Source: adapted from Nakata, 2010.

Macro	Medium
Harmony Aesthetics	Balance
	Harmony, Unity
	New and Old
	Scenery
	Noise
Freedom Of Behavior	Understanding
	People walking
	Behavior
Nature People	Smoking
	Interpersonal Comp.
	Liveliness
	Cars
	Nature
	Line of Sight
	Rain Protection
Publicness Usability	Usage
	Convenience
	Publicness
	Size
Space Attraction	Attraction
	Aspiration
	Entertainment
	Design
Function Maintain.	Managem. Ingenuity
	Safety
Emotion	Goodness
	Liking
	Pleasantness
Relaxing Rest	Familiarity
	Restfulness
	Therapeutic
	Comfortable
	Warming
Impression Ambiance	Ambiance
	Presence
	Cleanliness
	Material Perception
	High Class
	Seasons Perception
	Openness; enclosure
	Placed in the back
	Uncomfortable
	Intimidating
	Oppression
	Bright; Dark



Impressions showed that comfort is highly felt (12.8%) as well as personal emotions (i.e.: like/dislike, good/bad, pleasant/unpleasant) that had, combined, 18% of entries. An interpersonal impression may also be observed in responses such as people walking, usage and entertainment (14% of entries when combined).

Nakata's (2010) research shows that the basic elements that form a POPS (i.e.: greenery, sidewalk, street furniture and building) are the same ones that will attract or repel users and that the perception of intangible components is almost insignificant (e.g.: all five categories in the sensory component category combined only account for 34 entries or 2.28%). The characteristics most commonly cited also relate directly to tangible design decisions such as *the presence or absence* of elements and vegetation, *form*, *placement* and *space composition*. Impressions were very closely related to personal opinion, such as if the environment is good/bad, liking/disliking and whether it is pleasant or not. More subtle aspects of impressions, such as the ambience categories (Table 5.3) had few entries on average, suggesting a very simple perceptual structure: an element that is important;

the relation of that element to the overall structure (presence, shape, placement, and aesthetics); and the personal opinion of that (like/dislike, good/bad; pleasant/not; comfortable/not) (Table 5.4).

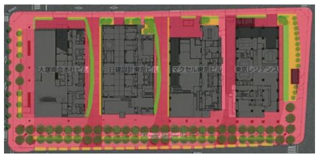
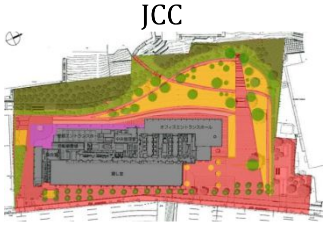
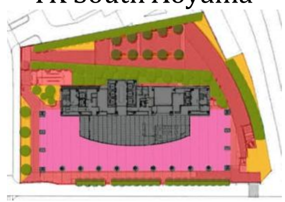
Table 5.4 – Summary of Nakata's (2010) Findings.

ELEMENTS	CHARACTERISTICS	IMPRESSIONS
Greenery	Shape	Comfort
Sidewalk	Presence/Absence	Like/Dislike
Space	Space Composition	Restfulness
Street Furniture	Vegetation	Entertainment
Building	View	Space Aspiration
	Placement	Goodness
	Amusement/Variety	Usage
	Aesthetics	People Walking
		Pleasantness

Source: developed by the author based on Nakata, 2010.

5.1 Semantic Differential Evaluation and Elements Ratio Analysis

Table 5.5 – Sites

 Pacific Century Place	 Eye Garden	 Nikken Sekkei
 Toranomon	 JCC	 TK South Aoyama
 Shibaura Rune Site	 Sumitomo Mita Twin Building West	 Sumitomo Mita Twin Building East
 Sumitomo Kanda	 Sumitomo Korakuen	 Sumitomo West Shinjuku

One may argue that the knowledge that greenery affects users' perception was already known – even if empirically – by urban designers around the world. The knowledge about how the manipulation of that variable changes - improve or worsen – that impression is what is missing. Does more vegetation improve perception? Or is mainly related to other qualities of the greenery (e.g.: smell, color, type, etc.) that were misinterpreted by participants? We measured each element area ratio in all sites studied by Nakata (2010) and crossed that information with the semantic differential evaluation data provided in his research. Elements ratio was defined as the amount of area occupied by each element divided by the publicly accessible area of the lot. Publicly accessible area was defined as the lot area minus the buildings enclosed or otherwise not freely accessible areas. Areas were analyzed in two different layers: ground level (seats, bushes, hedges and water) and coverage (trees and cover). Therefore, the areas of those two layers may overlap: a tree covered seat was accounted for its seating area in the "seat" category, while the tree canopy area was counted on the "tree" category (Table 5.5 and Table 5.6).

Table 5.6 – Sites Area Ratio per Category

Site Name	Seats	Bushes	Hedges	Trees	Cover	Water
Pacific Century	0.015	0.266	0.005	0.282	0.046	0.004
Eye Garden	0.014	0.259	0.020	0.240	0.049	0.013
Nikken Sekkei	0.021	0.124	0.061	0.208	0.000	0.000
Toranomon	0.003	0.132	0.017	0.257	0.294	0.014
Japan Center for Cities	0.034	0.302	0.090	0.260	0.028	0.038
TK South Aoyama	0.002	0.228	0.052	0.138	0.244	0.000
Shibaura Rune Site	0.013	0.116	0.017	0.295	0.134	0.000
Sumitomo Mita Twin Building West	0.011	0.203	0.114	0.242	0.031	0.000
Sumitomo Mita Twin Building East	0.007	0.292	0.000	0.271	0.262	0.000
Sumitomo Kanda	0.010	0.230	0.049	0.092	0.200	0.000
Sumitomo Korakuen	0.022	0.223	0.013	0.301	0.158	0.000
Sumitomo West Shinjuku	0.000	0.161	0.120	0.096	0.026	0.000

The ratio – amount of public space area occupied by each element – was measured based on the CEM survey photographs taken by the participants (for seats, bushes, hedges, trees, cover and water) and satellite images available on Google earth were also used as reference for tree coverage when 2010's October to November images were available (Figure 5.1).

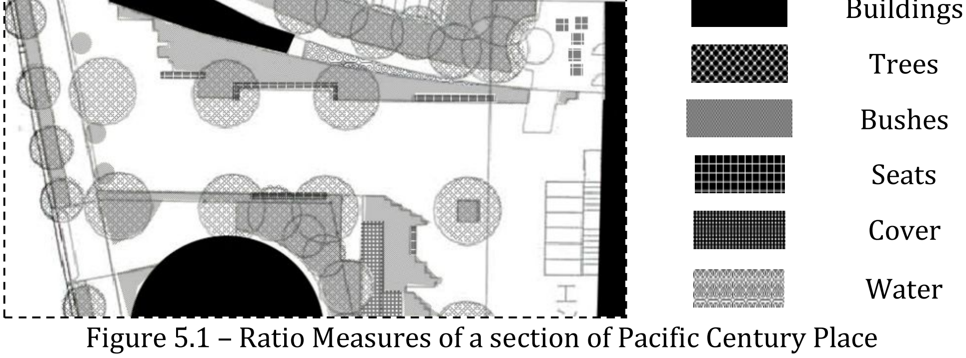


Figure 5.1 – Ratio Measures of a section of Pacific Century Place

The data from the semantic differential evaluation applied by Nakata (2010) was used for users' impressions. The questionnaire had 26 measurement scales from which 2 related to behavioral intent: stay duration and a place to rest (Table 5.7). The analysis was made using participants' average response per site and each site's physical characteristic's ratios (Table 5.6).

Table 5.7 – S.D. Questionnaire Measurement Scales

	Measurement	**Scale**
1	Comfort	Comfortable - Uncomfortable
2	Stay Duration	Long Stay – Short Stay
3	Size	Big – Small
4	Peacefulness	Peaceful – Loud
5	Sophistication	Sophisticated – Unsophisticated
6	Diversity	Diverse – Uniform
7	Liveliness	Lively – Decadent
8	Space Weight	Light – Heavy feeling
9	View	Good – Bad view
10	Organization	Orderly – Cluttered
11	Amount of Greenery	A lot – A little greenery
12	Vegetation placement	Good – Bad Greenery Placement
13	Abundance of Tree Shade	A lot – A little tree shade
14	Illumination	Bright – Dark
15	Calmness Feeling	Feel Calm – Do not feel calm
16	Safeness	Feel Safe – Do not feel safe
17	Openness	Feel – Do not feel openness
18	Oppression	Feel – Do not feel oppressed
19	Enclosure	Feel – Do not feel enclosed
20	A Place to Rest	Easy – Hard place to rest
21	Interesting	Interesting – Not interesting space
22	Harmony with Surrounding	Harmonic – Disharmonic
23	Color Variety	Colorful – Colorless
24	Atmosphere	Light – Dark Atmosphere
25	Newness	Contemporary – Nostalgic
26	Enjoyability	Enjoyable – Lack of enjoyment

Correlations between physical elements and impressions are listed in Table 5.8. The best predictor of stay duration was trees ratio (R^2adj=0. 46; p<0.008) through the single regression analysis formula Y=-2.73+ (10.19*Trees) where Y is the "stay duration" score.

A place to rest could also be predicted by tree ratio with a much better model (R^2adj=0. 85; p<0.001) through the formula Y=-3.80+ (16.73*Trees) where Y is the "place to rest" score. This prediction could also be made from the *hedge* ratio, but with a less robust model (R^2adj=0. 27; p<0.045).

Several impressions could be predicted from tree ratio: abundance of tree shade (R^2adj=0.47; p<0.008), calmness feeling (R^2adj=0.36; p<0.023) and comfort (R^2adj=0.28; p<0.045). Others could be predicted from seats ratio, such as abundance of tree shade (R^2adj=0.40; p<0.015), sophistication (R^2adj=0.36; p<0.015) and newness (R^2adj=0.34; p<0.028).

A logistic regression analysis was made using the raw data from the survey to predict users' satisfaction, according to tree ratio for the two activities: stay (Figure 5.2) and rest (Figure 5.3). The graph is divided in three areas, from negative, neutral to positive impressions. Logistic regression models can be seen in Table 5.9 and Table 5.10.

Table 5.8 – Correlations between Impression and Physical Elements.

		Seats Ratio	Bushes Ratio	Hedges Ratio	Tree Ratio	Cover	Water
A	Seats ratio						
B	Bushes ratio	0.32					
C	Hedges ratio	0.01	-0.13				
D	Trees ratio	0.48	0.12	-0.53			
E	Cover ratio	-0.49	0.01	-0.53	-0.02		
F	Water Ratio	0.58	0.39	0.14	0.25	-0.19	
1	Comfort	0.05	-0.20	0.01	0.59	-0.31	0.07
2	Stay Duration	0.15	0.06	-0.08	0.72	-0.29	0.12
3	Size	-0.07	0.19	0.23	0.26	-0.32	-0.1
4	Peacefulness	0.29	-0.23	0.29	-0.19	-0.54	0.40
5	Sophistication	-0.65	-0.48	0.41	-0.35	0.06	-0.29
6	Diversity	-0.08	0.10	0.21	0.40	-0.18	0.26
7	Liveliness	-0.18	-0.23	0.01	0.49	-0.15	-0.07
8	Space Weight	0.26	0.01	0.06	0.44	-0.29	0.22
9	View	-0.19	-0.09	0.56	0.01	-0.36	-0.35
10	Organization	-0.47	-0.56	0.21	-0.48	0.16	-0.34
11	Amount of Greenery	0.50	0.08	0.33	0.31	-0.83	0.22
12	Vegetation placement	0.15	-0.18	0.17	0.41	-0.62	0.09
13	Abundance of Tree Shade	0.68	0.05	-0.12	0.72	-0.67	0.22
14	Illumination	-0.16	-0.29	0.19	0.18	-0.11	0.02
15	Calmness Feeling	0.24	-0.15	-0.16	0.65	-0.27	0.28
16	Safeness	-0.08	-0.21	0.04	0.49	-0.14	0.10
17	Openness	-0.38	-0.20	0.33	-0.03	-0.27	-0.30
18	Oppression	-0.00	-0.30	0.08	0.34	-0.18	-0.20
19	Enclosure	0.40	0.24	-0.42	0.12	0.28	0.60
20	A Place to Rest	0.33	0.18	-0.59	0.93	0.05	0.28
21	Interesting	-0.16	-0.24	0.06	0.47	-0.08	0.12
22	Harmony with Surrounding	0.16	-0.05	0.10	-0.18	-0.14	-0.34
23	Color Variety	0.04	-0.03	0.50	0.26	-0.57	0.22
24	Light/Dark Atmosphere	-0.03	-0.11	0.25	0.37	-0.26	0.10
25	Newness	-0.63	-0.31	0.13	-0.44	0.11	-0.22
26	Pleasantness	-0.04	-0.27	0.16	0.49	-0.26	0.15

For this analysis, the 7 point scale was divided into three segments: -3, -2, -1 as negatives; 0 as neutral and +1, +2, +3 as positive. This means that in the case of a place to rest, answers that included "extremely agree", "agree" and "somewhat agree" with "hard to rest" are plotted as negative; "neither" is plotted as neutral and "extremely agree", "agree" and "somewhat agree" with "easy to rest" are plotted as positive.

The logistic regression makes it is possible to evaluate the satisfaction rate with any ratio instead of relying on averages. Plotting results using logistic regression allow designers to use ratio values that will satisfy more than half of users, which is extremely useful with data that vary from positive to negative impressions.

Both measurements of activities presented in the SD survey could be predicted by tree ratio, which had a good range, from 10 to 30% of the POPS area. Seats ratio did not correlate with neither stay or rest activity. This may have to do with the fact that seats ratio only varied from 0 to 3.4% of the total area. When taking into account that seats ratio correlated well with amount of greenery and abundance of tree shade, it is possible to assume that seat perception is related to tree placement and the overall design. This could also explain the inverse correlation with newness and sophistication.

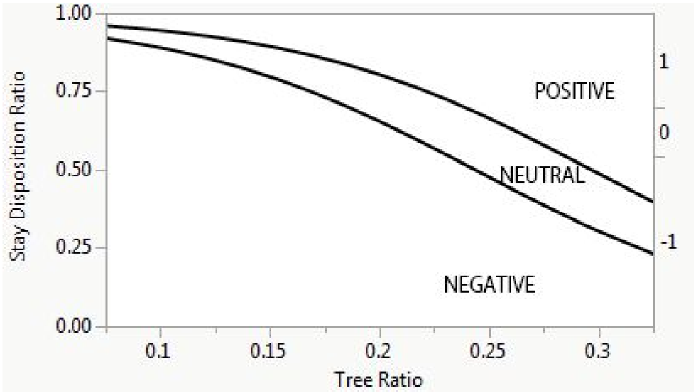


Figure 5.2 – Logistic Regression of "stay duration" by tree ratio.

Table 5.9 – Ordinal Logistic Model for Stay Disposition based on Tree ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	$\ln(\hat{Y}/(1-\hat{Y})) = 4.37 - 14.70 * [\text{Tree ratio}]$	0.10	p < .0001
Lower	$\ln(\hat{Y}/(1-\hat{Y})) = 3.59 - 14.70 * [\text{Tree ratio}]$	0.10	p < .0001

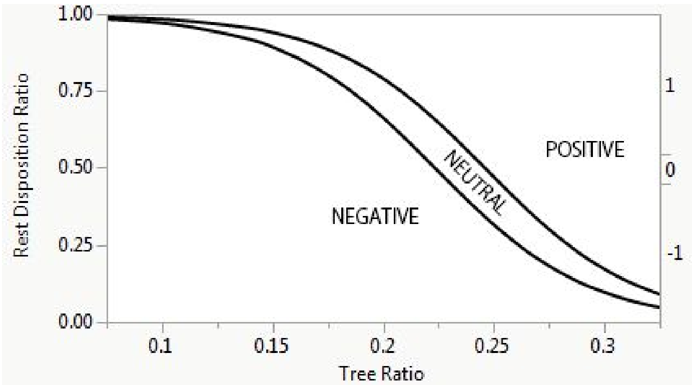


Figure 5.3 – Logistic Regression of "place to rest" by tree ratio.

Table 5.10 – Ordinal Logistic Model for Rest Disposition based on Tree ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	$\ln(\hat{Y}/(1-\hat{Y})) = 7.12 - 28.94 * [\text{Tree ratio}]$	0.28	p < .0001
Lower	$\ln(\hat{Y}/(1-\hat{Y})) = 6.46 - 28.94 * [\text{Tree ratio}]$	0.28	p < .0001

5.1.1.1.1 Discussion

Basic elements of public space design (i.e.: street furniture, greenery, buildings, sidewalk and overall space) were the ones that better caught participants' attention. The most quoted element, *greenery*, showed to be the best predictor of stay and rest activities, analyzed through trees ratio. This agrees with Tanaka & Kikata (2008) for rest activity and expands the results to include stay activity. Besides trees, the amount of bushes correlated negatively with the feeling of organization of the space.

The most prominent impression expressed by users, apart from the emotional ones (e.g.: goodness, liking and pleasantness) was *comfort* and *rest* both highly correlated with *tree ratio*. Some of the characteristics expected to be found in the physical elements were also addressed in the present study such as presence/absence and vegetation, while others like placement, space composition and shape need to be better explored.

The study adopted the ground level projection (depth x width) for ratio estimation. This seemed to have worked well for all elements except hedges. Since hedges work as visual barriers, a width x height measure obtained *in loco* may be a more suitable measure because it better relates to the amount of the visual field it occupies.

Because this study was based on Nakata's (2010) research, the definition of public space includes all publicly accessible areas of the lot and participants were instructed to explore the space as a whole. A more realistic measure would be to consider only those spaces that are perceived as a public space *a priori*, disregarding residual spaces such as back alleys, parking lots, service accesses and unloading docks that may be counted as public space in the FAR legislation, but does not contribute to the public good nor is perceived as useful public spaces unless the user is instructed to do so. This will probably lead to more robust results than the findings described in this study.

6 IVE VALIDITY

An '*on site'* survey followed by an identical IVE survey of the same sites was conducted to assess whether the impressions of simulated environments correlate with the impressions of real environments.

Four sites in walking distance from one another in Chiyoda-ward, Tokyo were selected, so that subjects could evaluate them on the same day. Its selection considered the seating amount variability, greenery amount variability and place scale. From the four selected sites, one was of small (600m^2), two of medium (2000~2500m^2) and one of large (4000m^2) scale (Figure 6.3, Figure 6.1, Figure 6.2 and Figure 6.4 respectively). Sites that had potential confounding variables were discarded. Since the evaluation is based on floor area ratio, sites that did not allow for a clear perception of floor area such as connection with underground and areas with restricted access but with visual permeability were discarded. Noisy areas were also discarded as a way to control sound environment – which would not be simulated on sub sequential experiments – as a confounding variable. Selected sites and their respective elements ratio may be seen in Table 6.1.

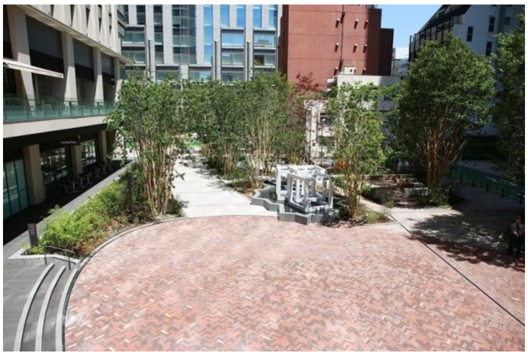


Figure 6.1 – Terrace Square

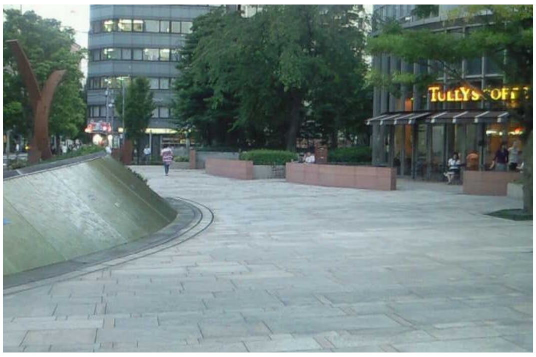


Figure 6.2 – Jinbocho Mitsui

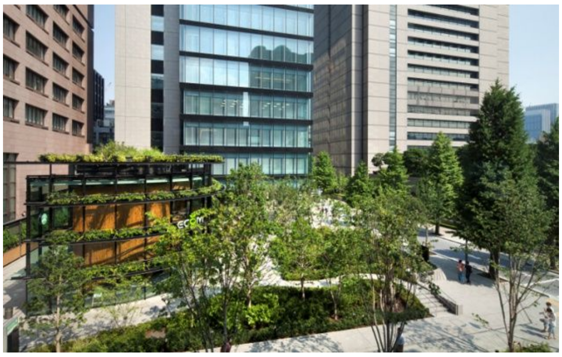


Figure 6.3 – Insurance Annex

Figure 6.4 – Watteras Tower

Table 6.1 – Sites Area Ratio per Category

Site	Seats	Bushes	Hedges	Trees	Cover	Water	Grass
Terrace Square	1.5%	18.3%	0%	26.2%	5.5%	1.9%	0%
Jinbocho Mitsui	2.6%	22%	3%	23.7%	0.4%	2.4%	0%
Insurance Annex	1.4%	40%	0%	30.6%	0%	0%	0%
Watteras Tower	1%	6.3%	0%	12.5%	1%	0.5%	25.7%

6.1 Procedure

6.1.1 On site Survey

For the '*on site' survey*, participants would receive orientations about the survey purpose, evaluation method and how to answer the questionnaire, after which they would walk to the first site and perform the evaluation.

After arriving at the site, participants were instructed to walk freely around the site for about 5min., and then answer the questionnaire (Table 3.1). The questionnaire was presented to the participants on their smart phones and they were instructed to check both sides of each scale before answering it (Figure 6.5). The form used and an English translation of it may be found in the Appendix section (Appendix 01).

Figure 6.5 – On site survey setting

Figure 6.6 – IVE survey setting.

A total of 20 people (12 male and 08 female) participated in the study, evaluating all four sites (80 observations in total). Participants were university students, from varied fields with an average age of 23.35 years (SD=4.78).

Sites were evaluated in two orders: Terrace Square, Jimbocho, Insurance Annex and Watteras or Watteras, Insurance Annex, Jimbocho and Terrace Square with half of the participants in each condition. The site order was not randomized because of geographical restrictions.

6.1.2 IVE Survey

The four sites with their surroundings were modeled using SketchUp and Unity softwares. The virtual environment models were as simple as possible, with special attention to preserve the size and proportion of the original environments. Building facades, and surrounding streets were textured with photographs taken on site and/or using the Google Street view database. Since the availability of vegetation models is limited, the virtual environment did not have the same species of the real environments, but tried to maintain the same heights, texture and volumes of the original designs as much as possible (Figure 6.7, Figure 6.8, Figure 6.9 and Figure 6.10).


Figure 6.7 – Terrace Square IVE


Figure 6.8 – Jinbocho IVE


Figure 6.9 – Insurance Annex IVE

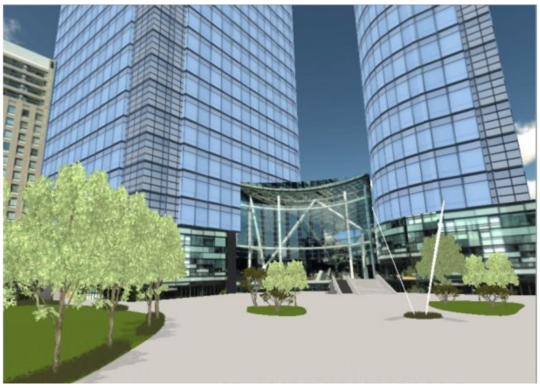


Figure 6.10 – Watteras Tower IVE

Virtual models were presented using an Oculus Rift DK2 head mounted display (Figure 6.11) and participants would move around the environment using a Logicool gamepad controller (Figure 6.12). Each environment was loaded, observed and evaluated with a brief (around 3-4 min) eye rest between stimuli (Figure 6.6). Participants were instructed about possible side effects of the VR equipment and to stop at any time they felt discomfort. If necessary, they could rest for as long as they wished between stimuli or end the experiment at any time.

Figure 6.11 – Oculus Rift

Figure 6.12 – Logicool Gamepad

Participants were allowed to walk around in the virtual space for as long as they deemed necessary to grasp it. Once they felt comfortable to evaluate it, they removed the headset and started the evaluation by filling, by hand, a printed questionnaire. Participants were instructed to either wear the headset again or use the screen in front of them to check any aspect of the environment they deemed necessary while answering the questionnaire.

A total of 20 people (10 male and 10 female) evaluated each of the four virtual sites (80 observations in total). Participants were university students, from varied fields with an average age of 22.05 years (SD=2.19). 17 of the 20 participants had participated in the *on site* survey. Sites were evaluated in the same two orders of the real environments so that the effect of evaluation order could be tested.

6.1.3 Results

Multiple regression analysis was used to determine whether the experience method (real or virtual) had any effect in each of the 23 evaluation scales.

No effect from experience method was observed in any of the five activity scales (Table 3.1), although an interaction ($p = 0.03$; $F(3, 152) = 3.03$; R^2Adj.=0.17) between the method of experiere and site types could be observed for *Read* activity (Figure 6.13). The method of experience had no effects in *Stay* ($p = 0.14$; $F(3, 152) = 1.84$; R^2Adj. = 0.25), *Eat/drink* ($p=0.36$; $F(3, 152) = 1.08$; R^2Adj. = 0.27), *Rest* ($p = 0.16$; $F(3, 152) = 1.73$; R^2Adj. =0.21) or *Wait* ($p = 0.08$; $F(3, 152) = 2.28$; R^2Adj. = 0.05) activities.

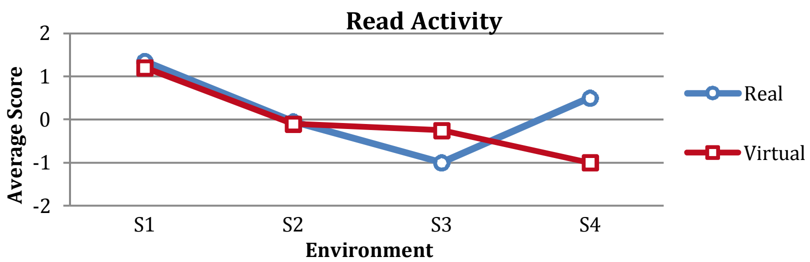


Figure 6.13 – Interaction between method of experience and site type for read activity.

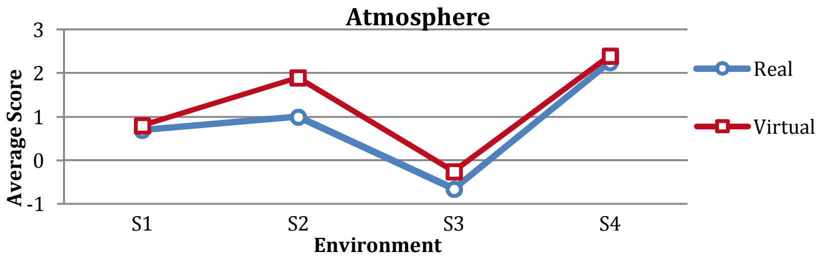


Figure 6.14 – Effects of method of experience in the impression of atmosphere.

Between the scales chosen to assess users' impressions, an effect of experience method was observed in *Atmosphere* ($p = 0.046$; $F\,(1, 152) = 4.04$; $R^2Adj. = 0.41$) and *Interest* ($p = 0.02$; $F\,(1, 152) = 5.49$; $R^2Adj. = 0.10$), (Figure 6.14 and Figure 6.15). Some scales had a small effect of experience method just outside the 5% confidence interval. They were *Appeal* ($p = 0.0546$; $F\,(1, 152) = 3.75$; $R^2Adj. = 0.05$), *Enclosure* ($p = 0.0527$; $F\,(1, 152) = 3.81$; $R^2Adj. = 0.36$) and *Openness* ($p = 0.064$; $F\,(1, 152) = 3.47$; $R^2Adj. = 0.48$). The other scales had no effect experience method and no interactions could be observed in any impression scale.

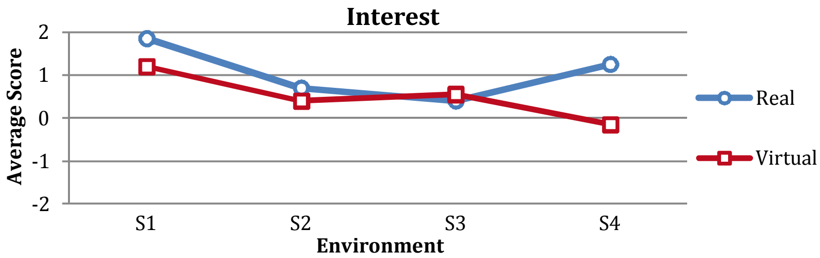


Figure 6.15 – Effects of method of experience in the impression of interest.

Between the physical scales, *Size* had main effect ($p = 0.048$; $F\,(1, 152) = 3.98$; $R^2Adj. = 0.60$) while *Greenery Placement* had interaction ($p = 0.001$; $F\,(3, 152) = 3.93$; $R^2Adj. = 0.06$) between experience method and site type.

The other two scales – *Willingness to Stay* and *Willingness to Pay* – also had no effect of experience method.

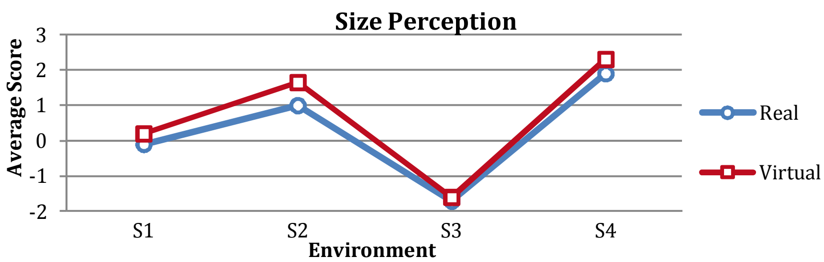


Figure 6.16 – Effects of method of experience in the size perception.

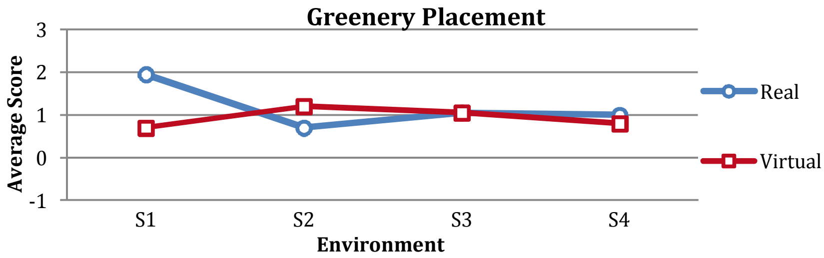


Figure 6.17 – Interaction between method of experience and site type for greenery placement perception.

6.1.4 Discussion

Overall, there were no significant effects caused by the way a user experience the environment: whether it is virtual or real, answers were very similar and no scale generated contradictory evaluation scores based on experience method. However, some differences were observed and its causes and correction method are discussed below.

Atmosphere and *Interest* differences (Figure 6.14 and Figure 6.15) arose from differences in the detailing of the virtual environment. In this experiment, shop facades had no picture attached to the models and glass material innate to the modeling software was used instead (Figure 6.18), which affected the users' experience of the virtual environment. This was corrected for the subsequent experiments (Figure 6.19).

Figure 6.18 – Shop facade before corrections (plaza with original configuration)

Figure 6.19 – Shop facade after corrections (plaza with a setting of the 1st experiment)

Differences in the perception of the *Size* of real and virtual environments arose due to the fact that the real environment prevented users to walk in the car lanes, while the virtual environment allowed (Figure 6.20). During the experience of the virtual environment, users constantly walked in the car lanes to observe the environment from farther away. This way the area of the car lane in virtual environments was perceived as part of the public space which inflated (Figure 6.16) *Size* perception and also explains the marginal differences in the perception of *Enclosure* and *Openness*. In subsequent experiments, small fences, shrubs and/or bollards were used to prevent user to step into car lanes and correct this problem (Figure 6.21).

The perceptual difference observed in *Greenery Placement* was not unexpected since the greenery utilized in the CG models was different from the actual species present in the real environments. The difference was felt in environment S1 (Terrace Square) which had a specific tree configuration used to seclude part of the environment, which could not be replicated with the available models. This specific problem was not addressed in sub sequential experiments because of the unavailability of models that could mimic the exact built environment. Since sub sequential experiments aimed to compare different design options of the same virtual sites, it is assumed to be of no consequence because the same perceptual error will be carried to all design variations of any specific site.

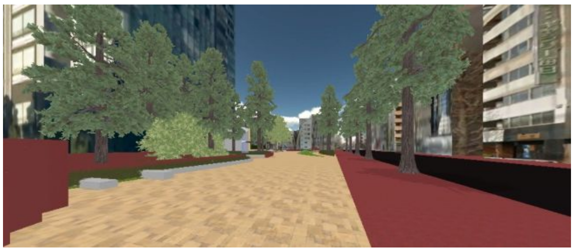


Figure 6.20 – Accessible car lane

Figure 6.21 – Inaccessible car lane

As a methodological validity, IVE environments generated similar results to real environments. The exception was *Greenery Placement* which depends on the models of greenery being used. For experiments that intend to compare virtual models of greenery to real greenery, the use of the exact models (e.g.: species, volume, texture, etc.) are necessary, although for virtual comparative studies, the perceptual difference may be carried as error, meaning that a difference of scores in a given scale reflects the difference of dependent variable, although it may not reflect the score to be obtained in a real setting.

Whenever computer graphics (CG) are used, there is a tradeoff between the level of detail, the cost to produce the CG and the improvement in response to be considered, which is why this experiment tried to not over detail its computer graphics. Future research may explore the relation between different detailing levels and a measurement scale's accuracy to determine the optimal CG cost ratio for each measurement scale.

7 FIRST EXPERIMENT: ELEMENTS EFFECT PRESENCE

Identified the elements that users claim to affect their perceptions and impressions of the environment, it was necessary to verify whether the stated elements were indeed having an effect or whether differences were arising from different aspects of the environment not consciously perceived by users.

With that purpose, a first experiment tested for the presence or abscense of an effect from the most common elements (i.e.: trees, seats, bushes) using immersive virtual environments, a method that allows the evaluation of diifferent design compositions while restricting the amount of confounding variables.

The environments were built in accordance to the original project, while conforming to the new variable levels. The amount of trees, bushes and seats would vary by adding or subtracting from the original designs, instead of being evenly distributed throughout the whole area.

7.1 Variables Selection

Based on the preliminary analysis described in chapter 5, "greenery" and "street furniture" were selected as variables. Greenery was separated into two different layers: bushes and trees. This was made for several reasons, the first being that they affect environment perception in different ways – while the trees provide cover and shadows with minimal obstruction of vision and movement, bushes obstruct movement, take the space of the environment and provide no shadow. The second reason is the fact that designers use both elements with different purposes in mind and they are not interchangeable. Thirdly, legislation in Japan considers – and scores – both elements separately. Therefore, there is theoretical and practical value in identifying the effects of each element separately even if users describe them together as "greenery".

Street furniture was simplified into seats for purely practical reasons: street furniture may be understood as a category of different elements that are not necessarily interchangeable meaning that the actual effect of each element would have to be assessed considerably increasing the number of variables rendering the study unfeasible. For seat type movable table and chairs were adopted. Previous studies (Gehl, 2011; Avalone Neto & Munakata,

2015) have shown that seats with backrest are preferred over simple benches and seats with tables often preferred overall, while movable seats are praised by Whyte (1980). Although the most flexible and preferred seat type, movable tables with 4 chairs are the seating that takes the most space, making them the most notable and allowing for an easier manipulation. The choice to adopt this kind of seat toke into consideration that, benches may not be noted by users and lead to misguiding results.

At last, tree height was included as a variable. Tree height is explicitly considered and individually scored in the "Tokyos' quality evaluation of public spaces in Japan" and they require an extra financial burden regarding unit cost and soil depth so the effects such an extra investment may have was of interest. For the first experiment, these variables were varied in two levels each, according to Table 7.1.

Table 7.1 – Factors selected for the 1st experiment

Factor	Level 1	Level 2
Seating Ratio (SR)	1%	5%
Bushes Ratio (BR)	10%	20%
Trees Cover Ratio (TCR)	20%	40%
Trees Height (TH)	5m	10m

The original seating design (sittable areas around flower beds and benches) of each space was maintained when possible and the area necessary to reach the predefined ratio was filled with tables and movable chairs. Seat type, material, design and color were kept constant across different stimulus.

Bushes and *Tree Cover Ratio* were achieved by adding or subtracting from the original design. Original placement was maintained when possible, but reducing the amounts resulted in the elimination of some areas previously present in the original design.

Building a full factorial design would require 16 stimuli per site. We chose to build a L_8 (2^7) Taguchi orthogonal array to evaluate the effect of each variable as well as the interactions between *Tree Height* and *Tree Cover Ratio*, *Tree Cover Ratio* and *Seating Ratio*, and *Tree Height* and *Seating Ratio* with only 8 stimuli per site (Table 7.2).

Table 7.2. – Taguchi design of the first experiment

	Tree Cover Ratio (TCR)	Tree Height (TH)	TCR x TH	Seating Ratio (SR)	TCR x SR	TH x SR	Bushes Ratio (BR)
Stimuli	1	2	3	4	5	6	7
1	20%	5m	1	1%	1	1	10%
2	20%	5m	1	5%	2	2	20%
3	20%	10m	2	1%	1	2	20%
4	20%	10m	2	5%	2	1	10%
5	40%	5m	2	1%	2	1	20%
6	40%	5m	2	5%	1	2	10%
7	40%	10m	1	1%	2	2	10%
8	40%	10m	1	5%	1	1	20%

7.2 Procedure

The same procedure of the validity experiment was adopted. Building façade texture was improved from the validity experiment to mitigate possible effects of display method present in *ambiance* and *interest* scales.

Each session consisted of the observation of one set of 8 stimuli, 2 from each of the 4 sites, either A, B, C or D stimuli group showed in random order (Table 7.3). Each environment would be loaded, observed and evaluated, followed by a brief (around 3-4 min) eye rest between stimuli. Participants were instructed about possible side effects of the VR equipment and to stop at any time the felt discomfort. If necessary, they could rest for as long as they wished between stimuli or end the experiment at any time.

Table 7.3 – Stimuli Distribution

Site	**S1**								**S2**								**S3**								**S4**							
Stimulus	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
Participant 1	A	A									A	A									A	A									A	A
Participant 2			B	B									B	B									B	B	B	B						
Participant 3					C	C									C	C	C	C									C	C				
Participant 4							D	D	D	D									D	D									D	D		
Participant 5	A	A									A	A									A	A									A	A
…																																

Participants were allowed to walk around in the virtual space for as long as they deemed necessary to grasp it. Once they felt comfortable to evaluate it, they removed the headset and started the evaluation by filling, by hand, a printed questionnaire. Participants were instructed to either wear the headset again or use the screen in front of them to check any aspect of the environment they deemed necessary while answering the questionnaire.

7.2.1 Participants

There were a total of 32 distinct stimuli – 8 variations to 4 different sites. Due to eye strain caused by prolonged usage of the VR equipment, only one set of 8 stimuli was randomly shown in a one hour session. The set contained 2 from each of the 4 sites stimuli so that the participant would see all 8 stimuli variations and all sites, but not the same stimulus at different sites (Table 7.3). This was done to prevent interaction between site and users, while any variation between users was eliminated by averaging the data.

A group of 4 participants provided 1 observation to all 32 stimuli. One person could participate in up to two sessions if they were willing to. For the second session, the participant was asked to return in another day and was given a set of stimuli (marked A-D in Table 7.3) different from the one he had previously evaluated.

A total of 56 people participated in the experiment, 33 participated in two sessions (evaluated 16 of 32 stimuli) and 23 participated in only 1 session, evaluating 8 stimuli. From those that participated of only one session, 1 person gave up in the middle of the evaluation and their data were discarded, resulting in a total of 89 sessions conducted with 88 of them yielding usable data. Each stimulus had a total of 22 observations with a total of 704 environment evaluations, gathered between January and February 2016.

Participants were all Japanese, university students (75 sessions) and office workers (13 sessions) from different fields, with an average age of 24 years (SD = 6.22).

7.3 Results

The data were analyzed using an average of each stimulus of each environment, resulting in 32 averaged data points – 8 for each environment. Each data point, therefore, is an average of 22 observations of a given stimulus. This was made to control for variance between participants and ensure that any statistical difference observed was due to variance in the stimuli and not derived from participants individual differences. An analysis of variance was made using the variables as predictors to the evaluation scales. "Site" was also included a predictor, as was the interactions with variables to assess variation between sites. A summary of the results is shown in Table 7.4

Table 7.4 – Effects summary.

	Activities					Impressions									Perceptions								
	Stay	Eat/Drink	Rest	Wait	Read	Appeal	Interest	Enclosure	Atmosphere	Relaxation	Openness	Oppression	Liveliness	Diversity	Size	Greenery Amount	Greenery Placement	Seat Amount	Seat Placement	Seat Design	View	Willingness to Pay	Willingness to Stay
TCR					40(+)	40(+)	40(+)	40(+)		40(+)	40(-)	40(+)			40(+)	40(+)							
TH				10(+)				10(+)												10(+)			
BR										20(+)	20(-)					20(+)							
SR	5(+)	5(+)	5(+)	5(-)	5(+)	5(+)	5(+)	5(+)	5(+)				5(+)	5(+)		5(+)	5(+)	5(+)	5(+)	5(+)	5(+)	5(+)	5(+)
TCR x TH										20x5 (-)	20x5 (+)												
TCR x SR																20x1 (-)							
TH x SR																							

All variables had two levels, as follows: tree cover ratio at 20 or 40% of floor area; tree height at 5 or 10m; bushes ratio at 10 or 20% of floor area and seating ratio at 1 or 5%of floor area. An indication such as 40(+) should be read as "and increase to 40% from 20% resulted in a positive effect on that evaluation scale". Interactions mark the only ones observed (such as 20x5 meaning *20% of floor area covered by 5m tall trees*) and the effect it had (such as (-) meaning *negative effect on that measurement scale*).

7.3.1 Activities

Table 7.5 – Effect on Activities

	Stay	Eat/drink	Rest	Read	Wait
TCR				5.91*	
TH					9.07*
BR					
SR	335.45**	384.89**	129.88**	47.74**	29.97*
TCR x TH					
TCR x SR					
TH x SR					
R^2	0.98	0.98	0.95	0.93	0.92

values expressed are F (1,31); ** = p<.0001; * = p<0.005.

All 5 activities were affected by the *Seating Ratio* (SR) with statistical significance. For all except *Wait* activity, environments with 5% were perceived as more suitable than those with only 1% of the floor area ratio occupied by seats. For wait activity the opposite effect was observed (Figure 7.1, Table 7.4 and Table 7.5).

Tree Cover Ratio (TCR) affected suitability perception of *Read* activity and environments that had 40% of the floor area covered by canopies being perceived as more suitable than those with only 20% of floor area.

Tree Height (TH) had an effect on *Wait* activity and environments with 10m tall trees were perceived as more suitable than environments with 5m tall trees.

Bushes ratio (BR) had no effect on the environments suitability for different activities, nor did the interactions TCR x TH, SR x TCR or SR x TR (Table 7.4 and Table 7.5)

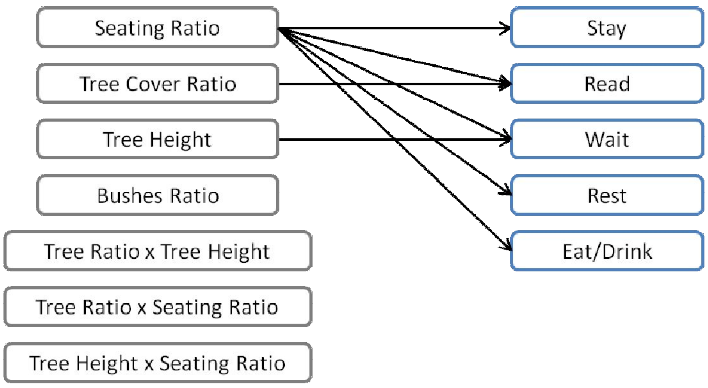


Figure 7.1 – Effects on Activities Suitability

7.3.2 Impressions

Increasing SR from 1% to 5% made 'A*ppeal', 'Interest', 'Enclosure'*, '*Atmosphere*', *'Liveliness'* and *'Diversity'* to be more positively felt. For positive impressions such as '*Appeal*' this means that the environment became more appealing, but this also means that potentially undesirable impressions, such as '*Enclosure'*, also increased (Figure 7.2, Table 7.4 and Table 7.6).

TCR also had a positive effect on *'Appeal'*, *'Interest'*, *'Enclosure'*, *'Relaxation'* and *'Oppression'* with 40% of floor area having a stronger effect that 20% of floor area covered by canopies while for 'O*penness'* the opposite was true (Figure 7.2, Table 7.4 and Table 7.6)

TH had an effect on the *'Enclosure'* with 10m tall trees causing the environment to be perceived as being more enclosed than 5m tall trees.BR had an effect on *'Relaxation'* and environments that had 20% were more relaxing than those with only 10% of floor area occupied by bushes. The opposite effect was observed for '*Openness'* impression (Figure 7.2, Table 7.4 and Table 7.6).

Interaction between TCR and TH was found in two scales: *'Relaxation'* and *'Openness'*. The combination of 20% floor area covered by 5m tall trees made environments feel less *'Relaxing'* and more '*Open'* than expected.

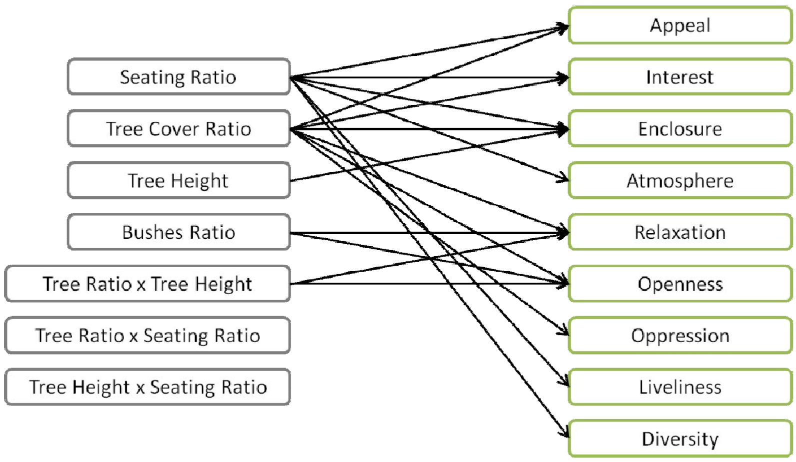


Figure 7.2 – Effects on Impressions

Table 7.6 – Effect on Impressions

	Appeal	Interest	Enclosure	Atmosphere	Relaxation	Openness	Oppression	Liveliness	Diversity
TCR	5.54*	5.65*	122.14 **		25.58*	94.20**	20.35*		
TH			6.27*						
BR					10.00*				
SR	33.37*	18.00*	12.76*	11.44*				148.19**	28.68*
TCR x TH					8.12*	8.42*			
TCR x SR									
TH x SR									
R^2	0.92	0.92	0.98	0.87	0.97	0.98	0.90	0.97	0.94

values expressed are F (1,31); ** = p<.0001; * = p<0.005.

7.3.3 Perceptions

SR had an effect on the perception of '*Greenery Amount*', '*Greenery Placement*', '*Seat Amount*', '*Seat Placement*', '*Seat Design*' and '*View*'. An increase in SR improved the perceived amount/placement/design/view (Figure 7.3, Table 7.4 and Table 7.7).

TCR had an effect on the perception of environment *'Size'* with environments that had tree canopies covering only 20% of the floor area being perceived as larger than those with 40% of its floor area covered by canopies. Also, with TCR at 40% of floor area, the environments were perceived as having a greater '*Greenery Amount*'. BR also had an effect on the perceived *'Greenery Amount'* with environments being perceived as having more greenery when bushes covered 20% than those environments where it only covered 10% of floor area (Figure 7.3, Table 7.4 and Table 7.7).

TH had an effect on *'Seat Design'* with 10m tall trees had a better effect than 5m tall trees.

An interaction between TCH and SR was found In '*Greenery Amount*', and greenery was perceived as less than expected when 20% floor area covered by tree canopies was combined with 1% of floor area ratio was occupied by seats.

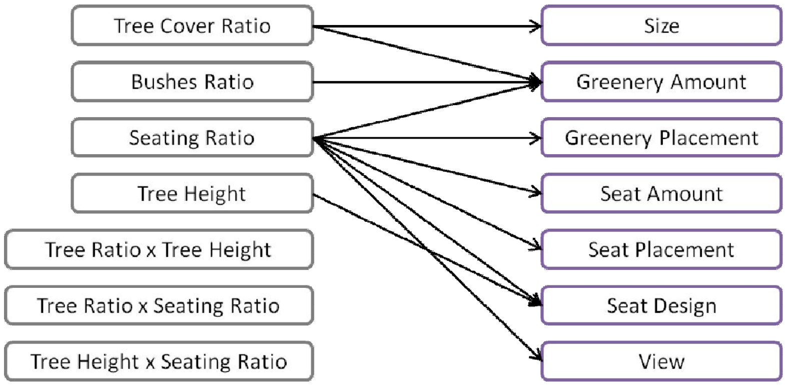


Figure 7.3 – Effects on Perception

Table 7.7 – Effect on Perceptions

	Size	Greenery Amount	Greenery Placement	Seat Amount	Seat Placement	Seat Design	View
TCR	4.98*	123.32**					
TH						6.02*	
BR		32.10*					
SR		8.24*	9.12*	638.28**	20.76*	43.65**	4.51*
TCR x TH							
TCR x SR		6.60*					
TH x SR							
R^2	0.97	0.96	0.91	0.99	0.90	0.94	0.71

values expressed are *F* (1,31); ** = p<.0001; * = p<0.005

7.3.4 Estimation of activity suitability from users' impressions

A second analysis was made to identify the relationship between an environments impression and users' perceptions of the environments suitability to develop different activities. In this analysis, averaged data was used and a multiple regression analysis was made using the impressions as predictors to the activity scales.

Several impression scales had collinearity making them redundant to predict a given behavior. Several possible models were tested using stepwise regression to identify which scales would best predict different activities using only non collinear scales. The best models had *relaxation* and *liveliness* as predictors (Figure 7.4). The numbers shown in Table 7.8 are the partial regression coefficient (β) and the variance inflation factor (VIF).

Table 7.8 – Activities estimation from impressions

	Stay	Eat/drink	Rest	Read	Wait
Relaxation	0.71 (1.27)	0.56 (1.27)	0.70 (1.27)	0.94 (1.27)	
Liveliness	1.18 (1.27)	1.53 (1.27)	0.67 (1.27)	0.67 (1.27)	-0.15 (1.00)
R^2	0.87**	0.83**	0.75**	0.75**	0.13*

values expressed are *partial regression coefficient (β),* followed by *(VIF).*
** = p<.0001; * = p<0.005.

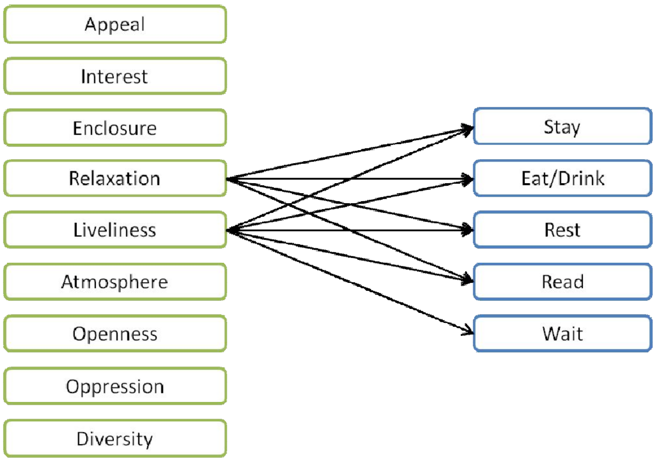


Figure 7.4 – Activity Predictions from Impressions of the Environment

7.3.5 Estimation of activity suitability from environmental perception

The same process and analysis were made using the perception scales as predictors to the activity scales (Figure 7.5). The values expressed in Table 7.9 are partial regression coefficients and the variance inflation factor (VIF).

Table 7.9 – Activities estimation from perceptions

	Stay	Eat/drink	Rest	Read	Wait
Size	0.14 (1.71)	0.20 (1.71)			
Greenery Amount					
Greenery Placement					-0.28 (2.43)
Seat Amount	0.37 (1.67)	0.60 (1.67)	0.20 (1.15)	0.14 (1.15)	-0.15 (1.30)
Seat Placement					
Seat Design	1.05 (1.74)	1.00 (1.74)	0.52 (1.23)	0.73 (1.23)	0.59 (1.64)
View	0.66 (1.18)	0.56 (1.18)	0.76 (1.18)	0.75 (1.18)	0.29 (1.99)
R^2	0.88	0.91	0.82	0.56	0.45
Prob. > p	**	**	**	**	**

values expressed are *partial regression coefficient (β)* , followed by *(VIF).*
** = p<.0001; * = p<0.005.

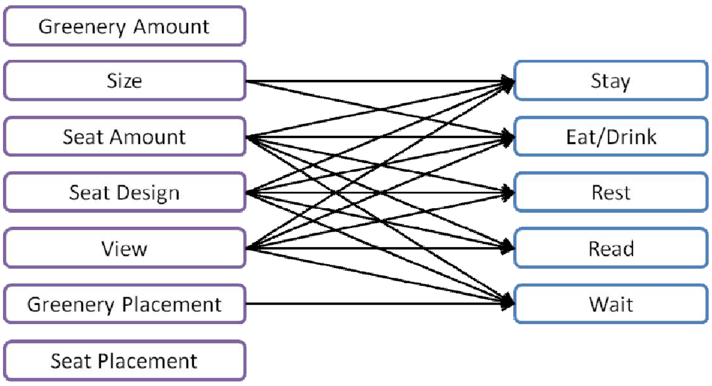


Figure 7.5 – Activities Predictions from the Perception of the Environment

7.3.6 Relationship between perceptions and impressions:

A multiple regression analysis was made using the perception scales as predictors to the impressions scales. This was made to establish a relation between what is perceived by users out of the environment and the impressions felt by users (Figure 7.6). Table 7.10 shows those estimations. The values expressed are partial regression coefficients and VIF was between 1.00 and 2.73.

Table 7.10 – Impressions estimation from perceptions

	Appeal	Interest	Enclosure	Atmosphere	Relaxation	Openness	Oppression	Liveliness	Divrsity
Size	0.16		-0.62	0.36	-0.32	0.57	-0.41	0.24	
Greenery Amount	0.22							0.23	
Greenery Placement	0.59	0.60							0.81
Seat Amount				0.11				0.40	
Seat Placement									
Seat Design									
View	0.56	0.59		0.45	0.58				
R^2	0.75	0.75	0.68	0.85	0.55	0.77	0.65	0.88	0.63
Prob. > p	**	**	**	**	**	**	**	**	**

values expressed are *partial regression coefficient (β)*;
** = p<.0001; * = p<0.005

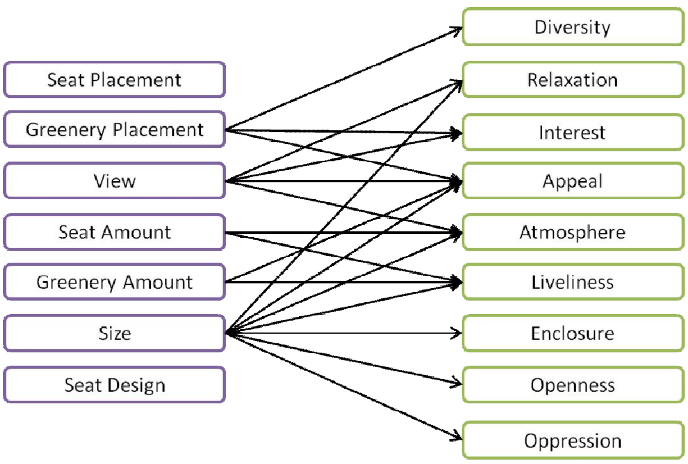


Figure 7.6 – Impressions Predictions from Environment Perception

7.3.7 Willingness to pay and stay

7.3.7.1 Willingness to pay:

The users were willing to pay more for a cup of coffee in environments with 5% of floor area occupied by seats than in environments with only 1% ($R^2 = 0.90$; $F(1, 31) = 54.15$; $p < .0001$). Increasing seats from 1 to 5% translates into an average 17% increase in willingness to pay for a cup of coffee.

Table 7.11 – Elements effects on Willingness to Pay (by site)

Site	**S1**	**S2**	**S3**	**S4**	**Average**
Standard Price *	262	230	212	299	251
Seating ratio at 5%	+43 (16%)	+42 (18%)	+80 (38%)	+5 (2%)	+43 (17%)
Bushes ratio 20%	-	-	-	-	-
Trees cover ratio at 40%	-	+19 (8%)	-	-	+\5 (2%)
Tree Height at 10m	-	-	-	-	-
Tree cover ratio 20% x Tree Height at 5m.	-	-	+22 (10%)	-	+6 (2%)

*prices for Seating ratio at 1%, Bushes ratio 10%, Tree cover ratio of 20% and Tree height of 5m.

7.3.7.2 Willingness to stay:

The users were willing to stay, on average, 43% longer in environments with 5% of floor area occupied by seats than in environments with only 1% ($R^2 = 0.95$; $F(1, 31) = 114.55$; $p < .0001$).

Table 7.12 – Elements effects on Willingness to Stay (by site)

Site	**S1**	**S2**	**S3**	**S4**	**Average**
Standard Price *	22min	15min	12min	21min	18min
Seating ratio at 5%	+6min (27%)	+7min (47%)	+14min (117%)	+3min (14%)	+8min (43%)
Bushes ratio 20%	-	-	-	-	-
Trees cover ratio at 40%	-	-	-	-	-
Tree Height at 10m	-	-	-	-	-

*Stay time for Seating ratio at 1%, Bushes ratio 10%, Tree cover ratio of 20% and Tree height of 5m.

7.3.8 Demographic analysis

Several demographic factors could have an effect on environment perception, such as gender (male or female), architectural background (architect or layperson) and work experience (student or worker). The effects of gender and architectural background were tested and are shown below.

7.3.8.1 Effects of gender

To investigate if there were any effect of gender, the data was averaged by site, stimuli and gender, resulting in 64 data points: 4 sites, 8 stimuli and 2 gender categories. This was done to eliminate the effect of differences between participants.

Because each stimulus is, essentially, a different environment structure, analysis used gender as a predictor for each of the 23 evaluation scales (Table 3.1) by stimulus, meaning that, in each of the 8 stimulus (Table 7.2) the average male and female answers for each environment were compared.

With 8 stimuli and 23 evaluation scales, 184 possible gender effects were tested. Each analysis considered 8 data points that represented the average male and female answer for each of the 4 sites given an evaluation scale and stimuli.

Effects of gender were only observed in 6 scales across all 184 possible stimuli/evaluation scale combinations. No effect could be seen in stimulus 1, 4, 5 or 7 (Table 7.2).

In stimulus 2 (tree ratio at 20%, tree height of 5m, seating ratio at 5%, and bushes ratio at 20%), gender effect could be observed in *eat/drink activity* ($R^2 = 0.63$; $F(1, 7) = 10.40$; $p = 0.0180$) and in *atmosphere* ($R^2 = 0.50$; $F(1, 7) = 6.05$; $p = 0.0492$). Women found the environments to be better suited to eat/drink activity and as having a better atmosphere than as perceived by man.

Stimulus 3 (tree ratio at 20%, tree height of 10m, seating ratio at 1%, and bushes ratio at 20%) showed a gender effect in *greenery amount* ($R^2 = 0.68$; F (1, 7) = 13.07; p = 0.0112) and women perceived the environment as having more greenery than did men.

In *stimulus* 6 (tree ratio at 40%, tree height of 5m, seating ratio at 5%, and bushes ratio at 10%), gender effect could be observed in *wait activity* ($R^2 = 0.51$; F (1, 7) = 6.15; p = 0.0479) and *liveliness* ($R^2 = 0.52$; F (1, 7) = 6.47; p = 0.0439), with women perceiving the environment and more suitable for wait activity and more lively than did men.

In stimulus 8 (tree ratio at 40%, tree height of 10m, seating ratio at 5%, and bushes ratio at 20%) gender effect could only be seen in *eat/drink activity* ($R^2 = 0.61$; F (1, 7) = 9.20; p = 0.0230) and women found the environments to be more suitable to eat/drink activity than man.

Since no evaluation scale had a consistent effect across different stimulus it is possible to assert that no gender effect could be consistently observed.

7.3.8.2 Effects of architectural background

Amongst the participants there were students and workers with and without architectural background meaning that the most suitable way of testing for expertise effect would be to look into differences between four groups: architectural students, non-architectural students, architects and non-architects, but with 4 different groups and 8 stimuli on 4 different sites, it is not possible to objectively evaluate the effects of participant's expertise in this manner because the data is heavily skewed towards students over workers. With the data averaged by stimuli, site, and the four groups, there are 128 distinct data points but with an irregular distribution. Overall, there were 22 observations of each stimulus of each site, but, when broken into the four expertise groups, one group will average 10 participants while another may average only 2.

There were no sufficient office workers with or without an architectural background in the sample to conduct a proper analysis. Any visible effect from expertise would not be distinguished from personal differences between participants, since there would not be sufficient individuals of each expertise group represented at all 32 different environment settings. Therefore, no definite statistical conclusion regarding expertise effect can be drawn from this dataset.

The effect of architectural background can be tested, however, within the student group (architecture students vs. non-architecture students), since there is sufficient data and an acceptable data distribution. An analysis to test the effects of architectural background on university students was conducted using the dataset averaged by site, stimuli and the four expertise groups. The analysis was then conducted by work/student condition, and the analysis regarding workers was disregarded.

Architecture background was used as predictor for each of the 23 evaluation scales (Table 3.1) by stimuli, meaning that, for each of the 8 stimuli (Table 7.2) the average answer of architecture students and non-architecture students for each environment was compared.

From the 184 possible expertise effects tested (23 evaluation scales in 8 different stimuli) only 3 showed an effect of architectural background. They were *view* ($R^2 = 0.55$; F (1, 7) = 7.20; p = 0.0364) in stimulus 1, *wait activity* ($R^2 = 0.51$; F (1, 7) = 6.17; p = 0.0476) in stimulus 5 and *greenery amount* ($R^2 = 0.62$; F (1, 7) = 9.89; p = 0.0200) in stimulus 6. Participants with architectural background found environments to have a worse view, being better for wait activity and as having more greenery than participants with no architectural background. No other effect could be seen in stimulus 2, 3, 4, 7 or 8.

Since there was no consistent effect across different stimuli it is possible to assume that architectural background had no effect on students' perception of the environment.

7.3.9 Discussion

Overall, all activities (*Stay, Rest, Eat/drink* and *Read*) with the exception of *Wait* are correlated, perceived and affected in a similar manner, being positively affected by *Seating Ratio*. *Read* activity was also positively affected by the *Tree Cover Ratio*.

Users based their judgment mainly on the perception of *Seat Amount*, *Seat Design, View* (*Stay*, *Rest*, *Eat/drink*) and environment *Size* (*Stay* and *Eat/drink*).

Lively and *Relaxing* environments are the most suitable for *Stay*, *Eat/drink*, *Rest* and *Read* activities. *Livable* environments are perceived through environment *Size*, *Seat Amount* and *Greenery Placement*, while the perception of environment *Size* and *View* will determine how *Relaxing* it will be perceived.

Wait activity requires a different environment, where less seats and taller trees are desirable. It is negatively affected by the perception of *Seat Amount* and *Greenery Placement*, but still positively affected by *View* and *Seat Design*. Less *Livable* places are more suitable for this activity.

Increasing *Seating Ratio* to 5% of floor area improved the environment *Appeal, Interest, Liveliness, Atmosphere* and *Diversity* impression, but it also made the environment seem more *Enclosed*.

Increasing *Tree Cover Ratio* improved the environments *Appeal, Interest* and *Relaxation* while making it seem more *Enclosed*, *Oppressive* and less *Open*.

Other, minor effects could be observed: taller trees increased the feeling of *Enclosure*; more bushes made it more *Relaxing*, but less open and the combinations of smaller trees (5m) at smaller ratios also made the environment more *Open* but less *Relaxing*.

Users' perception of the environment *Size* affected environment *Appeal*, *Liveliness*, *Atmosphere*, *Relaxation*, *Openness*, *Oppression* and *Enclosure*. *View* affected environment *Appeal*, *Interest*, *Atmosphere* and *Relaxation*. *Greenery Placement* affected environment *Appeal*, *Diversity*, *Interest* and *Liveliness*. The perception of *Seat Amount* affected *Atmosphere* and *Liveliness* while *Greenery Amount* only affected *Appeal*.

Seating Ratio affected the most users' perception of the environment, having an effect on how users perceive *Greenery Amount* and *Placement*; *Seat Amount*, *Placement* and *Design* and *View*. *Tree Cover Ratio* positively affected *Amount of Greenery* and negatively affected environment *Size* perception.

Other variables had a smaller effect on users' perception of the environment: *Amount of Greenery* perception was positively affected by the *Amount of Bushes* and negatively affected by the relation between less tree ratio and less seat ratio (trees as 20% of floor area and 1% of seats). *Seat Design* perception was also negatively affected by *Seating Ratio*. Table 7.4 summarizes the findings.

Some differences between sites were observed under the same conditions. Those differences were expected since the four sites were completely different in several aspects such as size, enclosure, retail space, location, access, surroundings and relationship to the street for which no control method was attempted. Broadly speaking, all sites displayed the same effects with more or less intensity with no environment displaying an "inverse" effect on a systematic way or across several scales. The environment's effects and interactions observed are briefly discussed below.

Terrace Square (S1) was perceived as more suitable than other environments for stay, rest and read activities: Trees at 20% also interacted positively with the environment for stay activity. It was perceived as less suitable than other environments for wait activity. It had a positive effect for environment appeal, interest, relaxation, diversity and enclosure. The feeling of enclosure was enhanced when combined with trees at 20%. With seats at 1%, S1 was perceived as less livable than other environments in the same condition. Users also perceived this environment as having fewer seats than other environments when seating ratio was only 1% of FAR; less greenery than other environments with the same bushes ratio, although the greenery was perceived as better placed. Its seat design was also perceived as better than other environments, when tree canopies occupied 20% of floor area. Differences in perception may be due to environment enclosure because S1 was the most enclosed space, with buildings close to the site on all sides and/or element placement since S1 had a distinct grove like area designed to be perceived as such (Figure 6.1).

Jinbocho (S2) was perceived as more suitable than other environments for stay activity when bushes were at 10%. It also was perceived as less suitable for read activity and people are willing to stay for shorter times than other environments under the same conditions. It was perceived as less enclosed, less relaxing, more spacious and livelier than other environments at the same condition. Enclosure perception was accentuated when trees were at 5m and mitigated when seating ratio was at 1%. It was also seen as less relaxing when seats were at 1%. It was perceived as larger than other environments under the same conditions and seat design perception was improved when tree height were 5m. Impressions regarding enclosure, relaxation, openness, unsuitability for reading and environment size perception may be related with the amount of environment enclosure, since S2 was the least enclosed space, with only one side enclosed and three sides open to the streets (Figure 6.2).

Insurance Annex (S3) was perceived as worse than other environments under the same conditions for stay and eat/drink activities and better for wait activity. When tree canopies occupied 20% of floor area, suitability for wait activity was worse than in other environments under the same conditions. When seats were at 1%, suitability for stay, eat/drink, rest and read activities declined as did environment appeal, interest, relaxation and diversity impressions. Users were inclined to pay less for a cup of coffee (Table 7.11) and stay less time in the environment than in other environments under the same conditions (Table 7.12). It was perceived as more enclosed and less spacious (accentuated when trees were 5m tall); more oppressive, having worst atmosphere, more relaxing (mitigated by trees at 20%), and less lively than other environments under the same conditions. It was also perceived as smaller, with more greenery (mitigated by bushes at 10%), better placed greenery, fewer but better placed and better designed seats (mitigated by seats at 1%) S3's differences in perception most likely were related to environment scale: with an open public space area under 600m², it was the smallest space studied and the easiest environment to be grasped and judged in its totality (Figure 6.3). On small environments, 1% of floor area may be translated in only one seat affecting the way (units instead of volume) the environment is perceived and judged.

7.4 Conclusions:

It is clear that seating ratio is the element that most affect users' perceptions, impressions and, ultimately the activities users will perform in the public space. Overall, increasing the amount of seats in the public space will improve impressions and perceived suitability for different activities. Conversely, it will also make it feel more enclosed and less suitable for wait activity.

Although tree cover ratio did not have a direct effect on intended activities, it did had an effect in several impressions of the environment, such as appeal, interest, relaxation, oppression openness and enclosure as well as the perception of environment size and greenery placement. It had a greater impact than bushes, which just affected the perception of openness and relaxation. Furthermore, this experiment investigated users' evaluations once they are already in the environment and it does not account for effects in perception when observed from afar, which may affect users' decision to enter the public space or contribute to other dimensions of the built environment.

The effects from different sites seems to derive from environment scale and degree of enclosure and environments of different scales is perceived differently, especially very small (under 1000m^2) and very large (over 3000m^2). The specific effect of environment scale and degree of enclosure (enclosed in one, two, three or four of its sides) should be further explored in future research.

This study provided an insight of what have and what does not have an effect, but it was very limited since it only used two levels for each variable. Further experiments that explore the limits to which increasing seating, bushes and tree ratio starts to have a negative impact were still necessary.

8 SECOND EXPERIMENT: SEATS EFFECT RANGE

In the first experiment, it was established that increasing seating ratio will improve perceptions and impressions of the environment as well as perceived suitability for different activities, as shown in Table 7.4.

The second experiment assessed whether the effect persisted at higher seating ratios or whether perception and impressions would deteriorate. It also tested the effects of environment scale as it was considered in the first experiment.

8.1 Implementation

The same methodology of the first experiment was adopted for comparative purposes and IVEs were used to test the effects of different seating ratios and environment size combinations. This experiment adopted two variables, each varying in three levels: seating ratio at 1%, 3% and 10% and environment size varying from small (600m^2), medium (2000m^2) and large (3500m^2), resulting in 9 different environment combination (Table 8.1).

Table 8.1 – Stimuli matrix

	Small (600m^2)	Medium (2000m^2)	Large (3500m^2)
Seating ratio at 1%	S01	S04	S07
Seating ratio at 3%	S02	S05	S08
Seating ratio at 10%	S03	S06	S09

While the first experiment used variations of four real environments with different areas, surrounding conditions, street width and so on, the second experiment controlled for all variables except seating ratio and POPS area (Table 8.1).

Figure 8.1 – Stimulus 01

Figure 8.2 – Stimulus 02

Figure 8.3– Stimulus 03

Figure 8.4– Stimulus 04

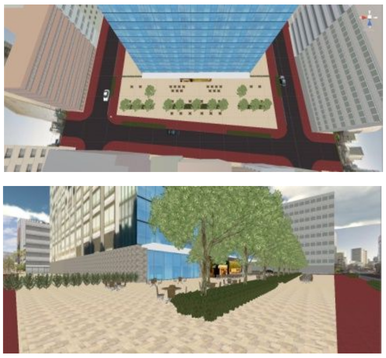


Figure 8.5 – Stimulus 05

Figure 8.6 – Stimulus 06

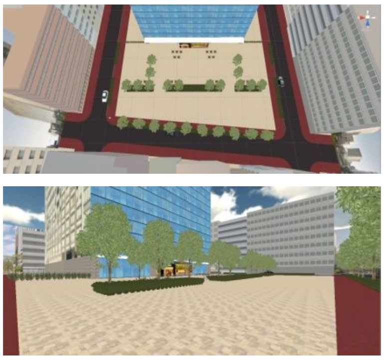


Figure 8.7 – Stimulus 07

Figure 8.8 – Stimulus 08

Figure 8.9 – Stimulus 09

IVE stimuli were made using SketchUp and compiled into the software Unity for the final environments. All stimuli had 10% of floor area covered by bushes and 10% covered by trees. The site was always open to 3 sides to streets 7m wide while the fourth side was occupied by a 120m tall (34 floors) building with a coffee shop on the ground level. All sidewalks were designed with 4m wide and the total area of the plaza includes sidewalk area (Figure 8.1 to Figure 8.9). Stimuli were presented to participants using an Oculus rift HMD (Figure 6.11), and participants were able to move around the environment using a Logicool gamepad (Figure 6.12).

Questionnaires were presented in paper format, after the participant examined each environment. Participants were still able to see the environment in the monitor and move through it while answering the questionnaire and were free to wear the IVE goggles as much as they wanted for each environment, even in the middle of the questionnaire if they deemed necessary.

8.1.1 Participants

There were 20 participants in the study (13 Male, 7 Female), all Japanese university students from different fields. Participants averaged 21.25 years of age (SD=1.52) and each of them evaluated all 9 stimuli.

8.2 Results

An analysis of variance was conducted to evaluate the presence/absence of each variable's effect and differences between levels.

8.2.1 Activities:

Seating ratio had an effect in *Stay*, *Eat/drink* and *Rest* activities. Increasing seating ratio from 1% to 3% increased perceived suitability for those activities while increasing it to 10% reduced perceived suitability (Table 8.2).

No effect of *Seating Ratio* could be observed in *Read activity* while *Wait* activity was negatively affected. Although increasing *Seating Ratio* from 1% to 3% had no significant effect, increasing it up to 10% reduced perceived suitability for *Wait* activity.

Scale also had an effect. For *Stay* activity small environments were worse than medium or large environments, but no statistical difference was observed between medium and large scale environments and no interaction was observed.

For *Eat/drink* activity and *Read* activity, small environments were less suitable than medium environments and large environments were not statistically different than neither small nor medium environments. No interaction was observed for either *Stay*, *Eat/drink*, *Read* or *Rest* activities (Table 8.2).

No effect of scale was observed for *Rest or Wait* activities. An interaction could be observed between small environments and seating ratio at 10% for *wait* activity: for small environments the negative effect of a high *Seating Ratio* was mitigated by environment size. Differences between *Wait* and other activities may arise from a specific behavior required for such activity – visual search. The more things occupy the field of vision the more strain a visual search requires but an environment with only 600m^2 may be small enough that more elements in the visual field will not cause strain since the environment may be fully grasped with ease.

Table 8.2 – Effect on Activities

	Stay	Eat/drink	Rest	Read	Wait
Seating Ratio	21.00**	12.30**	5.89**		20.42**
Scale	8.93*	3.51*		5.15*	
SR x Scale					2.50*
R^2	0.27	0.19	0.12	0.12	0.23

values expressed are F (2,171); ** = p<.0001; * = p<0.005.

8.2.2 Impressions:

Seating Ratio effects could also be seen in *Appeal*, *Interest*, *Atmosphere* and *Diversity*. Increasing *Seating Ratio* up to 5% improved the impression, but increasing past 5% worsens it.

For *Relaxation*, *Openness, Oppression* and *Enclosure* there was no effect when *Seating Ratio* was increased from 1% to 3%, but an effect could be seen between 1% and 10%. The impressions were worst with seating at 10% of floor area ratio and environment were perceived as being less *Relaxing*, less *Open* more *Oppressive* and more *Enclosed*.

There was a clear effect where *Liveliness* increased as *Seating Ratio* increased. No upper limit was found for this effect and it probably relates with the environment affordance – the more seats, the more the environment allow for it to be bustling with activities. It is worth noticing that the simulated environments had no people in it but empty chairs. One may assume that a lot of empty seats would signalize the absence of people (and the opposite of liveliness) but since all environments were equally empty and since humans make comparative rather than objective judgment, it is reasonable to assume that the affordance for liveliness was assessed. This assessment may change with different amounts of people occupying the environment (e.g.: one person occupying only one seat in a 10% seating ratio environment) but that still has to be tested in further studies.

Interest, *Liveliness* and *Diversity* were also affected by *scale* and small environments were worse than medium ones. No difference between medium and large or small and large environments was observed and no interaction was observed.

Feelings of *Enclosure* and *Oppression* were mitigated by the *Scale* of large environments ($3500m^2$), although small and medium environments were statistically the same. No interaction was observed.

The opposite happened to *Openness*: medium and large environments were perceived as more open than small scale environments, although no statistical difference could be observed between medium and large environments and no interaction was observed.

No effect of *Scale* or interaction could be observed for *Appeal*, *Atmosphere* or *Relaxation*.

Table 8.3 – SR and Scale Effects on Impressions

	Appeal	Interest	Enclosure	Atmosphere	Relaxation	Openness	Oppression	Liveliness	Diversity
Seating Ratio	12.23**	12.71**	9.09*	7.57*	18.92**	19.02**	18.77**	69.40**	7.25*
Scale		5.67*	7.90*			8.93*	7.35*	8.16*	7.73*
SR x Scale									
R^2	0.17	0.20	0.17	0.11	0.21	0.25	0.24	0.49	0.17

values expressed are F (2, 171); ** = p<.0001; * = p<0.005.

8.2.3 Perception:

There was an effect of *Seating Ratio* in the perception of environment *Size* and seat placement. Increasing *Seating Ratio* up to 10% will make the environment feel smaller with worst placed seats. This effect is probably due to cluttering. No statistical difference was found between 1% and 3% *Seating Ratio*.

The perception of *Seat Amount* matched the actual *Seating Ratio* at all variable levels, showing that no perception bias arose from the method chosen.

Although the data show an effect of *Seating Ratio* in *Greenery Placement*, since the environment changes size, greenery was, indeed, placed differently (e.g.: different distances from the curb) making it impossible to say if the observed effect is the effect of a bias or actual greenery placement.

Seating Ratio did not have an effect in the perception of *Greenery Amount*, *Seat Design* or *View*.

Size perception did match actual *environment Scale* at all levels, showing that no scale perception bias arose from the selected method. No interaction between *Seating Ratio* and environment *Size* was observed.

An effect of *Scale* could be observed in the perception of *Greenery Amount* and *Seat Amount*. Small environments were perceived as having less than medium or large scale environments with the same ratio (i.e.: greenery at 10% of floor area) and no interaction was observed.

No effect of *Scale* or interactions could be observed in the perception of *Seat Placement*, *Seat Design* or *View*.

Table 8.4 – SR and Scale Effects on Perceptions

	Size	Greenery Amount	Greenery Placement	Seat Amount	Seat Placement	Seat Design	View
Seating Ratio	5.49*		4.96**	232.70**	5.31*		
Scale	66.29**	8.66*	0.95*	24.93**			
SR x Scale							
R^2	0.46	0.11	0.10	0.75	0.10		

values expressed are F (2, 171); ** = p<.0001; * = p<0.005

8.2.4 Willingness to pay and willingness to stay:

No valid model that included both *Seating Ratio* and environment *Scale* could be made. When considering only *Seating Ratio* as a predictor, a small effect ($R^2 = 0.06$; F (2, 177) = 5.19; p = 0.0065) in *Willingness to Pay* could be observed. *Willingness to Pay* increases with *Seating Ratio* up to 3%, but diminished as it reached 10%. Environment *Scale* had no effect in *Willingness to Pay* and no interaction was observed.

Willingness to Stay was effected ($R^2 = 0.09$; F (2, 171) = 6.07; p = 0.0028) by *Seating Ratio* with increasing duration up to 3% and diminishing durations at 10%. No effect of *Scale* or interaction was observed.

8.2.5 Demographic analysis

Effects of gender and architectural background were tested and the results are described below.

8.2.5.1 Effects of gender

To analyze the effects of gender, the averaged data by stimuli and gender was used, resulting in 18 data points. Each data point was the average answer for a given stimulus and gender, and corresponded to the averaged answer of 7 participants when female and 13 participants for male data points. An analysis of variance using male and female averaged answers for the 9 stimuli was conducted.

Whiting the 23 different evaluation scales (Table 3.1) only perception of seat design was affected by gender ($R^2 = 0.86$; F (1, 17) = 96.79; p < .0001), with women perceiving seats as better designed than man. All other evaluation scales had no significant gender effect.

8.2.5.2 Effects of architectural background

The effects of architectural background used an averaged answer by background and stimuli, resulting in 18 data points – one for each stimulus and background. An analysis of variance using background as predictors for each of the 23 evaluation scales was conducted.

Four evaluation scales were affected by architectural background: *Appeal* ($R^2 = 0.28$; F (1, 17) = 6.12; p = 0.0250), *Diversity* ($R^2 = 0.25$; F (1, 17) = 5.22; p = 0.0363), *Greenery Amount* ($R^2 = 0.29$; F (1, 17) = 6.41; p = 0.0222) and *View* ($R^2 = 0.34$; F (1, 17) = 8.12; p = 0.0116). All other scales had no significant effect of architectural background.

Generally, people with architectural background found environments to be less appealing, less diverse, having less greenery and having a worse view, in agreement with Llinares & Inarra, (2014) and Akalin, Yildirm, Wilson & Kilicoglu (2009) that people with architectural background are more critical of the environment than laypeople.

8.3 Discussion

The effects of *Seating Ratio* in perceived suitability for different activities agreed with the first experiment and suggest that optimal ratio is between 3 and 5% of floor area (Figure 8.10). When combining the results of both studies, no discrepancies were found and a seating ratio of 3% or 5% received similar ratings for all activities and impression scales (Figure 8.10 and Figure **8.12**).

Between both experiments, impressions followed one of three distinctive patterns: a) score improved linearly, as seating ratio improved: this happened to *Openness*, *Oppression* and *Liveliness*; b) score improved up to 3% to 5% and worsened past 5% - *Appeal*, *Interest*, *Relaxation* and *Diversity*; and c) score improved linearly up to 5% and remained the same past that point – *Enclosure* and *Atmosphere* (Figure 8.12).

Seating Ratio had effects similar to the first experiment in environmental perception for the *perception of Size*, *Greenery Amount*, *Greenery Placement*, *Seat Amount* and *Seat Placement* (Figure 8.14). Differences were found, however, regarding the perception of *Seat Design* and *View*: while in the first experiment a positive effect of *Seating Ratio* in those scales was found, no effect was found in the second experiment. This discrepancy is not unexpected since their experiments utilized four different environments – with different seat designs and surrounding buildings – and this study controlled for such variables.

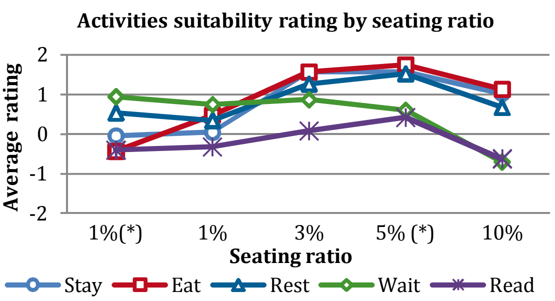


Figure 8.10 – Activities average rating by seating ratio.
"(*)" denotes results obtained from 1st experiment

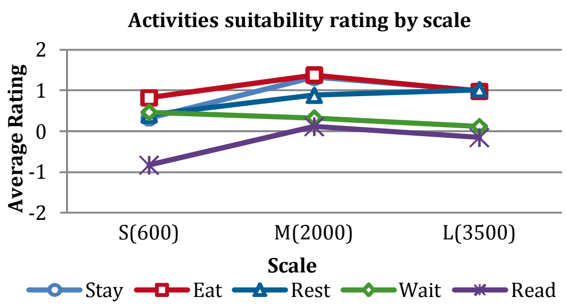


Figure 8.11 – Activities average rating by scale.

This study also found an effect of *Scale*, as expected from the results of the first experiment. Small environments (600m²) were, indeed, perceived as less suitable for *Stay*, *Eat/drink* and *Read* activity (Figure 8.11) as well as *less Interesting*, *more Enclosed*, *less Open*, *more Oppressive*, *less Lively* and *less Diverse* aelement environments built with the same elements composition (Figure 8.13). Small environments were perceived as having *less Greenery* and *less Seating* than bigger environments, which substantiates that the perception of smaller environments (600m²) is different than the medium (2000m²) or large (3500m²) environments (Figure 8.15). In small environments, it is possible for the user to grasp the whole environment at a glance. In this situation, it appears that the user registers the environment "by numbers" (i.e.: "*there are 3 seats here*") while in a bigger environments, this is not possible and a perception "by area" (i.e.: "*there are a lot/not enough seats here*") seems to be used.

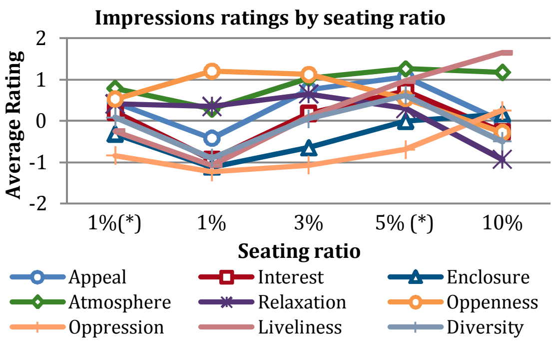


Figure 8.12 – Impressions average rating by seating ratio.
"(*)" denotes results obtained from 1st experiment

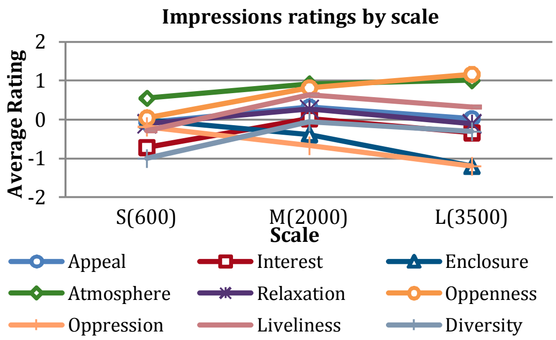


Figure 8.13 – Impressions average rating by scale.

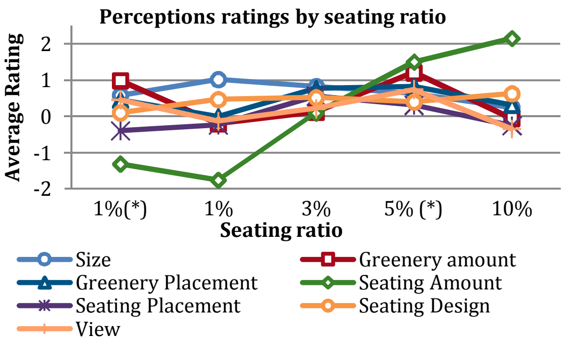


Figure 8.14 – Perceptions average rating by seating ratio.
"(*)" denotes results obtained from 1st experiment

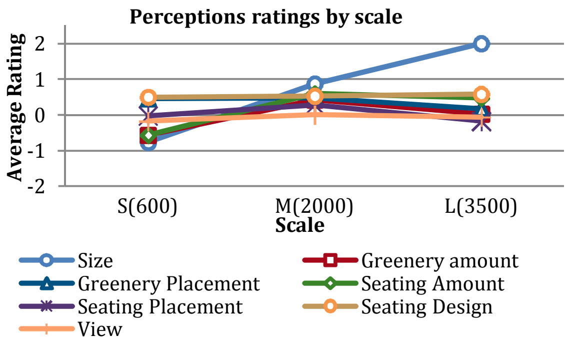


Figure 8.15 – Perceptions average rating by scale.

As with the first experiment, increasing seating ratio to 3% also increased *Willingness to Pay* and *Stay*. This shows a perceived improvement in the overall quality of the environment and not only in specific individual metrics: users perceived the environment as, overall, better and were willing to stay longer and pay more for a cup of coffee based solely on the amount of seats in the POPS.

8.4 Multi-regression Analysis

A Multi-regression analysis was conducted. While the analysis of variance allows for the evaluation of the presence/absence of a variable effect and to identify which levels are different from others, the multiple regression analysis allows a quantification of each level of each variable for each evaluation scale, which allows for a simple and quick comparison between different scenarios. Table 8.5 summarizes the results.

Table 8.5 – Formulae from seating ratio and environment scale.

Scale	Formulae				R^2	Prob>t ratio
Stay Activity	+0.88	-0.83 [if seating ratio = 1%] +0.68 [if seating ratio = 3%] +0 [if seating ratio = 10%]	-0.55 [if scale is 600] +0.43 [if scale is 2000] +0 [if scale is 3500]		0.25	<.0001**
Eat/Drink Activity	+1.06	-0.58 [if seating ratio = 1%] +0.51 [if seating ratio = 3%] +0 [if seating ratio = 10%]	-0.24 [if scale is 600] +0.32 [if scale is 2000] +0 [if scale is 3500]		0.15	<.0001**
Rest Activity	+0.77	-0.42 [if seating ratio = 1%] +0.5 [if seating ratio = 3%] +0 [if seating ratio = 10%]	-0.37 [if scale is 600] +0.12 [if scale is 2000] +0 [if scale is 3500]		0.09	0.0022**
Wait Activity	+0.31	+0.44 [if seating ratio = 1%] +0.56 [if seating ratio = 3%] +0 [if seating ratio = 10%]	+0.16 [if scale is 600] +0.03 [if scale is 2000] +0 [if scale is 3500]	-0.56 [600x1%] -0.03 [600x3%] +0.12 [2000x1%] +0.21 [2000x3%]	0.24	<.0001**
Read Activity	-0.28	-0.03 [if seating ratio = 1%] +0.37 [if seating ratio = 3%] +0 [if seating ratio = 10%]	-0.53 [if scale is 600] +0.4 [if scale is 2000] +0 [if scale is 3500]		0.08	0.0047**
Appeal	+0.1	-0.52 [if seating ratio = 1%] +0.65 [if seating ratio = 3%] +0 [if seating ratio = 10%]			0.12	<.0001**
Interest	-0.34	-0.59 [if seating ratio = 1%] +0.52 [if seating ratio = 3%] +0 [if seating ratio = 10%]	-0.38 [if scale is 600] +0.38 [if scale is 2000] +0 [if scale is 3500]		0.17	<.0001**
Enclosure	-0.53	-0.58 [if seating ratio = 1%] -0.12 [if seating ratio = 3%] +0 [if seating ratio = 10%]	+0.52 [if scale is 600] +0.15 [if scale is 2000] +0 [if scale is 3500]		0.17	<.0001**
Atmosphere	+0.82	-0.54 [if seating ratio = 1%] +0.21 [if seating ratio = 3%] +0 [if seating ratio = 10%]	-0.28 [if scale is 600] +0.09 [if scale is 2000] +0 [if scale is 3500]		0.10	0.0010**
Relaxation	+0.02	+0.33 [if seating ratio = 1%] +0.63 [if seating ratio = 3%] +0 [if seating ratio = 10%]			0.17	<.0001**
Openness	+0.68	+0.52 [if seating ratio = 1%] +0.44 [if seating ratio = 3%] +0 [if seating ratio = 10%]	-0.63 [if scale is 600] +0.14 [if scale is 2000] +0 [if scale is 3500]		0.24	<.0001**
Oppression	-0.68	-0.55 [if seating ratio = 1%] -0.38 [if seating ratio = 3%] +0 [if seating ratio = 10%]	+0.5 [if scale is 600] +0.02 [if scale is 2000] +0 [if scale is 3500]		0.23	<.0001**
Liveliness	+0.23	-1.29 [if seating ratio = 1%] -0.13 [if seating ratio = 3%] +0 [if seating ratio = 10%]	-0.51 [if scale is 600] +0.41 [if scale is 2000] +0 [if scale is 3500]		0.46	<.0001**
Diversity	-0.45	-0.45 [if seating ratio = 1%] +0.5 [if seating ratio = 3%] +0 [if seating ratio = 10%]	-0.55 [if scale is 600] +0.4 [if scale is 2000] +0 [if scale is 3500]		0.15	<.0001**
Size Perception	0.7		-1.47 [if scale is 600] +0.16 [if scale is 2000] +0 [if scale is 3500]		0.42	<.0001**
Greenery Amount	-0.04		-0.52 [if scale is 600] +0.46 [if scale is 2000] +0 [if scale is 3500]		0.09	0.0002**
Greenery Placement	+0.36	-0.36 [if seating ratio = 1%] +0.40 [if seating ratio = 3%] +0 [if seating ratio = 10%]	+0.09 [if scale is 600] +0.11 [if scale is 2000] +0 [if scale is 3500]		0.06	0.0242*
Seat Amount	+0.17	-1.92 [if seating ratio = 1%] -0.07 [if seating ratio = 3%] +0 [if seating ratio = 10%]	-0.73 [if scale is 600] +0.43 [if scale is 2000] +0 [if scale is 3500]		0.75	<.0001**
Seat Placement	No valid model.					
Seat Design	No valid model.					
View	No valid model.					
Willingness to Pay	+258.33	-26.67 [if seating ratio = 1%] +40 [if seating ratio = 3%] +0 [if seating ratio = 10%]			0.06	0.0065**
Willingness to Stay	+26.22	-4.22 [if seating ratio = 1%] +7.11 [if seating ratio = 3%] +0 [if seating ratio = 10%]			0.06	0.0028**

8.5 Nominal Logistic Regression Analysis

At last, we conducted a logistic regression analysis for each scale. Logistic regressions use the raw data to plot the response along the range of the dependent variable. In this kind of analysis, it is possible to identify what percentage of respondents would find any value of the dependent variable acceptable or not, which allows for a dynamic visualization of the effects the variables have in each scale and is not constrained by interpretations of average. Alongside each regression plot, the regression model and its probability range is provided.

Several scales had a response better fitted for quadratic rather than linear functions. In those cases, linear regression will not yield a valid regression model and a quadratic logistic regression is provided. When plotted into a quadratic surface, the probabilities of higher and lower responses are maximized. The quadratic plot uses the same arithmetic and structural parameters, but the curves are plotted as to become a folded pile of curves with the optimal response at the same point (critical value) instead of shifting logistic curves. While the continuous response plot displays the population response score along the variables range, the quadratic surface plot is centered around a critical value "X" that will yield the highest probability of favorable outcomes (highest scores). Critical values are plotted at Mean (X) – 0.5*b1/b2 where "b1" is the linear coefficient and "b2" is the quadratic coefficient.

Even when a linear or quadratic model was not statistically significant, the analysis is shown for comparison purposes. For easy recognition, models that were not statistically significant are shaded gray.

The graph is divided in three areas, from negative, neutral to positive responses. The 7 point scale was divided into three segments: -3, -2, -1 as negatives; 0 as neutral and +1, +2, +3 as positive. In other words, answers that included "extremely agree", "agree" and "somewhat agree" with the negative side of the scale (e.g.: unsuitable, unappealing, etc.) is plotted as negative; "neither" is plotted as neutral and "extremely agree", "agree" and "somewhat agree" with the positive side of the scale is plotted as positive.

8.5.1 Activities

8.5.1.1 Stay Activity

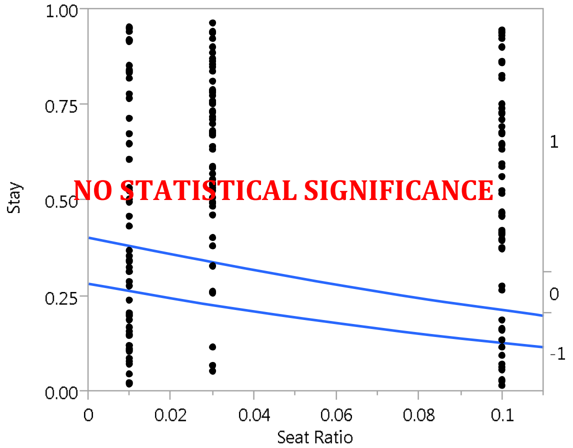


Figure 8.16 – Logistic Regression for Stay Activity from Seating Ratio

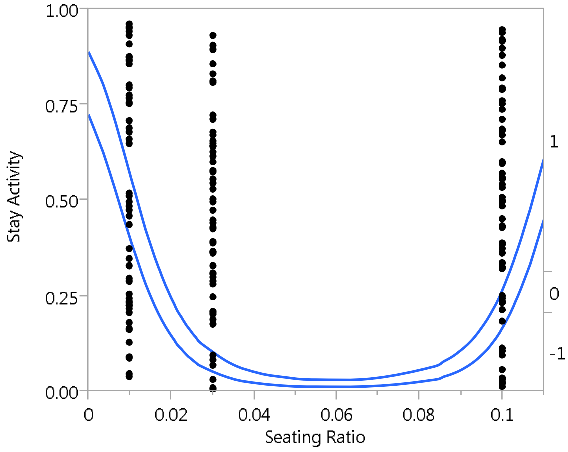


Figure 8.17 - Quadratic Logistic Regression for Stay Activity from Seating Ratio

Table 8.6 – Logistic Model for Stay Activity based on seating ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	ln (Ŷ/(1- Ŷ)) = – 0.75 – 10.70* [seating ratio]	0.02	p = 0.0952
Lower	ln (Ŷ/(1- Ŷ)) = – 1.59 – 6.19* [seating ratio]	0.04	p = 0.0952

A statistically significant logistic regression model could not be made for stay activity from seating ratio. The quadratic logistic regression model was statistically significant ($R^2 = 0.11$; $p < .0001$) and shows a critical value of 0.06, or 6% of floor area ratio as seating being optimal for stay activity.

8.5.1.2 Eat/Drink Activity

No statistically significant logistic regression model could not be made to Eat/drink activity from seating ratio. The quadratic logistic regression model was statistically significant ($R^2 = 0.11$; $p < .0001$) and shows a critical value of 0.05, or 5% of floor area ratio as seating being optimal for eat/drink activity.

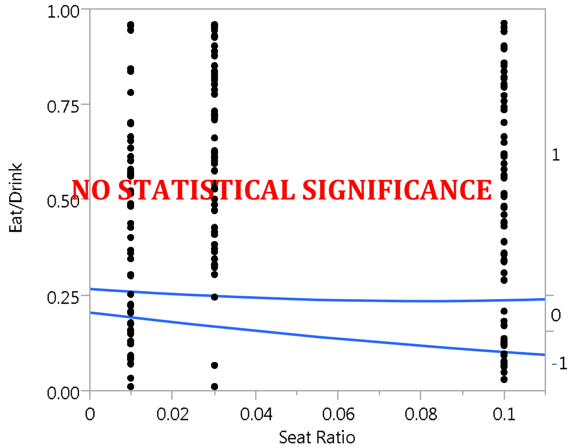


Figure 8.18 – Logistic Regression for Eat/drink Activity from Seating Ratio

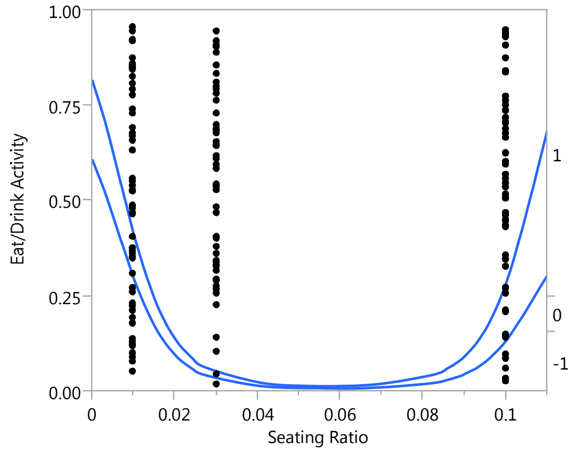


Figure 8.19 – Quadratic Logistic Regression for Eat/drink Activity from Seating Ratio

Table 8.7 – Logistic Model for Eat/Drink Activity based on seating ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	ln (Ŷ/(1- Ŷ)) = – 1.27 – 7.36* [seating ratio]	0.01	p = 0.1783
Lower	ln (Ŷ/(1- Ŷ)) = – 2.46 – 7.43* [seating ratio]	0.01	p = 0.1783

8.5.1.3 Rest activity:

No statistically significant logistic regression model could be made for rest activity from seating ratio. The quadratic logistic regression model was statistically significant ($R^2 = 0.03$; $p = 0.0447$) and shows a critical value of 0.06, or 6% of floor area ratio as seating being optimal for rest activity.

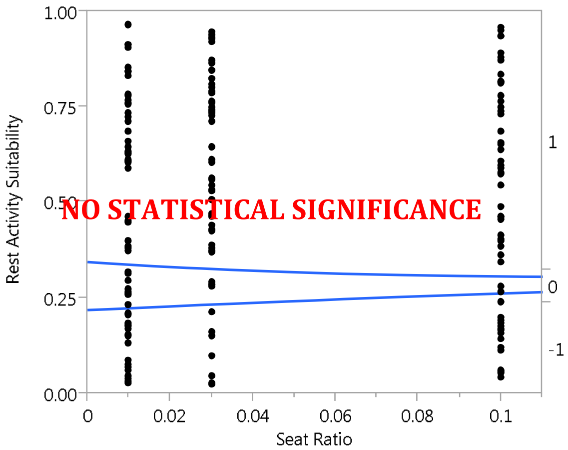


Figure 8.20 – Logistic Regression for Rest Activity from Seating Ratio

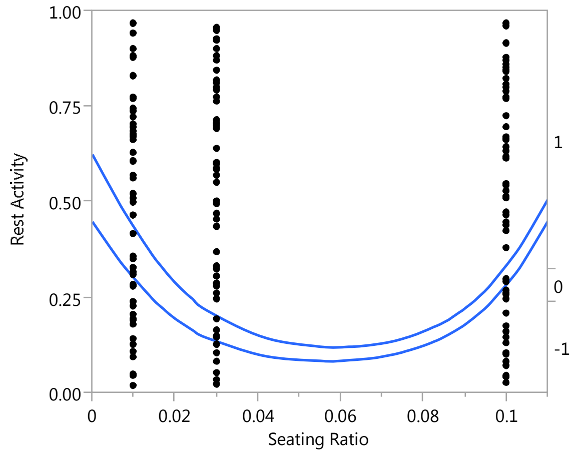


Figure 8.21 – Quadratic Logistic Regression for Rest Activity from Seating Ratio

Table 8.8 – Logistic Model for Rest Activity based on Seating Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	ln (Ŷ/(1- Ŷ)) = – 1.10 – 1.27* [seating ratio]	0.0075	p = 0.33
Lower	ln (Ŷ/(1- Ŷ)) = – 1.66 – 10.94* [seating ratio]		

8.5.1.4 Wait activity:

A statistically significant logistic regression model could be made for wait activity from seating ratio. The quadratic logistic regression model was also statistically significant (R^2 = 0.11; $p < .0001$) but since the relationship between variables is linear, it does not provide a useful critical value.

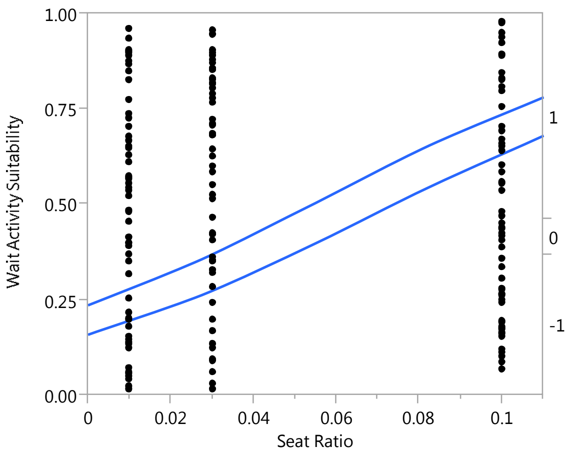


Figure 8.22 – Logistic Regression for Wait Activity from Seating Ratio

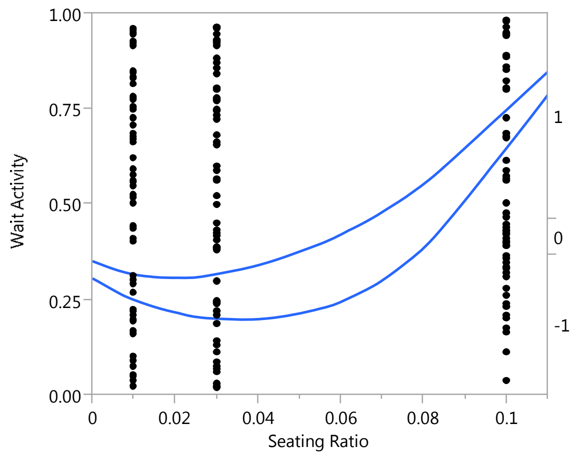


Figure 8.23 – Quadratic Logistic Regression for Wait Activity from Seating Ratio

Table 8.9 – Logistic Model for Wait Activity based on Seating Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	ln (Ŷ/(1- Ŷ)) = – 1.57 + 24.55* [seating ratio]	0.10	p <.0001**
Lower	ln (Ŷ/(1- Ŷ)) = – 2.30 + 13.88* [seating ratio]		

8.5.1.5 Read activity:

No statistically significant logistic regression model or quadratic logistic regression model ($R^2 = 0.02$; p = 0.0776) could be made for read activity from seating ratio.

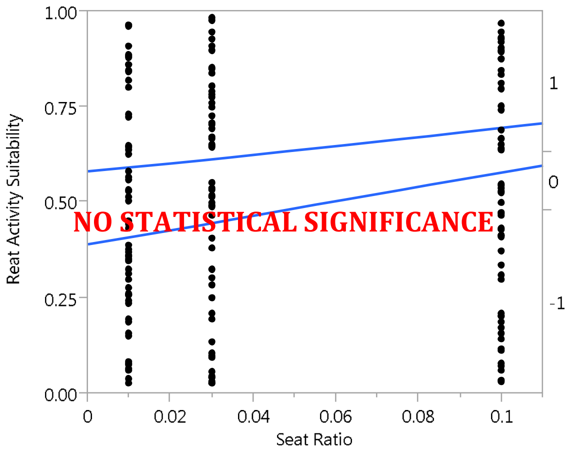


Figure 8.24 – Logistic Regression for Read Activity from Seating Ratio

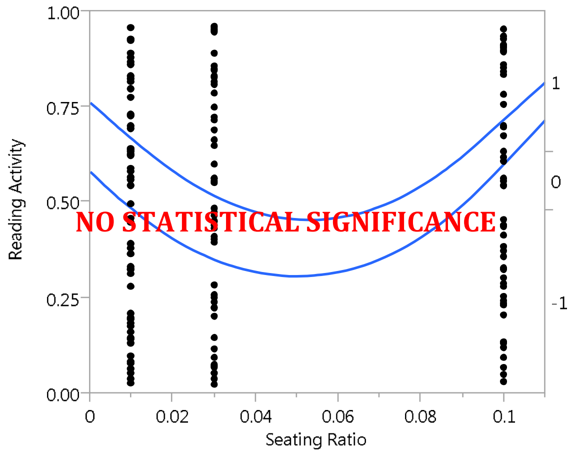


Figure 8.25 – Quadratic Logistic Regression for Read Activity from Seating Ratio

Table 8.10 – Logistic Model for Read Activity based on Seating Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	ln (Ŷ/(1- Ŷ)) = – 0.07 + 7.12* [seating ratio]	0.01	p = 0.1401
Lower	ln (Ŷ/(1- Ŷ)) = – 0.79 – 1.76* [seating ratio]		

8.5.2 Impressions

8.5.2.1 Appeal:

No statistically significant logistic regression model could be made for appeal from seating ratio. The quadratic logistic regression model was statistically significant ($R^2 = 0.08$; p <.0001) and shows a critical value of 0.05 and 0.06, or 5 to 6% of floor area ratio as seating being optimal for impressions of environment appeal.

Table 8.11 – Logistic Model for Appeal based on Seating Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	ln (Ŷ/(1- Ŷ)) = – 0.24 + 2.23* [seating ratio]	0.009	p = 0.19
Lower	ln (Ŷ/(1- Ŷ)) = – 0.70 – 8.93* [seating ratio]		

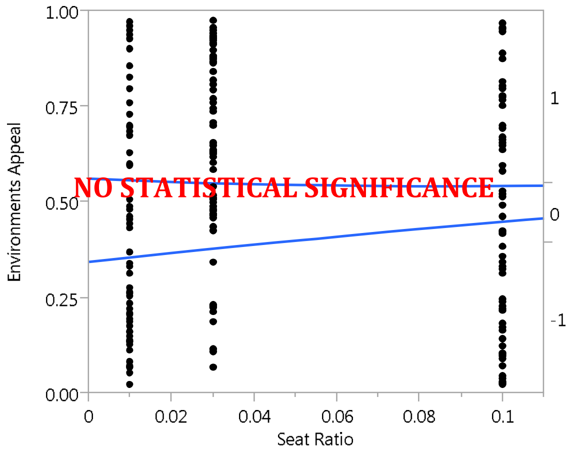


Figure 8.26 – Logistic Regression for Appeal from Seating Ratio

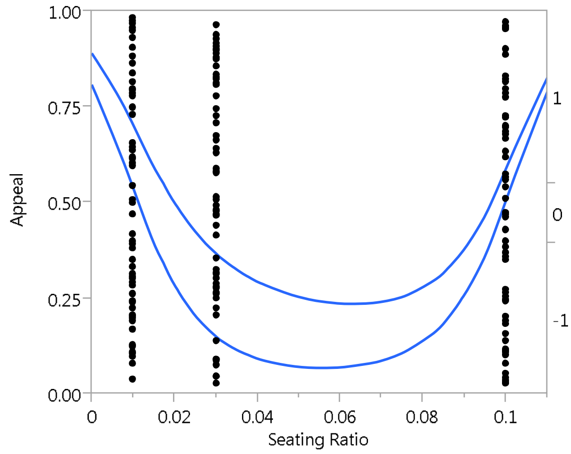


Figure 8.27 – Quadratic Logistic Regression for Appeal from Seating Ratio

8.5.2.2 Interest:

No statistically significant logistic regression model could be made for interest from seating ratio. The quadratic logistic regression model was statistically significant ($R^2 = 0.07$; p <.0001) and shows a critical value of 0.06, or 6% of floor area ratio as seating being optimal for impressions of environment interest.

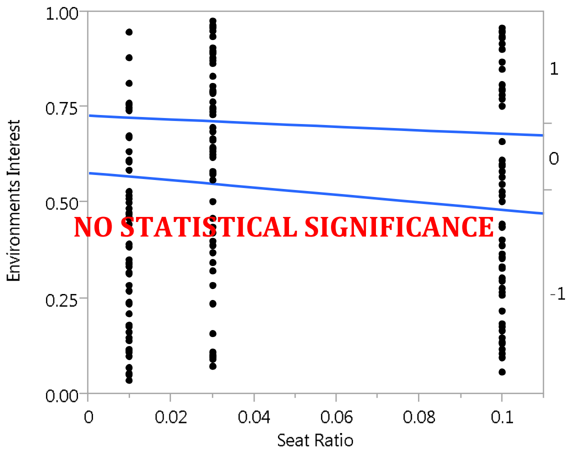


Figure 8.28 – Logistic Regression for Interest from Seating Ratio.

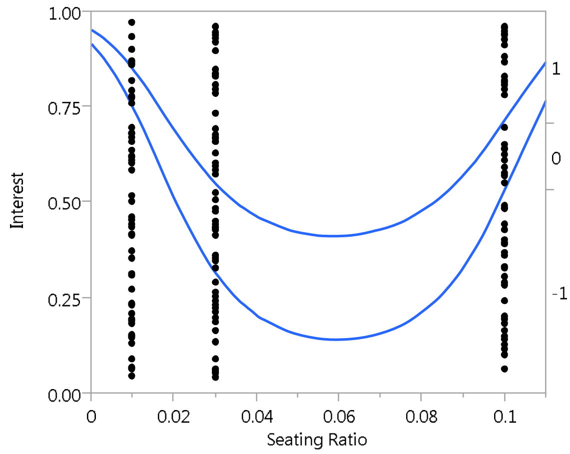


Figure 8.29 – Quadratic Logistic Regression for Interest from Seating Ratio

Table 8.12 – Logistic Model for Interest based on Seating Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	$\ln(\hat{Y}/(1-\hat{Y})) = +0.75 - 3.44^{*}$ [seating ratio]	0.003	p = 0.5889
Lower	$\ln(\hat{Y}/(1-\hat{Y})) = -0.60 + 1.23^{*}$ [seating ratio]		

8.5.2.3 Enclosure:

A statistically significant logistic regression model could be made for enclosure from seating ratio. The quadratic logistic regression model was also statistically significant ($R^2 = 0.07$; p = 0.0004) but since the relationship between variables is linear it does not provide a useful critical value.

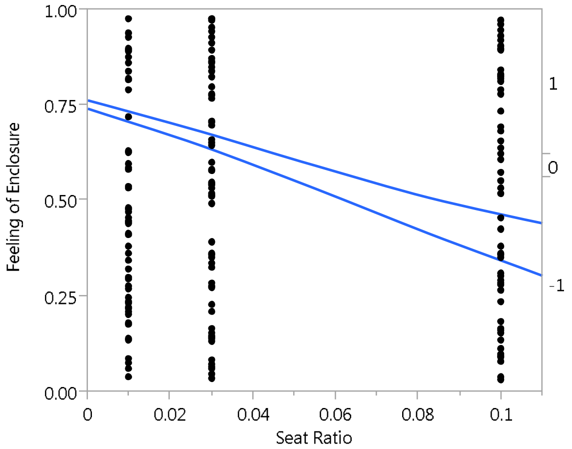


Figure 8.30 – Logistic Regression for Enclosure from Seating Ratio

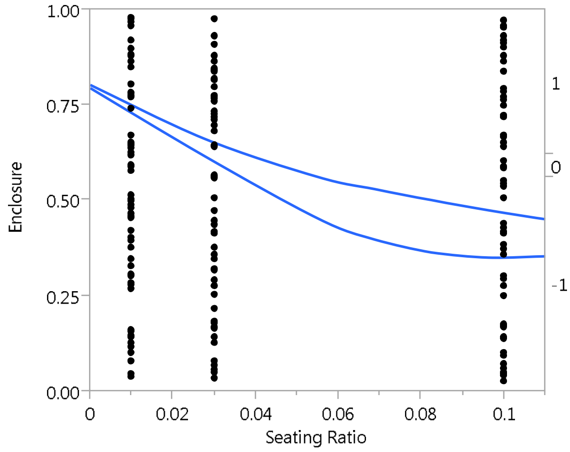


Figure 8.31 – Quadratic Logistic Regression for Enclosure from Seating Ratio

Table 8.13 – Logistic Model for Enclosure based on Seating Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	ln (Ŷ/(1- Ŷ)) = + 1.13 – 15.85* [seating ratio]	0.06	p < .0001**
Lower	ln (Ŷ/(1- Ŷ)) = – 2.43 + 9.20* [seating ratio]		

8.5.2.4 Atmosphere:

No statistically significant logistic regression model could be made for atmosphere from seating ratio. The quadratic logistic regression model was statistically significant (R^2 = 0.03; p = 0.0328) and shows a critical value close to 0.06, or 6% of floor area ratio as seating being optimal for impressions of environment atmosphere.

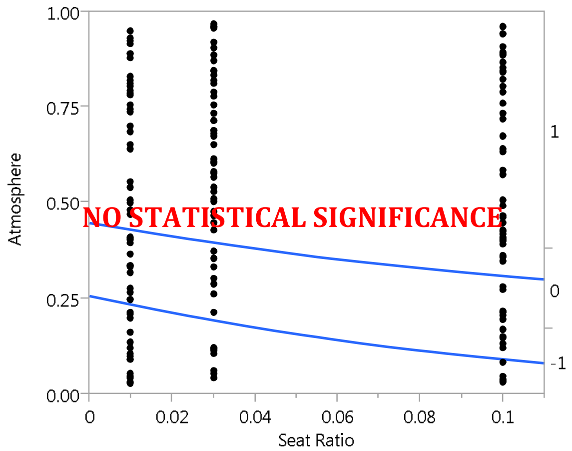


Figure 8.32 – Logistic Regression for Atmosphere from Seating Ratio

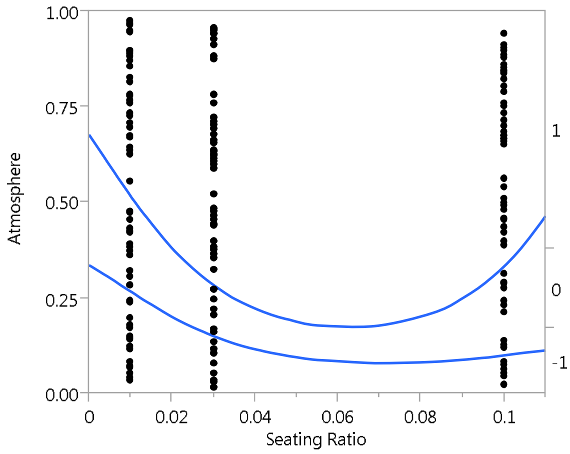


Figure 8.33 – Quadratic Logistic Regression for Atmosphere from Seating Ratio

Table 8.14– Logistic Model for Atmosphere based on Seating Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	ln (Ŷ/(1- Ŷ)) = – 0.77 – 12.67* [seating ratio]	0.015	p = 0.0842
Lower	ln (Ŷ/(1- Ŷ)) = – 1.06 – 0.94* [seating ratio]		

8.5.2.5 Relaxation

A statistically significant logistic regression model could be made for relaxation from seating ratio. The quadratic logistic regression model was also statistically significant (R^2 = 0.11; p <.0001) and shows a critical value close to 0.04, or 4% of floor area ratio as seating being optimal for impressions of environment relaxation.

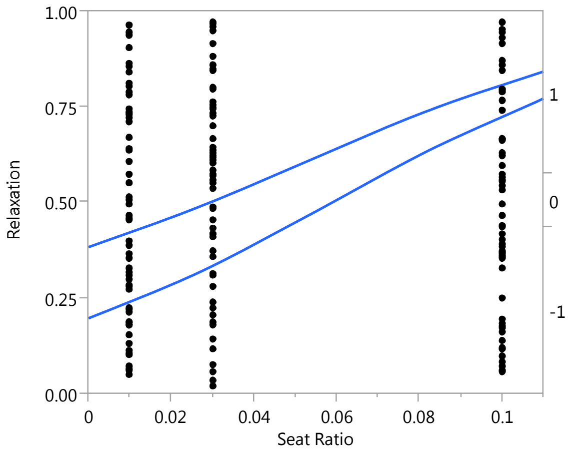


Figure 8.34 – Logistic Regression for Relaxation from Seating Ratio

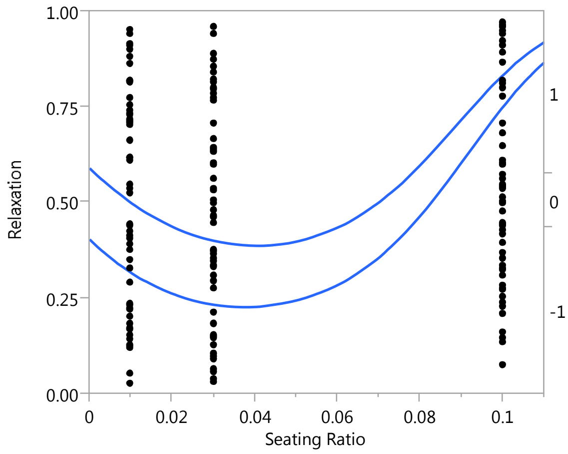


Figure 8.35 – Quadratic Logistic Regression for Relaxation from Seating Ratio

Table 8.15 – Logistic Model for Relaxation based on Seating Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	$\ln(\hat{Y}/(1-\hat{Y})) = -1.15 - 24.86^*$ [seating ratio]	0.09	p <.0001**
Lower	$\ln(\hat{Y}/(1-\hat{Y})) = -1.20 - 3.69^*$ [seating ratio]		

8.5.2.6 Openness:

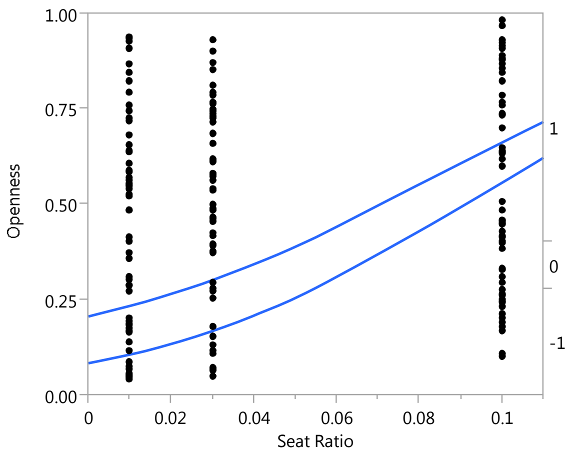


Figure 8.36 – Logistic Regression for Openness from Seating Ratio

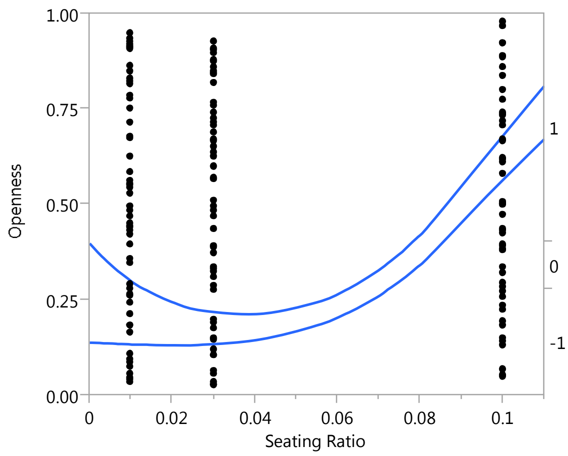


Figure 8.37 – Quadratic Logistic Regression for Openness from Seating Ratio

Table 8.16 – Logistic Model for Openness based on Seating Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	$\ln(\hat{Y}/(1-\hat{Y})) = -2.25 - 27.62^*$ [seating ratio]	0.11	p <.0001**
Lower	$\ln(\hat{Y}/(1-\hat{Y})) = -1.86 - 7.07^*$ [seating ratio]		

A statistically significant logistic regression model could be made for openness from seating ratio. The quadratic logistic regression model was also statistically significant ($R^2 = 0.12$; p <.0001) but since the relationship between variables is linear it does not provide a useful critical value.

8.5.2.7 Oppression:

A statistically significant logistic regression model could be made for oppression from seating ratio. The quadratic logistic regression model was also statistically significant ($R^2 = 0.12$; p <.0001) but since the relationship between variables is linear it does not provide a useful critical value.

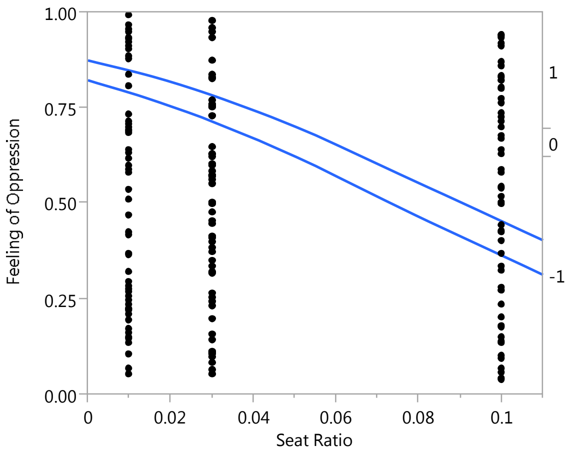


Figure 8.38 – Logistic Regression for Oppression from Seating Ratio

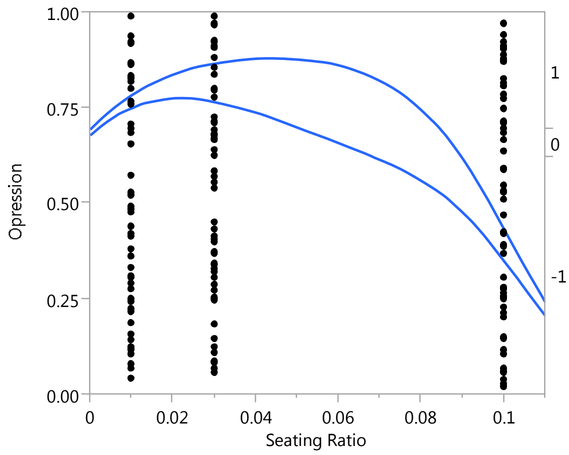


Figure 8.39 – Quadratic Logistic Regression for Oppression from Seating Ratio

Table 8.17 – Logistic Model for Oppression based on Seating Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	ln (Ŷ/(1- Ŷ)) = + 1.88 – 22.97* [seating ratio]	0.09	p <.0001**
Lower	ln (Ŷ/(1- Ŷ)) = – 0.87 – 9.31* [seating ratio]		

8.5.2.8 Liveliness:

A statistically significant logistic regression model could be made for liveliness from seating ratio. The quadratic logistic regression model was also statistically significant ($R^2 = 0.21$; p <.0001) and shows a critical value close to 0.08, or 8% of floor area ratio as seating being optimal for impressions of environment liveliness.

Table 8.18 – Logistic Model for Liveliness based on Seating Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	ln (Ŷ/(1- Ŷ)) = + 1.70 – 46.11* [seating ratio]	0.19	p <.0001**
Lower	ln (Ŷ/(1- Ŷ)) = + 0.12 – 21.25* [seating ratio]		

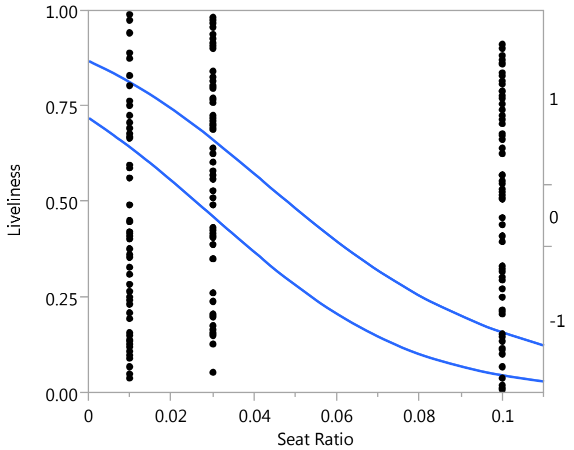


Figure 8.40 – Logistic Regression for Liveliness from Seating Ratio.

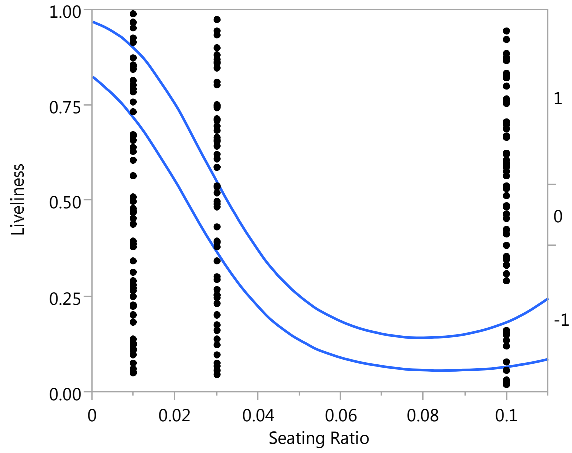


Figure 8.41 – Quadratic Logistic Regression for Liveliness from Seating Ratio.

8.5.2.9 Diversity:

A statistically significant logistic regression model could not be made for diversity from seating ratio. The quadratic logistic regression model was statistically significant ($R^2 = 0.04$; $p = 0.0069$) and shows a critical value close to 0.06, or 6% of floor area ratio as seating being optimal for impressions of environment diversity.

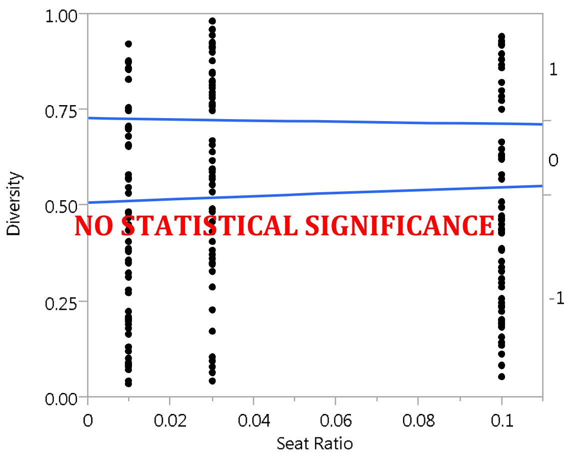


Figure 8.42 – Logistic Regression for Diversity from Seating Ratio.

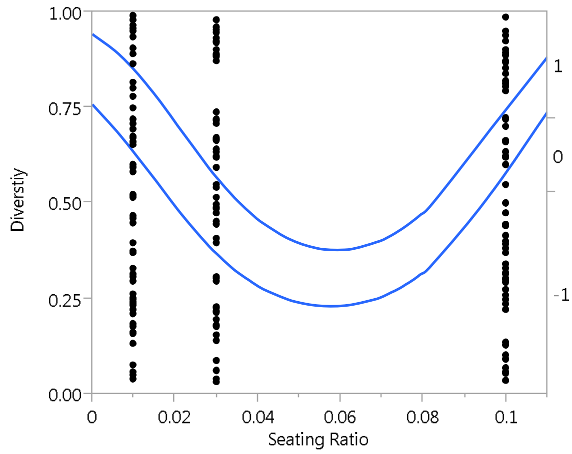


Figure 8.43 – Quadratic Logistic Regression for Diverstity from Seating Ratio.

Table 8.19 – Logistic Model for Diversity based on Seating Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	$\ln(\hat{Y}/(1-\hat{Y})) = +0.63 + 0.26^{*}$ [seating ratio]	0.0014	p = 0.7783
Lower	$\ln(\hat{Y}/(1-\hat{Y})) = -0.21 - 3.34^{*}$ [seating ratio]		

8.5.3 Perceptions

8.5.3.1 Size Perception:

A statistically significant logistic regression model could be made for size perception from seating ratio. The quadratic logistic regression model was not statistically significant (R^2 = 0.02; p = 0.0839).

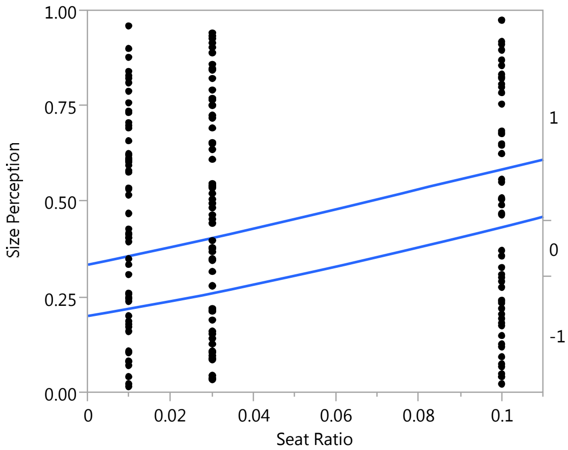


Figure 8.44 – Logistic Regression for Size Perception from Seating Ratio.

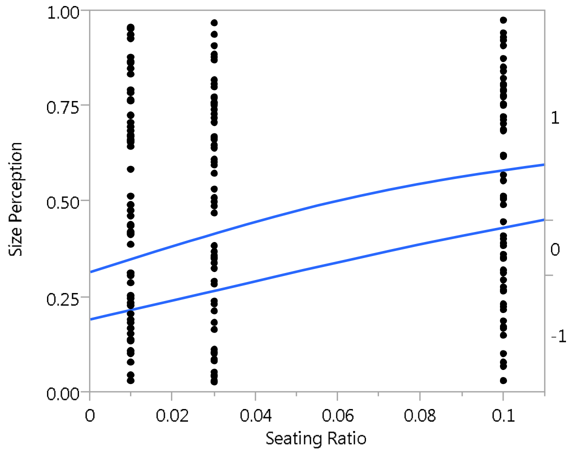


Figure 8.45 – Quadratic Logistic Regression for Size Perception from Seating Ratio.

Table 8.20 – Logistic Model for Size Perception based on Seating Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	ln (Ŷ/(1- Ŷ)) = –1.19 + 12.39* [seating ratio]	0.02	p = 0.0169
Lower	ln (Ŷ/(1- Ŷ)) = – 1.60 + 5.88* [seating ratio]		

8.5.3.2 Greenery amount:

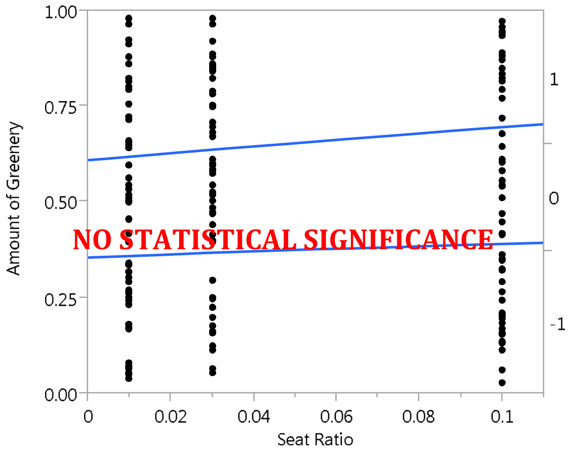


Figure 8.46 – Logistic Regression for Greenery Amount from Seating Ratio.

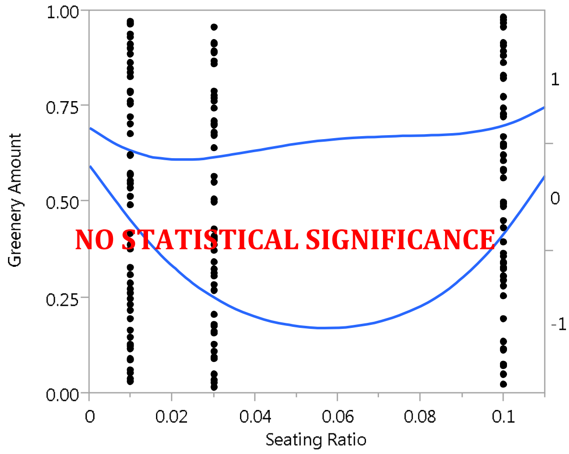


Figure 8.47 – Quadratic Logistic Regression for Greenery Amount from Seating Ratio.

Table 8.21 – Logistic Model for Greenery Amount based on Seating Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	ln (Ŷ/(1- Ŷ)) = – 0.10 + 3.46* [seating ratio]	0.0002	p = 0.6345
Lower	ln (Ŷ/(1- Ŷ)) = – 0.43 + 4.33* [seating ratio]		

No statistically significant logistic regression model or quadratic logistic regression model could be made for greenery amount from seating ratio.

8.5.3.3 Greenery placement:

No statistically significant logistic regression model could be made for greenery placement from seating ratio. The quadratic logistic regression model was statistically significant ($R^2 = 0.03$; $p = 0.0176$) and shows a critical value close to 0.06, or 6% of floor area ratio as seating being optimal for impressions of greenery placement.

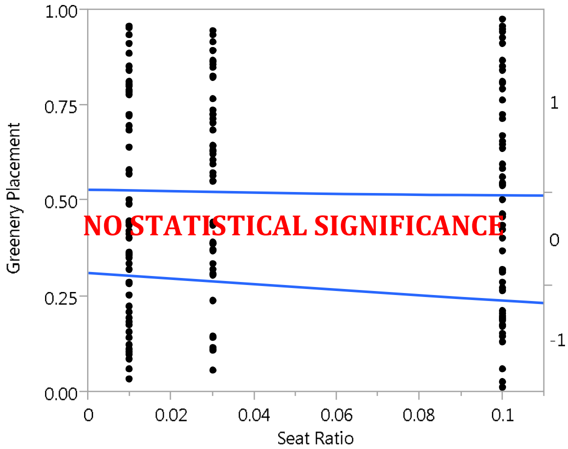


Figure 8.48 – Logistic Regression for Greenery Placement from Seating Ratio.

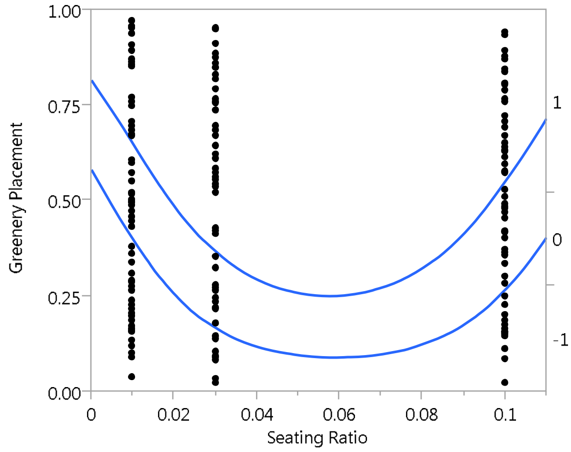


Figure 8.49 – Quadratic Logistic Regression for Greenery Placement from Seating Ratio

Table 8.22 – Logistic Model for Greenery Placement based on Seating Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	$\ln(\hat{Y}/(1-\hat{Y})) = -0.41 - 2.97*$ [seating ratio]	0.002	p=0.6401
Lower	$\ln(\hat{Y}/(1-\hat{Y})) = -0.77 + 2.05*$ [seating ratio]		

8.5.3.4 Seat Amount:

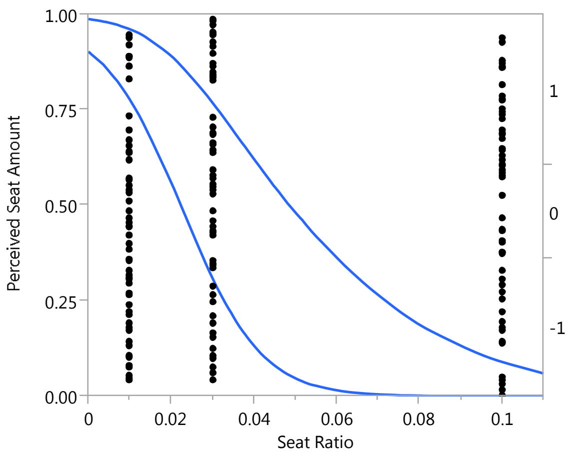


Figure 8.50 – Logistic Regression for Seat Amount from Seating Ratio.

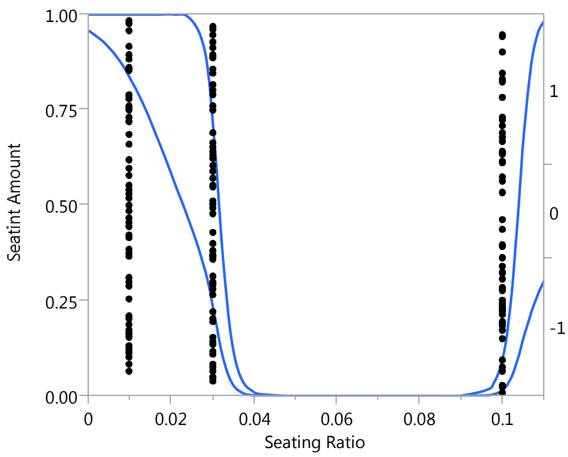


Figure 8.51 – Quadratic Logistic Regression for Seats Amount from Seating Ratio.

Table 8.23 – Logistic Model for Seat Amount based on Seating Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	ln (Ŷ/(1- Ŷ)) = + 4.32 – 134.70* [seating ratio]	0.38	p=<0.001**
Lower	ln (Ŷ/(1- Ŷ)) = + 1.97 – 43.04* [seating ratio]		

A statistically significant logistic regression model could be made for seat amount from seating ratio. The quadratic logistic regression model was also statistically significant (R^2 = 0.42; p <.0001) and shows a critical value close from 0.04 to 0.09, or 4 to 9% of floor area ratio as seating being optimal for perceptions of seat amount.

8.5.3.5 Seat Placement:

No statistically significant logistic regression model or could be made for seat placement from seating ratio. The quadratic logistic regression model was statistically significant (R^2 = 0.03; p = 0.0334) and shows a critical value between 0.05 and 0.06, or between 5 and 6% of floor area ratio as seating being optimal for impressions of seat placement.

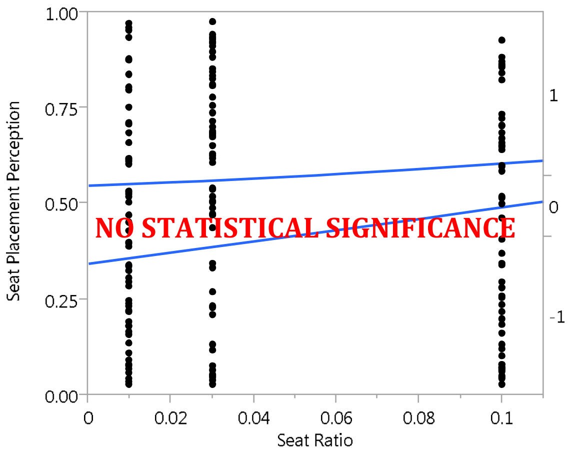


Figure 8.52 – Logistic Regression for Seat Placement from Seating Ratio.

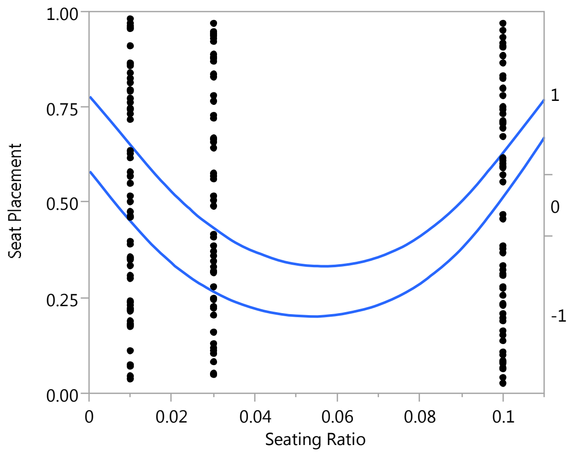


Figure 8.53 – Quadratic Logistic Regression for Seat Placement from Seating Ratio.

Table 8.24 – Logistic Model for Seat Placement based on Seating Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	ln (Ŷ/(1- Ŷ)) = – 0.28 + 4.94* [seating ratio]	0.008	p = 0.2280
Lower	ln (Ŷ/(1- Ŷ)) = – 0.79 – 4.40* [seating ratio]		

8.5.3.6 Seat Design:

No statistically significant logistic regression model or quadratic logistic regression model (R^2 = 0.0045; p = 0.8388) could be made for the perception of seat design from seating ratio.

Table 8.25 – Logistic Model for Seat Design based on Seating Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	ln (Ŷ/(1- Ŷ)) = – 1.57 – 6.41* [seating ratio]	0.004	p = 0.5534
Lower	ln (Ŷ/(1- Ŷ)) = – 0.34 – 3.75* [seating ratio]		

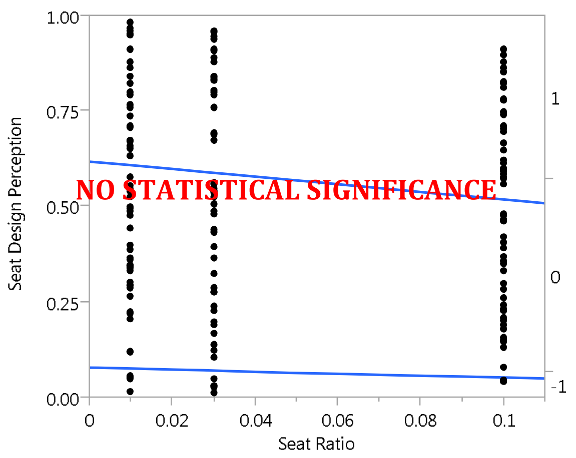


Figure 8.54 – Logistic Regression for Seat Design from Seating Ratio.

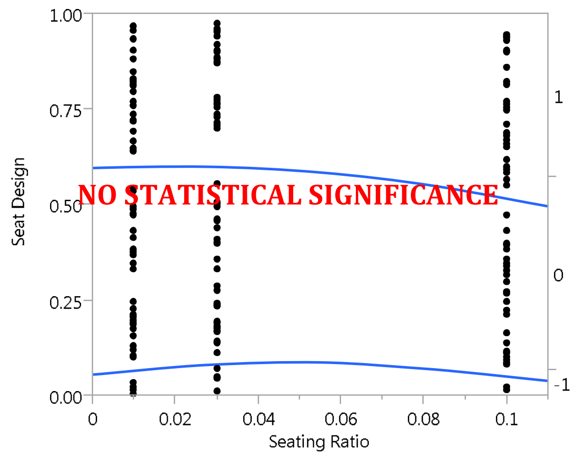


Figure 8.55 – Quadratic Logistic Regression for Seat Design from Seating Ratio.

8.5.3.7 View:

A statistically significant logistic regression model could be made for view from seating ratio. The quadratic logistic regression model was also statistically significant ($R^2 = 0.03$; $p = 0.0323$) and shows a critical value close to 0.05, or 5% of floor area ratio as seating being optimal for perceptions of view.

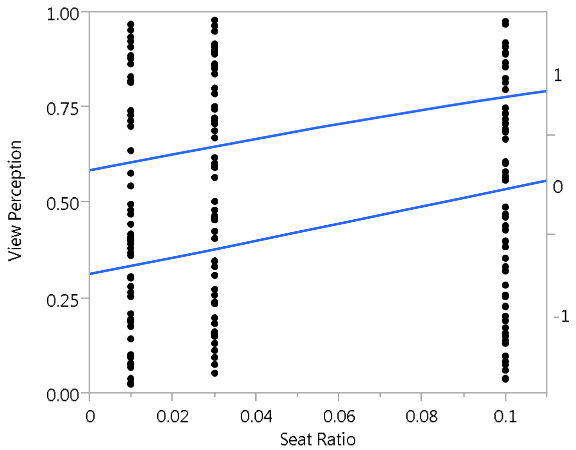


Figure 8.56 – Logistic Regression for View from Seating Ratio.

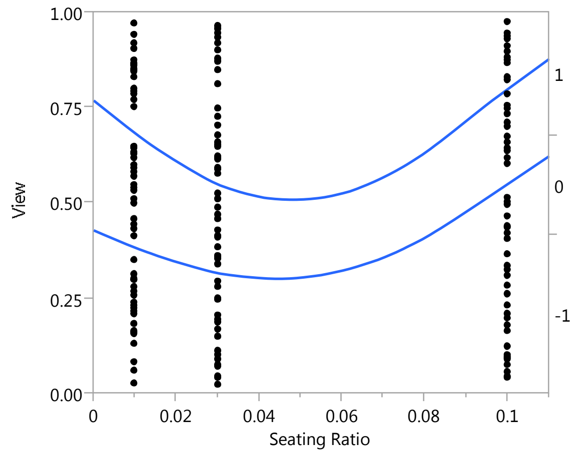


Figure 8.57 – Quadratic Logistic Regression for View from Seating Ratio.

Table 8.26 – Logistic Model for Seat Amount based on Seating Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	$\ln(\hat{Y}/(1-\hat{Y})) = -0.27 - 11.57^{*}$ [seating ratio]	0.02	p=0.0408*
Lower	$\ln(\hat{Y}/(1-\hat{Y})) = -0.42 + 5.06^{*}$ [seating ratio]		

9 THIRD EXPERIMENT: TREES EFFECT RANGE

The first experiment investigated the presence/absence of an effect of and the presence/absence of interactions of tree ratio to tree height and seating ratio and, for that purpose, adopted 20% and 40% of floor area ratio (FAR) as the variable levels. It identified an effect of tree ratio on 9 out of 23 measurement scales. This experiment expands the range of tree ratio from 5% to 50% and investigates the effects and possible interactions with environment scale.

9.1 Implementation

The same methodology adopted in the first experiment was adopted for practical and comparative purposes. This experiment adopted two variables, each varying in three levels: tree ratio at 5%, 10% and 50% and environment size varying from small (600m^2), medium (2000m^2) and large (3500m^2), resulting in 9 different environment combination (Table 9.1). All other variables, such as surrounding buildings, amount of bushes, seats or cars were controlled for. The stimuli created can be seen in Figure 9.1 to Figure 9.9.

Table 9.1 – Stimuli Matrix

	Small (600m^2)	Medium (2000m^2)	Large (3500m^2)
Tree cover ratio at 5%	S01	S04	S07
Tree cover ratio at 10%	S02	S05	S08
Tree cover ratio at 50%	S03	S06	S09

An immersive virtual environment (IVE) of each stimulus was digitally modeled using SketchUp and compiled into the software Unity for materials, lighting and camera positioning. Participants experienced the environment through an Oculus rift HMD and were able to move around it using a Logicool gamepad.

Stimuli consisted of the same plaza used for the second experiment, (10% of floor area covered by bushes, 3 of its sides open to 7m wide streets and the fourth side occupied by a building with a coffee shop at the ground level and 4m wide sidewalks) with the only difference being that tree ratio varied and seating was fixed at 3% of FAR (Figs. 9.1 to 9.9).

The same questionnaire and same proceeding was used.


Figure 9.1 – Stimulus 01


Figure 9.2 – Stimulus 02


Figure 9.3 – Stimulus 03


Figure 9.4 – Stimulus 04


Figure 9.5 – Stimulus 05

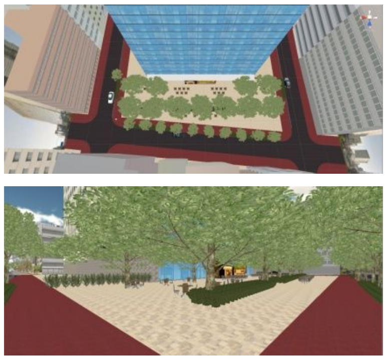


Figure 9.6 – Stimulus 06

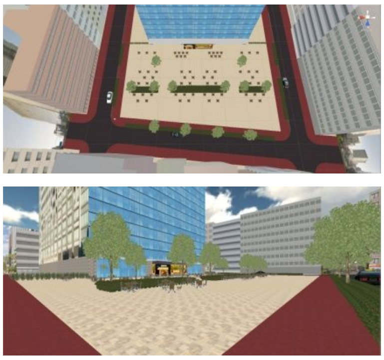


Figure 9.7 – Stimulus 07

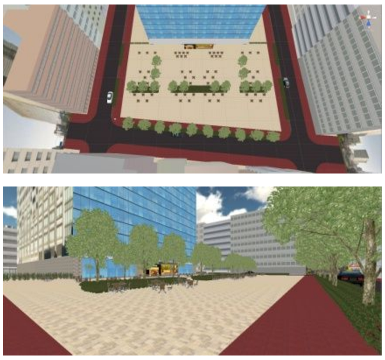


Figure 9.8 – Stimulus 08

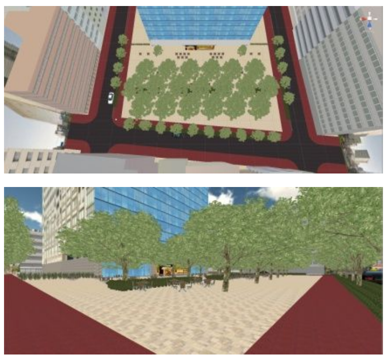


Figure 9.9 – Stimulus 09

9.1.1 Participants

A total of 20 participants (13 Male, 7 Female) took part in the study, each evaluating all 9 stimuli, with a total of 180 observations. They were all Japanese university students from different fields of study and averaged 21.3 years of age (SD=1.89)

9.2 Results

To evaluate the effects of tree ratio and environment scale in each measurement scale, an analysis of variance was conducted and the following results were found:

9.2.1 Activities:

Tree Cover Ratio had an effect on *Read* activity and increasing it from 5% or 10% to 50% increased perceived suitability for *Read* activity. It also had a small effect in *Stay* and *Rest* activities. But only between the ratios of 5% and 50%, while no statistical difference could be perceived between 5% and 10% or 10% and 50% of *Tree Cover Ratio*. No effect of *Tree Cove Ratio* could be observed on *Eat/drink* or *Wait* activity (Table 9.2).

Scale also had an effect in *Stay*, *Rest* and *Read* activities where small environments were worse than medium or large environments but no statistical difference was observed between medium and large scale environments and no interaction was observed.

For *Wait* activity, small environments were perceived as more suitable than medium or large environments while no statistically difference could be observed between medium and large environments. No effect of scale was observed in *Eat/drink* activity and no interaction between *Tree Cover Ratio* and environment *Scale* was observed for any activity (Table 9.2).

Table 9.2 – Effect on Activities

	Stay	Eat/drink	Rest	Read	Wait
Tree Cover Ratio	10.76**		3.45*	12.70**	
Scale	6.64*		8.20*	9.70**	6.77*
TCR x Scale					
R^2	0.17		0.12	0.22	0.08

values expressed are F (2,171); ** = p<.0001; * = p<0.005.

9.2.2 Impressions:

A direct effect of *Tree Cover Ratio* could be seen in *Appeal* and increasing *Tree Cover Ratio* improved environment *Appeal* at all levels.

Interest, *Enclosure*, *Relaxation*, and *Oppression* had no effect when *Tree Cover Ratio* was increased from 5% to 10% but a positive effect could be seen between 5% and 50% and between 10% and 50%.

A negative effect of *Tree Cover Ratio* could be perceived in the impressions of *Openness* and when *Tree Cover Ratio* was increased from 5% or 10% to 50% the environment was perceived as less *Open*.

Diversity was affected by *Tree Cover Ratio*, but only when increasing it up to 50% and no statistical difference could be observed between 5% and 10% or 10% and 50%. *Tree Cover Ratio* had no effect in *Atmosphere* or *Liveliness*.

The environment *Scale* had a direct effect in *Openness* perception and the larger the environment, the more open it was perceived. *Interest*, *Liveliness* and *Diversity* were also affected by scale and small environments were worse than medium or large ones. No difference between medium and large environments was observed.

Atmosphere was also affected by *Scale* and large environments were perceived as better than small ones. No difference between medium and large or small and large environments was observed.

Medium and large environments were perceived as less *Enclosed* than small environments and small environments were perceived as more *Oppressive* than large ones although no statistical difference could be observed between small and medium or medium and large environments.

No effect of environment *Scale* could be observed for environment *Appeal* or *Relaxation*. Interactions between *Tree Cover Ratio* and environment *Scale* could be observed only in impressions of *Enclosure* (R^2 = 0.36; F (4, 171) = 3.59; p = 0.0078), *Openness* (R^2 = 0.33; F (4, 171) = 2.89; p = 0.0237) and *Oppression* (R^2 = 0.15; F (4, 171) = 2.90; p = 0.0235) where large environments with 50% of tree ratio coverage were perceived as less open, more enclosed and more oppressive than expected. No other interaction between *Tree Cover Ratio* and environment *Scale* could be observed in any perception scale.

Table 9.3 – TCR and Scale Effects on Impressions

	Appeal	Interest	Enclosure	Atmosphere	Relaxation	Openness	Oppression	Liveliness	Diversity
Tree Cover Ratio	14.74**	12.32**	31.53**		15.03**	17.80**	5.33*		3.62*
Scale		9.22*	9.53**	4.77*		18.27**	4.03*	11.50**	12.04**
TCR x Scale			3.59*			2.89*	2.90*		
R^2	0.17	0.20	0.36	0.09	0.15	0.33	0.15	0.12	0.16

values expressed are *F* (2, 171); ** = p<.0001; * = p<0.005.

9.2.3 Perception:

Tree Cover Ratio directly affected the perception of *Greenery Amount* and increasing tree coverage increased perceived greenery amount at all levels. *View* required a larger coverage ratio to be affected and an effect could be observed when the ratio was incremented from 5% to 50% and from 10% to 50% but no effect was observed when incrementing from 5% to 10%.

A small effect could be perceived with *Greenery Placement* and *Seat Amount* where increasing tree ratio from 5% to 50% improved perception but no effect could be seen in increments from 5% to 10% or 10% to 50%. *Tree Cover Ratio* did not have an effect in the perception of *Size*, *Seat Placement* or *Seat Design*.

Environment *Scale* matched actual environment *Size* at all levels, showing that no scale perception bias arouse from the selected method. No interaction between *Tree Cover Ratio* and environment *Size* was observed.

An effect of scale could be observed in *Greenery Amount*, *Seat Amount* and *View* perception. Small environments were perceived as having less seats/greenery and worst view than medium or large scale environments with the same ratio (i.e.: greenery at 10% of floor area), no statistical difference could be observed between medium and large environments and no interaction was observed.

No effect of *Scale* nor interactions could be observed in the perception of greenery placement, seat placement or seat design.

Table 9.4 – TCR and Scale Effects on Perceptions

	Size	Greenery Amount	Greenery Placement	Seat Amount	Seat Placement	Seat Design	View
Tree Cover Ratio		72.17**	6.49*	3.83*			7.45*
Scale	88.30**	12.36**		18.81**			14.37**
TCR x Scale							
R^2	0.52	0.50	0.10	0.21			0.22

values expressed are F (2, 171); ** = p<.0001; * = p<0.005

9.2.4 Willingness to pay and willingness to stay:

Tree Cover Ratio had a positive effect on both *Willingness to Pay* (R^2 = 0.10; F (2, 171) = 6.30; p = 0.0023) and *Willingness to Stay* (R^2 = 0.22; F (2, 171) = 14.19; p <.0001) and people were willing to pay more and stay longer in environments with 50% of tree coverage than in environments with only 5% of tree ratio coverage. No statistical difference could be observed between 5% and 10% or 10% and 50%.

Scale also had an effect and people were *Willing to Pay* (R^2 = 0.10; F (2, 171) = 3.37; p = 0.0333) more and *Willing to Stay* (R^2 = 0.22; F (2, 171) = 8.66; p = 0.0003) longer at larger environments than small ones. Additionally, people also were willing to stay more in medium sized environments than small ones, although this could not be observed in willingness to pay. No interaction between scale and tree ratio was observed.

In numbers, when *Tree Cover Ratio* was at 50% of floor area, participants were *Willing to Pay* up to 16.8% more and *spend* 34% *more time* than at times when trees covered only 5% of the floor area. People were also *Willing to Pay* 12.4% more and stay 40.9% longer in larger environments than in smaller ones and stay 52.3% more in medium sized environments than in small ones.

9.2.5 Demographic analysis

The influence of gender and architectural background were tested and are shown below.

9.2.5.1 Effects of gender

The averaged data by stimuli and gender was used to analyze the effects of gender. There were two data points for each stimulus, one for the male average answer (13 participants) and another for the female (7 participants) averaged answer. Analysis of variance was done with gender as predictor for each of the 23 evaluation scales, using those 18 data points.

Whiting the 23 different evaluation scales (Table 3.1) gender effect was found in *Atmosphere* (R^2 = 0.28; F (1, 17) = 6.19; p = 0.0243) and *Seat Placement* (R^2 = 0.22; F (1, 17) = 4.56; p = 0.0485) with women judging the environment as having a better *Atmosphere* and better *Placed Seats* being better than as judge by men. All other evaluation scales had no significant gender effect.

9.2.5.2 Effects of architectural background

The averaged answer by background and stimuli was used to test for the effects of architectural background, resulting in 18 data points: two for each stimulus, one for architecture students and another for non-architect students. An analysis of variance using background as predictors for each of the 23 evaluation scales was conducted.

Only *Atmosphere* ($R^2 = 0.22$; $F(1, 17) = 4.60$; $p = 0.0476$) was affected by architectural background, with architectural students perceiving the environment as having a worse atmosphere than non-architecture students. This notion agrees with Llinares & Inarra, (2014) and Akalin, Yildirm, Wilson & Kilicoglu (2009) that people with architectural background are more critical of the environment than laypeople. All other scales had no significant effect of architectural background.

9.3 Discussion

In agreement with the first experiment, *Tree Cover Ratio* had a clear effect in suitability for read activity. A small effect in stay and rest activities was also observed in the this but not in the first experiment. Since the improvement of perceived suitability was small for these two activities, it could only be observed at greater differences of *Tree Cover Ratio* (e.g. 5% and 50%) but not at smaller (e.g., 20% and 40%) ones, when the effects seem to be negligible. Also in agreement with the first experiment, no effect could be observed for *Eat/drink* or *Wait* activities (Figure 9.10).

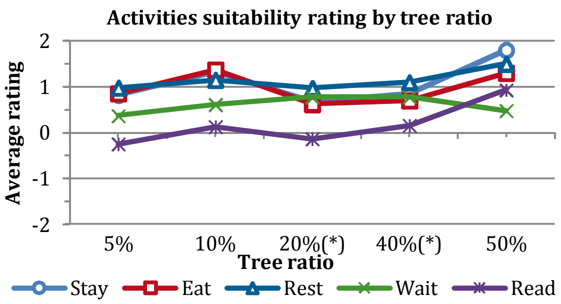


Figure 9.10 – Activities average scores by Tree Cover Ratio.
"(*)" denotes results obtained in the 1st experiment.

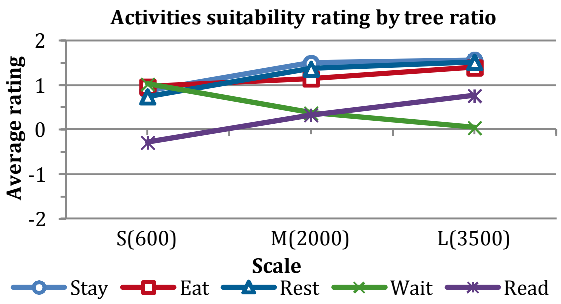


Figure 9.11 – Activities average scores by scale.

Perception of *Appeal*, *Interest*, *Enclosure*, *Relaxation*, *Openness* and *Oppression* were affected by *Tree Cover Ratio* in a similar manner as the first experiment, as were the absence of effects on the *Atmosphere* and *Liveliness* evaluation scales. A difference could be observed in the impression of *Diversity*: although in the first experiment no effect was found, a small effect could be observed when increasing tree ratio from 5% to 50% (Figure 9.12). This too can be expected as the effect is small and could only be observed at a high ratio difference.

Perception of *Greenery Amount*, *Seat Placement* and *Seat Design* was consistent with the first experiment. *Greenery Placement* and *Seat Amount* showed a small effect, while no effect was found in the first experiment which may be explained by *Tree Cover Ratio* range evaluated. Differences between experiments could be observed in view and environment *Size* perception scales: while the first experiment found a small effect of *Tree Cover Ratio* in the perception of environment size and no effect on perceived *View*, no effect was found for the perception of environment *Size* and a small effect in *View* perception (Figure 8.14) in this experiment. Since in both cases the effect observed is small, differences could be attributed to *Tree Cover Ratio* range studied, but further investigations are necessary for conclusive results.

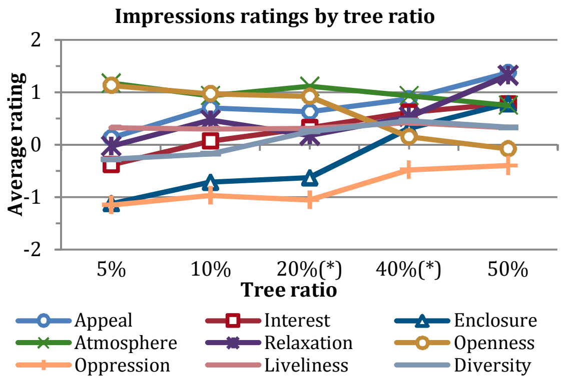


Figure 9.12 – Impressions average scores by Tree Cover Ratio.
"(*)" denotes results from the 1st experiment.

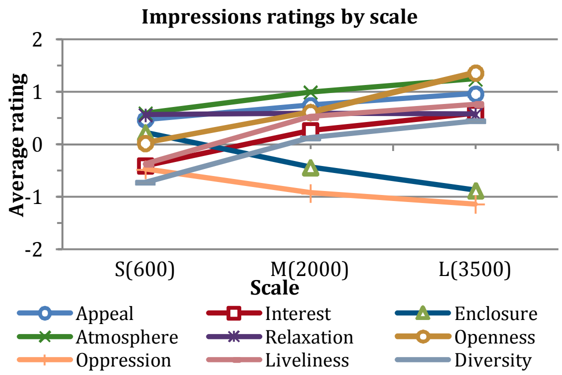


Figure 9.13 – Impressions average scores by scale.

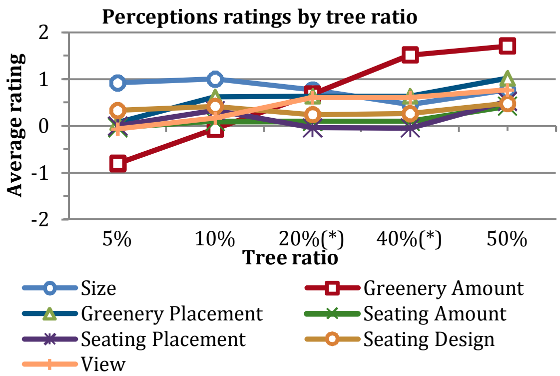


Figure 9.14 – Perceptions average scores by Tree Cover Ratio.
"(*)" denotes results from the 1st experiment.

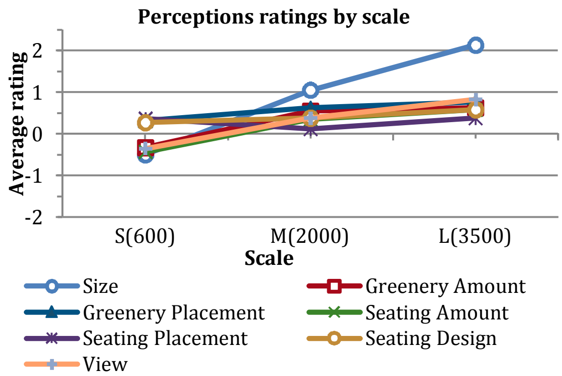


Figure 9.15 – Perceptions average scores by scale.

Overall, when the effect of *Tree Cover Ratio* is present it seems to follow a response curve similar to that proposed by Jiang, Larsen Deal & Sulivan (2015) in which, although there is an effect, it offers only a small improvement in perception/impression/suitability in the ranges from 5% and 50% and large increments in the range between 0% and 5%. The only exceptions to this pattern were the perception of greenery amount and enclosure, both with a more steep increment curve.

The effects of *Scale* partially agreed with the suppositions drawn in the first experiment, that small environments are perceived somewhat different than other environments. Small environments were perceived to be less suitable for *Stay*, *Rest* and *Read* activity, more suitable for *Wait* activity, less *Open*, less *Interesting*, less *Lively*, less *Diverse*, more *Enclosed*, more *Oppressive*, smaller, having less *Seats*, less *Greenery* and worst *View*.

No consistent difference was observed, however, between medium and large scale environments, with the exception of *Atmosphere*, where large environments were perceived as better than medium or small environments.

Environment *Scale* had not observable effect in suitability for *Eat*/drink activity, impression of *Appeal*, *Relaxation* or perception of *Greenery Placement*, *Seat Placement* or *Seat Design*.

9.4 Multi-regression analysis

A Multi-regression analysis was also conducted for *Tree Cover Ratio* as to allow for a quantification of each level of each variable for each evaluation scale, allowing for a simple and quick comparison between different scenarios.

Table 9.5 – Formulae for Tree cover ratio and environment size.

Scale	Formulae				R^2	Prob>t ratio
Stay Activity	+1.31	-0.49 [if Tree Cover Ratio = 5%] +0.01 [if Tree Cover Ratio = 10%] +0 [if Tree Cover Ratio = 50%]	-0.44 [if scale is 600] +0.19 [if scale is 2000] +0 [if scale is 3500]		0.17	<.0001**
Eat/Drink Activity	+1.17	-0.32 [if Tree Cover Ratio = 5%] +0.19 [if Tree Cover Ratio = 10%] +0 [if Tree Cover Ratio = 50%]	-0.21 [if scale is 600] -0.02 [if scale is 2000] +0 [if scale is 3500]		0.05	0.0479*
Rest Activity	+1.21	-0.23 [if Tree Cover Ratio = 5%] -0.06 [if Tree Cover Ratio = 10%] +0 [if Tree Cover Ratio = 50%]	-0.46 [if scale is 600] +0.16 [if scale is 2000] +0 [if scale is 3500]		0.12	0.0002**
Wait Activity	+0.49		+0.54 [if scale is 600] -0.11 [if scale is 2000] +0 [if scale is 3500]		0.07	0.0013**
Read Activity	+0.27	-0.52 [if Tree Cover Ratio = 5%] -0.14 [if Tree Cover Ratio = 10%] +0 [if Tree Cover Ratio = 50%]	-0.56 [if scale is 600] +0.06 [if scale is 2000] +0 [if scale is 3500]		0.21	<.0001**
Appeal	+0.73	-0.60 [if Tree Cover Ratio = 5%] -0.03 [if Tree Cover Ratio = 10%] +0 [if Tree Cover Ratio = 50%]	-0.25 [if scale is 600] +0.02 [if scale is 2000] +0 [if scale is 3500]		0.17	<.0001**
Interest	+0.16	-0.54 [if Tree Cover Ratio = 5%] -0.09 [if Tree Cover Ratio = 10%] +0 [if Tree Cover Ratio = 50%]	-0.56 [if scale is 600] +0.11 [if scale is 2000] +0 [if scale is 3500]		0.20	<.0001**
Enclosure	-0.36	-0.78 [if Tree Cover Ratio = 5%] -0.36 [if Tree Cover Ratio = 10%] +0 [if Tree Cover Ratio = 50%]	+0.59 [if scale is 600] -0.08 [if scale is 2000] +0 [if scale is 3500]	+0.19 [5%x600] +0.26 [5%x2000] +0.13 [10%x600] +0.19 [10%x2000]	0.36	<.0001**
Atmosphere	+0.95	+0.22 [if Tree Cover Ratio = 5%] -0.02 [if Tree Cover Ratio = 10%] +0 [if Tree Cover Ratio = 50%]	-0.35 [if scale is 600] +0.05 [if scale is 2000] +0 [if scale is 3500]		0.07	0.0112*
Relaxation	+0.58	-0.62 [if Tree Cover Ratio = 5%] -0.12 [if Tree Cover Ratio = 10%] +0 [if Tree Cover Ratio = 50%]			0.15	<.0001**
Openness	+0.67	+0.46 [if Tree Cover Ratio = 5%] +0.29 [if Tree Cover Ratio = 10%] +0 [if Tree Cover Ratio = 50%]	-0.64 [if scale is 600] -0.06 [if scale is 2000] +0 [if scale is 3500]	-0.09 [5%x600] +0.02 [5%x2000] -0.23 [10%x600] -0.26 [10%x2000]	0.33	<.0001**
Oppression	-0.84	-0.31 [if Tree Cover Ratio = 5%] -0.13 [if Tree Cover Ratio = 10%] +0 [if Tree Cover Ratio = 50%]	+0.37 [if scale is 600] -0.08 [if scale is 2000] +0 [if scale is 3500]	+0.28 [5%x600] +0.18 [5%x2000] +0.09 [10%x600] +0.09 [10%x2000]	0.15	0.0004**
Liveliness	+0.31		-0.68 [if scale is 600] +0.22 [if scale is 2000] +0 [if scale is 3500]		0.12	<.0001**
Diversity	-0.04	-0.24 [if Tree Cover Ratio = 5%] -0.14 [if Tree Cover Ratio = 10%] +0 [if Tree Cover Ratio = 50%]	-0.67 [if scale is 600] +0.18 [if scale is 2000] +0 [if scale is 3500]		0.15	<.0001**
Size Perception	+0.89		-1.39 [if scale is 600] +0.15 [if scale is 2000] +0 [if scale is 3500]		0.49	<.0001**
Greenery Amount	+0.28	-1.08 [if Tree Cover Ratio = 5%] -0.35[if Tree Cover Ratio = 10%] +0 [if Tree Cover Ratio = 50%]	-0.61 [if scale is 600] +0.27 [if scale is 2000] +0 [if scale is 3500]		0.49	<.0001**
Greenery Placement	+0.57	-0.5[if Tree Cover Ratio = 5%] +0.05 [if Tree Cover Ratio = 10%] +0 [if Tree Cover Ratio = 50%]			0.07	0.0019**
Seat Amount	+0.17	-0.20 [if Tree Cover Ratio = 5%] -0.07 [if Tree Cover Ratio = 10%] +0 [if Tree Cover Ratio = 50%]	-0.60 [if scale is 600] +0.18 [if scale is 2000] +0 [if scale is 3500]		0.21	<.0001**
Seat Placement	No valid model.					
Seat Design	No valid model.					
View	+0.29	-0.36 [if Tree Cover Ratio = 5%] -0.12 [if Tree Cover Ratio = 10%] +0 [if Tree Cover Ratio = 50%]	-0.64 [if scale is 600] +0.09 [if scale is 2000] +0 [if scale is 3500]		0.20	<.0001**
Willingness to Pay	+299	-43 [if Tree Cover Ratio = 5%] -1 [if Tree Cover Ratio = 10%] +0 [if Tree Cover Ratio = 50%]	-33 [if scale is 600] +2 [if scale is 2000] +0 [if scale is 3500]		0.10	0.0008**
Willingness to Stay	+31	-8 [if Tree Cover Ratio = 5%] -3 [if Tree Cover Ratio = 10%] +0 [if Tree Cover Ratio = 50%]	-9 [if scale is 600] +2.5 [if scale is 2000] +0 [if scale is 3500]		0.21	<.0001**

9.5 Nominal Logistic Regression

The same logistic regression and quadratic logistic regression analysis were conducted for tree cover ratio at each scale using raw data to allow for a dynamic visualization of the effects the variables had at each scale without being constrained by averages interpretation.

The same treatment described in section 8.5 was applied. Alongside each regression plot, the regression model and its probability range is provided. For easy recognition, models that were not statistically significant are shaded gray.

9.5.1 Activities

9.5.1.1 Stay activity:

A statistically significant logistic regression model could be made for *Stay* activity from *Tree Cover Ratio*. The quadratic logistic regression model was also statistically significant ($R^2 = 0.09$; $p = 0.0005$) and shows a critical value of 0.35, or 35% of floor area ratio as tree cover being optimal for stay activity.

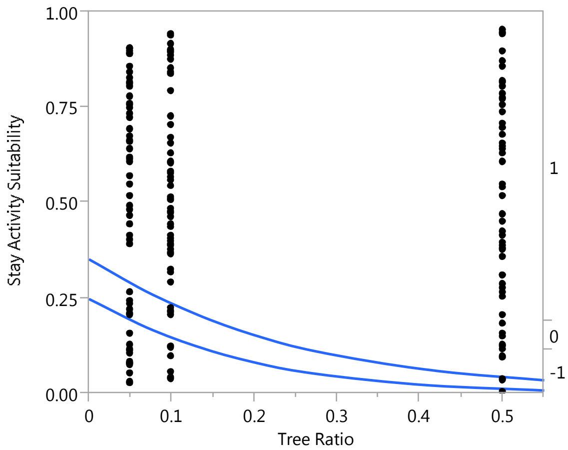


Figure 9.16 – Logistic Regression for Stay Activity from Tree Cover Ratio.

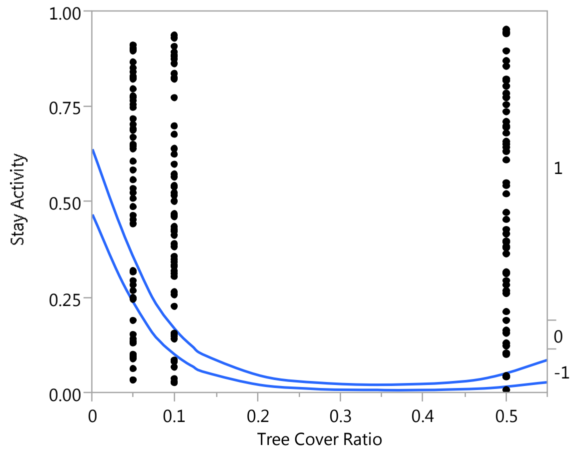


Figure 9.17 – Quadratic Logistic Regression for Stay Activity from Tree Cover Ratio.

Table 9.6 – Logistic Model for Stay Activity based on Tree Cover Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	$\ln(\hat{Y}/(1-\hat{Y})) = -0.96 - 6.92*$ [tree cover ratio]	0.08	p = 0.0002**
Lower	$\ln(\hat{Y}/(1-\hat{Y})) = -1.83 - 3.21*$ [tree cover ratio]		

9.5.1.2 Eat/Drink activity:

No statistically significant logistic regression model or quadratic logistic regression model ($R^2 = 0.02$; $p = 0.4222$) could be made to eat/drink activity from tree cover ratio.

Table 9.7 – Logistic Model for Eat/Drink Activity based on Tree Cover Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	$\ln(\hat{Y}/(1-\hat{Y})) = -1.63 - 0.67*$ [tree cover ratio]	0.003	p = 0.6546
Lower	$\ln(\hat{Y}/(1-\hat{Y})) = -1.62 - 0.92*$ [tree cover ratio]		

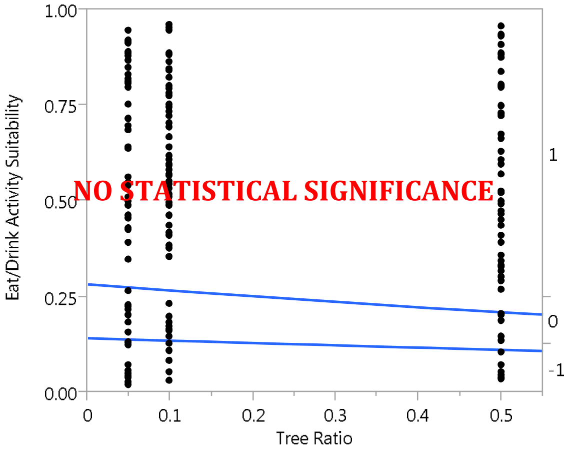


Figure 9.18 – Logistic Regression for Eat/drink Activity from Tree Cover Ratio.

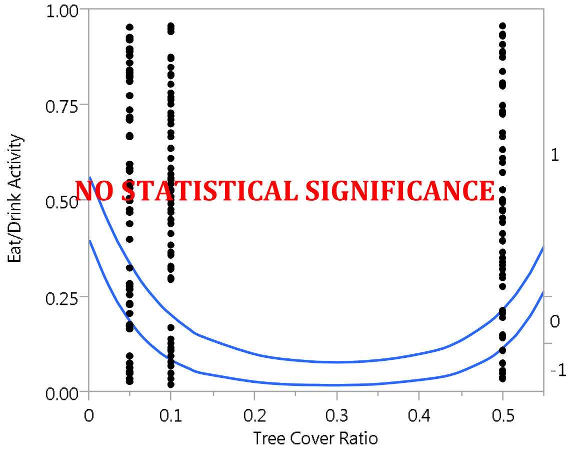


Figure 9.19 – Quadratic Logistic Regression for Eat/drink Activity from Tree Cover Ratio.

9.5.1.3 Rest activity:

No statistically significant logistic regression model or quadratic logistic regression model ($R^2 = 0.03$; $p = 0.1923$) could be made for rest activity from tree cover ratio.

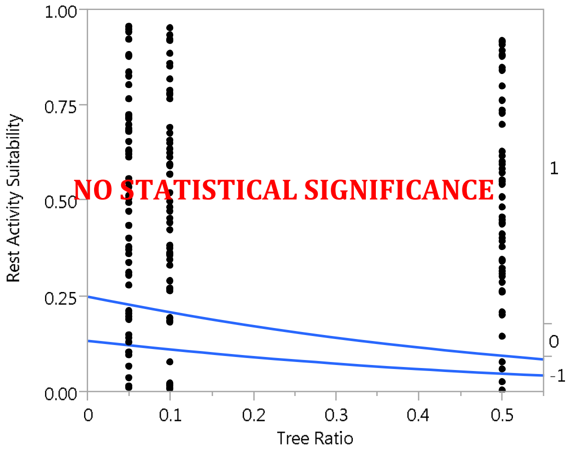


Figure 9.20 – Logistic Regression for Rest Activity from Tree Cover Ratio.

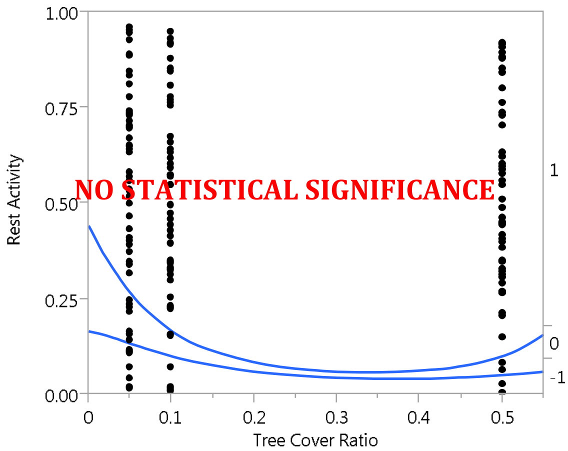


Figure 9.21 – Quadratic Logistic Regression for Rest Activity from Tree Cover Ratio.

Table 9.8 – Logistic Model for Rest Activity based on Tree Cover Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	$\ln(\hat{Y}/(1-\hat{Y})) = -1.72 - 2.41*$ [tree cover ratio]	0.002	p = 0.0978
Lower	$\ln(\hat{Y}/(1-\hat{Y})) = -1.88 + 2.18*$ [tree cover ratio]		

9.5.1.4 Wait activity:

No statistically significant logistic regression model or quadratic logistic regression model ($R^2 = 0.02$; $p = 0.2110$) could be made for wait activity from tree cover ratio.

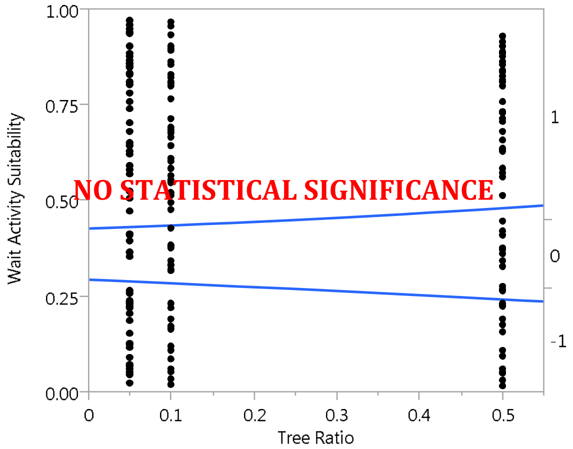


Figure 9.22 – Logistic Regression for Wait Activity from Tree Cover Ratio.

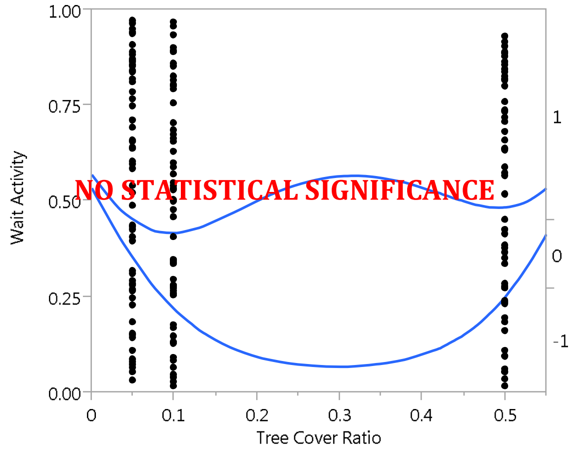


Figure 9.23 – Quadratic Logistic Regression for Wait Activity from Tree Cover Ratio.

Table 9.9 – Logistic Model for Wait Activity based on Tree Cover Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	ln (Ŷ/(1- Ŷ)) = – 0.66 – 0.20* [tree cover ratio]	0.006	p = 0.3208
Lower	ln (Ŷ/(1- Ŷ)) = – 1.45 + 1.34* [tree cover ratio]		

9.5.1.5 Read activity:

A statistically significant logistic regression model could be made for read activity from tree cover ratio. The quadratic logistic regression model was also statistically significant ($R^2 = 0.06$; $p = 0.0004$) and shows a critical value between 0.35 and 0.40, or 35 to 40% of floor area ratio as tree cover being optimal for read activity.

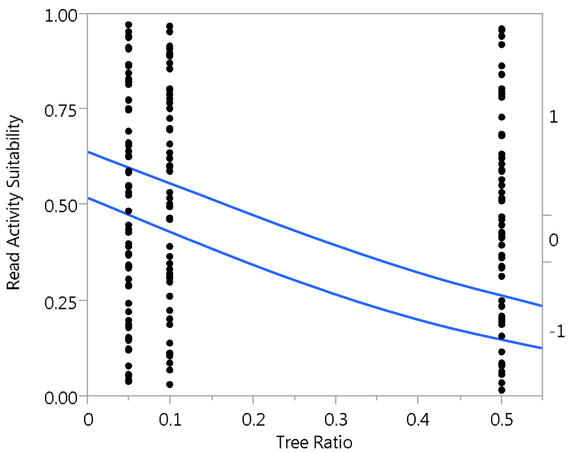


Figure 9.24 – Logistic Regression for Read Activity from Tree Cover Ratio.

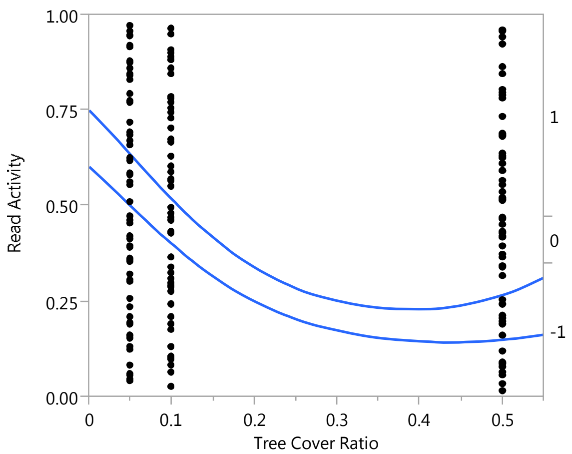


Figure 9.25 – Quadratic Logistic Regression for Read Activity from Tree Cover Ratio.

Table 9.10 – Logistic Model for Read Activity based on Tree Cover Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	ln (Ŷ/(1- Ŷ)) = + 0.36 – 3.95* [tree cover ratio]	0.06	p <.0001**
Lower	ln (Ŷ/(1- Ŷ)) = – 1.10 – 1.51* [tree cover ratio]		

9.5.2 Impressions

9.5.2.1 Appeal:

A statistically significant logistic regression model could be made for environment appeal from tree cover ratio. The quadratic logistic regression model was also statistically significant ($R^2 = 0.06$; $p = 0.0003$) and shows a critical value between 0.30 and 0.40, or 30 to 40% of floor area ratio as tree cover being optimal for environment appeal.

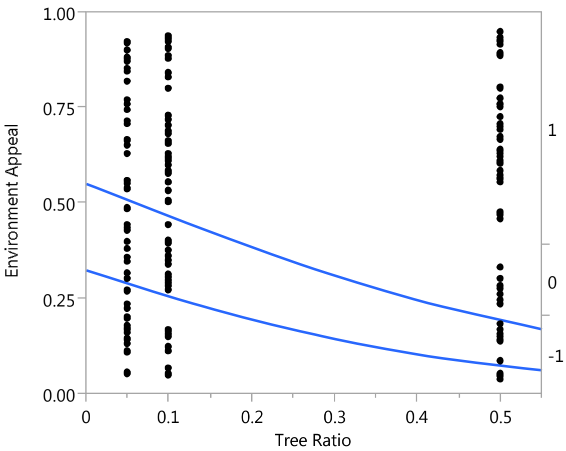


Figure 9.26 – Logistic Regression for Appeal from Tree Cover Ratio.

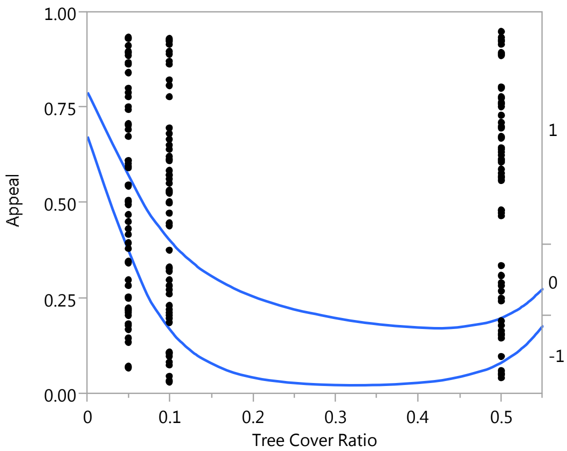


Figure 9.27 – Quadratic Logistic Regression for Appeal from Tree Cover Ratio.

Table 9.11 – Logistic Model for Appeal based on Tree Cover Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	$\ln(\hat{Y}/(1-\hat{Y})) = -0.33 - 4.14^{*}$ [tree cover ratio]	0.05	p = 0.0002**
Lower	$\ln(\hat{Y}/(1-\hat{Y})) = -0.68 - 2.46^{*}$ [tree cover ratio]		

9.5.2.2 Interest:

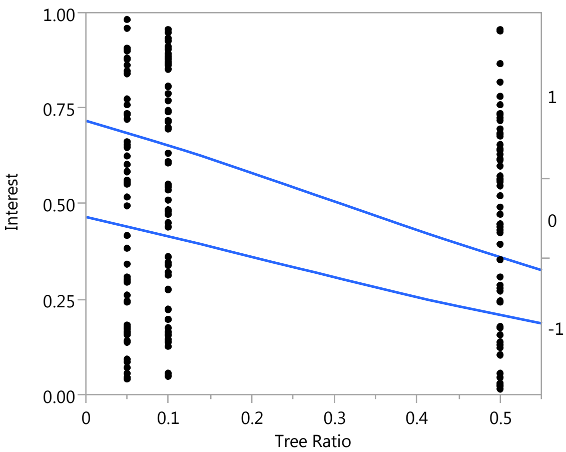


Figure 9.28 – Logistic Regression for interest from tree cover ratio.

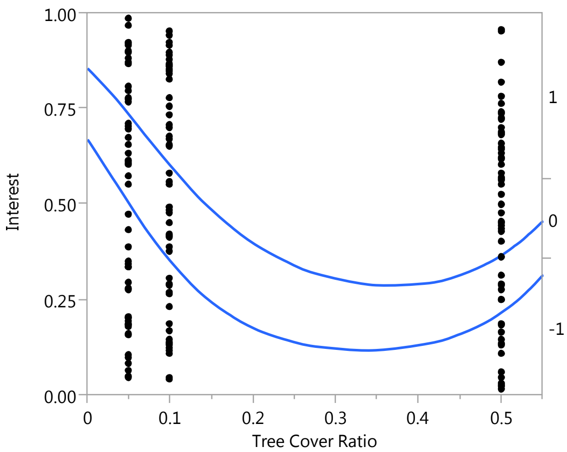


Figure 9.29 – Quadratic Logistic Regression for Interest from Tree Cover Ratio.

Table 9.12 – Logistic Model for interest based on Tree Cover Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	$\ln(\hat{Y}/(1-\hat{Y})) = +0.50 - 3.24^{*}$ [tree cover ratio]	0.04	p = 0.0003**
Lower	$\ln(\hat{Y}/(1-\hat{Y})) = -0.11 - 2.65^{*}$ [tree cover ratio]		

A statistically significant logistic regression model could be made for environment interest from tree cover ratio. The quadratic logistic regression model was also statistically significant ($R^2 = 0.05$; $p = 0.0012$) and shows a critical value between 0.30 and 0.35, or 30 to 35% of floor area ratio as tree cover being optimal for environment interest.

9.5.2.3 Enclosure:

A statistically significant logistic regression model could be made to the environment enclosure from tree cover ratio. The quadratic logistic regression model was also statistically significant ($R^2 = 0.16$; $p < .0001$) but offers no useful critical value since the relationship between variables is linear.

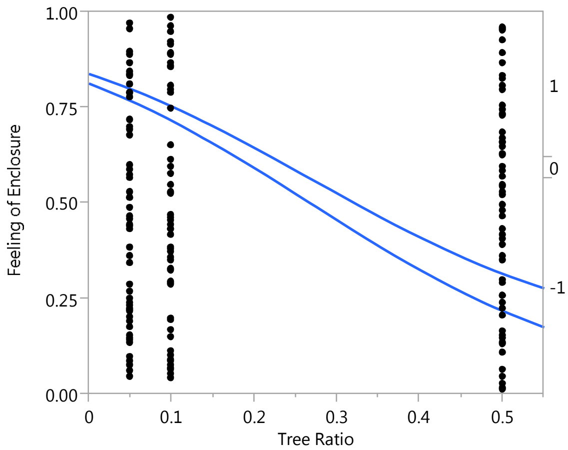


Figure 9.30 – Logistic Regression for Enclosure from Tree Cover Ratio.

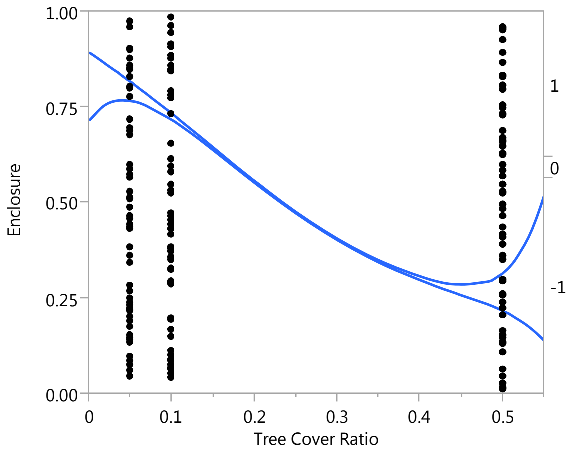


Figure 9.31 – Quadratic Logistic Regression for Enclosure from Tree Cover Ratio.

Table 9.13 – Logistic Model for enclosure based on Tree Cover Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	$\ln(\hat{Y}/(1-\hat{Y})) = +1.62 - 5.54^{*}$ [tree cover ratio]	0.15	p <.0001**
Lower	$\ln(\hat{Y}/(1-\hat{Y})) = -1.86 - 0.19^{*}$ [tree cover ratio]		

9.5.2.4 Atmosphere:

No statistically significant logistic regression model or quadratic logistic regression model ($R^2 = 0.003$; $p = 0.9212$) could be made for atmosphere from tree cover ratio.

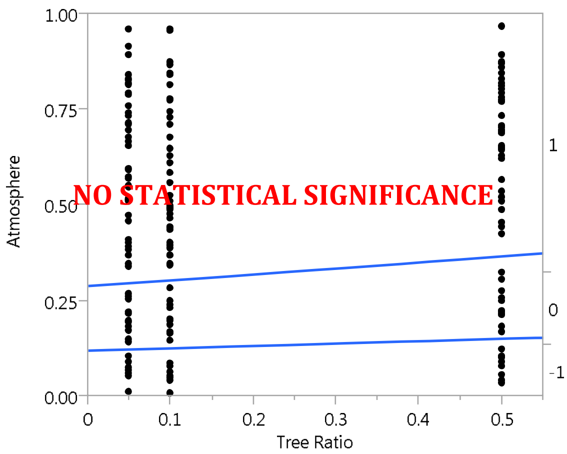


Figure 9.32 – Logistic Regression for Atmosphere from Tree Cover Ratio.

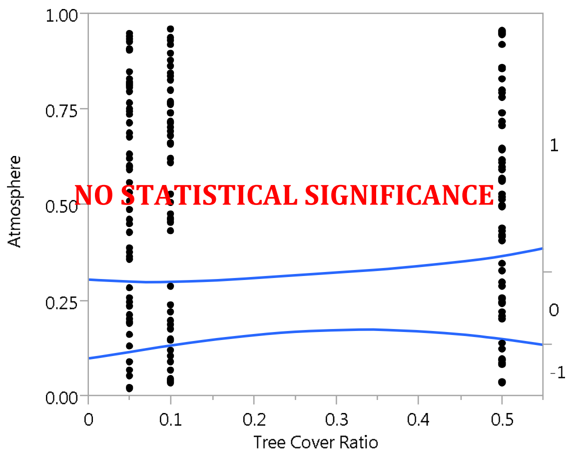


Figure 9.33 – Quadratic Logistic Regression for Atmosphere from Tree Cover Ratio.

Table 9.14 – Logistic Model for Atmosphere based on Tree Cover Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	$\ln(\hat{Y}/(1-\hat{Y})) = -1.78 + 0.68*$ [tree cover ratio]	0.002	p = 0.6709
Lower	$\ln(\hat{Y}/(1-\hat{Y})) = -1.43 + 0.71*$ [tree cover ratio]		

9.5.2.5 Relaxation

A statistically significant logistic regression model could be made for environment relaxation from tree cover ratio. The quadratic logistic regression model was also statistically significant ($R^2 = 0.08$; $p < .0001$) but offers no useful critical value since the relationship between variables is linear.

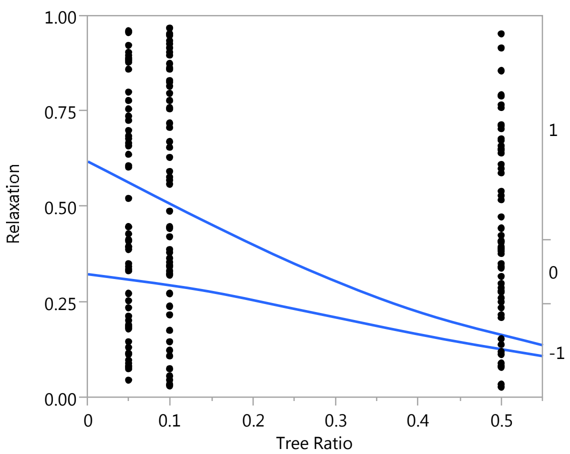


Figure 9.34 – Logistic Regression for Relaxation from Tree Cover Ratio.

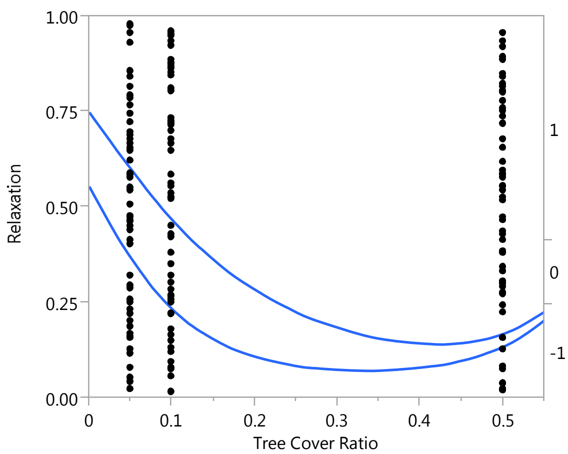


Figure 9.35 – Quadratic Logistic Regression for Relaxation from Tree Cover Ratio.

Table 9.15 – Logistic Model for Relaxation based on Tree Cover Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	ln (Ŷ/(1- Ŷ)) = – 0.17 – 3.45* [tree cover ratio]	0.08	p <.0001**
Lower	ln (Ŷ/(1- Ŷ)) = – 0.26 – 5.79* [tree cover ratio]		

9.5.2.6 Openness:

A statistically significant logistic regression model could be made for openness from tree cover ratio. The quadratic logistic regression model was also statistically significant ($R^2 = 0.04$; $p = 0.0048$) but offers no useful critical value since the relationship between variables is linear.

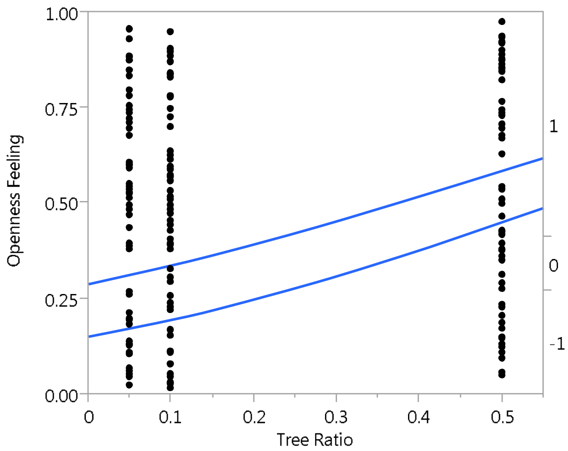


Figure 9.36 – Logistic Regression for Openness from Tree Cover Ratio.

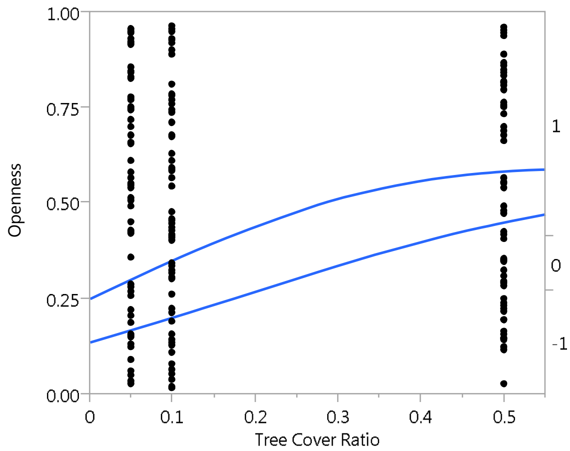


Figure 9.37 – Quadratic Logistic Regression for Openness from Tree Cover Ratio.

Table 9.16 – Logistic Model for Openness based on Tree Cover Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	ln (Ŷ/(1- Ŷ)) = – 1.55 + 3.27* [tree cover ratio]	0.04	p = 0.0006**
Lower	ln (Ŷ/(1- Ŷ)) = – 1.64 + 1.03* [tree cover ratio]		

9.5.2.7 Oppression:

A statistically significant logistic regression model could be made for openness from tree cover ratio. The quadratic logistic regression model was also statistically significant ($R^2 = 0.03$; $p = 0.0332$) but offers no useful critical value since the relationship between variables is linear and the effect is small.

Table 9.17 – Logistic Model for oppression based on Tree Cover Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	ln (Ŷ/(1- Ŷ)) = + 1.58 – 1.72* [tree cover ratio]	0.002	p = 0.0268*
Lower	ln (Ŷ/(1- Ŷ)) = – 0.36 + 0.65* [tree cover ratio]		

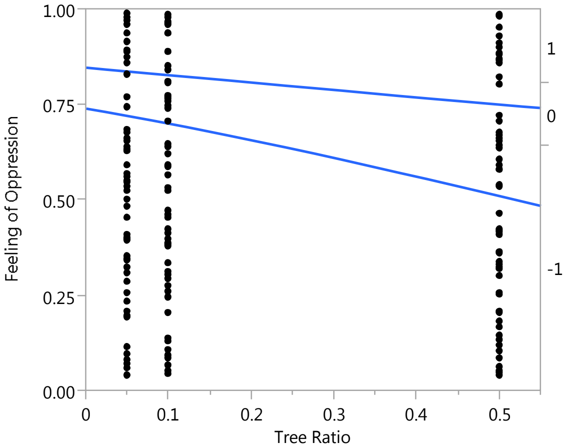


Figure 9.38 – Logistic Regression for Oppression from Tree Cover Ratio.

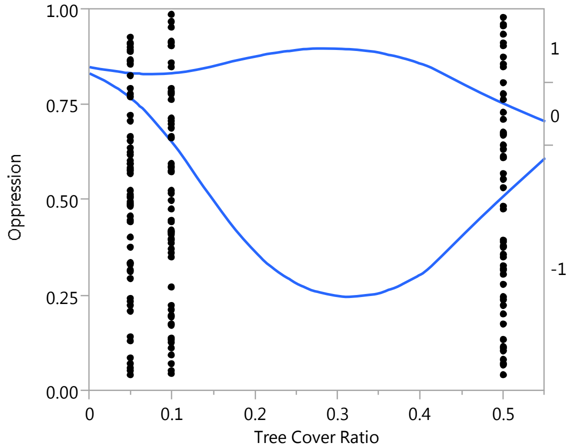


Figure 9.39 – Quadratic Logistic Regression for Oppression from Tree Cover Ratio.

9.5.2.8 Liveliness:

No statistically significant logistic regression model or quadratic logistic regression model ($R^2 = 0.005$; $p = 0.7710$) could be made for liveliness from tree cover ratio.

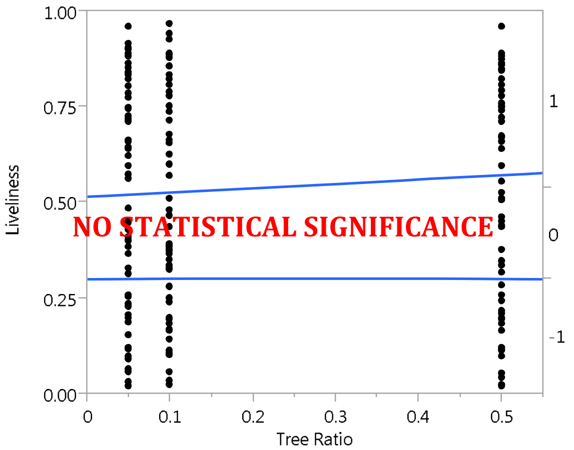


Figure 9.40 – Logistic Regression for Liveliness from Tree Cover Ratio.

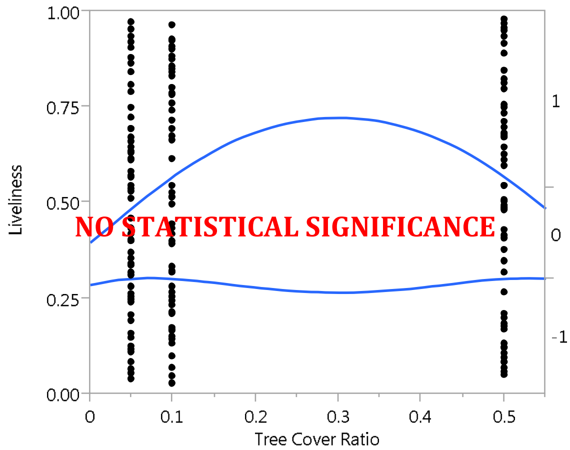


Figure 9.41 – Quadratic Logistic Regression for Liveliness from Tree Cover Ratio.

Table 9.18 – Logistic Model for Liveliness based on Tree Cover Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	$\ln(\hat{Y}/(1-\hat{Y})) = -0.48 + 0.25*$ [tree cover ratio]	0.001	$p = 0.7411$
Lower	$\ln(\hat{Y}/(1-\hat{Y})) = -0.82 + 0.72*$ [tree cover ratio]		

9.5.2.9 Diversity:

A statistically significant logistic regression model could be made for diversity from tree cover ratio. The quadratic logistic regression model was also statistically significant ($R^2 = 0.03$; $p = 0.0275$) but offers no useful critical value since the relationship between variables is linear.

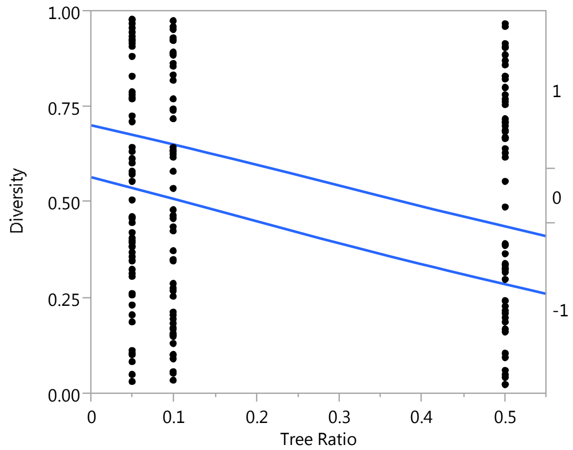


Figure 9.42 – Logistic Regression for Diversity from Tree Cover Ratio.

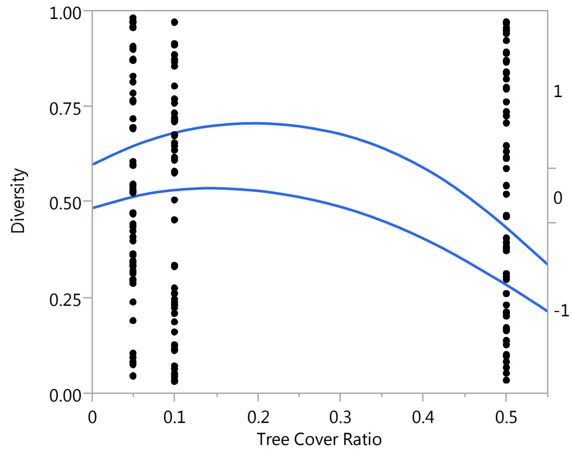


Figure 9.43 – Quadratic Logistic Regression for Diversity from Tree Cover Ratio.

Table 9.19 – Logistic Model for Diversity based on Tree Cover Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	$\ln(\hat{Y}/(1-\hat{Y})) = +0.65 - 2.65^{*}$ [tree cover ratio]	0.03	$p = 0.0054^{**}$
Lower	$\ln(\hat{Y}/(1-\hat{Y})) = -0.78 - 1.07^{*}$ [tree cover ratio]		

9.5.3 Perceptions

9.5.3.1 Size Perception:

No statistically significant logistic regression model or quadratic logistic regression model ($R^2 = 0.004$; $p = 0.8804$) could be made for size perception from tree cover ratio.

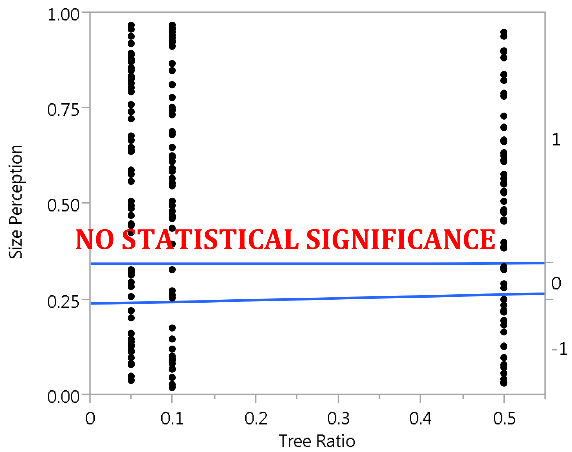


Figure 9.44 – Logistic Regression for Size Perception from Tree Cover Ratio.

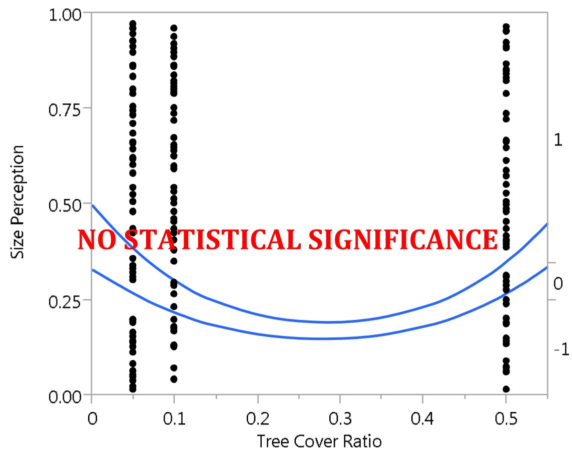


Figure 9.45 – Quadratic Logistic Regression for Size Perception from Tree Cover Ratio.

Table 9.20 – Logistic Model for size perception based on tree ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	ln (Ŷ/(1- Ŷ)) = – 1.01 + 0.19* [tree cover ratio]	0.0008	p = 0.8906
Lower	ln (Ŷ/(1- Ŷ)) = – 1.83 – 0.50* [tree cover ratio]		

9.5.3.2 Greenery amount:

A statistically significant logistic regression model could be made for the perception of the greenery amount from tree cover ratio. The quadratic logistic regression model was also statistically significant ($R^2 = 0.20$; $p < .0001$) but offers no useful critical value since the relationship between variables is linear.

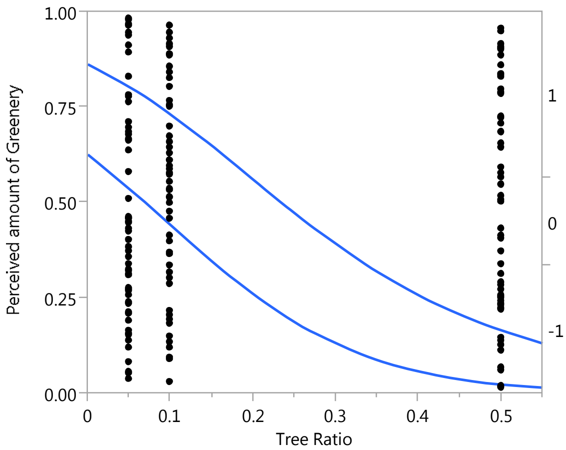


Figure 9.46 – Logistic Regression for Greenery Amount from Tree Cover Ratio.

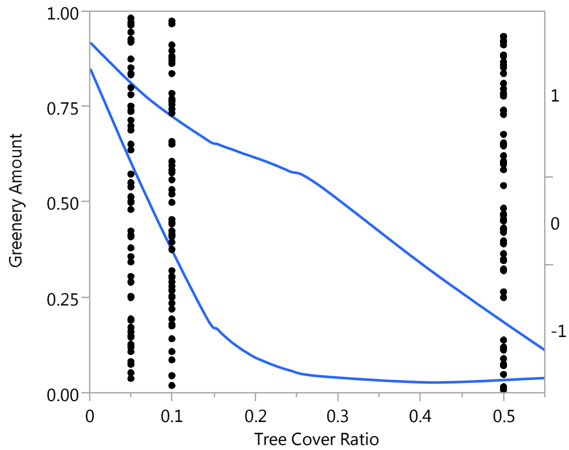


Figure 9.47 – Quadratic Logistic Regression for Greenery Amount from Tree Cover Ratio.

Table 9.21 – Logistic Model for Greenery Amount based on Tree Cover Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	ln (Ŷ/(1- Ŷ)) = + 1.51 – 10.19* [tree cover ratio]	0.19	p <.0001**
Lower	ln (Ŷ/(1- Ŷ)) = + 0.54 – 4.63* [tree cover ratio]		

9.5.3.3 Greenery placement:

A statistically significant logistic regression model could be made for the perception of the greenery amount from tree cover ratio. The quadratic logistic regression model was also statistically significant ($R^2 = 0.03$; $p = 0.0216$) with a critical value of 0.35 or 35% of floor area ratio as critical value for the perception of greenery placement. Since the relationship between variables is linear, the logistic regression is a more suitable measure of the relationship between variables.

Table 9.22 – Logistic Model for Greenery Placement based on Tree Cover Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	ln (Ŷ/(1- Ŷ)) = – 0.22 – 2.12* [tree cover ratio]	0.03	p = 0.0062**
Lower	ln (Ŷ/(1- Ŷ)) = – 0.54 – 2.89* [tree cover ratio]		

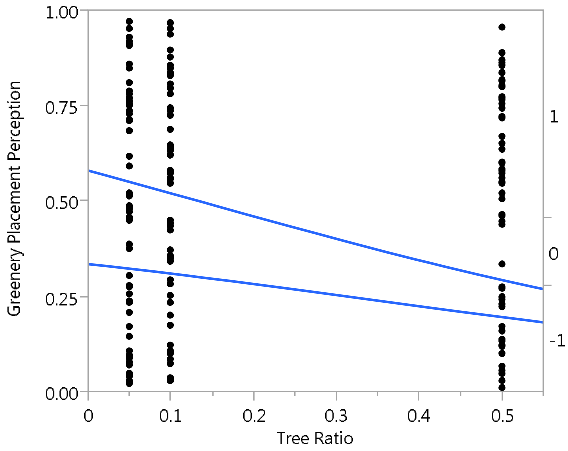


Figure 9.48 – Logistic Regression for Greenery Placement Perception from Tree Cover Ratio.

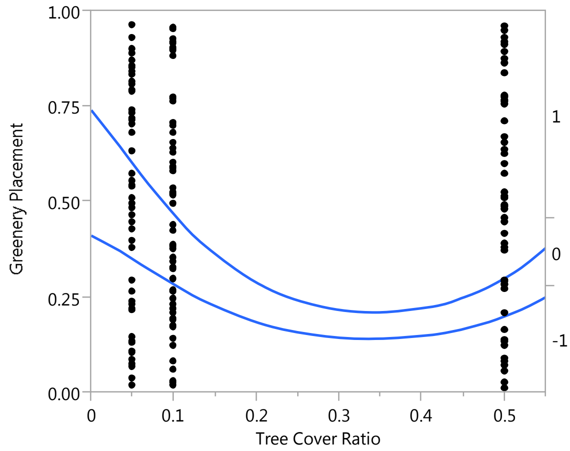


Figure 9.49 – Quadratic Logistic Regression for Greenery Placement from Tree Cover Ratio.

9.5.3.4 Seat Amount:

A statistically significant logistic regression model could be made for the perception of seat amount from tree cover ratio. The quadratic logistic regression model was not statistically significant ($R^2 = 0.02$; $p = 0.0578$).

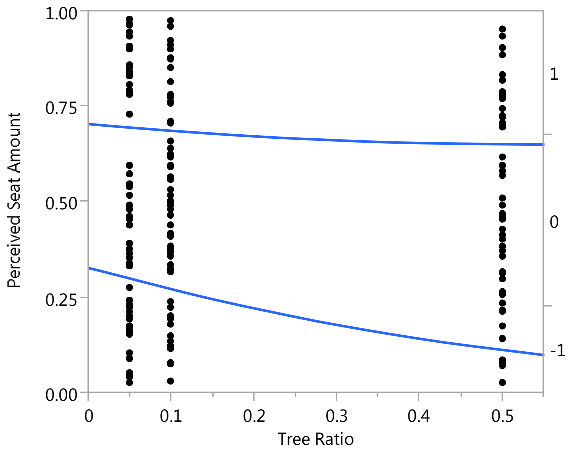


Figure 9.50 – Logistic Regression for Seat Amount Perception from Tree Cover Ratio.

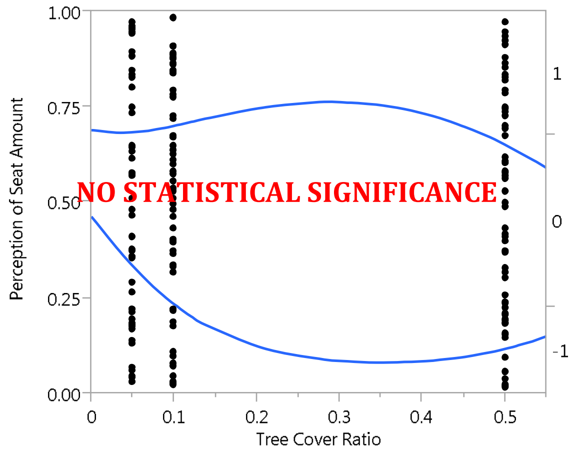


Figure 9.51 – Quadratic Logistic Regression for Seat Amount from Tree Cover Ratio.

Table 9.23 – Logistic Model for seat amount perception based on tree ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	$\ln(\hat{Y}/(1-\hat{Y})) = +0.11 - 2.47^{*}$ [tree cover ratio]	0.02	p = 0.0204*
Lower	$\ln(\hat{Y}/(1-\hat{Y})) = +0.24 + 0.39^{*}$ [tree cover ratio]		

9.5.3.5 Seat Placement:

A statistically significant logistic regression model could be made for the perception of seat placement from tree cover ratio. The quadratic logistic regression model was not statistically significant ($R^2 = 0.02$; $p = 0.1157$).

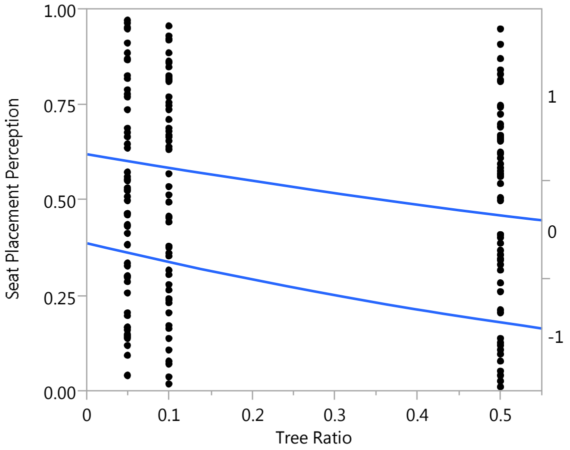


Figure 9.52 – Logistic Regression for Seat Placement Perception from Tree Cover Ratio.

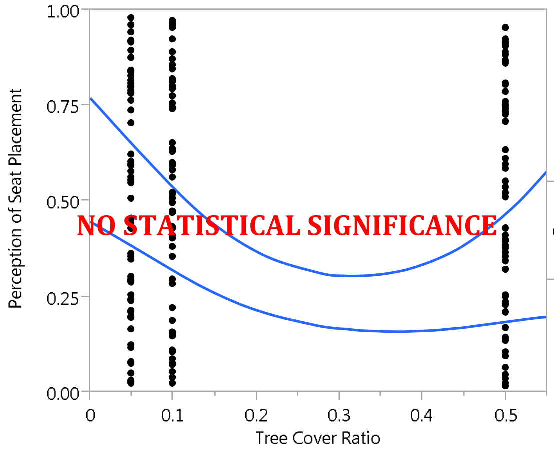


Figure 9.53 – Quadratic Logistic Regression for Seat Placement from Tree Cover Ratio.

Table 9.24 – Logistic Model for seat placement based on Tree Cover Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	ln (Ŷ/(1- Ŷ)) = + 0.02 – 2.23* [tree cover ratio]	0.02	p = 0.0468*
Lower	ln (Ŷ/(1- Ŷ)) = – 0.48 – 0.34* [tree cover ratio]		

9.5.3.6 Seat Design:

No statistically significant logistic regression model or quadratic logistic regression model (R^2 = 0.003; p = 0.9247) could be made for the perception of seat design from tree cover ratio.

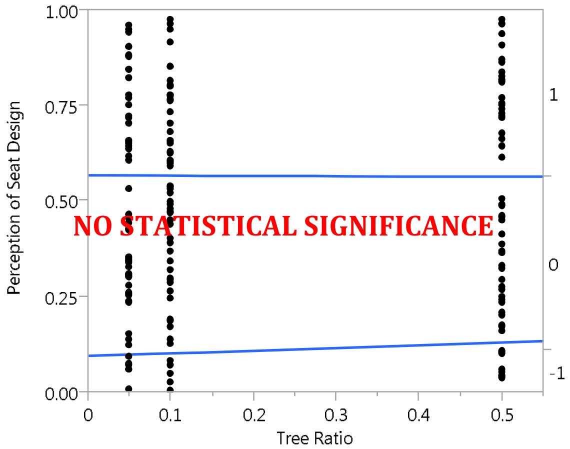


Figure 9.54 – Logistic Regression for Seat Design Perception from Tree Cover Ratio.

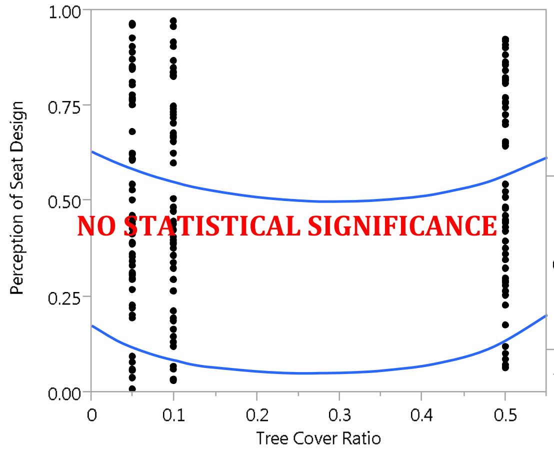


Figure 9.55 – Quadratic Logistic Regression for Seat Design from Tree Cover Ratio.

Table 9.25 – Logistic Model for Seat Design based on Tree Cover Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	ln (Ŷ/(1- Ŷ)) = – 1.50 + 0.60* [tree cover ratio]	0.001	p = 0.8110
Lower	ln (Ŷ/(1- Ŷ)) = + 0.09 – 0.19* [tree cover ratio]		

9.5.3.7 View:

A statistically significant logistic regression model could be made for the perception of the greenery amount from tree cover ratio. The quadratic logistic regression model was also statistically significant ($R^2 = 0.03$; $p = 0.0253$) but offers no useful critical value since the relationship between variables is linear.

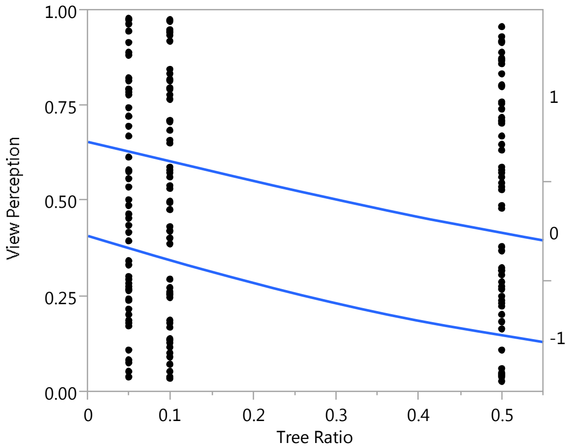


Figure 9.56 – Logistic Regression for View Perception from Tree Cover Ratio.

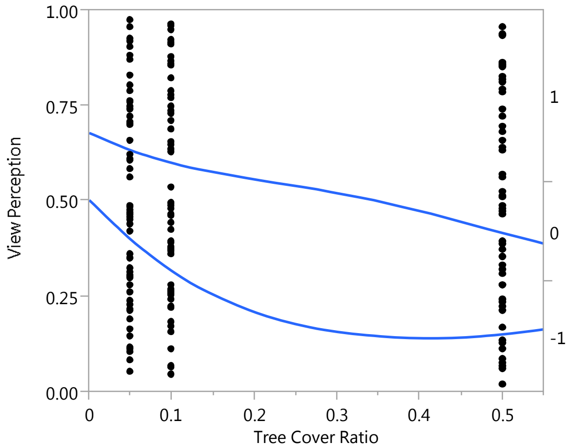


Figure 9.57 – Quadratic Logistic Regression for View Perception from Tree Cover Ratio.

Table 9.26 – Logistic Model for View based on Tree Cover Ratio:

Curve	Logistic function	R^2	Prob.>ChiSq
Upper	$\ln(\hat{Y}/(1-\hat{Y})) = +0.17 - 3.10*$ [tree cover ratio]	0.03	p = 0.0049**
Lower	$\ln(\hat{Y}/(1-\hat{Y})) = -0.33 - 0.88*$ [tree cover ratio]		

10 CONCLUSIONS

Urban designers commonly manipulate different physical elements during the design process with the purpose of obtaining high public space attendance and improve users' perceptions and impressions of the built environment.

The present study looked into the relationship between the quantity of those physical elements and specific user activities, perceptions and impressions. It adopted an exploratory survey to assess which elements are most perceived by POPS users and investigated the effects of such elements. The effects of seating ratio, bushes ratio and tree cover ratio, as well as tree height and environment scale were tested. The compiled results of all four studies are described below.

10.1 Overall scale analysis

Small environments (600m^2) were perceived as less suitable than medium environments (2000m^2) for all (stay, eat/drink, rest and read) except wait activity. This probably occurs because, small environments reduces distances among people possibly making them feel uncomfortable. There is a necessary distance between people just passing by and people staying in the environment and the smaller scale studied (600m^2) do not seem to provide it. For wait activity the necessity is different and being seen/search for others requires less strain, making smaller environments the most desirable. Small environments were worse than other environments in practically all impression and physical scales – small environments do seem to be perceived somewhat different than other scales and, as so, should adopt a different design strategy. The results that large environments are preferred over smaller ones are in agreement with Talbot, Bardwell & Kaplan (1987).

In some cases, large scale (3500m^2) also was less favorable than medium scale (2000m^2) environments. When an environment is as large as 3500m^2 and does not vary in design it becomes monotonous and it directly affects users' perception, impressions and the environments suitability for different activities. Medium scale environment seems to be the scale more suitable for the design to be perceived as one environment while still not being monotonous. Large environment can be divided into smaller sections with different characteristics which may cause them to be perceived as a group of smaller environments with different characteristics.

10.2 Conclusions about Seats

Increasing the seating ratio up to 5% of FAR increases environmental suitability to stay, eat/drink and rest activities but when it passes 5% suitability diminishes. For wait activity, the opposite is true and the effects are similar with seats between 1 and 3% but decreases as seating ratio increases. No effect could be consistently observed for read activity.

Appeal, interest and diversity, will also improve when seating ratio increases up to 5% but will worsen past it. Other impressions are consistently affected by seating ratio and will consistently be affected by it, such as enclosure, openness, oppression and liveliness. Atmosphere improves up to 5% and stagnates, while relaxation is constant up to 5% when it starts to worsen.

The amount of seats also affects how the environment is perceived. Increasing seating ratio pass 5% will cause the environment to be perceived as smaller and seat placement as worse.

Increasing seat ratio up to 5% will increase willingness to pay and stay duration, while further increases will worsen it. Considering only willingness to pay, seating ratio at 10% is as bad as only 1% of floor area ratio.

Overall, seating ratio seems to be ideal between 3 and 5% for most activities, impressions and perceptions, in agreement with Whyte (1980). The exception to this is wait activity which seems to require the opposite of other activities.

10.3 Conclusions about Trees

Increasing tree coverage ratio to 50% increases environment suitability for read, stay and rest activities, although, for stay and rest, no difference could be found between 5 and 10% or 10 and 50%. No effect could be consistently observed for eat/drink or wait activity.

Increasing tree ratio will make the environments to be perceived as more appealing, interesting, relaxing and diverse (marginally) but also, more enclosed, less open and more oppressive. It had no effect in the environments atmosphere or liveliness.

Environments with a higher tree ratio were perceived as having more greenery but, at 50%, greenery placement also was perceived as better and as having a higher seat amount. Higher tree ratio also improved the perception of view, willingness to pay and willingness to stay, but it had no effect in the perception of environment size, seat placement, seat design.

Overall, increasing tree ratio made the environments' perception, impressions and suitability for activities to either improve or remain the same, with the exceptions of enclosure, openness and oppression. It also positively affected willingness to pay and willingness to stay in the environment.

Small environments (600m^2) were perceived as less suitable for stay, rest and read and more suitable for wait activity.

10.4 Conclusions about Bushes

Bushes ratio had no effect in increasing the environments suitability for any of the 5 activities studied. It also had a minor effect on the users' impressions of the environment. From all nine impressions studied, it only affected relaxation and openness: increasing bushes amount will improve how relaxing the environment is perceived but it will make is seem less open. Increasing bushes negatively affect openness by increasing the percentage of floor area with obstructions and increasing occlusion (depending on the bush's height), in agreement with Imamoglu (2000) and Stamps (2007). Regarding perception, increasing the amount of bushes in the environment will only affect the perception of greenery amount.

These results reflect only the effects from sheer amount or the ratio of floor area occupied by bushes. Other research has found other effects that arise from different placement patters and species viability (Kaplan & Kaplan, 1989; Kuper, 2017).

10.5 Design recommendations

There are several ways to incorporate the findings of this research into POPS design, depending on the desired purpose. Designers can use the recommendations described below to improve environment perception, impressions and perceived suitability for different activities, while governments may wish to incorporate it into building standards to improve overall POPS quality. While the recommendations described below offer a quick reference and practical rule of thumb, if the purpose is to design for a specific activity or focus on a specific impression, designers may prefer to use the multi regression and/or logistic analysis for the desired effect.

Overall impression of the environment is not determined only by the elements ratio, but is also directly affected by several other aspects such as layout, climate, culture, programming, maintenance, etc. (see Figure 2.3). Urban designers ought to consider all of those elements into urban design while using the design recommendations presented here as a reference guide to the effects of the adopted ratios.

Designers may wish to incorporate the research method adopted in this research into the design process, and elicit potential users to evaluate different design options as IVE environments at different stages of design. Since designers already commonly create virtual environments as a rendering tool, the extra work to transform them into functional IVEs is very small while the feedback at the design stage may be invaluable.

10.5.1 Design for activities

Designers should consider which specific activities for which they are designing the environment, since perceived suitability is affected by seating and tree ratio. Environments or areas with different purposes should be designed with different ratios in mind.

- <u>Stay, Eat/Drink, Rest and Read</u> requires similar environments. They are most affected by seating ratio, which is ideal around 5% of floor area ratio.
- <u>Read activity</u> is also affected by the tree cover ratio and increasing tree cover improves perceived suitability.
- <u>Wait activity</u> requires an environment different from the other activities, and reducing seating ratio and increasing tree height will improve its suitability. The environment of the area destined for wait activity may also benefit from easily recognizable visual landmarks, such as sculptures or water fountains. Visual easiness is imperative since visual search is a requirement.

10.5.2 Seating ratio

<u>Seating ratio should be between 3% and 6% of floor area</u> (the area occupied by seats and tables) with the exception of environments or areas designed for wait activity. Environments with excessive (10%) of insufficient (less than 3%) seating ratio are perceived less suitable for different activities and cause worse impressions on users. The exceptions to this rule are wait activity for which less seating improves suitability and perception of liveliness which improves even at greater seating ratios.

10.5.3 Tree cover ratio

Although tree cover ratio does not affect perceived suitability for activities other than read, it does improve users' impressions of the environment considerably. Overall, the more tree cover the better are the impressions of the environment, at least up to 50% of floor area which are the limits of this investigation. The obvious exceptions to this rule is perceived openness, oppression and enclosure which are negatively affected by higher cover ratios (less open, more oppressive and more enclosed).

10.5.4 Bushes and tree height

Bushes ratio did not affect perceived suitability for different activities or users' impressions of the environment and may be freely used. The exception to this is perceived relaxation which increases and perceived openness which decreases at higher ratios. Bushes ratios, as described here, refer to shrubs, plants and flower pots that do not obstruct view of the environment as hedges would do. Several aspects of bushes other than the ground cover ratio may have an effect on users' that is out of the scope of this research.

Tree height may also be freely adopted since it also had no overall effect on perceived suitability for different activities or users' impressions of the environment, with the exception of improving perceived suitability for wait activity and increasing perceived enclosure with higher trees.

10.5.5 Environment size/scale

Environments with an area close to 2000m^2 are, overall, better perceived, cause better impressions on users and are perceived as more suitable for stay, eat/drink, rest and read activities.

Environments with an area superior to 2000m^2 can improve the way the environment is perceived merely by subdividing it so that users do not perceive the whole environment from one observation point.

Special attention should be given to environments or areas with less than 1000m^2 since they are perceived differently from larger places. In these places, users' judgments are affected by the quantity (units) rather than the total area occupied by it. The environment can be easily perceived at a glance and they are judged more critically. Small places are the most suitable for wait activity because it can be easily surveyed.

11 Limitations and Future Research Possibilities

No research can address all aspects of a subject as to eliminate any further advancement possibilities. The following chapter addresses the limitations of the present study and the possibilities for future developments in the subject.

11.1 Research limitations

The present study was made in Japan and, as such, is limited by its cultural factors. Although there is the possibility that different cultures will yield similar results, a generalization cannot be stated without further studies.

Different social and economic strata may also yield different results. Japan does not have a population with clear socioeconomic differences but other settings may have to incorporate socioeconomic conditions into the data treatment. If there is a difference in environmental preference for different activities based on socioeconomic factors, there may be design repercussions in perceptions of territoriality and feeling of belonging.

Although expertise bias did not limit the present research, the fact that a large subset of the participants were university students is a clear limitation. The first aspect of this limitation is age: with the average age being 23 in the preliminary study, 24 in the first experiment, and 21 years old for the second and third experiments, this study is clearly representative of users in their 20's. The second, more subtle aspect is the lifestyle: as people graduate and move on, their lifestyle and preferences will mature which may greatly differ from the preferences gathered in this study.

Tree cover ratio measured the overall area of the canopy tree against the floor area ratio, but it did not take into consideration the canopy density itself. There may be some differences in the effects of dense canopies and sparse ones, as suggested by Gerstenberg & Hofmann (2016); Lohr & Pearson-Mins (2006) and Nelson, Johnson, Strong, Rudakewich, (2001). If there is an effect of the canopy density itself in the perception and impressions of the environment, a tree cover ratio measure that accounts only for the leaf area of the canopy may be more suitable.

At last, this research addressed environmental perception on a specific moment where the user is already in the public space and before he/she have sat. There are other environmental evaluations that will happen before and after that moment. Generally speaking, there are at least three distinct moments where the environment will be evaluated by the user and perception may be affected by different things at different moments.

The first moment is the approach, when the user is observing the environment from outside and have to decide whether to enter or not. In this situation tree height, for example, may have a completely different effect, especially at different distances.

The second moment is when the potential user has entered the environment and is considering it as a whole, which is the moment evaluated in this research.

A third moment is once the user will choose a place to perform an activity. The user will then make comparative judgments between different parts of the environment and aspects such as people surrounding a given seat, distance from foot and vehicle traffic and the presence or absence of short walls, hedges, etc. may have a greater effect on users' perceptions and impressions of a section of the environment as opposed to another.

11.2 Future Development Possibilities

There is still a lot to be learned from this study and replications with different ethnical and social demographic groups may offer interesting insights.

Future studies may explore the effects of canopy density into users' perception and impressions of the built environment. Since *tree cover* is widely used to regulate the thermal environment, such study may contribute to a comprehensive guide of tree cover design that structure tree height, trunk size, canopy density and tree cover ratios' effects on users.

This research adopted a table with four seats as representative of the "seating" element, but seats with different characteristics may have different perceptions at the same ratio levels. Interactions between seating ratio and seat characteristics could also be tested.

This research adopted "greenery" as two distinct elements: tree cover ratio and bushes ratio. Future research may investigate the effects of grass cover and hedge ratios.

Grass cover provides a greenery element without the obstruction caused by bushes and, as so, it may provide the benefits of greenery placement without the downside of increasing the feeling of enclosure and oppression. It may also be perceived as a different element altogether since it allows for other activities such as lying down and play.

Hedges, on the other hand, may be used as two distinct elements: as a surface material to cover walls and building facades or as *standalone* elements in the environment. Some studies have investigated the use of hedges as green walls into building façade and its effects on oppressiveness mitigation (Asgarzadeh, Koga, Yoshizawa, Munakata & Hirate, 2010) but still no conclusive design guidelines could be drawn.

As *standalone* elements, hedges obstruct movement, vision and have the potential to change environment size perception by dividing the environment into sub-areas and because they are commonly bundled into "landscape" or "greenery" in research, there is still a lot to be discovered about how to properly use hedges to nudge users into prolonging their stay and improve their perceptions and impressions of the built environment.

Another factor that was purposefully kept constant was the design pattern or the elements' placement pattern. Different patterns will most likely affect users perceptions and impressions of the environment and may interact with element amounts as have been shown in landscape preference research. Future research can profit greatly by investigating elements placement, environment enclosure settings and seats design variation as well as combining quantitative and qualitative characteristics to provide designers with data to back their design decisions. Research in the field should always go beyond the preference matrix (coherence, complexity, legibility and mystery) to try and establish a specific purpose based design guidelines.

12 REFERENCES

Abdulkarim, D. & Nasar, J. L., (2013). *Do Seats, Food Vendors and Sculptures Improve Plaza Visitability?* Environment and Behavior XX (X) 1-21.

Akalin, A., Yildririm, K., Wilson, C., Kilicoglu, O., (2009). *Architecture and Engineering Students Evaluations of House facades: preference, complexity and impressiveness*. Journal of Environmental Psychology 29, 124-132

Akamine, R., Funahashi, Kunio, Suzuki, T., Kita, M. and Li, B. (2003) *A Study on Use of Open Spaces at Osaka Amenity Park (OAP) and in its Neighbourhood*. Journal of Architectural Planning, AIJ, 566, pp.71-79.

Appleton, J., (1975). *The Experience of Landscape*. London: John Wiley.

Asgarzadeh, M., Lusk, A., Koga, T., Hirate, K., (2012). *Measuring oppressiveness of streetscapes*. Landscape and Urban Planning 107 (1), 1–11.

Avalone Neto, O., Munakata, J. (2015). *Seat Choice and Distance Judgment in Public Space*s. Perceptual & Motor Skills 121, 2, 548-567.

Banerjee, T., (2001) *The Future of Public Space: Beyond Invented Streets and Reinvented Places*, Journal of the American Planning Association, 67:1, 9-24

Bardwell, L. V. (1985). *Nature around the corner: Preference and use of nearby natural areas in the urban setting*. Unpublished master's thesis, University of Michigan, Ann Arbor.

Bishop, I. D., Ye, W. S., Karadaglis, C., (2001). *Experimental approaches to perception response in virtual worlds*. Landscape and Urban Planning, 54, 115-123.

Blascovich, J., Loomis, J., Beall, A. C., Swinth, K. R., Hoyt, C. L., & Bailenson, J. N., (2002). *Immersrive Virtual Environment Technology as a Methodological Tool for Social Psychology*. Psychological Inquiry, 13 (2), 103-124.

Bureau of Urban Development of the Tokyo Metropolitan Government (2010). *Comprehensive Design Permission Outline: implementation details*, [東京都総合設計許可要綱実施細目]. Available at: http://www.toshiseibi.metro.tokyo.jp/kenchiku/kijun [in Japanese]

Chen, Y., Liu, T., Xie X., Marusic, B. G., (2016). *What Attracts People to Visit Community Open Spaces? A case study of the overseas Chinese town community in Shenzhen, China*. International Journal of Environmental Research and Public Health, 13, 644-661.

Coley, R. L., Kuo, F. E., Sullivan, W. C., (1997). *Where does Community Grow? The Social Context Created by Nature in Urban Public Housing*. Environment and Behavior 29 (4), 468-494.

De Magalhães, C. & Trigo, S. F., (2016). *Contracting out publicness: The private management of the urban public realm and its implications*. Progress in Planning, *in press.*

Donovan, G. H., Butry, D. T., (2010). *Trees in the city: Valuing street trees in Portland, Oregon*. Landscape and Urban Planning 94, 77-83.

Downes, M.& Lange, E., (2015). *What you see is not always what you get: A qualitative, comparative analysis of ex ante visualizations with ex post photography of landscape and architectural projects*. Landscape and Urban Planning, 142. 136-146

Dwyer, J. F., McPherson, E. G., Schroeder, H. W., Rowntree, R. A. (1992). *Assessing the Benefits and Costs of the Urban Forest*. Journal of Arboriculture 18 (5), 227-234.

Fernandez-Palacios, B. J., Morabito, D., Remondino, F., (2016). *Access to complex reality-based 3D models using virtual reality solutions*. Journal of Cultural Heritage, *in press*.

Fujita, S. & Ito, K. (2006). *A Study on Public Open Space from the viewpoint of the pedestrian traffic*. Architectural Institute of Japan, AIJ, 355-356 [in Japanese]

Gehl, J. (2011). *Life between buildings: using public space*. Washington, DC: Island Press (First published in 1971)..

Gerstenberg, T., Hofmann, M., (2016). *Perception and preference of trees: A psychological contribution to tree species selection in urban areas*, Urban Forestry & Urban Greening, 15, pp. 103-111.

Graham, D. A., Vanos, J. K., Kenny, N. A., Brown, R. D., (2016). *The Relationship Between Neighborhood Tree Canopy Cover and Heat-related Ambulance Calls During Extreme Heat Events in Toronto Canada*. Urban Forestry & Urban Greening 20, 180-186.

Hall, E. T. (1990). *The Hidden Dimension*. New York: Anchor Books. (Original work published 1966).

Hayashi, T. & Ohno, R. (1995). *A study of affordance in outdoor space for choosing a spot to sit in an urban park*. Architectural Institute of Japan, 851, 852 [in Japanese].

Hsieh, M. & Lee, W. (2010) *Effect of Spatial Elements in an Open Space on a Subject's Psychological Perception*. Journal of Asian Architecture and Building Engineering, 9 (1), 111-116.

Iguchi, Y., (2011). *A Study on the Relation between Variables and Impressions of Open Spaces resulting from the Comprehensive Design System*. [総合設計制度活用による公開空地の設計要因と印象の関係に関する研究]. Master thesis, Chiba University, Japan [In Japanese].

Imamoglu, Ç., (2000). *Complexity, Liking and Familiarity: architecture and non-architecture Turkish students' assessments of traditional and modern house facades*. Journal of Environmental Psychology 20, 5-16.

Ishikawa, N., Fukushige, M. (2012). *Effects of street landscape planting and urban public parks of dwelling environment evaluation in Japan*, Urban Forestry & Urban Greening, 11, pp. 390-395.

Jackson, R. E. & Cormack, L. K., (2010). *Reducing the presence of navigation risk eliminates strong environmental illusions*. Journal of Vision, 10(5): 9, 1-8.

Jansen-Osmann, P., Berendt, B. (2002). *Investigating Distance Knowledge Using Virtual Environments*. Environment and Behavior 34 (2), 178-193.

Jiang, B., Larsen, L., Deal, B. and Sullivan, W. C. (2015) *A dose-response curve describing the relationship between tree cover density and landscape preference*. Landscape and Urban Planning 139, 16-25.

Kakutani, H. (2005) *A Study on constituent element and perception of public open space. Analysis with cases that applied the system of comprehensive planning in Hiroshima City*. Research Reports of the School of Engineering, Kinki University, 39, 101-107

Kaplan, R. (1980). *Citizen participation in the design and evaluation of a park*. Environment and Behavior, 12, 494-507.

Kaplan, R. (1985a). *Nature at the doorstep: Residential satisfaction and the nearby environment*. Journal of Architectural and Planning Research, 2, 115-127.

Kaplan, R. (1985b). *The analysis of perception via preference: A strategy for studying how the environment is experienced*. Landscape Planning, 12, 161-176.

Kaplan, R., & Kaplan, S. (1989). *The experience of nature*: *A psychological perspective*. New York, NY: Cambridge University.

Kellert, S. R., Wilson, E. O. (1993) *The Biophilia Hypothesis*. Washington, DC: Island Press

Koga, T., Taka, A., Munakata, J., Kojima, T., Hirate, K. and Yasuoka, M. (1999) *Participatory research of townscape, using caption evaluation method: studies of the cognition and the evaluation of townscape*, Part 1. Journal of Architectural Planning and Environmental Engineering, AIJ, 517, 79-84.

Krosnick, J. A., Judd, C. M. & Witterbrink, B., (2005). *Attitude measurement*. In Albattacin, D., Johnson, B. T. & Zanna, M. P. (Eds.), *Handbook of attitudes and attitude change*. Mahwah, N.J: Erlbaum.

Kuo, F. E., Bacaicao, M., & Sullivan, W. C., (1998). *Transforming Inner-City Landscapes: trees, sense of safety and preference*. Environment and Behavior, 30 (1), 28-59.

Kuper, R., (2017). *Evaluations of Landscape Preference, Complexity and Coherence for designed digital landscape models*. Landscape and Urban Planning 157, 407-421

Lange, E., (2001). *The Limits of Realism: Perceptions of Virtual Landscapes*. Landscape and Urban Planning 54, 163-182.

Lefebvre, H. (1991). *O Direito à cidade [Le Droit à la Ville]*. São Paulo: Ed. Moraes Ltda.

Langstraat, F. & Van Melik, R., (2013) *Challenging the 'End of Public Space': A Comparative Analysis of Publicness in British and Dutch Urban Spaces*, Journal of Urban Design, 18:3, 429-448.

Li, P., Chen, M., Hibino, H., Koyama, S., Zheng, M,C., (2009). *Rest Facilities at Commercial Plazas through User Behavior Perspective*. Journal of Asian Architecture and Building Engineering, 8 (1), 127-134.

Lindquist, M., Lange E., Kang, B., (2016). *From 3D landscape visualization to environmental simulation: The contribution of sound to the perception of virtual environments*. Landscape and Urban Planning 148, 216-231.

Llinares, C., Inarra, S., (2104). *Human Factors in Computer Simulations of Urban Environment: differences between architects and non-architects assessments*. Displays 35, 126-140.

Lohr, V.I., Pearson-Mims, C.H. (2006). *Responses to scenes with spreading, rounded, and conical tree forms*. Environment and Behavior 38 (5), 667–688.

Matsumoto, N., Kanazawa, J., Kito, T., (2012). *Study on the Impression and Space-volume Sensuousness of a room with Slender Upper Aperture*. Journal of Environmental Engineering, 77 (673), 529-534.

Mehta, V., (2007). *Lively Streets: Determining environmental characteristics to support social behavior*. Journal of Planning Education and Research, 27, 165-187.

Ministry of Land Infrastructure and Transport, MLIT. (2003) *Introduction of Urban Land Use Planning System in Japan*. Available at www.mlit.go.jp/common/000234477.pdf. Retrieved in 2016.12.07.

Mochinaga, A. & Ishida, T., (2014). *Evaluation of Brightness and Activity Impressions of Outdoor Space by a Scale Model Experiment*. Journal of Environmental Engineering, 79 (706), 1017-1027 [in Japanese].

Nakata, H., (2010). Study on the Qualitative Improvement of Privately Owned Public Spaces created by the Comprehensive Design System [総合設計制度活用例における公開空地の質的向上に関する研究]. Master thesis, Chiba University, Japan [in Japanese]

Naoi, T., Yamada, T., Iijima, S., Kumazawa, T., (2011). *Applying the caption evaluation method to studies of visitors' evaluation of historical districts*. Tourism Management 32, 1061-1074.

Nasar, J. L., (1990). *The Evaluative Image of the City*, Journal of the American Planning Association, 56:1, 41-53

Nelson, T., Johnson, T., Strong, M., Rudakewich, G. (2001). *Perception of tree canopy*. Environmental Psychology 21 (3), 315–324.

Németh, J. (2009). *Defining a Public: The Management of Privately Owned Public Space*. Urban Studies, 46(11) 2463–2490.

Ng, W.-Y., Chau, C.-K., Powell, G., Leung, T.-M. (2015). *Preferences for street configuration and street planting in urban Hong Kong*. Urban Forestry and Urban Greening 14, 30-38.

Ohno, R., Soeda, M., Kondo, Y., Hashimoto, N., Sato, M. (2006). *Seat preference in public squares and distribution of the surrounding people: An examination of the validity of using visual simulation*. 7th EAEA Conference, Dortmund, Germany.

Orians, G.H. & Heerwagen, J.H. (1992). *Evolved Responses to Landscapes*. *In* J. Barkow, L. Cosmides and J. Tooby. *The Adapted Mind: Evolutionary Psychology and the Generation of Culture*. New York: Oxford University Press.

Otani, H., Kitahara, T., Gotou, H., Kamia F., (1991). *A Study in the Structure of Semi-public spaces: interviews with public space managers of Nagoya City and reports of observational survey*. [半公共空間の構成に関する研究：名古屋市公開空地の管理者ヒアリング調査、観察調査報告]. Architectural Institute of Japan, Toukai Branch Research Report (29), 485-488 [in Japanese]

Palliwoda, J., Kowaric, I., von der Lippe, M. (2017). *Human-biodiversity interactions in urban parks: The species level matters*. Landscape and Urban Planning 157, 394-406.

Patterson, Z., Darbani, J. M., Rezaei, A., Zacharias, J., Yazdizadeh, A., (2017). *Comparing text-only and virtual reality discrete choice experiments of neighborhood choice*. Landscape and Urban Planning, 157, 63-74.

Project for Public Spaces. (2009) Placemaking and Public Space Guidelines: prepared for the city of Surrey. Available at https://www.surrey.ca/files/FINALplacemakingguidelines.pdf

Raskovic, S. & Decker, R., (2015). *The influence of trees on the perception of urban squares*. Urban Forestry & Urban Greening 14, 237-245.

Ready R. C., Berger, M. C., Blomquist, G. C., (1997). *Measuring Amenity Benefits from Farmland: hedonic pricing vs. contingent valuation*. Growth and Change 28, 438-458.

Ryu, J., Hashimoto, N., Sato, M., Soeda, M., Ohno, R., (2007) *Application of Human-scale Immersive VR System for Environmental Design Assessment - A Proposal for an Architectural Design Evaluation Tool*. Journal of Asian Architecture and Building Engineering 6 (1), 57-54.

Smithsimon, G., (2008). *Dispersing the Crowd: bonus plazas and the creation of public space*. Urban Affairs Review 43 (3), 325-351

Sommer, R. (1997). *Further cross-national studies of tree form preferenc*e. Ecol. Psychology 9 (2), 153–160.

Sommer, R. (2002). *From Personal Space to Cyberspace*. Serie: Textos de Psicologia Ambiental, nº 1. Brasilia, DF: UnB, Laboratorio de Psicologia Ambiental.

Sommer, R., Summit, J. (1995). *An exploratory study of preferred tree form*. Environment and Behavior 27 (4), 540–557.

Sommer, R., Summit, J. (1996). *Cross-national rankings of tree shape*. Ecol. Psychology 8 (4), 327–341.

Stamps, A. E., (1990). *Preliminary Findings Regarding Effects of Photographic and Stimulus Variable on Preferences for Environmental Scenes*. Perceptual and Motor Skills, 71, 231-234.

Stamps, A. E., (1993). *Simulation effects on Environmental Preference*. Journal of Environmental Management 38, 115-132.

Stamps, A. E., (2001). *Evaluating Enclosure in Urban Sites*. Landscape and Urban Planning 57, 25-42.

Stamps, A. E., (2003). *Permeability and Environmental Enclosure*. Perceptual and Motor Skills 96, 1305-1310.

Stamps, A. E. & Krishnan, V. V., (2006). *Spaciousness and Boundary Roughness*. Environment and Behavior, 38 (6), 841-872.

Stamps, A. E., (2007). *Evaluating Spaciousness in Static and Dynamic Media*. Design Studies 28, 535-557.

Summit, J. Sommer, R., (1999). *Further Studies of Preferred Tree Shapes*. Environment and Behavior, 31 (4), 550-576.

Talbot, J. F., & Kaplan, R. (1984). *Needs and fears: The response to trees and nature in the inner city*. Journal of Arboriculture, 10, 222-228.

Talbot, J. F., & Kaplan, R. (1986). *Judging the sizes of Urban Open Areas: is bigger always better?* Landscape Journal, 5, 83-92.

Talbot, J. F., Bardwell, L. V., & Kaplan, R. (1987). *The functions of urban nature: Uses and values of different types of urban nature settings*. Journal of Architectural and Planning Research, 4, 47-63.

Tanaka, F. & Kikata, J. (2008) *Research on Urban Landscape and Public Space by the Caption Evaluation Method – Case Study on Kagoshima City*. Architectural Institute of Japan Research Paper, 47 (3), 221-224.

Taylor, M.S., Wheeler, B. W., White, M. P. (2015). Research note: *Urban street tree density and antidepressant prescription rates* – A cross-sectional study in London, UK. Landscape and Urban Planning 136, 174-179.

Tsuchida, H. & Tsumita, H. (2005) *Analysis on Liking of Place for Taking a Rest and Waiting – A study on urban public space (Part 2)*. Journal of Architectural Planning, AIJ, 596, 59-66.

Ulrich, R. S., (1979). *Visual Landscapes and Psychological Well-Being*. Landscape Research 4(1), 17-23.

Ulrich, R. S., (1981). *Natural versus Urban Scenes: Some Psychophysiological Effects*. Environment and Behavior, 13 (5) 523-556.

Ulrich, R. S., (1984). *View through a window may influence recovery from surgery*. Science. 224(4647):420-421.

Washburne, R., Wall, P., (1980). *Black-White ethnic differences in outdoor Recreation*. Research Paper INT-249. Ogden, UT: USDA. Forest Service, Intermountain Forest and Range Experiment Station.

Wilcox, L. M., Allison, R. S., Elfassy, S., Grelik, C., (2003). *Personal Space in Virtual Reality*. Proceedings of the Human Factores and Ergonomics Society. 47th Annual Meeting 2003, 2097-2101.

Witmer, B. G., & Singer, J. M. (1998). *Measuring presence in virtual environments: A presence questionnaire*. Presence: Teleoperators and Virtual Environments, 7, 225–240.

Whyte, W. H. (1980). *The Social Life of Small Urban Spaces*. New York: Project for Public Spaces.

13 Appendices

APPENDIX 01

1. Questionnaire in Japanese.
2. Questionnaire in English.

名前:　　　　　　　　年齢:　　　　　　　　専門　　　　　　　　空間番号:

	非常にそう思う	そう思う	ややそう思う	どちらでもない	ややそう思う	そう思う	非常にそう思う	
	↓	↓	↓	↓	↓	↓	↓	

行動性

滞在するのに不適切である	1	2	3	4	5	6	7	滞在するのに適している
飲食するのに不適切である	1	2	3	4	5	6	7	飲食するのに適している
休憩するのに不適切である	1	2	3	4	5	6	7	休憩するのに適している
待合わせするのに不適切である	1	2	3	4	5	6	7	待合わせするのに適している
読書するのに不適切である	1	2	3	4	5	6	7	読書するのに適している

印象系

空間に魅力がない	1	2	3	4	5	6	7	空間に魅力がある
空間に面白みを感じない	1	2	3	4	5	6	7	空間に面白みを感じる
囲まれ感を感じない	1	2	3	4	5	6	7	囲まれ感を感じる
暗い雰囲気だと感じる	1	2	3	4	5	6	7	明るい雰囲気だと感じる
落ち着きを感じない	1	2	3	4	5	6	7	落ち着きを感じる
開放感を感じない	1	2	3	4	5	6	7	開放感を感じる
圧迫感を感じない	1	2	3	4	5	6	7	圧迫感を感じる
にぎわいを感じない	1	2	3	4	5	6	7	にぎわいを感じる
空間が一様である	1	2	3	4	5	6	7	空間に多様性を感じる

物理性

狭い	1	2	3	4	5	6	7	広い
空間に緑が少ない	1	2	3	4	5	6	7	空間に緑が多い
植栽の配置が悪い	1	2	3	4	5	6	7	植栽の配置が良い
空間にある席が少ない	1	2	3	4	5	6	7	空間にある席が多い
座席の配置が悪い	1	2	3	4	5	6	7	座席の配置が良い
座席のデザインが悪い	1	2	3	4	5	6	7	座席のデザインが良い
風景が悪い	1	2	3	4	5	6	7	風景が良い

この空間に移動販売の屋台があって、飲み物を購入し、ここで飲むこととします。
その時にコーヒーまたはお茶一杯に最大いくらまで払っても良いと思いますか。
0円　100円　200円　300円　400円　500円　600円　1000円以上

この空間ではどのぐらいの時間を過ごしたいと思いますか？
0分　5分　10分　15分　30分　1時間　2時間以上

	HIGHLY AGREE	AGREE	SOMEWHAT AGREE	NEITHER	SOMEWHAT AGREE	AGREE	HIGHLY AGREE	

Behavior

Unsuitable for stay	1	2	3	4	5	6	7	Suitable for stay
Unsuitable to eat	1	2	3	4	5	6	7	Suitable to eat
Unsuitable for rest	1	2	3	4	5	6	7	Suitable for rest
Unsuitable for wait	1	2	3	4	5	6	7	Suitable for wait
Unsuitable to read	1	2	3	4	5	6	7	Suitable to read

Impression

It is not appealing	1	2	3	4	5	6	7	It is appealing
It is not an interesting place	1	2	3	4	5	6	7	It is an interesting place
I do not feel enclosed	1	2	3	4	5	6	7	I feel enclosed
It has a gloomy atmosphere	1	2	3	4	5	6	7	It has a cheerful atmosphere
It is not relaxing	1	2	3	4	5	6	7	It is relaxing
It is not an open space	1	2	3	4	5	6	7	It is an open space
I do not feel oppressed	1	2	3	4	5	6	7	I feel oppressed
It is not a lively place	1	2	3	4	5	6	7	It is a lively place
It is an uniform place	1	2	3	4	5	6	7	It is a diverse place

Physical

Small	1	2	3	4	5	6	7	Large
There is little greenery	1	2	3	4	5	6	7	There is a lot of greenery
Greenery is badly placed	1	2	3	4	5	6	7	Greenery is well placed
There is little seats	1	2	3	4	5	6	7	There is a lot of seats
Seats are badly placed	1	2	3	4	5	6	7	Seats are well placed
Seats have a bad design	1	2	3	4	5	6	7	Seats have a good design
It has a bad view	1	2	3	4	5	6	7	It has a good view

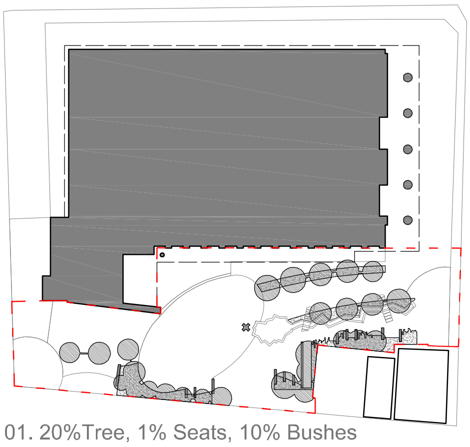
APPENDIX 02

1. Sites Floor Plans with variables levels

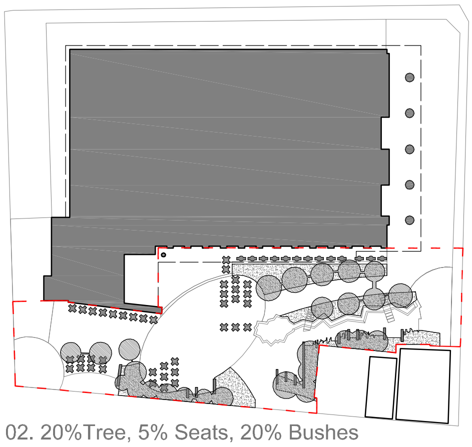
2.Stimuli floor plans.

3. Sites Pictures.

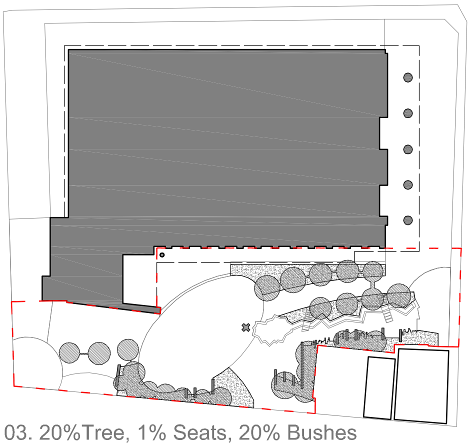
TERRACE SQUARE (S1)



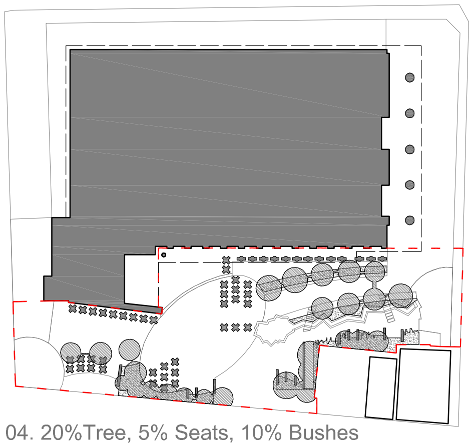
01. 20%Tree, 1% Seats, 10% Bushes
Trees height - 5m



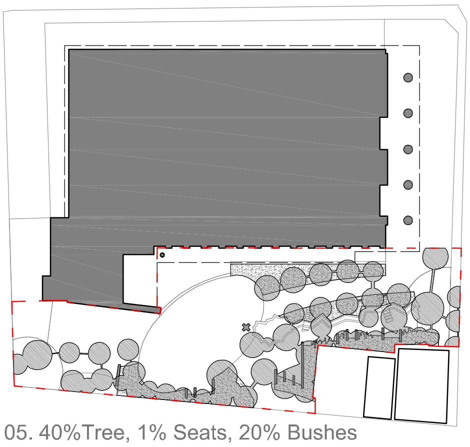
02. 20%Tree, 5% Seats, 20% Bushes
Trees height - 5m



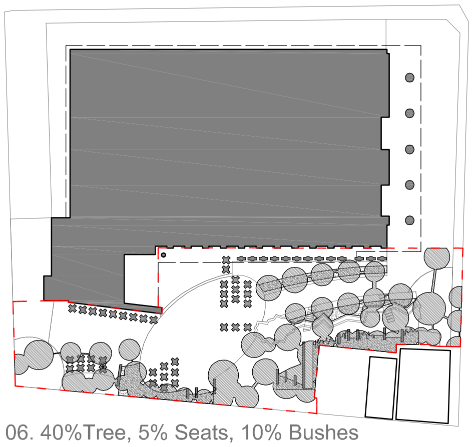
03. 20%Tree, 1% Seats, 20% Bushes
Trees height - 7m



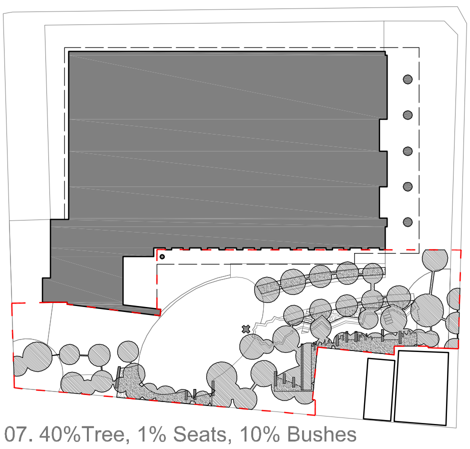
04. 20%Tree, 5% Seats, 10% Bushes
Trees height - 7m



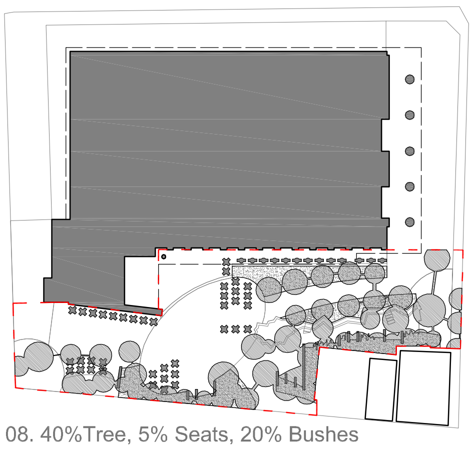
05. 40%Tree, 1% Seats, 20% Bushes
Trees height - 5m



06. 40%Tree, 5% Seats, 10% Bushes
Trees height - 5m



07. 40%Tree, 1% Seats, 10% Bushes
Trees height - 7m

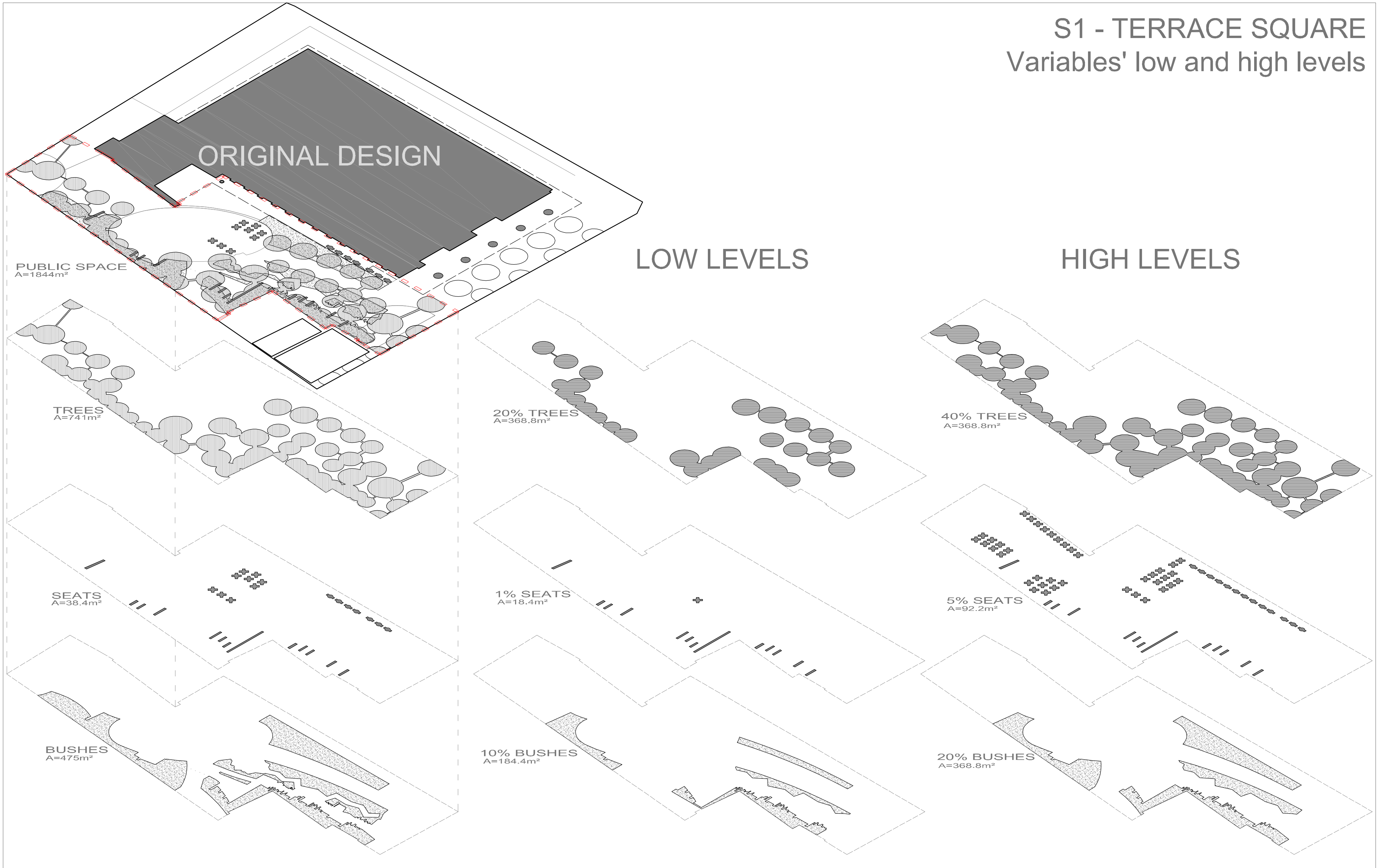


08. 40%Tree, 5% Seats, 20% Bushes
Trees height - 7m

Scale: 1/1500

S1 - TERRACE SQUARE
Stimuli floor plans

S1 - TERRACE SQUARE
Variables' low and high levels

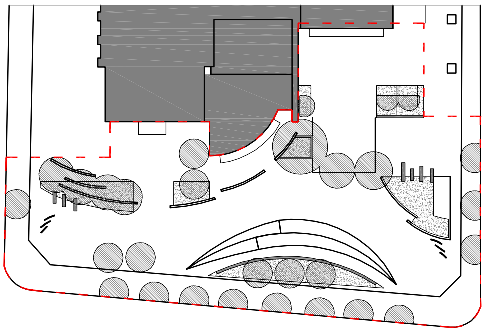




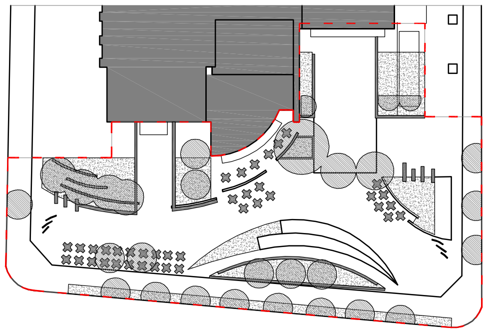




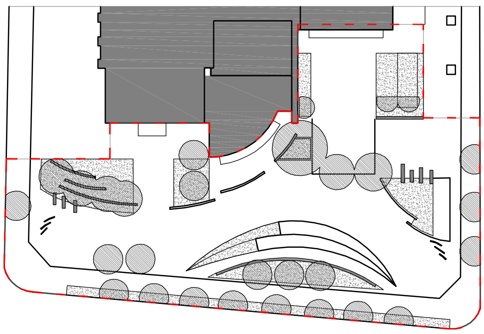
JINBOCHO (S2)



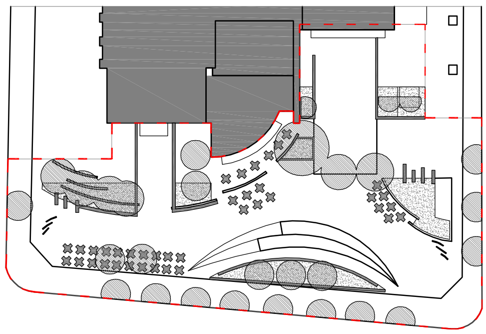
01. 20%Tree, 1% Seats, 10% Bushes
Trees height - 5m



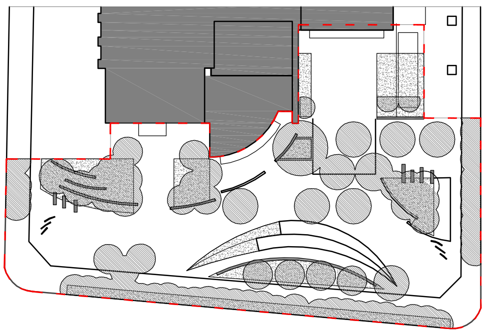
02. 20%Tree, 5% Seats, 20% Bushes
Trees height - 5m



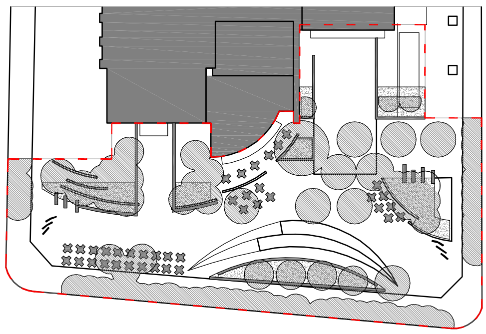
03. 20%Tree, 1% Seats, 20% Bushes
Trees height - 7m



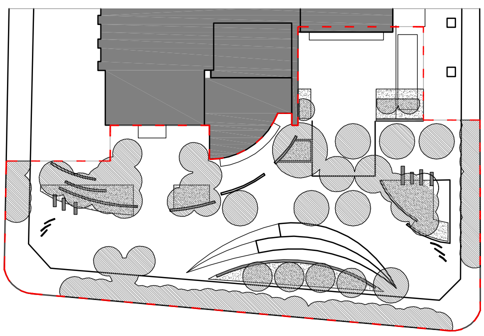
04. 20%Tree, 5% Seats, 10% Bushes
Trees height - 7m



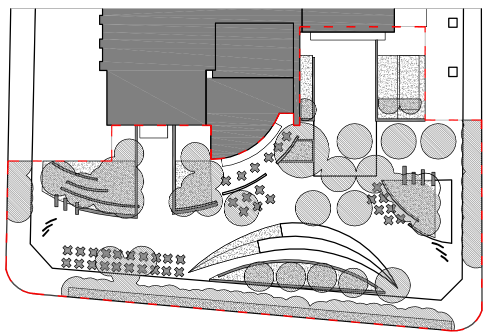
05. 40%Tree, 1% Seats, 20% Bushes
Trees height - 5m



06. 40%Tree, 5% Seats, 10% Bushes
Trees height - 5m



07. 40%Tree, 1% Seats, 10% Bushes
Trees height - 7m

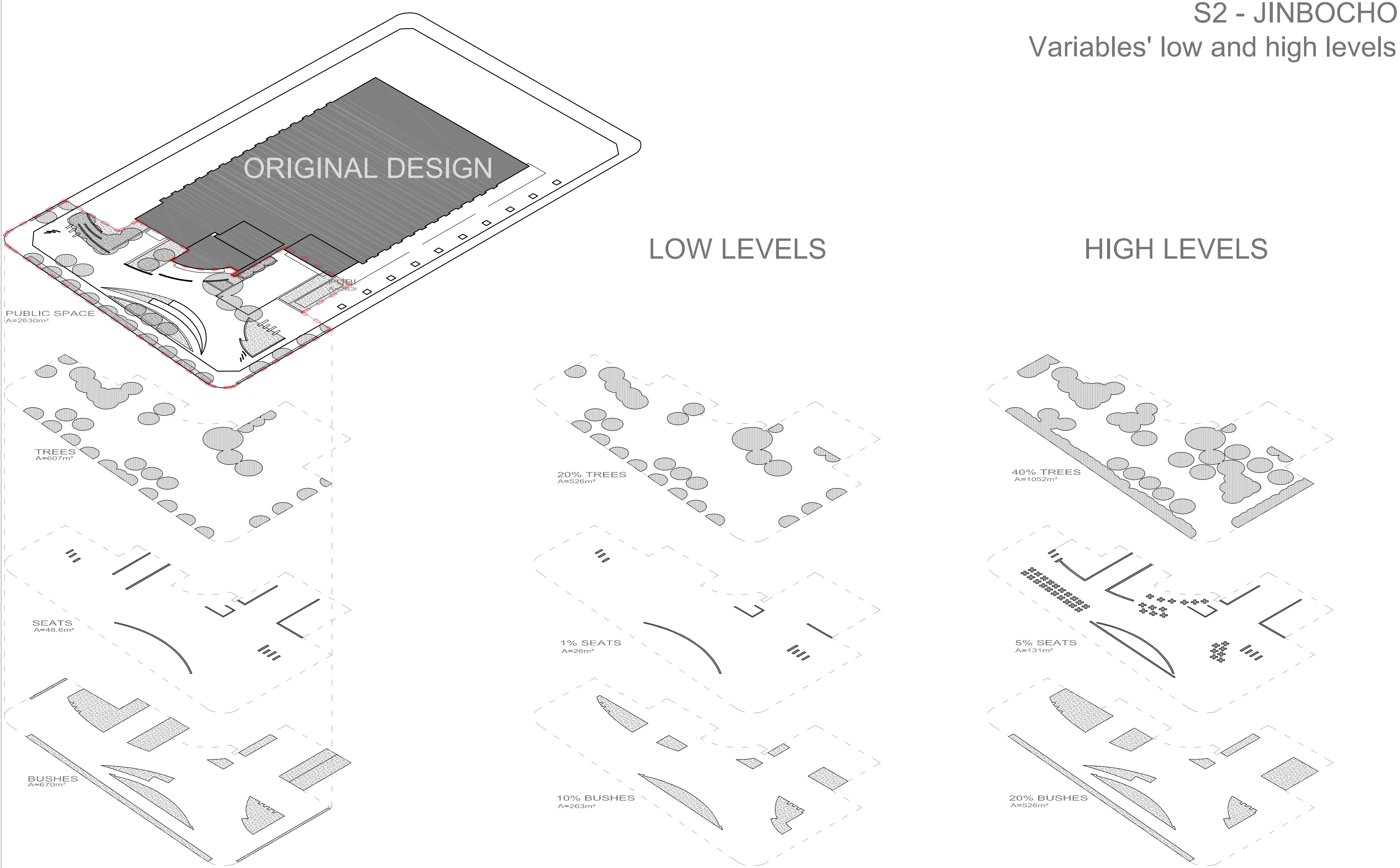


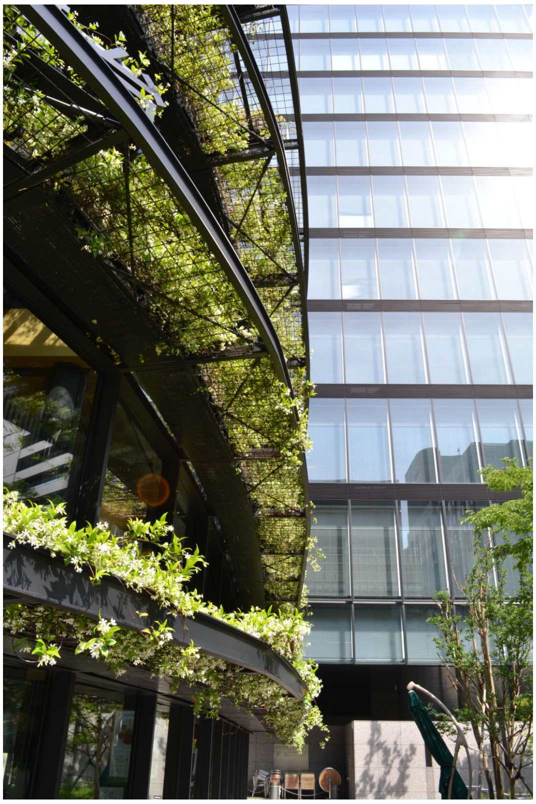
08. 40%Tree, 5% Seats, 20% Bushes
Trees height - 7m

Scale: 1/1250

S2 - JINBOCHO
Stimuli floor plans

S2 - JINBOCHO
Variables' low and high levels

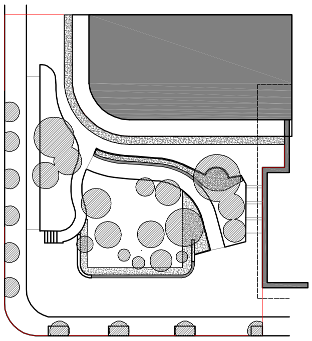




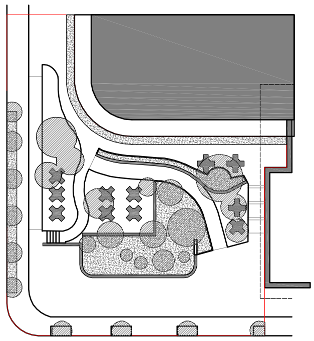




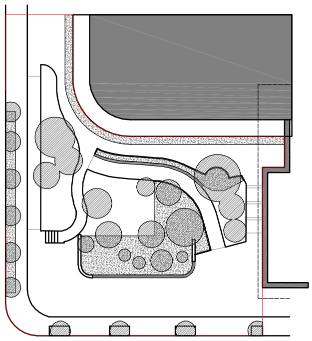
INSURANCE ANNEX (S3)



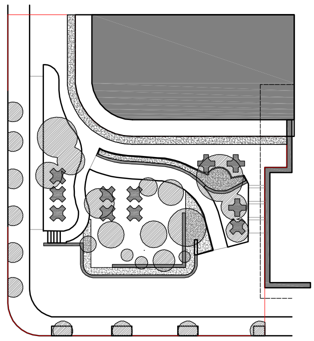
01. 20%Tree, 1% Seats,
10% Bushes, Trees height - 5m



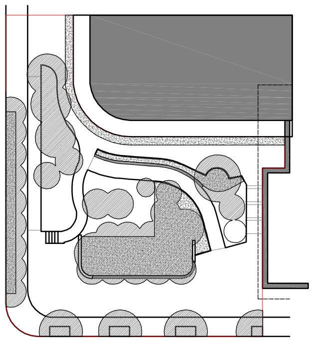
02. 20%Tree, 5% Seats,
20% Bushes, Trees height - 5m



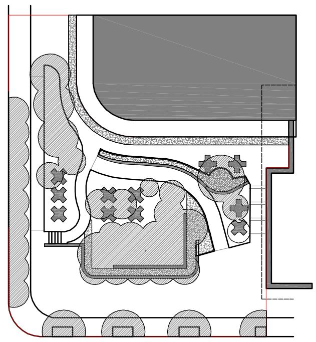
03. 20%Tree, 1% Seats,
20% Bushes, Trees height - 7m



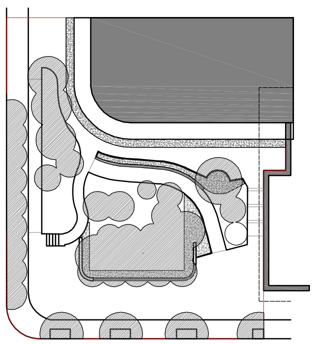
04. 20%Tree, 5% Seats,
10% Bushes, Trees height - 7m



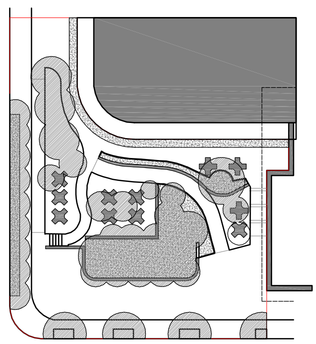
05. 40%Tree, 1% Seats,
20% Bushes, Trees height - 5m



06. 40%Tree, 5% Seats,
10% Bushes, Trees height - 5m



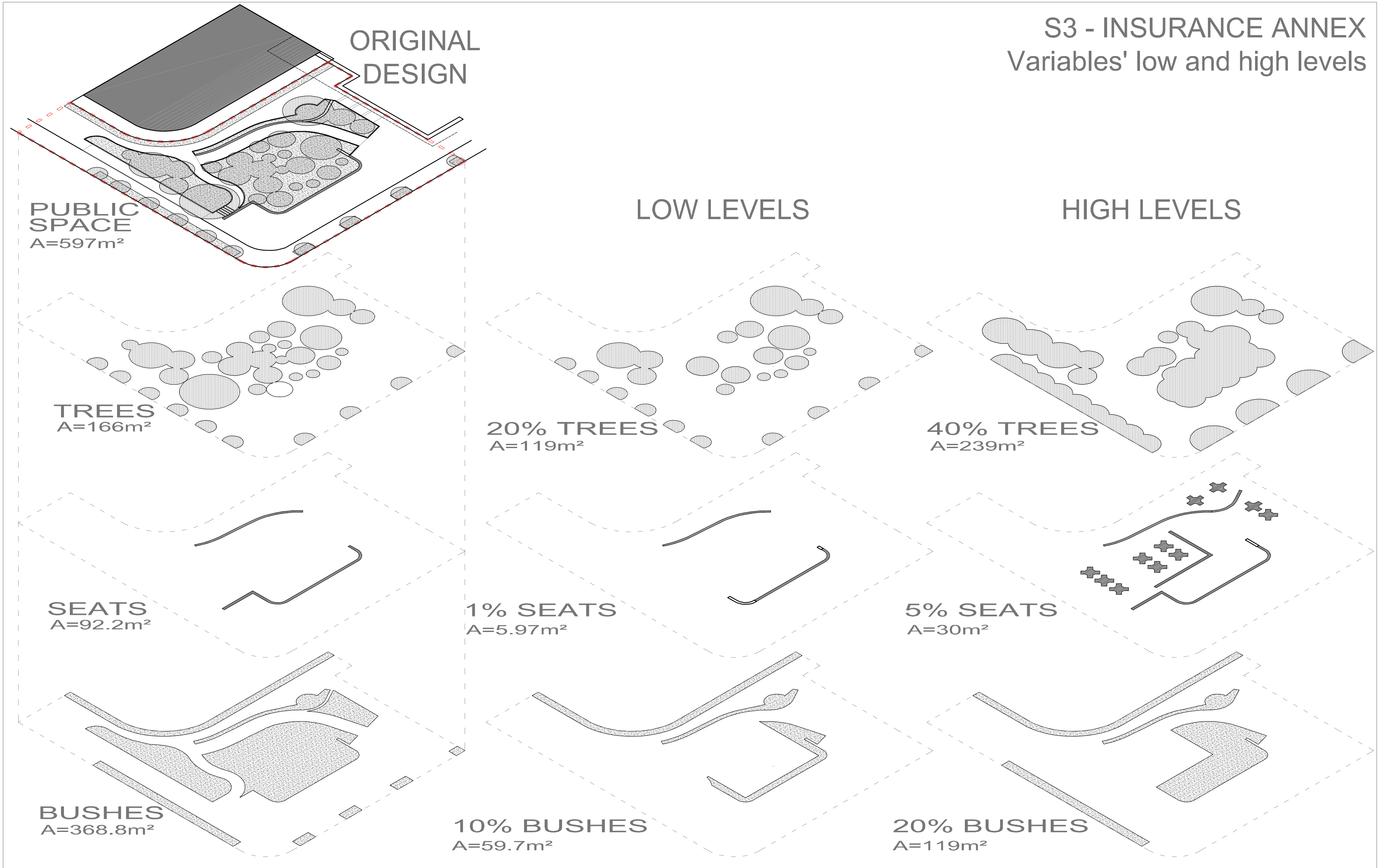
07. 40%Tree, 1% Seats,
10% Bushes, Trees height - 7m



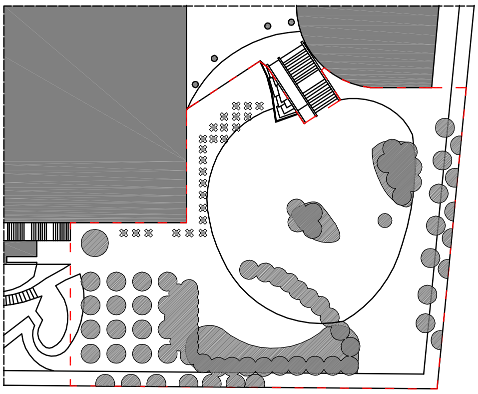
08. 40%Tree, 5% Seats,
20% Bushes, Trees height - 7m

Scale: 1/750

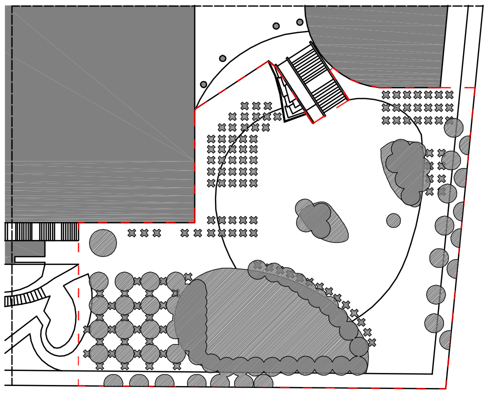
S3 - INSURANCE ANNEX
Stimuli floor plans


S3 - INSURANCE ANNEX
Variables' low and high levels
ORIGINAL DESIGN
LOW LEVELS
HIGH LEVELS
PUBLIC SPACE
A=597m²
TREES
A=166m²
20% TREES
A=119m²
40% TREES
A=239m²
SEATS
A=92.2m²
1% SEATS
A=5.97m²
5% SEATS
A=30m²
BUSHES
A=368.8m²
10% BUSHES
A=59.7m²
20% BUSHES
A=119m²

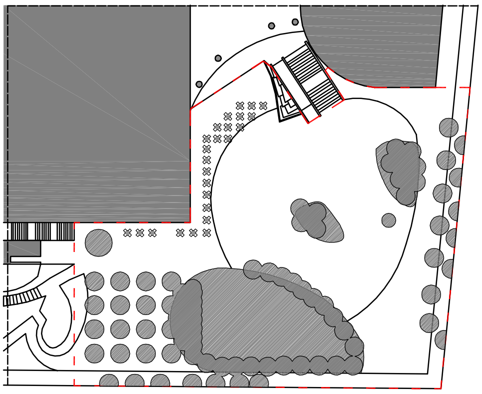
WATERRAS (S4)



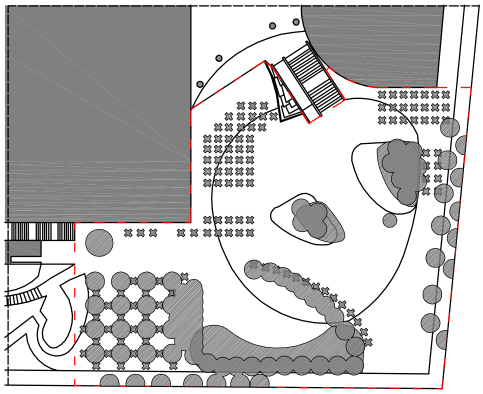
01. 20%Tree, 1% Seats, 10% Bushes, Trees height - 5m



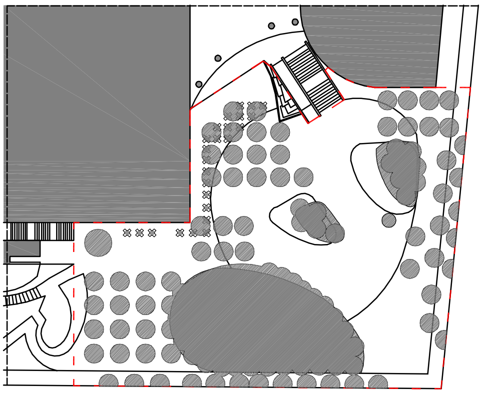
02. 20%Tree, 5% Seats, 20% Bushes, Trees height - 5m



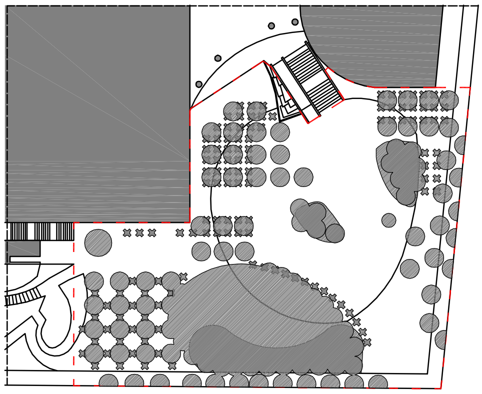
03. 20%Tree, 1% Seats, 20% Bushes, Trees height - 7m



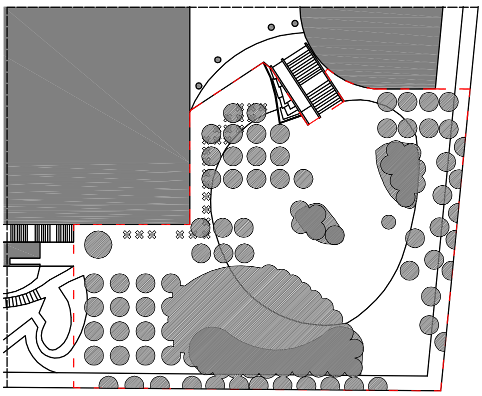
04. 20%Tree, 5% Seats, 10% Bushes, Trees height - 7m



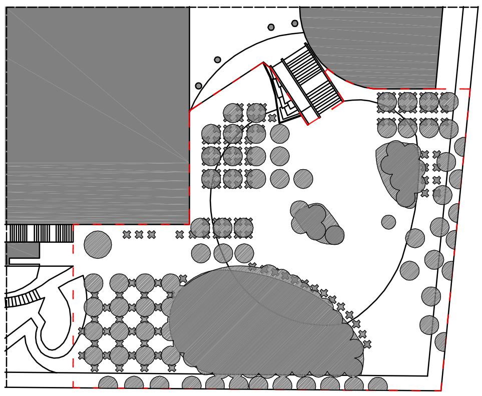
05. 40%Tree, 1% Seats, 20% Bushes, Trees height - 5m



06. 40%Tree, 5% Seats, 10% Bushes, Trees height - 5m



07. 40%Tree, 1% Seats, 10% Bushes, Trees height - 7m

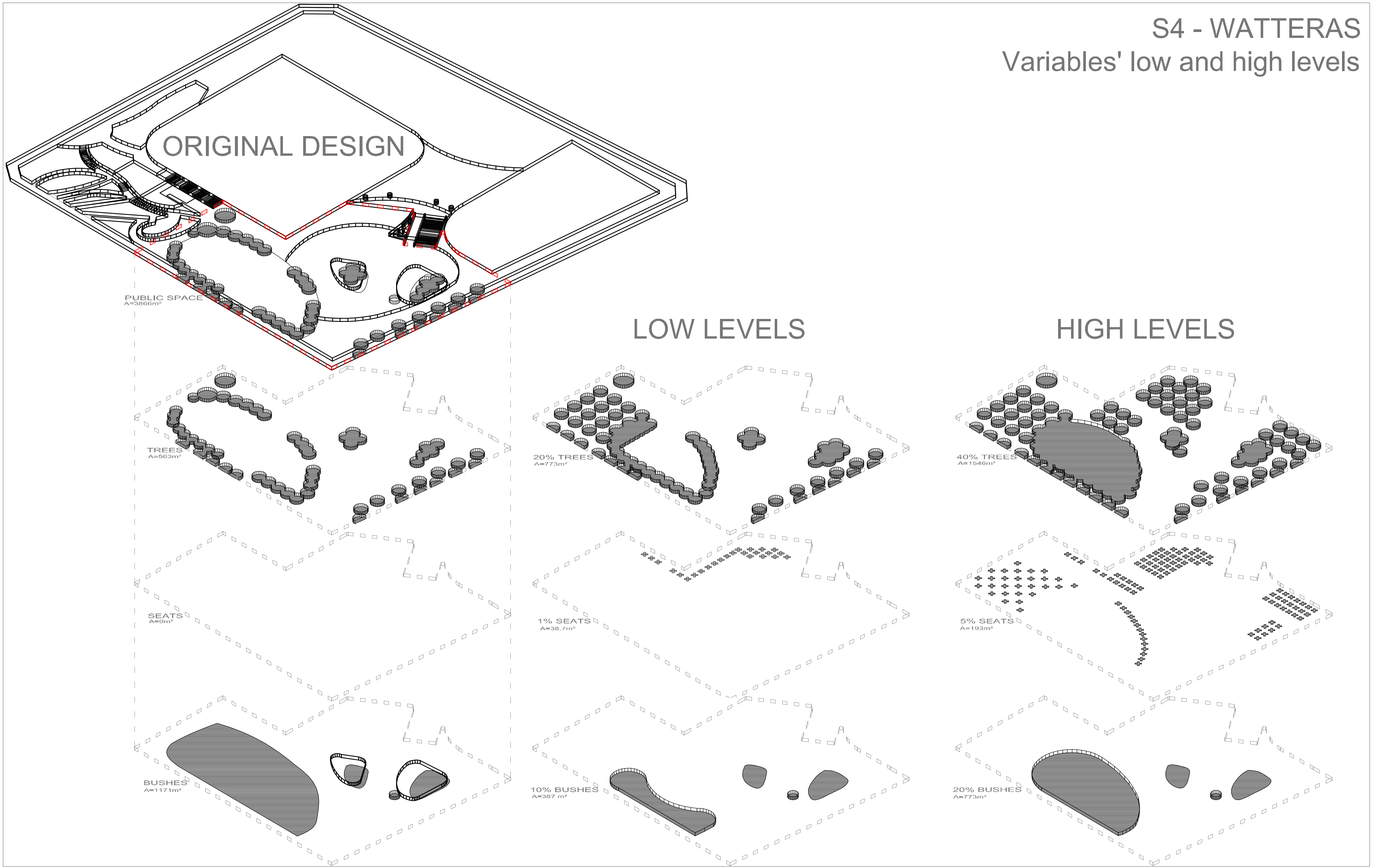


08. 40%Tree, 5% Seats, 20% Bushes, Trees height - 7m

Scale: 1/1500

S4 - WATTERAS
Stimuli floor plans

S4 - WATTERAS
Variables' low and high levels



Appendix 03

1. Iguchi (2011) interview results [in Japanese]
2. Translation of Iguchi's (2011) interview results.

ヒアリング結果を項目ごとに要約したものを表 3 に示す。公園などと同等に公開空地も周辺住民等、ユーザーの目的地になるような、そこに行きたくなるような公開空地が理想的であり、そのためには賑わいが必要という意見を得られた。また建物に向かう導線を賑わいで満たし、通って行きたくなるような導線を設計することでユーザーの滞在時間を増やし、よりよい公開空地になるのではとの意見を得た。設計者が多くの条件との調整に悩んでおり、最終的にはクライアントの意向が優先されるといった話が聞けた。また建築までの導線の中でいかに様々な行為を誘発させることができるか重視していた。設計者としては積極的にイベントなどで屋外空間を利用してもらいたいが、法規的な問題もあり、思うようには利用されていない。そこでどのような広場空間が必要とされているかを知る必要があると考えられる。小川、噴水等の水景も、実際には維持管理の問題があるが、ユーザーにどのような影響を与えるのか気になるとの意見も聞けた。クライアントの要望がある中で、設計者への意志は反映させるのは難しいので、この研究が説得材料になればいいという意見も頂いた。

Q1. 携わった公開空地の事例を教えて下さい
品川フロントビル・角川第 3 ビル・西新宿 8 丁目ビル・國學院キャンパス（設計者 A：以下 A） 東京ミッドタウン・ソニーシティ大崎・大手町一丁目地区第一種市街地再開発事業・住友商事外構リノベーション（設計者 B：以下 B）
Q2. 利用者にとって良い公開空地とはどういったものだと思いますか
ビルユーザーと周辺住民で良い公開空地というのは違うとは思うが、共通するものは導線。 ビルユーザーなら導線に休憩スペースなどがあり、周辺住民ならショートカットやあえて通りたくなるような導線が大事。現状、公開空地が目的地、コンテンツとして捉えられている例はないので、その為ににぎわいは必要。 (A) 同じく導線で、あえて滞留させるような導線がいい。 (B)
Q3. それを実現するためにどういった要素が必要だと考えていますか
植栽、にぎわいを演出するために花が咲く植栽を選んだりする。 (A) 植栽、ベンチ、気候。自然によって気持ちよく感じてもらうなど。 (B)
Q4. それらの要素がどうあるべきか考えていますか
導線はメインエントランスに最短でつながるものと、滞留につながるサブがあればいいかもしれない。芝生などもいいかも。 (A)
Q5. 建築条件の制約とその要素の設計の間に衝突や悩ましいこと等ありますか、またある要素と別の要素の間に衝突や調整に悩むことがありますか
滞留などが望ましいと思うが、クライアントからは滞留させるななどの要望が出ることがある。ベンチにホームレスなどが寝れないようになど。維持管理はクライアントが行うので、クライアントが納得するような材料が必要。 (A) にぎわいをもたせるために広場空間など作っても制度の問題で商業活動ができなかったりする。 (B)
Q6. 要素と要素の間に衝突があった場合、どうされていますか
設計者の仕事の主はパラメーターの調整。相反するものが出てきた場合、施主の要望が優先になる。逆に全く制約がない方が難しい (A) 例えば通りで植樹の種類を揃えようとしても、クライアントの要望でバラバラになったりする。クライアントの要望が強く、設計者の意志が入ることは殆ど無い。(B)

Translation of the interview results presented by Iguchi (2011).

A synthesis of the designers answers to each question is presented in the table below.

The designers interviewed are of the opinion that, ideally, POPS, as with parks and other public space, should be lively places, making them an appealing destination to the surrounding population and other users. Moreover, the liveliness of the space should attract passers by and inducing a desire to enter the space and prolong the stay of users already present.

Designers have to deal with several design requirements and restrictions, but the desires of the client are the most important and will be a priority over other priorities. Apart from that, the priority is to induce diverse behavior on the environment, allied with the access to the building. While it is the desire of the urban designer to create environments that will actively promote a number of events and outside activities there is limitations that arise from regulations and the space may not be used as expected.

This must be taken into consideration in the design. Elements such as water streams or fountains require constant maintenance, but its actual impact on users' impressions is unclear. There is a constant struggle between the desires of the client and the intentions of the designer, which is why this research is needed.

Q1. Please tell me some examples of POPS in which you participated if the design.
Shinagawa Front Building, Kadogawa 3rd Building, Nishi-Shinjuku 8 Chome Building, Kokugakuin Campus (Designer A). Tokyo Mid Town, Sony City Otaki, Otemachi 1 Chome 1st redevelopment project, Sumitomo Corporation Outer Structure Renovation (Designer B)
Q2. What makes a POPS good for users?
I think it is different for the building occupants and the surrounding population, but the guiding principles are the same. For the building users, is the presence of rest spaces and the like and for the community, the connection with the surroundings and a walkable space is the important part (A). I think the same, the guiding principle is to create stay (B).
Q3. To accomplish that, which elements do you think are necessary?
Greenery, flower beds that bring liveliness to the space (A). Greenery, benches, climate and nature to provide good feelings (B).
Q4. And how do you think these elements should be allocated in the environment?
The pathway should connect the main entrance to the street in the shortest path possible. If, by doing that, it also connects with areas of stay and rest, it is even better. Grass is also good (A).
Q5. How do you deal with the conflicts between architectural constraints and design intentions or between conflicting design intentions?
Although I think it is important to induce stay, sometimes the client requests a design that does not induce stay or to use benches that will not allow homeless persons to sleep on and so on. Since it is the client that will have to provide the maintenance, we must use materials and the like that will comply with the clients' demands (A). There are times that, although we want to create livable plazas, there is a conflict between design regulations and intended commercial activities that prevent it (B).
Q6. How do you deal with conflict between elements?
The designers' job is to deal with several parameters, but when there is a conflict, the clients wishes takes precedent. But, on the contrary, the difficulty is when there are no restrictions (A). Let's say that the designer wants all trees aligned with the street by the client wants it distributed instead of aligned. The will of the client will prevail and the intentions of the designer will wither (B).

APPENDIX 04

1. Transcriptions from the interviews with POPS designers [in Japanese]

2016年11月29日に行ったヒアリング
名：設計者１　「39歳・男・建築専攻・現在に公開空地の設計を行ってます・先生の立場はない」
会社：日建設計「ランドスケープデザイン部門」

SINOPSYS:

Q1: 公開空地を設計するための一般的な手順を説明してください。
設計者１：1. サイトのコンテクスト「駅の位置、動線、道路の大きさ、商店街、人口データ、植生データ」; 2.　歴史「その場の歴史、文化、」を学ぶ；3.　建物とそこ機能と用途「オフィスビル、足元には商業」；４．　法律と条令「必要な緑化の面積、バリアフリー、空地として広場の面積」；５．場所のコンセプト「緑、豊かな、グリーン多い・少ない場所、オープン空間のがいいのが、イベントとかのやるために、ハードベーヴ中心にやってたほうが良いのか」；６．建物の一階「機能の関係性」；７．隣の物との関係性；８．　空間のゾーニング；９．動線；１０．　エントランスに向かう通路；１１．デザイン行動；１２. クライアントの好み；１３．　カーラースキーム「color scheme

Q2: 公開空地を設計するためには利用者に対して、何を分かれば有用だと思いますか？また、それは何のために有効ですか？出来るだけ具体的に答えてください。
設計者１: 分かるではなく、利用者のニーズを想像して、設計します。気持ち良く滞在して貰いたい。利用者の組合わせはベンチのはば幅や配置の調整で決定します。

Q3: 具体的に設計するためにはどんな物理要素が必要ですか？
設計者１：植物、舗装、施設「ベンチ、照明、壁、駐輪スペース」

Q4: その要素の量はどう判断していますか「例：数；割合；見た目；設計者の直感；等」
設計者１：植栽は、法や条例で決定「面積割合」; 舗装は見た目；施設は最適な量を決定します「直感」。

Q5: 設計するためにはどのようなデータが必要ですか？また、何に対して、またはどんなデータがあれば、設計に役に立つと思いますか？
設計者１：流動のデータ、交通、周辺の植生のデータ。

Q6: 公開空地の設計方法は他の公共空間の設計「例：広場、公園」と同様ですか？
設計者１：基本的にはアプローチの仕方は同じだけど、公園とか広場には誰にも開いてる。公開空地のほうは企業・事業者のために価値観を作らないといけないのでより私的。

Q7: 設計プロセスとしては原案を自分で考えて決定してから描くものか「Black Box」、または、提案が出来てなくても、描いて始めて、直しながらを決定するものだと思いますか？「white box」。
設計者１：White box. ダイアグラムでいろいろなバリエーションの整理をします。スターディの2,3案をよくします。

Q8: 海外での公開空地を設計する場合は日本と同じように設計しても良いですか？日本と異なることや、設計するために欲しい情報をお答えください。
設計者１：違います。日本は特殊で、レギュレーションが厳しい。非常に細かい所まで決められてる。中国はかなりものすごい権力持ってる人のトップダウンで決まることが多いです。コンテクストや歴史や文化に対しての情報が欲しい。

Q9: 前の質問に対して、日本と異なる場合、何の物理要素を扱って、違う文化や空間の使い方を設計出来ますか。
設計者１：実は変わらない。アプローチの仕方は実は一緒ですけどバイアスの掛け方が違う。

Q10:　これまでお伺いしていないことで、公開空地の設計の際に重要だと思うことがあれば教えてください。
設計者１：設計側にフェードバックをして必要あると最近考えてる。今までランドスケープデザインというカテゴリよりもパブリックスペースのデザインという言い方をしてます。

2016年11月29日に行ったヒアリング
名：設計者1　「39歳・男・建築専攻・現在に公開空地の設計を行ってます・先生の立場はない」
会社：日建設計「ランドスケープデザイン部門」

Q1: 公開空地を設計するための一般的な手順を説明してください。
設計者1：まずはですね、僕らは「僕は」サイトのコンテクストを分析をします。例えば、鉄道の駅はどこにあります、どうやって人はここにくるのか、大きい道路があるのか、商店街が近くにあるのか、住宅があるのか、そういうまぁ、周辺のコンテクストだったり、後は…地形とか、サイトと言う、それともっとな大きいスケールでの地形、それから植生とかそういた物を Analyze をまずします。それから…歴史、その場所の歴史の読み取り。どういう歴史とか文化そういた物がその場所にあったのか、もしくは今でもあるのか。それとのもう一つが…まぁ、当然、公開空地があるという、建物も一緒に立つことが多いと言う訳ですけども、建物の機能と用途ですね。まぁ、オフィスビルなのか、足元には商業。どういた商業なのか。クライアントはどういたターゲットのテナントを持ってこようとしているのか。それと、もう一つ：法律とか条令。まぁ、例えば、必要な緑化の面積とか。もしくは、例えば、バリアフリーとかそういったことの観点、の配慮が必要か。空地として広場のなにか面積が規定されているかとか。そういたレギュレーションのチェック。まぁ、大きくはその三つ：周辺のコンテクスト、歴史、法律。それをまず分析して、とういうところから。その分析した上で、その場所のコンセプトはいろいろあるわけですけれども…公開空地は緑、豊かな･･･なるべく、グリーン多いエリアにするべきのか、もう少し芝生の広場をオープン空間のがいいのが、または、ここでいろいろなイベントとかのやるために、ハードベーヴ中心にやってたほうが良いのか。まぁ、そのへんから…前段の Analyze から読み取りから、コンセプトを立てます。その上でまぁ、設計はやっぱり、その次に考えるのは本当に公開空地に隣接する建物の一階、もしくは二階レベルの機能との関係性。もうしくは本当に隣接するの道路もしくは隣地、隣のものとの関係性のなかで･･･空間のゾーニング。まぁ、例えば、やっぱり動線ですかね。メインのオフィスとかのエントランスに向かって比較的大きな空間を作ったり、住宅地にある場合は、少しそういうグリーンのバーファーを作ったり、人が通りぬける空間だったら、その人は通りぬけるといったときにどの気持ち良い空間を作れるかとか、まぁ、そういたことのゾーニングしながら…まぁ、最初はダイアグラムで整理をしていく。その次はまぁ、すこし、デザイン行動見たいなものを決めて行くですかね。ゾーニングの後に、好みの部分とか、クライアントの好みとかあるんですけど、まぁ、少しシャープでエッジデザインのほうが良いのか、少しやわらかいデザインで、やったほうがいいのか例えばカーラースキーム「color scheme 」グレイッシュ、クールのほうが良いのか、少しベイジュ良かった、温かみがあったほうが良いのか。まぁ、そういた部分「…」テクスチャ、カーラースキーム、デザイン…行動、ルールみたいなものを定めていく。それはクライアントとのやり取りをしながら。もうしくは建築とはそういう物のデザインとの関連しながら決めていきます。

Q2: 公開空地を設計するためには利用者に対して、何を分かれば有用だと思いますか？また、それは何のために有効ですか？出来るだけ具体的に答えてください。
設計者1：…まぁ、当然その公開空地を利用する人というのは確かに、もしオフィスとだとオフィスワーカー；商業にあるだと商業に利用する方；もしくは近隣に住んでいる方；まぁ、いろいろな属性があるだと思います…当然、それぞれの人はその公開空地の使い方が違います。

オラヴォ：もう、実際に、近くに住んでる方々が高齢者か子供のほうが多い、その割合はどのぐらいとかは、そこまでは調べますか？
設計者1：調べないです。
オラヴォ：で、実際にどの行動をとるか、例えば、ここで飲食するべきとか、飲食禁止とか、そこまでは、かんがえてますか？
設計者1：んんんん…
オラヴォ：例えば、スケボー、とかは･･･
設計者1：まぁ、そう言う意味で行くと、結構、禁止事項見たいな物って言うのは我々もそうだけど、どちらかと言うと、建物が公開空地を維持管理して行く、業者が比較的まず、あの、決定権を持っているね。当然スケボーはほぼ間違いなく禁止だし、まぁ、飲食見たいな物って言うのはまぁ、ケースバイケースではありますけれど、我々としては基本的にそこでどれだけ滞在して、気持ち良く滞在してもらえるかは設計者側としての、まぁ、基本的な欲求としてあります。公開空地の意味としてはそこにどれだけ滞在して貰えるか、

ですから、むしろ、飲食して貰ったりとか…オフィスワーカーとお昼時にじゃぁ、ここでお弁当買って、食べれるような場所を作ろうとか、周囲のかたもう、例えば、こどもとかは…少しピックニックで使えるとか、そういたことのは、まぁ、アクティビティのバリエーションを考えます。

オラヴォ：利用者がどの活動に行うべきとか、細かくまでを考えた上で、設計が変わるでもないですね。一般的にまぁ、滞在とか、長く入て欲しいとか、でも、実際に、ちょっと打ち合わせできるところとか、短期休憩とか、そこまでは考えながら設計をやてますか。

設計者１：はい、やります。やっぱり、あのう、場所と場所とか、その土地柄とか、ユーザを、訪れ人たちの属性によては、本当に長い時間居て貰ったほうが良い場合もありますし、本当待ち合わせとか、本当にちょっとの時間、そこで、10 分とかだけというのもありますし、そういう風にリラックスをするための場所を作っていったり、その、オフィスワーカー見たいな人がいれば、多少少しクリエイティブな、感性を刺激するような場所を作ろうかとか、そういった事は当然、利用者のニーズを、まぁ、想定ですけど、想定しながら、そういう空間作りを配慮していく。例えば、それはどういう風に現れると、ベンチとか、そういた物の寸法に現れます。例えば、ちょっと一人になってゆっくり休めたいだたら、もしくは一人、二人ぐらいなスケールのベンチだけど、もう少しオフィスワーカーの人たちがクリエイティブの話をするだったら、例えばちょっと、面と向かって、座れるようなベンチにしようか…4,5 人が座れるようなスケールが違うし、当然、その場合コーヒーが飲みたい、カフェを近くあったほうが良いかな。一人にいたほうが良いだったら、少し離れて、静かに、やや自然が多いところ…で、そういう場所を作る。

Q3: 具体的に設計するためにはどんな物理要素が必要ですか？

設計者１：ランドスケープで公開空地を作ると、まずは植物ですね。植物が多いそれからグラウンドカーバー、それから舗装ですね、それはもう石、ペーヴィング　ウッドデッキとかであったり、まぁ、いろいろあるんですけど。それと施設。施設といってるのはベンチとか、照明、壁みたいな。もしくは水系…そういったようなエレメントが基本的な要素。
舗装、植栽、施設は 3 点。プラスアルファなに何か必要なものあるかどうかはケースバイケースですね。例えば駐輪スペースが欲しいとか…

Q4: その要素の量はどう判断していますか「例：数；割合；見た目；設計者の直感；等」

植栽については、法や条例等に定められる必要緑化面積を満たす数量を最低限確保しながら、空間の質に適した植栽の量や、樹種、密度等々を決定していきます。
舗装に関しては、周辺との連続性や土地のコンテクスト、建物外観や建物内部の舗装との関連性、動線を考慮して決定していきます。
施設に関しては、その施設の機能的側面を考慮して最適な量や位置を決定してきます。

Q5: 設計するためにはどのようなデータが必要ですか？また、何に対して、またはどんなデータがあれば、設計に役に立つだとおもいますか？

設計者１：データですか。役に立たないことはないけれども、じゃぁ、それがデザインを決定するまでのファクターまではないかな。まぁ、我々は　実際そこまでをサーヴェイをして、決めてたこともないから…まぁ、だいたい、今までやって来たことの中だと一つ、やっぱり、その交通拠点みたいな、駅とか、もし建物を立つだとすると建物の利用者と人数を合わせて、どういう人の流れが実際にここに建物ができたら流れて来るのか。というのは、一応やってますし、やっぱり、メイン動線ですよね。人があまり来ない。どう考えても、あまり人が通らない場所、絶対ここにがすごい多くの人が来るとか、まぁ、人の流動のデータ見たいなを一応解析します。それから車も解析します。それは、まぁ、公開空地の中に車は入らないですけど、どういた交通が周辺にあるって言うのは確認しますね…
それともう一つ、植物とかを決めていく要因になるんですけどう、周辺の植生のデータですね。周辺には当然似たような公開空地があったり、または、少し離れれば、比較的な自然な植生が残っているだと、そういた物にはどういた植物実際にあるのか、というとどういた鳥とか生態系のネットワークが成立してる、または、もうしく、それがないのか。そういたことって言うのはデータとして使います。ある植物を具体的に決めていく時は使います。

アヴァロネ：設計のチームとしては実際敷地まで入て、人数を数えたり、車を数えたりとかはしますか。

設計者１：設計者としてはしませんけど、大きいな開発になると…どちらかにいうと設計に役立つより、歩道にこんなでかい建物がドンと建つと歩道が人で溢れかえちゃうことが

ある。ですので、日本の法制度として、そういた物ちゃんと数えて、必要におうじて、例えば歩道が２メートルしかないけれど、それに隣接するまさに公開空地としての歩道幇助空地…じゃぁ、なんメートル取ろうか。プラス歩道２メートルの幇助空地、または 5 メートル欲しいようね。そうしないとここに大量の人が来る、窮屈で歩けないよね。ということは必要になってくるので、あらかじめやります。

Q6: 公開空地の設計方法は他の公共空間の設計「例：広場、公園」と同様ですか？
設計者１：基本的にはアプローチの仕方は同じ。しかし、違うかなと思えるとすると、他の公共的な施設、公園とか駅前の広場、つまり、本当にそれは行政が管轄しているところで、やっぱり、公共性の高さ、まぁ、老若男女、誰にとっても、便利、安全、って言うことがやっぱり、最重要。それはどうしても、例えば税金を使って、アカウンタビリティがかなり強い。公開空地には基本的にそれに準ずる物のです。やっぱり、それを出資する事業者、まぁ、民間事業者である物が多いですから、当然その公開空地の価値はその民間事業者の建物とか、そもそも、例えば企業としての価値。CSR とかそういた物にまで還元させなきゃいけないと中々事業者としては実施する価値・意味はない。やや事業者側に…として設計をすると。当然例えばカフェとかあるとして、そこでお茶が飲めて、それでは気持ち良いから人が来る。それでビジネスが発展して利益が上がる。そうすると床の賃料も高く出来るようね。そういた、経済的な価値のバランスって言うのは考える。

Q7: 設計プロセスとしては原案を自分で考えて決定してから描くものか「Black Box」、または、提案が出来てなくても、描いて始めて、直しながらを決定するものだと思いますか？「white box」。
設計者１：難しいですね。どっちもある。あの、やっぱり、ファーストインプレーション見たいなもので、自分の中で「この空間は絶対これだ！」って言うすごく強くて明解なコンセプトが…生まれれば、もうそれで行き切っちゃうこともうあるんですけど、でも中々ね、そんなに簡単には設計出来ない。まぁ、当然、設計者がいれば、事業者もうクライアントもう当然行政の人もういろいろなステークホルダが実はその公開空地に作るに当たって、介在して来るので、１設計者だけでの意見で物を決める訳には行かないですね。そうしていくとまぁ、当然、我々は最初これがいいんじゃないか。あるシナリオを提案します。当然、「やや、それじゃないんか」ともしくは「こういったことを考えてくれ」っていろんな意見があります。そういた物をヒアリングして、やり取りしながら、一方で建築設計者とか、我々社内、ランドスケープチームとかが例えば、これはこういう風で考えてるけどこういう意見もう頂いてると悩ましいと当然、ブレインストーミングして、でなんかやるかなを言いながら、少しずつ、少しずつそれを解決。結果的に、当初描いた物と全然違う物になるということはよくある。

アヴァロネ：でも、原案がどうですか。自分で何回を描いて替わったりとか、または頭の中で、敷地のことを考えて、望んでることを整理して、実際に描くときがだいたい決まってるのか？

設計者１：具体的にはプラニングする時は決まってる。しかし、その前に、やっぱり、その最初はダイアグラムでいろいろなバリエーションの整理をしますね。いきなりこう、具体的な「ここに木があって、ここにベンチがあって、」っていうことは描かない。最初は、やっぱり、もう少し、ゾーンとか空間の考え方なので、いろいろ弄る。それは自分の中でもやるし、ちょっと、僕も年を取ってるので、細かいは若い人にスタイルをして貰ったりはありますけれど、設計者としてはまずやっぱり、自分の中にする。で、やっぱり、いろいろ考えたけど「これかな」っていうのも作ってから、絵にする。でも、それ 1 案じゃないです。2 案 3 案ぐらいあります。これとこれを実は変えたらそれが良いとか。離れてるけど、引っ付いたほうが良いのかな。いうのはあるので、スターディの 2,3 案をよくします。

Q8: 海外での公開空地を設計する場合は日本と同じように設計しても良いですか？日本と異なることや、設計するために欲しい情報をお答えください。
設計者１：僕は海外での経験は中国はあるんですけどね。中国っていうのは特殊な世界ので、少なくと日本の設計仕法のはやっぱり、違いますね。いろいろ他にも内の会社は東南アジアから、中国とかロシアとか、まぁ、いろな所でやてますけれども、日本ではかなり特殊だと思う、公開空地の設計、すごく細かい話、何より、レギュレーションが厳しい。非常に細かい所まで決められてる上に、そういうクライアントや行政のやり取り、積み上げで決めてくことが多いですけれども、まぁ、ちょっと、他の国とか分からないですけど、中国はかなりものすごい権力持ってる人のトップダウンで決まることが多いです。ということが何をするかといろいろのコンテクストや歴史、文化を読みときますけれども、当然日本から行っているので、彼らの情

報より少ない情報でしかない。なので、いろいろ組み立てるいくよりもう、簡単に言うとクライアントのトップ、好みとか、そういたところで…まぁ、我々のシナリオをあるべきなんじゃないかなぁというシナリオにその…あのクライアントのトップの好み見たいな物をバイアスをかなり掛けって、提案をします。それは良いかどうか分かりません。

アヴァロネ：そこでの人々は「公共空間の」違う使い方にしてるかどうか。どう思いますか。

設計者１：それはですね、実は変わらないかな、結果的には思ってるですね。

アヴァロネ：もちろん、規制とか、好みは違うですけど、同じ考え方で、海外の人々は日本人と同じ用に公開空地を使ってますので、同じように植栽、放送、施設、の考えながら設計をやって、規制とか、好みに磨けるですか。

設計者１：そうです。我々のアプローチの仕方は実は一緒なんですけど、少しバイアスの掛け方が違う。

アヴァロネ：結局、そこの住民とかの使え方の違いとか情報ではなくて、クライアントの情報が一番掛かってるですかね。

設計者１：です！まぁ、もちろん、それがあの…半社会的な空間を作ることになってないんですけど…やっぱり気候風土とか、こんなへんにちゃんと読みとかないと、どうしてもね、あの、例えばヨーロッパに行けば、オープンテラスがあって皆が佇んでる。中国の内陸の奥地の方では「27:33」実はそういう文化は全然ないですので、そういう空間作ろうとしても「人」来ないですから。「やぁ、でも、そう言ってもそんな文化これから作ってたら良いじゃない」を提案するけど、やっぱり、中々それは「こんなのいらないよ！」という経験はよくあります。

アヴァロネ：以外に「ここでこの習慣とか文化があるのでこれを作ってください」という。。。

設計者１：それはあります。ただ、それは結構人のアクティビティとかよりもやや伝統的なモチーフとか分かりやすい歴史の表現とかそういた事という事になりやすいです。

~~Q9: 前の質問に対して、日本と異なる場合、何の物理要素を扱って、違う文化や空間の使い方を設計出来ますか。~~

Q10:　これまでお伺いしていないことで、公開空地の設計の際に重要だと思うことがあれば教えてください。

設計者１：どういう使われ方にしてるのかと…想像しながら設計するっということが重要なのかなあと。…設計というのは、やっぱりあれ：デザイン、設計、図面、まとめ…まぁ、建設中はそれを管理する…竣工したら、終わっちゃうって多いですけど、設計者としては…まぁ、それは当然、実はそこで初めて空間が出来て、人たちが実際に使うのでそういた部分をもう一回ちゃんと分析をしたい。本当に自分の人たちが「こうじゃないか」の設計をしてますが本当でそう使われているのか？とかそういた事もう少し分析してちゃんと、もう一回設計側にフェードバックをして必要あると最近考えてる。

今までのようにランドスケープって、とても狭い日本の学校教育とかでいくと、すごく小さいですよね。建築っていっぱいあるけど、千葉大学にはランドスケープあるけど、そんなにない。アカデミックな世界で学んできた事で、今までのパラダイムだと、どうしてそのデザイン様式というのが…結構色濃くある。もっと、使われ方とかソフトウエアーですね。パブリックスペースで行われる…まぁ、どんなイベントだと、アクテイビテイだったりとか、もともとちゃんと分析しておかないとややエゴイスティクなデザインに陥る可能性じゃないかな。

まぁ、我々としてはそういった部分を、今までランドスケープデザインというカテゴリよりもパブリックスペースのデザインという言い方をしてます。まぁ、そういう言葉の定義というならば、やっぱり、その使われ方、公開空地として、公共的な空間も、下手するともう建物の良いな空間を含めて…どういた人とどういた感じ…そういた部分がまず、最重要なことじゃないか…という風にちゃんと捕らえ直して設計していきたい

2016年11月30日に行ったヒアリング
名：設計者2「39歳・男・園芸専攻・現在に公開空地の設計を行ってます・先生の立場はない」
会社：日建設計「ランドスケープデザイン部門」

SINOPSYS:

Q1: 公開空地を設計するための一般的な手順を説明してください。
設計者２：1.敷地、周辺、コンテクスト分析。2.設計のテーマ。3.コンセプト。4.用途。5.空間のプログラムやゾーニング。6.空間構成「閉じてる・開いてる」。

Q2: 公開空地を設計するためには利用者に対して、何を分かれば有用だと思いますか？また、それは何のために有効ですか？出来るだけ具体的に答えてください。
設計者２：利用者分布「オフィスワーカー、商業人、周辺の主民、」; 年齢；子供の存在；外人の存在；観光客の存在。
マネジメントや収益の得られ方と自立的に公開空地や公園が成立して行けるようなシステムを作るために有効である。

Q3: 具体的に設計するためにはどんな物理要素が必要ですか？
設計者２：ベンチ、芝生、舗装、壁、階段、排水、植物。

Q4: その要素の量はどう判断していますか「例：数；割合；見た目；設計者の直感；等」
設計者２：緑化率は制度で決定ですので、割合で決めます。他の要素は直感で決めます。

Q5: 設計するためにはどのようなデータが必要ですか？また、何に対して、またはどんなデータがあれば、設計に役に立つだとおもいますか？
設計者２：敷地周辺のバックグラウンド、文化的、歴史的、地形情報、どういた人たちをその商業に呼び込もうとしているのか。

Q6: 公開空地の設計方法は他の公共空間の設計「例：広場、公園」と同様ですか？
設計者２：僕は割りと同じ用に取らえてますけど、公園や広場だと非常にもう、完全にパブリックな空間になってますけれども、公開空地だと、所有者が居てそれから公開していくと言う関係になるので設計に与える影響は大きいですよ。オーナーが入るって言うことは、最初から無視出来ないので、スタンスが違って来るかなとは思います。

Q7: 設計プロセスとしては原案を自分で考えて決定してから描くものか「Black Box」、または、提案が出来てなくても、描いて始めて、直しながらを決定するものだと思いますか？「white box」。
設計者２：最初はブラックボックスで、描きを始まったら、ホワイトボックスです。

Q8: 海外での公開空地を設計する場合は日本と同じように設計しても良いですか？日本と異なることや、設計するために欲しい情報をお答えください。
設計者２：海外の公開空地はより高い意識で社会に貢献します。日本の公開空地のシステムって、建蔽率をはげるためのです。海外では日本より公開空地の社会的な役割や価値観をより深く理解してます。

Q9: 前の質問に対して、日本と異なる場合、何の物理要素を扱って、違う文化や空間の使い方を設計出来ますか。
設計者２：文化によりますと違うエレメントを使ってると言うことです。全体的の設計の流れは一緒です。

Q10:　これまでお伺いしていないことで、公開空地の設計の際に重要だと思うことがあれば教えてください。
設計者２：ありません。

2016年11月30日に行ったヒアリング
名：設計者 2　「39 歳・男・園芸専攻・現在に公開空地の設計を行ってます・先生の立場はない」
会社：日建設計「ランドスケープデザイン部門」

Q1: 公開空地を設計するための一般的な手順を説明してください。
設計者 2：まずは、敷地分析、周辺分析、周りのコンテクストを理解する。敷地のコンテクストを理解してから始まりますね。その上で、その周辺環境を理解した上で、今回の設計のテーマがどういう所にあって、どういう人に対象に、あの、公開空地ですから、まぁ、パブリックな一般市民を対象にすることが多いんですけど…そういう対象者に対して、どういったようの空間をするべきなのかということを考えます。で、その上で、あのうどういたコンセプトで設計を取り込むのかを理解した上で具体的にデザインに入っていくですけど。それは大きいな流れだと思いますね。…デザイン自体とはそれぞれの空間のコンセプトやテーマによって違うので中々言葉で説明する…一般的に一つの方法っていうのは難しいですけど、まぁ、今言ったところが一番大きいな所でここからさらに具体的に行くと、じゃぁ、そういった人を対象にどういう空間であると、っていうことが決まったと何回でどういった用途があるというのがありますから、それによって、空間のプログラムやゾーニングがあって…で、ゾーニングとともに、まぁ、用途のプログラムがあって、あとは…そうですね、閉じたい空間、開きたい空間とか。そのような…その用途と空間体験に対して、どういた空間構成にすべきなのかという所からデザインを進めていく。

Q2: 公開空地を設計するためには利用者に対して、何を分かれば有用だと思いますか？また、それは何のために有効ですか？出来るだけ具体的に答えてください。
設計者 2：うんんん。分かれば有用…そうですね、だから、それが、たしかに公開空地・パブリックな物を対象にするランドスケープが多いですけど、パブリックと言ってもいろんなパブリックがそこに含まれている訳で…それは、オフィスワーカーだったり、それから商業に訪れる人たちだったり、それから周辺の住民だったり、あとは年齢によってもどのぐらい子供がいるのかいないのかどういたような年齢層の人たちを対象にしているのかということを関係してきますし、もしくは最近東京なんかだと外人がどのぐらいいるのかとかって言うのだって、そういうのも必要でもあるし…例えば観光客が訪れる場所だとか、そういった、なんか、ターゲットというのは十分に理解する必要があると思いますね。最近の流れだと、あの…ただ公開空地で特に…公園なんかだとそういうのが多いですけど、どういう風にこう…パブリックスペースをそのマネジメントをしていくっていうことが重要になって来てますけど、そうした時に、こう…対象が何で、どういう所からを収益が得られて、出来れば、こう…自立的に公開空地や公園が成立して行けるようなシステムを作るって言うことが重要だと思うので、そういった意味で、利用者・ターゲットがなんなのかって言うことは理解することは重要だと思います。

アヴァロネ：人々の分布を実際に調べたりするんですか？

設計者 2：そこまで自分たちで分析してということは中々難しいかもしれないですけど…例えば、そうですね、今シンガポールで仕事をしてるんですけど、じゃぁ、シンガポールがどの国で、どういう人たち、人種がいて…まぁ、そこは結構、多様な民族がいる訳ですけど、じゃぁ、そこで中華系の人は何割で、インド系が何割で、アラビア系が何割でとか、そういたような事とかは、まぁ、バックグラウンドとして、十分に理解しておく必要がある。そういうベーシックなバックグラウンドとしての情報十分に集めた上で設計に有効あります。

Q3: 具体的に設計するためにはどんな物理要素が必要ですか？
設計者 2：それが、ベンチが必要とか…これの回答は何？ベンチ、植栽、とか、そういうこと？

アヴァロネ：はい。

設計者 2：あぁぁ、それはでも、今まで話して来た、1 番みたいなこと、2 番みたいなことによって、どういった要素がそこで必要かと全然替わって来るので、なんか、一般的にそれを答えるって非常に…全くコンテクストのないところで難しいと思います。

アヴァロネ：じゃぁ、そういえば、全くの植栽ないの公開空地とかが…

設計者 2：あると思います。

アヴァロネ：じゃぁ、何の目的で植栽ないの空間をするかとか。

設計者 2：んんんんん。

アヴァロネ：あの、コンセプトやテーマを決めるときが…あるテーマに対して、どや

てそれを実現に出来るかとかは…ある物を、まぁ、空間に入れる、入れてないときでもなんかをさせているじゃないですか。
設計者２：そうですね。
アヴァロネ：公開空地の設計者としてはなんの物を扱うべき？
設計者２：例えば、今、仰ったように、じゃぁ、公開空地、ランドスケープだから、植栽がなきゃいけないということはないと思うので、例えば、今まで、設計したプロジェクトの中で言うと、あるイギリスのウォーターフロントのプロジェクトなんですけど、どこでは、あの、海に面している、湾岸の公開空地・オープンスペースで、そこなんか、基本は植栽がなくて…メインの空間は特に木が生い茂っているという所ではなくて、まぁ、基本的にはベンチがあって、人の行き来、流動、起伏があって、ちょっと高い所から、海を眺められるとか、特に海に面して、人が座れるような空間を構成をしてまして、そこでは基本はあまり植栽はないけれども、まぁ、ひとがいっぱい集まって、海を眺めたり、会話を楽しんでしたり、で時々こういうイベントがあって、まぁ、文化的にそのイベントがあって、そこで、コンサートとがあったりとか、そうすると、なんか、多様な利用が出来るような広がりもあって…というような設計をしたこともありますけど。だから、なんか、物理要素って言った時に設計するためにどんな物理要素が必要かと言うと、なんか、必ずしも必要な物というと特定な、絶対これがないといけないと言う物はない。
アヴァロネ：じゃぁ、よく扱う要素。「**鈴木**：どう言う事？」例えば、説明したプロジェクトの設計だと椅子とかの数や配置だけを決めてだと終わり？その設計のデザインプロセスで、何の事に考えながら、デザインを決めましたか。
設計者２：それは、その場合に関しては、まぁ、人がいろいろ行き来するので、人の動線と海風が強いので、風から守りような起伏の作り方と…で、その間に、そのヒダのように、折曲がった所に人が座れるように空間をたくさん作る。それが海に面している。と言うことが一つ。で、それから、それとともに、こう…文化的なエリアで、そういたイベントが行われる時に集客が出来るような広がりなる空間を残しておくっていう。
アヴァロネ：その広がり空間のあの…
設計者２：芝生だった。
アヴァロネ：じゃぁ、芝生は使いました。舗装もう。。。
設計者２：舗装ある。
アヴァロネ：別の設計の考えたにすると、同じように緑を入れるかどうかということを、まぁ、舗装、ベンチ、まぁ、風通りによって、まぁ、壁を入れたりとか…
設計者２：そうですね。そういう意味で要素として、まぁ、よく扱うのは、やっぱり、舗装、壁、階段とか、排水とか後は…植物。。。

Q4: その要素の量はどう判断していますか「例：数；割合；見た目；設計者の直感；等」
設計者２：まず、植物に関しては大体多くのプロジェクトで緑化率特に国内のプロジェクトなのが多いですけど基本あるですけど、まぁ、緑化率要求されてる物が多いのでそれはまず答えなきゃいけない。限られた公開空地の中で緑のそこで何割とかということで、まぁ、かなり縛られている気がする。緑の量はそれでかなり縛られます。ということは、残りが、まぁ、ハードになる訳ですけど…そういう所からかなり量が決められて来るですね。制度の中で縛られてくる。まず、その縛りが非常に大きい。
アヴァロネ：はい。緑の量の法が制度から決められて行くですけど、座席とか、カバー、水の量はどやて決められますか。
設計者２：それはやっぱり、どういった利用の空間にするのかとか、接しの要求だとか、商業も頼んでやって、どのぐらいのベンチが必要だとか、そういった用途にやっぱり関係して来ますけれども、だから、必ずしも、なんか、それも…この、まぁ、設計者の直感ではないですね。やっぱり、要求としてどういたような物を、求められていて、そこにどれだけの…それぞれの量が必要なのか…というのが大きいと思いますね。そういたようのなんか、こう…要求、いろんな、そういう、総合的な要求に対して設計者として、まぁ、一つの空間としてどうやてそれを配分して空間を作っていくのが。こういう所が設計者の仕事だと思います。
アヴァロネ：でも、緑は緑で、日本で特集だと思いますが、他の要素が、やっぱり、決ま

ったルールを利用しているではなく、図面の見た目や直感で決まっているのか。例えば、地基地の中で、何千人が通るだとこのぐらいの席とか、このぐらいのカバーのあった方が良いだとか。

設計者２：人が通るだったら、やっぱり、それだけの舗装空間あって良いとかと言うのは決められていきますね。例えば、オリンピック見たいなイベントがあったらそれだけの何万人の人が行き来する訳だから、その二週間の間に…そこではしっかり、それが機能するような舗装空間を作って上げなきゃいけない。でも、それは二週間だけだからその後にそこはどう言う風なのかと言うことも考慮した訳で、そうするとなんか、やっぱり、テンポラリな空間があって、まぁ、将来的にそれはもうちょっと縮まるとか。だから、そういた、なんか、用途によって、それに答えるべき量が変わってきますね。

Q5: 設計するためにはどのようなデータが必要ですか？また、何に対して、またはどんなデータがあれば、設計に役に立つだとおもいますか？

設計者２：まずは、最初に言ってたような、こう、周辺環境だったりとかが理解出来るような情報…なんか、バックグラウンドですね。敷地周辺のバックグラウンドだったり、なんか、文化的な話だったり、歴史的な話だったり、で、そういたようなベーシックな概要は必要ですようね。で、それから、敷地自体の地形情報。それからが…後はその気候に適した植物のリスト。後は、まぁ、利用者の具体的な情報、どう言う割合でどう言う人がいるだとか、商業的な話だとどう言うような商業を考えていて、施主が考えていて…どういた人たちをその商業に呼び込もうとしているのか。ターゲット見たいな情報が必要。

Q6: 公開空地の設計方法は他の公共空間の設計「例：広場、公園」と同様ですか？

設計者２：僕は割りと同じ用に取らえてますけど、ただ…まぁ、でも、やっぱり、対象とする物は先言ってたように公園や広場だと非常にもう、完全にパブリックな空間になってますけれども、公開空地だと、やっぱり、その所有者が居てそれから公開していくと言う関係になるので…そういう意味でオーナーがいるということは設計に与える影響は大きいですね。彼らの要求に答えながら、だけどパブリックの利用者を対象にしているっていう所が少し違うかな。で、そうしたときにやっぱり、そこマネジメントにして行く…エコノミカルな話もあるので、だからどのぐらい、こう、pay があって、それに本当その空間を保てるとかその仕組みを作ると言うことが重要になると思うから…それは最近公園とかでも重要はなってきてますけど、パークマネジメント・エリアマネジメントと言う話…ただ、まぁ、オーナーがいるって言うことは、それは、全く、あの、もっとも、最初から無視出来ないので、そのへんは少し、この、スタンスが違って来るかなとは思います。

Q7: 設計プロセスとしては原案を自分で考えて決定してから描くものか「Black Box」、または、提案が出来てなくても、描いて始めて、直しながらを決定するものだと思いますか？「white box」。

設計者２：頭の中で思考するということですかね。たぶん、両方ですけどね…最初はブラックボックスで、描きを始まったら、ホワイトボックスに。流れとしてはそう思いますけど。全く、何の意味がなく、描くって言うことがないから…と言うことはそれなりになんか、思考した上で手が動くと言うことですから、しかし、思考の部分がこう言うブラックボックスで、描き始めた後ホワイトボックス。

Q8: 海外での公開空地を設計する場合は日本と同じように設計しても良いですか？日本と異なることや、設計するために欲しい情報をお答えください。

設計者２：結構海外で仕事してるんですけど、一方で日本の仕事をそんなにいっぱいしてる訳じゃないですけど、たぶん、僕の理解で、大きいかなと思うのは…たぶん、まぁ、場合にもよりますけど、こう、統計で見たときに海外の方が…公開空地に対する、何ですかね、施主の…理解と言うか、社会に貢献すると言うような意識がより高いような気がなんとなくします。日本の公開空地のシステムって、やっぱり、建蔽率をあげるために、公開空地と言うのは非常にそのシステム強いじゃないですか。で、海外で公開空地っていたときにそのシステムはどこまでにあるのか、僕はそこまで詳しくないですけど、ただ、一般的に、やっぱり、絶対にこう、ある敷地があっても、社会と接点との部分っていうのは常にあるじゃないですか。それは、ある、まぁ、公開空地ですね。そうした時なんか、パブリックなその、町との繋がりの部分に対する、考え方が非常にフレキシブルで、その、理解がそこに対する思い入り見たいのは結構強いかな…と言う気がします。そうすると設計する上でも、やりやすい部分もうありますし、まぁ、それもちろん、施主によるんだけど、一般的にちょっとそう言う理解はもうちょっと深い

かな、と言うのは僕の意識です。

アヴァロネ：一般的に言うだと海外は日本の公開空地に比べて、より公開されていると言うこどですか。よりパブリックですか。

設計者２：と言うかそういた敷地っていうのは絶対に出て来るので…別にそれが海外が多いではないですけど、そういた空間を、じゃぁ、設計者の設計図して、で施主がそれにオッケー出したりとか、で、そこでどう言う風にすべきかといたときの…えと、理解の深さ見たいな…なんかただ、自分たちの利益の、建蔽率のためにとか、なんかその、言うよりはもうちょっと公開空地が社会に与えるメリット見たいな…それが自分たちの企業にしても、もし、オーナーとしても、それがどいう風な意味が…あの、一つの社会貢献にあると思いますけど、なんかそういって一般的なこう、認識としてそういった空間の大切さみたいなものの社会全般に理解を深いじゃないかなという感じにします。

Q9: 前の質問に対して、日本と異なる場合、何の物理要素を扱って、違う文化や空間の使い方を設計出来ますか。

設計者２：僕はロンドンに 10 年に入たんですよ。サンフランシスコに 3 年入て、そういた所で仕事…ヨーロッパまぁ、仕事したり、してまして。アメリカに入た時はけっこ中国の仕事が多かった。まぁ、中国の仕事をしてましたけど、で、最近がシンガポールやたり…ドバイで仕事したり、してるんですけど。まぁ、基本的には今ここで質問で出るの文化とか空間の使い方の違いって言うのは非常に各国に非常に違うのでそういた所はあの理解して、取り組むっていうのは非常に重要ですようね。

アヴァロネ：そういえば、国による、空間の作り方がことなりますか？または同じように公開空地という広場がどの国でも、同じ物の扱い、同じ利用者が同じようにその空間を取れていますのか。

鈴木：そうですね。たぶん、公開空地だけではなくて、パブリックスペース全体の利用のしかたとして、それぞれ、やっぱり、少しずつ違うと思います。例えば、イギリスなんて、冬に本当に寒くて、暗くて見たいな…そうするとはるが来て、夏が来て、そうすると、もう、とにかく皆芝生の上で座って、ランチを食べたりとか、そういたような外の利用の仕方というのは非常にあって、そうすると公開空地の、なんか、そういたように、そいう場があればそういう利用がされる所とか…一方で中国ではあまり、こう、芝生の上に人が座ってする見たいな、あまりない。日本でも、最近は、こう、芝生の上でなんか、いろいろのイベントをしたり、ヨーガしたりとか、ピクニックはあれですけど、じゃぁ、そういう物が、じゃぁ、東京の都心でどれだけやるかと言うと中々少ないかなだし…大分増えて来てますけど、それが…また、そういう文化や…パブリック空間のその…パブリックスペースの利用の仕方、それの文化の浸透度によって、なんか、そこにそういう場があっても、しつらえがあっても利用のされ方が違ったり、利用の頻度が違ったり、なんか、そこが賑わう、活気付く、度合いが違ったりするので、それぞれのなんか、そういう文化やバックグラウンドにあった、なんか、仕組み作り見たいのがないと十分、公開空地が利用されないというのはありますね…

アヴァロネ：実際に、文化を意識をしながら、違う視点から、違う国で、設計を始まってるということですか？文化によりますと違うエレメントを使ってると言うことですか。

設計者２：そうですね。

アヴァロネ：ちなみに、例えが、ウルグアイの国見たいに、行ったことないの国だったら、なんの視点からはじまりますか。

設計者２：言ったような、その、文化とか、どういた実施、どういた歴史を持っていて、じゃぁ、そういう流れでパブリックスペースと言う物がどう言う風に…パブリックって言う物がまず、どう取られていて…じゃぁ、パブリックスペースって言う物がどういう風に利用されていて…で、じゃぁ、今現在でどういう風にその、まぁ、与えられたプロジェクトがどう言う意味があって、どういた利用を望まれるとかということを理解した上で設計が始まる。

Q10: これまでお伺いしていないことで、公開空地の設計の際に重要だと思うことがあれば教えてください。

設計者２：大体はなした。

2016 年 12 月 09 日に行ったヒアリング
名：設計者 3　「42 歳・男・園芸専攻・現在に公開空地の設計を行ってます・先生の立場である」
会社：千葉大学・

SINOPSYS:

Q1: 公開空地を設計するための一般的な手順を説明してください。
設計者 3：公開空地の位置、周りとの街区との関係、街区の繋がりで歩道動線、公開空地の形状。利用を想像して、緑地を作ったりとか、ちょっと囲まれた広場をデザインします。

Q2: 公開空地を設計するためには利用者に対して、何を分かれば有用だと思いますか？また、それは何のために有効ですか？出来るだけ具体的に答えてください。
設計者 3：利用者に対してには分からなくてもと良いなと思います。一般的に使える環境であれば良いなと思います。

Q3: 具体的に設計するためにはどんな物理要素が必要ですか？
設計者 3：ベンチ、テーブル、緑地、植栽と照明です。

Q4: その要素の量はどう判断していますか「例：数；割合；見た目；設計者の直感；等」
設計者 3：見た目と後は設計者としての感覚です。

Q5: 設計するためにはどのようなデータが必要ですか？また、何に対して、またはどんなデータがあれば、設計に役に立つだとおもいますか？
設計者 3：利用者の人数、昼と夜でどうやて人数が変わるのか。後は風の動きと気温のデータです。そのデータがあるとその公開空地に意味付けしやすいとは思います。

Q6: 公開空地の設計方法は他の公共空間の設計「例：広場、公園」と同様ですか？
設計者 3：同じですね。設計の仕方でも、利用者の使い方や空間のとらえかたもう同じです。

Q7: 設計プロセスとしては原案を自分で考えて決定してから描くものか「Black Box」、または、提案が出来てなくても、描いて始めて、直しながらを決定するものだと思いますか？「white box」。
設計者 3：私の場合はまず、手書き始める。手書きをしながら、考えていくの方が多いです。「white box」

Q8: 海外での公開空地を設計する場合は日本と同じように設計しても良いですか？日本と異なることや、設計するために欲しい情報をお答えください。
設計者 3：基本的には日本と同じ用に、設計してもよいとは思うですけど、文化の違いとか空間の使い方の違いがあれば、情報として欲しいです。

Q9: 前の質問に対して、日本と異なる場合、何の物理要素を扱って、違う文化や空間の使い方を設計出来ますか。
設計者 3：基本的には物理的な要素については違いはないと思います。

Q10:　これまでお伺いしていないことで、公開空地の設計の際に重要だと思うことがあれば教えてください。
設計者 3：高密度な都市ではやっはり、公開空地のオープンスペース見たいな大事な存在であるとは思いますから…その面積、形状は非常に大事だとおもいます

2016年12月09日に行ったヒアリング
名：設計者3「42歳・男・園芸専攻・現在に公開空地の設計を行ってます・先生の立場である」
会社：千葉大学・

Q1: 公開空地を設計するための一般的な手順を説明してください。
設計者3：まずは…その公開空地の位置、場所どう言う、周りとの街区との関係、どこにあるはまず。その公開空地が…そのまわりの街区の繋がりの中で歩道動線になるは開くときを開いたい。他の状況との、まぁ、イメージして設計します。で、一方で、そうじゃなくて、その状況が、回りからあまり関係がない場所…であれば、まぁ、できるだけ、その〜、プロジェクトの中の、敷地の中における利用を想像して、出来るだけ、まぁ、緑地を作ったりとか、ちょっと囲まれた広場、中にあるみたいな物をそくていして、デザインします。

Q2: 公開空地を設計するためには利用者に対して、何を分かれば有用だと思いますか？また、それは何のために有効ですか？出来るだけ具体的に答えてください。
設計者3：利用者に対してには別にそこが公開空地であるとは…分からなくてもと良いなと思います。ふつに,
ずっと、使える環境であれば良いなと思います。公開空地においては、まぁ当然、パブリックな場所ではあるですが、あの〜、それぞれの敷地の中に得られるですから、時間帯によっては、まぁ、クローズしちゃって、はあるんですけど、まぁそうじゃなくて、やっぱ、空地と公開空地によては、xxx「5:32」的なある訳。と言うことは利用者にしていただきたいと思います。

アヴァロネ：子供でも、高齢者でも、社会人でも、一般人でも、同じ用に使えるようにしてるですか。

設計者3：はい、はい。

Q3: 具体的に設計するためにはどんな物理要素が必要ですか？
設計者3：なんか、そこで自由に活動できるような、ベンチとか、テーブルとかそういう物はまずあった方が良いと思うし、後は…物理要素か…当然緑地、植栽な、植物ですし、また、照明ですね。そのぐらいですね。

Q4: その要素の量はどう判断していますか「例：数；割合；見た目；設計者の直感；等」
設計者3：量の判断は、あの、Q1で言ったように公開空地の、どういう場所に設定されているのかと、どういう場所にあるに応じて、やっぱ、違って来ると思います。囲まれた場所であれば、当然あのそれだけ緑に必要し…で〜、ゆっくり寛ぎりようなテーブルとか、ベンチをちゃんと配置したほうが良いです。で、一方で、人が、多くの人が通り抜けるような場所であれば、まぁ、それほど…あの…そのベンチとかテーブルを置くなくても良いと思います。

アヴァロネ：どうやってその量の判断、適切な量を決めますか。

霜田：あぁぁ、公開空地の形によって、量は、だから、見た目ですね。見た目と後は感覚的な…設計者としての感覚があって…先言った物を決めます、判断します。

Q5: 設計するためにはどのようなデータが必要ですか？また、何に対して、またはどんなデータがあれば、設計に役に立つだとおもいますか？
設計者3：データ。そこ利用をする、想定する、利用者、人数。後はその昼と夜でどれだけ人口って言うか、人数が変わるとか…後は公開空地と言う以上はやっぱり、都市の空間の中で開けたのスペースですから…風の動きとか、後は気温のデータとか、後その公開空地の意味付けしやすいとは思います「11:30」。

Q6: 公開空地の設計方法は他の公共空間の設計「例：広場、公園」と同様ですか？
設計者3：同じですね。

アヴァロネ：設計の仕方、プロセスは同じ？　**設計者3**：同じです。
アヴァロネ：利用者の使い方や空間のとらえかたもう同じ？　**設計者3**：同じです。

Q7: 設計プロセスとしては原案を自分で考えて決定してから描くものか「Black Box」、または、提案が出来てなくても、描いて始めて、直しながらを決定するものだと思いますか？「white box」。
設計者3：私の場合はまず、手書き始める。手書きをしながら、考えていくの方が多いです。「white box」

Q8: 海外での公開空地を設計する場合は日本と同じように設計しても良いですか？日本と異なることや、設計するために欲しい情報をお答えください。

設計者３：基本的には日本と同じ用に、設計してもよいとは思うですけど、やっぱり、国によっては宗教ね、が違って…まぁ、広場の使われ方は宗教でが変わるので、そういた情報はやっぱり、設計する時、どういたユーザに…というのは必要だと。。。

アヴァロネ：とはいえ、文化の違いとか空間の使い方の違いがあれば、情報として欲しいですね。

設計者３：はいそうでう。

Q9: 前の質問に対して、日本と異なる場合、何の物理要素を扱って、違う文化や空間の使い方を設計出来ますか。

設計者３：基本的には、そんな、国によってその、オープンスペース・公開空地…どう使うか、そんな違いはないと思うです。どんな国に公園や広場あります。だから、別にそんな物理的な要素については違いはないと思うですけど、あの、例えば、ムスリムの人たちは敵的にお祈りしなきゃいけないなので…まぁ、その宗教の違いあるというのは広場にその場所を設計しなっきゃいけない。

アヴァロネ：物理要素としてはあまり変わらない？

設計者３：変わらない。

Q10: これまでお伺いしていないことで、公開空地の設計の際に重要だと思うことがあれば教えてください。

設計者３：大事だと思うのは公開空地の中はどう設計するかと言うのは、私はランドスケープアーキテクトですね…まぁ、面積だけ取れれば、まぁ、公開空地と言うか一応理論じょうはね、計画じょうは良いだけども、それ以上に公開空地の配置、どう言う所に置けられるのかと言うを…ちゃんと検討しないとその公開空地はよくに利用されないかもしれないし、高密度な都市ではやっぱり、公開空地のオープンスペース見たいな大事な存在であるとは思いますから…その面積、形状は非常に大事だとおもいます。

APPENDIX 05

1. Publications

PUBLISHED PAPER

TITLE: Physical Element Effects in Public Space Attendance

AUTHORS: Avalone Neto, O., Jeong, S., Munakata, J., Yoshida, Y., Ogawa, T., Yamamura, S

PUBLISHED IN: Journal of Asian Architecture and Building Engineering 15 (3), 479-485 (2016)

Physical Element Effects in Public Space Attendance

Olavo Avalone Neto*[1], Sinwon Jeong[2], Jun Munakata[3], Yushi Yoshida[4], Takahiro Ogawa[4] and Shinji Yamamura[5]

[1] Ph.D. Candidate, Department of Architecture, Graduate School of Engineering, Chiba University, Japan
[2] Assistant Professor, Department of Architecture, Faculty of Engineering, Tokyo University of Science, Japan
[3] Professor, Department of Architecture, Graduate School of Engineering, Chiba University, Japan
[4] Senior Consultant, Nikken Sekkei Research Institute, Japan
[5] Principal Consultant, Nikken Sekkei Research Institute, Japan

Abstract

This paper seeks to determine which physical elements of privately owned public spaces affect users' impressions, which characteristics of these elements are noticed, and what impressions they cause. The study is based on a caption evaluation and semantic differential survey of 12 public spaces in the center of Tokyo. Ten participants were surveyed for each space, and 1494 of the obtained entries were analyzed. The semantic differential survey was then cross-referenced with density measures to evaluate the effect of physical elements' densities on participants' impressions.

It was found that the physical elements that caught users' attention were greenery, street furniture, the building, the sidewalk and the space itself. From all of the elements, tree coverage density was the best predictor of desire to stay and rest activities in the space. A logistic regression analysis of each activity by tree density is also provided.

Keywords: behavior; public space; caption evaluation; semantic differential; impression

1. Introduction

In 1961, New York City started to offer a floor-area ratio (FAR) bonus to ensure the provision of public spaces on the ground level (Whyte, 1988; Smithsimon, 2008). This practice has since been widely used by different countries and is generally referred to as "increasing FAR". In Japan, similar policies have been adopted since 1971 through the Comprehensive Design System (Sogo Sekkei Seido) and have been used as a deregulation policy since the 1980s to promote urban redevelopment through the Building Standards Law (Kenchiku Kijun Hou) (Akamine *et al.*, 2003; MLIT, 2003).

In 2015, there were approximately 720 privately owned public spaces (POPS) in the Tokyo area alone. Lately, the design of public spaces generated by these policies has considered not only the lot area but also the integration of the public space with its surroundings, thereby connecting the lot to existing spaces and infrastructures. This design has played an important role in the production of public spaces.

Although POPS are widely recognized for enhancing the quality of public spaces and are a valuable urban development tool, there is little research regarding the quantification and placement of the physical elements that compose those plazas and the effects on users' impressions and behaviors. This leaves the design of POPS to each designer's individual ability and personal judgment.

This research seeks to improve the knowledge about the effects of physical elements on users' impressions and behavior and to fill the gap in knowledge so that urban planners can create evidence-based designs and reduce the difference between expected and actual effects on users' impressions by the built environment.

1.1 Physical Elements and Users' Impressions

Some studies sought to establish a relationship between POPS physical elements and the impressions they caused. Kakutani (2005) used the semantic differential method (SDM) to evaluate POPS produced through the comprehensive design system in Hiroshima. He analyzed overall area and typology relations of public spaces on users' impressions with a focus on policy making rather than public space design.

Fujita & Ito (2006) characterized POPS in the Minato ward of Tokyo by its connections with walking paths and evaluated them based on pedestrian traffic

*Contact Author: Olavo Avalone Neto, Ph.D. Candidate,
Chiba University, Nishi-Chiba Campus, Faculty of Engineering,
Bld. 10, 3F, 1-33 Yayoi-cho, Inage Ward, Chiba City,
Chiba Prefecture, 263-8522, Japan
Tel: +81-80-3383-0072
E-mail: avalone@gmail.com
(*Received October 4, 2015 ; accepted July 11, 2016*)
DOI http://doi.org/10.3130/jaabe.15.479

and traffic direction. Their results are somewhat useful for building placement and policy decisions.

According to Tanaka & Kikata (2008), physical elements such as benches and stairs/steps are directly related to a good impression of public spaces for stay, rest and passing through activities. However, their research was limited to three public spaces in Kagoshima with the caption evaluation method.

Tsuchida & Tsumita (2005) studied how the physical characteristics of the public space affect wait and rest activities. They selected 16 areas in different POPS and asked participants to mark on a map the areas where they would want to stay or rest and give their reasoning. The study indicates a positive effect of *greenery* and *seats* on rest activities, while *greenery* has a negative and *visibility* a positive effect on wait activities. Unfortunately the study asked participants to adopt one of two pre-determined behaviors: rest or wait. If participants were allowed to evaluate the environment for any behavior, a better relationship between behavior, physical aspects and impressions could have been established.

2. Study Area and Sample Size

For the purpose of this study, 12 POPS in the center of Tokyo with lot areas larger than 3000 m^2 constructed after 1990 were chosen (Table 1.).

Table 1. Sites Chosen for the Survey

Site	Ward	Lot area [m^2]	Open space ratio	Built in
Building 01	Chiyoda	6383	52.2%	2011
Building 02	Chiyoda	20875	75.0%	2003
Building 03	Chiyoda	6079	45.8%	2003
Building 04	Minato	3647	47.5%	2004
Building 05	Chiyoda	6368	54.0%	1999
Building 06	Minato	3039	50.6%	2003
Building 07	Minato	3217	57.1%	2009
Building 08	Minato	15206	65.6%	2006
Building 09	Minato	5479	56.3%	2006
Building 10	Chiyoda	3101	53.7%	2006
Building 11	Bunkyo	3417	52.0%	1998
Building 12	Shinjuku	3734	61.9%	2009

Data were gathered over 4 days in October and November 2010 from 12:30 to 17:30, on sunny or partially cloudy days (16ºC – 19ºC) that offered suitable weather conditions for outside activities.

Questionnaires were collected from a total of 30 participants (23 males and 7 females), aged between 21 and 29 years (M=23; SD=1.54), university students who were randomly assigned to visit four of the 12 sites. Each site had an average of 10 participants, leading to a total of 120 site observations.

All participants in this study were architecture students for practical reasons because they develop a specialized language (Wilson, 1996) that facilitates built environment description. A laypersons description of the environment would be in too broad terms or too ambiguous for the purpose of this study.

Although there are several studies (Hershberger, 1969; Devlin & Nasar, 1989; Nasar, 1989; Devlin, 1990; Stamps, 1991; Hubbard, 1994; Brown & Gifford, 2001) that found a perceptual difference between architects and non-architects, those differences are related to the overall evaluation of building facades made from pictures or slides and not real environments or public spaces.

Other researchers also found no difference between architects and laypersons (Nasar & Purcel, 1990; Imamoglu, 2000), showing that correlation is dependent on the evaluation scales and the object of evaluation. On the evaluation of outdoor spaces using semantic differential scales no difference was found between architects and laypersons measuring variation, friendliness, functionality and desirability scales (Yazdanfar *et al.*, 2015).

3. Methods

3.1 Caption Evaluation Method (CEM) Survey

A CEM survey was conducted to identify which physical elements to select from those commonly found in POPS, how they are evaluated and which impressions are caused within users. Based on users' responses to different environments, a structural relation between physical elements, element characteristics and impressions was constructed.

This method was chosen because it allows real environment evaluations while prompting users to note which elements caught their attention and what impressions they caused.

In a CEM survey, participants move freely (e.g. walk around, sit) in the environment with a camera and photograph elements that catch their attention. Participants will then take note about why that particular scene caught his or her attention with a subtitle for each picture. Later, each picture is attached to an evaluation card in which the participants describe (characterize) the picture's scenery or elements and the reason (impression) it caught their attention (Koga, T., Taka, A., Munakata, J., Kojima, T. *et al.*, 1999; AIJ, 2011).

Participant's evaluations were made by describing the elements that caught their attention, their characteristics and the impressions they caused under the following structure: ○○is ○○ because ○○; where "○○" is the element, characteristic and impression, respectively. Participants could take and evaluate as many pictures as they wished and write as many entries per picture as they deemed necessary (M=12.14; SD=5.93). From the 120 site visits, a total of 1494 entries were made. These entries were classified and divided into groups using the KJ method, which agglutinates answers by similarity. All answers where categorized into medium and macro groups of elements, characteristics and impressions (Figs.1., 2. and 3.).

Overall, elements were classified into 11 macro categories composed of 64 smaller ones (Fig.1.); characteristics were classified into 10 macro categories composed of 40 smaller ones (Fig.2.); and impressions were classified into 9 macro categories composed of 45 smaller ones (Fig.3.).

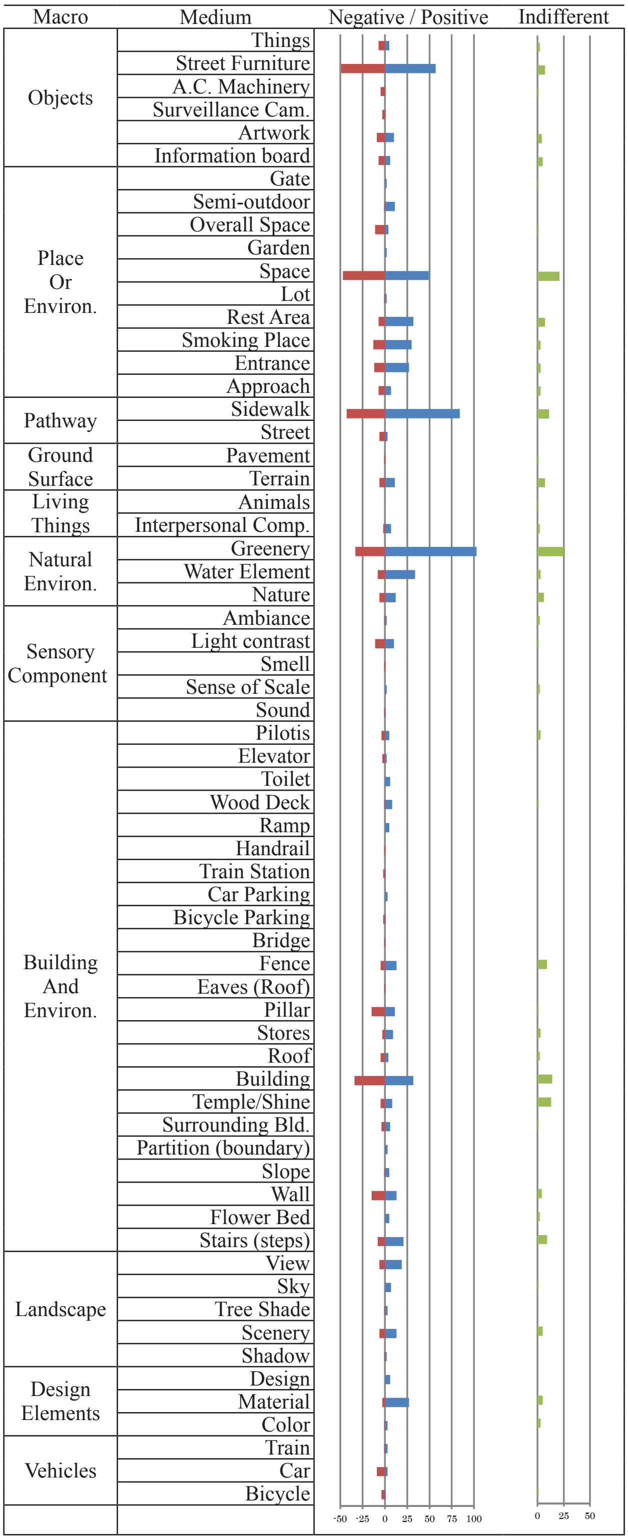


Fig.1. Elements Extracted from the CEM Survey

Between the *elements* pointed out by the participants, greenery was the most relevant, with 256 entries (E) (77% positive (P), 13% negative (N) and 10% indifferent (I)), followed by sidewalks (138 E, 61% P, 31% N and 8% I), space (117 E, 42% P, 40% N, 18 I), street furniture (113 E, 51% P, 43% N, 6% I) and building (80 E, 40% P, 42% N, 18% I). All other characteristics had less than 46 entries overall.

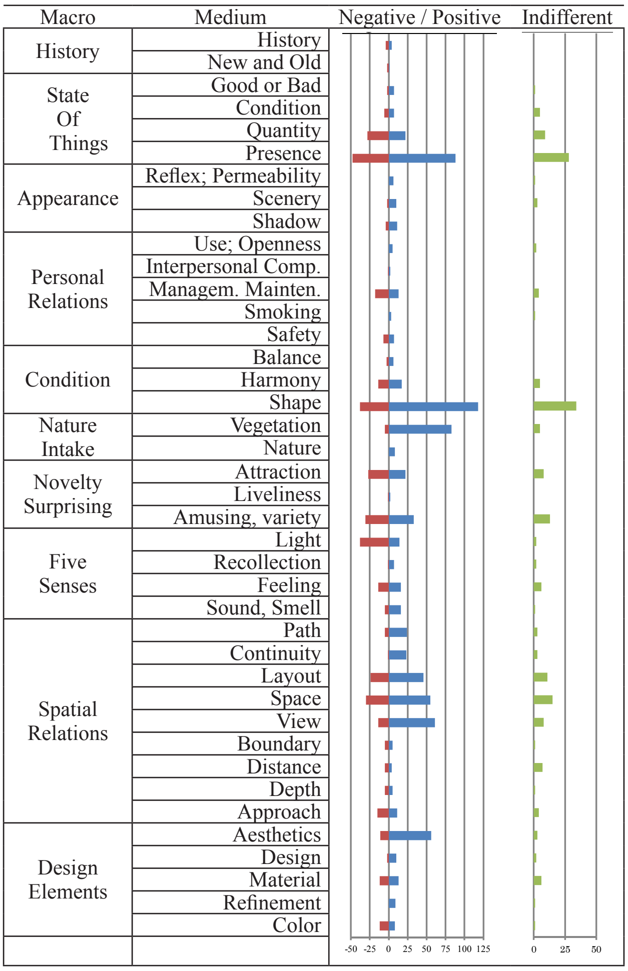


Fig.2. Characteristics Extracted from the CEM Survey

From the element *characteristics* noted by the participants, shape was the most prominent (190 E, 62% P, 17% N, 21% I), followed by presence/absence (164 E, 54% P, 29% N, 17% I), space composition (100 E, 55% P, 30% N, 15% I), vegetation (93 E, 90% P, 5% N, 5% I), view (83 E, 73% P, 17% N, 10% I), placement (81 E, 57% P, 30% N, 13% I), amusement/variety (77 E, 43% P, 40% N, 17% I) and aesthetics (70 E, 80% P, 16% N, 4% I). Other characteristics varied from a range of 3 to 59 entries (0.2% to 4%) as shown in Fig.2.

Comfort was the most cited *impression* (191 E, 68% P, 29% N, 3% I), followed by like/dislike (162 E, 78% P, 21% N, 1% I), restfulness (122 E, 55% P, 37% N, 8% I), entertainment (88 E, 60% P, 20% N, 20% I), space aspiration (87 E, 38% P, 21% N, 41% I), goodness (72 E, 96% P, 1% N, 3% I), usage (68 E, 49% P, 35% N, 16%

I), people walking (56 E, 54% P, 39% N, 7% I) and pleasantness (52 E, 67% P, 33% N). Other impressions varied from a range of 2 to 43 entries (0.13% to 3%) as shown in Fig.3.

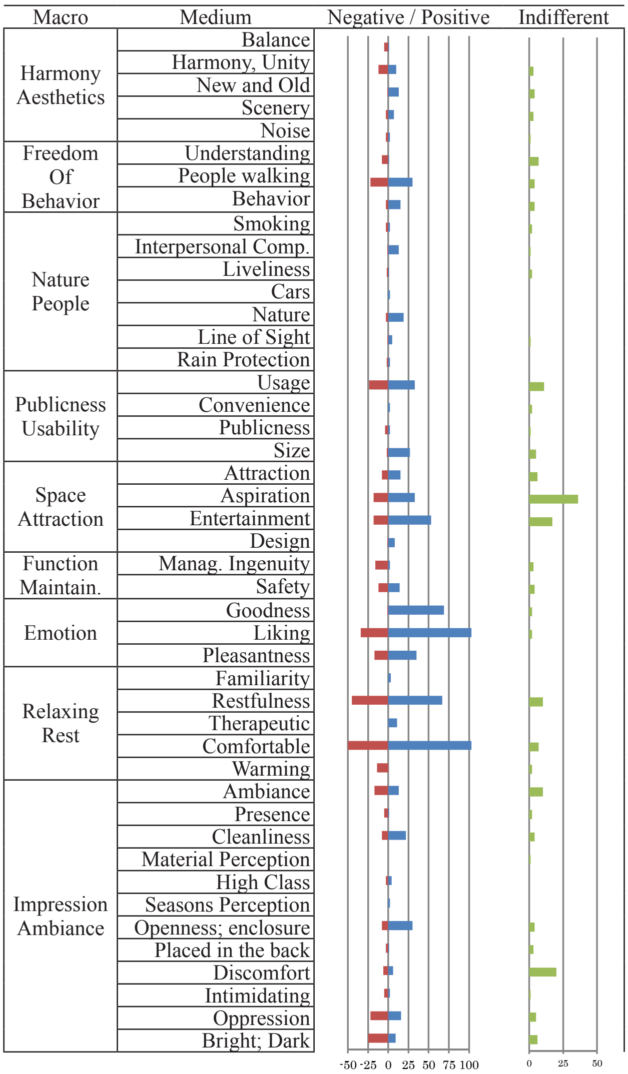


Fig.3. Impressions Extracted from the CEM Survey

3.1.1 Results

The overwhelming majority of answers identifying elements that attract attention pointed to tangible physical elements that compose the built environment (i.e., greenery, sidewalk, street furniture and building) or to the intangible that is the sum of those elements (i.e., space). Those five categories alone account for 704 (47%) of the 1494 entries gathered in the survey.

Of the characteristics, the shape of the environment or things (12.7%) and the presence or absence of elements were the most cited (11%), and three (placement, space composition and view) of the nine categories of spatial relation combined accounted for 17.7% of entries (264 E), while vegetation accounted for 6.2% of entries.

The data regarding users' impressions showed that comfort (12.8%) and personal emotions (i.e., like/dislike, good/bad, pleasant/unpleasant) were commonly felt and composed 18% of entries. Interpersonal impressions may also be observed in responses such as people walking, usage and entertainment (14% of entries combined).

3.1.2 Discussion

The results show that the basic elements that form a POPS (i.e., greenery, sidewalk, street furniture and building) are the same ones that will attract or repel users. Although this may seem to be an obvious conclusion, the magnitude to which these elements are perceived in relation to other elements (Fig.1.) is surprising, and the perception of intangible components is almost insignificant (e.g., all five categories in the sensory component category combined accounted for only 34 entries or 2.28%). Based on these results, future research should seek further evidence for how and to what extent these basic elements affect users' perceptions.

This can also be observed in the characteristics pointed out with entries that directly relate to tangible design decisions such as the presence or absence of elements and vegetation, form, placement and space composition. Although this has been explored in previous research (Tanaka & Kikata, 2008; Tsuchida & Tsumita, 2005), directives regarding how to manipulate these variables in public space designs to garner specific impressions from users are limited.

Impressions are very closely related to personal opinion (e.g., is the environment good/bad, liked/disliked, pleasant/unpleasant, etc.). More subtle aspects of impressions, such as the ambience categories (Fig.3.), had few entries on average, which suggests a very simple perceptual structure: an important element is sought; the relationship between that element and the overall structure (presence, shape, placement, and aesthetics) is perceived; and the personal opinion of that characteristic is felt (like/dislike, good/bad; pleasant/not; comfortable/not).

The results are limited by the participants age group (M=23; SD 1.54) and specialty (architecture students). Furthermore, the present study could not control for individual differences or the possible effect of subjects and site combinations. The analysis considers entries for all 12 POPS and difference between sites will be investigated in future research.

3.2 Semantic Differential Evaluation and Density Analysis

To analyze how much of each element was used in each project and their effects on users' impressions, a semantic differential questionnaire combined with the element density measurements was used. The element density was defined as the amount of area occupied by an element divided by the publicly accessible area of the lot. The publicly accessible area was defined as the lot area minus the buildings' enclosed or otherwise not freely accessible areas. Areas were analyzed in two different layers: ground level (seats, bushes, hedges and water) and coverage (trees and cover). Therefore, the areas of those two layers may overlap: a tree covering a seat was counted for its seat area in the "seat" category, while the tree canopy area was counted in the "tree" category (Table 2.).

Table 2. Site Area Ratio per Category

Site	Seats	Bushes	Hedges	Trees	Cover	Water
Building 01	0.015	0.266	0.005	0.282	0.046	0.004
Building 02	0.014	0.259	0.020	0.240	0.049	0.013
Building 03	0.021	0.124	0.061	0.208	0.00	0.00
Building 04	0.003	0.132	0.017	0.257	0.294	0.014
Building 05	0.034	0.302	0.09	0.26	0.028	0.038
Building 06	0.002	0.228	0.052	0.138	0.244	0.00
Building 07	0.013	0.116	0.017	0.295	0.134	0.00
Building 08	0.011	0.203	0.114	0.242	0.031	0.00
Building 09	0.007	0.292	0.000	0.271	0.262	0.00
Building 10	0.01	0.23	0.049	0.092	0.20	0.00
Building 11	0.022	0.223	0.013	0.301	0.158	0.00
Building 12	0.00	0.161	0.12	0.096	0.026	0.00

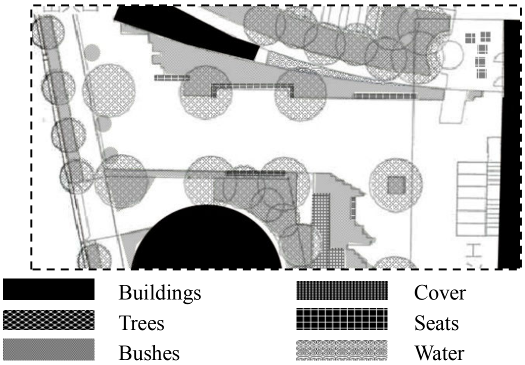


Fig.4. Density Measure of a Section of Bld. 01's POPS

Table 3. SD Questionnaire Measurement Scales

	Measurement	Scale
1	Comfort	Comfortable - Uncomfortable
2	Stay Duration	Long Stay – Short Stay
3	Size	Big – Small
4	Peacefulness	Peaceful – Loud
5	Sophistication	Sophisticated – Unsophisticated
6	Diversity	Diverse – Uniform
7	Liveliness	Lively – Decadent
8	Space Weight	Light – Heavy feeling
9	View	Good – Bad view
10	Organization	Orderly – Cluttered
11	Amount of Greenery	A lot – A little greenery
12	Vegetation placement	Good – Bad Greenery Placement
13	Abundance of Tree Shade	A lot – A little tree shade
14	Illumination	Bright – Dark
15	Calmness Feeling	Feel Calm – Do not feel calm
16	Safeness	Feel Safe – Do not feel safe
17	Openness	Feel – Do not feel openness
18	Oppression	Feel – Do not feel oppression
19	Enclosure	Feel – Do not feel enclosure
20	A Place to Rest	Easy – Hard place to rest
21	Interesting	Interesting – Not interesting space
22	Harmony with Surroundings	Harmonic – Disharmonic
23	Color Variety	Colorful – Colorless
24	Atmosphere	Light – Dark Atmosphere
25	Newness	Contemporary – Nostalgic
26	Enjoyability	Enjoyable – Lack of enjoyment

The density – amount of public space area occupied by each element – was measured based on the CEM survey photographs taken by the participants (for seats, bushes, hedges, trees, cover and water) and satellite images available on Google earth were also used as reference for tree coverage when images from October to November 2010 were available (Fig.4.).

To consider the impact that such elements have on users' impressions, a semantic differential survey was applied to participants with a total of 26 measurement scales. In this survey, two of the scales were related to behavioral intent: stay duration and a place to rest (Table 3.).

An analysis of the participants' average response per site and each site's physical characteristics was performed (Table 2.). Effects of gender were tested but were not statistically significant.

3.2.1 Results

Correlations between physical elements and impressions are listed in Table 4. Measurement scales that did not correlate well (bellow 0.5) with any physical aspect are omitted.

The best predictor for stay duration was the tree ratio (R^2adj=0.46; p<0.008) through the single regression analysis formula Y=-2.73+(10.19*Trees), where Y is the "stay duration" score.

Table 4. Correlations of Impression and Physical Elements

Code	Physical Element or Impression	Seats Ratio	Bushes Ratio	Hedges Ratio	Tree Ratio	Cover Ratio	Water Ratio
A	Seats ratio						
B	Bushes ratio	0.32					
C	Hedges ratio	0.01	-0.13				
D	Trees ratio	0.48	0.12	-0.53			
E	Cover ratio	-0.49	0.01	-0.53	-0.02		
F	Water Ratio	0.58	0.39	0.14	0.25	-0.19	
1	Comfort	0.05	-0.20	0.01	0.59	-0.31	0.07
2	Stay Duration	0.15	0.06	-0.08	0.72	-0.29	0.12
4	Peacefulness	0.29	-0.23	0.29	-0.19	-0.54	0.40
5	Sophistication	-0.65	-0.48	0.41	-0.35	0.06	-0.29
6	Diversity	-0.08	0.10	0.21	0.40	-0.18	0.26
9	View	-0.19	-0.09	0.56	0.01	-0.36	-0.35
10	Organization	-0.47	-0.56	0.21	-0.48	0.16	-0.34
11	Amount of Greenery	0.50	0.08	0.33	0.31	-0.83	0.22
12	Vegetation placement	0.15	-0.18	0.17	0.41	-0.62	0.09
13	Abundance of Tree Shade	0.68	0.05	-0.12	0.72	-0.67	0.22
15	Calmness Feeling	0.24	-0.15	-0.16	0.65	-0.27	0.28
19	Enclosure	0.40	0.24	-0.42	0.12	0.28	0.60
20	A Place to Rest	0.33	0.18	-0.59	0.93	0.05	0.28
21	Interesting	-0.16	-0.24	0.06	0.47	-0.08	0.12
22	Harmony with Surrounding	0.16	-0.05	0.10	-0.18	-0.14	-0.34
23	Color Variety	0.04	-0.03	0.50	0.26	-0.57	0.22
25	Newness	-0.63	-0.31	0.13	-0.44	0.11	-0.22

A place to rest could also be predicted by tree ratio with a better model (R^2adj=0.85; p<0.001) through the formula Y=-3.80+(16.73*Trees), where Y is the "place to rest" score. This prediction could also be made from the hedge ratio but with a less robust model (R^2adj=0.27; p<0.045).

Several impressions could be predicted from the tree ratio: tree shade (R^2adj=0.47; p<0.008), calmness (R^2adj=0.36; p<0.023) and comfort (R^2adj=0.28; p<0.045). Others could be predicted from the seat ratio, such as the abundance of tree shade (R^2adj=0.40; p<0.015), sophistication (R^2adj=0.36; p<0.015) and newness (R^2adj=0.34; p<0.028).

A logistic regression analysis was made using the raw data from the survey to predict users' satisfaction according to the tree ratio for the two activities: stay (Fig.5.) and rest (Fig.6.). The graph is divided into three areas: negative, neutral and positive impressions.

For this analysis, the 7-point scale was divided into three segments: -3, -2, -1 as negatives; 0 as neutral; and +1, +2, +3 as positives. This means that in the case of "place to rest", the answers "extremely agree", "agree" and "somewhat agree" to the survey prompt "hard to rest" are plotted as negative; "neither" is plotted as neutral and "extremely agree", "agree" and "somewhat agree" in response to the prompt "easy to rest" are plotted as positive.

The logistic regression makes it possible to evaluate the satisfaction rate with any density instead of relying on averages. Plotting results using logistic regression allows designers to use density values that will satisfy more than half of the users, which is extremely useful for data that vary from positive to negative impressions.

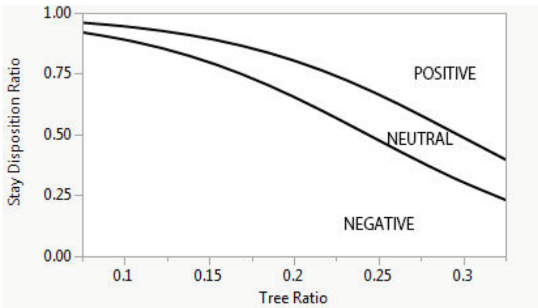


Fig.5. Logistic Regression of "Stay Duration" by Tree Ratio

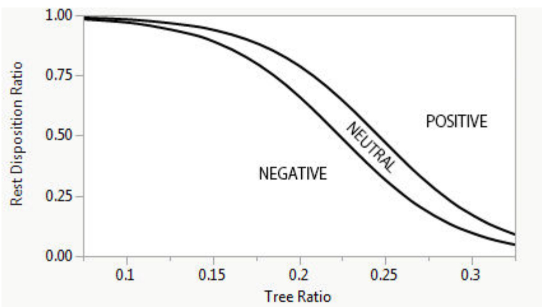


Fig.6. Logistic Regression of "Place to Rest" by Tree Ratio

3.2.2 Discussion

Both activity measurements in the SD survey could be predicted by tree ratio, which consisted of a broad range (from 10 to 30%) of the POPS area.

The seat ratio did not correlate with either the stay or rest activity. This may be because the seat ratio only varied from 0 to 3.4% of the total area. Considering that the seat ratio correlated well with the amount of greenery and abundance of tree shade, it is possible to assume that seat perception is related to tree placement and overall design. This could also explain the inverse correlation between the seat ratio and the newness and sophistication impressions.

It is worth noting that a negative correlation between the amount of bushes and organization exists (more bushes means a less organized space) because the number of bushes directly relates to the amount of greenery and overall space.

4. Conclusions

When asked to identify which physical elements caught their attention, participants pointed to basic elements: street furniture, greenery, buildings, sidewalk and overall space.

Greenery was the most cited physical element, and the tree ratio proved to be the best predictor of stay and rest activities. This result agrees with Tanaka & Kikata (2008) who related the amount of trees to rest activities and expands the results to include stay activities. In addition to trees, the amount of bushes correlated negatively with the impression of an organized space.

The most prominent impressions pointed out by users apart from emotional ones (e.g., goodness, liking and pleasantness) were *comfort* and *restfulness*; both highly correlated with the tree ratio.

Some of the characteristics expected to be found in the physical elements were also addressed in the present study such as *presence/absence* and *vegetation*, while others should be explored further in future research, particularly *placement*, *space composition* and *shape*.

A deeper study on the effects of hedges can profit from some *in loco* measures. A width x height measurement is probably more suitable for hedges instead of the flattened measure (depth x width) adopted in this study.

Further studies should also broaden the age group and include people from other fields of study to test education effect, which may lead to different results.

This study used all of the publicly accessible area of the lot to define the public space and instructed participants to explore the space as a whole. A more realistic measure would be to consider only those spaces that are perceived as a public space *a priori*, disregarding residual spaces such as back alleys, parking lots, service accesses and unloading docks that may be counted as public space in the FAR legislation but do not contribute to the public good, which will probably lead to more robust results to the findings described in this study.

Future studies can investigate impressions in other seasons to compare the effects of tree coverage and intended activity. Different climates, cultures, user profiles (e.g. age, necessities) and affordability could also yield different results that would be worth comparing.

References

1) Akamine, R., Funahashi, Kunio, Suzuki, T., Kita, M. and Li, B. (2003) A Study on Use of Open Spaces at Osaka Amenity Park (OAP) and in its Neighborhood. Journal of Architectural Planning, AIJ, 566, pp.71-79.
2) Architectural Institute of Japan - AIJ (2011) Survey Design for Housing and Urban Design. 1st ed. Tokyo: Ohmsha.
3) Brown, G. & Gifford, R. (2001). Architects predict lay evaluations of large contemporary buildings: whose conceptual properties? Journal of Environmental Psychology 21, pp.93-99.
4) Devlin, K. (1990) An examination of architectural interpretation: architects versus non-architects. Journal of Architectural and Planning Research, 7, pp.235-244.
5) Devlin, K. & Nasar, J. L. (1989). The beauty and the beast: some preliminary comparisons of 'high' versus "popular" residential architecture and public versus architect judgments of same. Journal of Environmental Psychology, 9, pp.333-334.
6) Fujita, S. & Ito, K. (2006). A Study on Public Open Space from the viewpoint of the pedestrian traffic. Architectural Institute of Japan, AIJ, pp.355-356.
7) Hershberger, R. G. (1969) A study of meaning and architecture. EDRA 1, pp.86-100.
8) Hubbard, P. (1996). Conflicting interpretation of architecture: an empirical investigation. Journal of Environmental Psychology, 16, pp.75-92.
9) Imamoglu, Ç. (2000) Complexity, liking and familiarity: architecture and non-architecture Turkish students' assessments of traditional and modern house facades. Journal of Environmental Psychology, 20, pp.5-16.
10) Kakutani, H. (2005) A Study on constituent element and perception of public open space. Analysis with cases that applied the system of comprehensive planning in Hiroshima City. Research Reports of the School of Engineering, Kinki University, 39, pp.101-107.
11) Koga, T., Taka, A., Munakata, J., Kojima, T., Hirate, K. and Yasuoka, M. (1999) Participatory research of townscape, using 'caption evaluation method': studies of the cognition and the evaluation of townscape, Part 1. Journal of Architectural Planning and Environmental Engineering, AIJ, 517, pp.79-84.
12) Ministry of Land Infrastructure and Transport, MLIT. (2003) Introduction of Urban Land Use Planning System in Japan. Available at www.mlit.go.jp/english. Retrieved in 2015.08.04.
13) Nasar, J. L. (1989). Symbolic meaning of house styles. Environment and Behavior, 21, pp.235-257.
14) Nasar, J. L. & Purcell, T. (1990). Architect Knowledge Structure and Aesthetic Response to Single Family Houses. In Culture-Space-History: Proceedings 11th International Conference of the IAPS. IAPS. Ankara, Turkey: METU Faculty of Architecture.
15) Smithsimon, G. (2008) Dispersing the Crowd. Bonus Plazas and the Creation of Public Space. Urban Affairs Review, 43 (3), pp.325-351.
16) Stamps, A. E. (1991) Comparing preferences of neighbors and a neighborhood design review board. Environment and Behavior, 23, pp.618-629.
17) Tanaka, F. & Kikata, J. (2008) Research on Urban Landscape and Public Space by the Caption Evaluation Method – Case Study on Kagoshima City. Architectural Institute of Japan Research Paper, 47 (3), pp.221-224.
18) Tsuchida, H. & Tsumita, H. (2005) Analysis on Liking of Place for Taking a Rest and Waiting – A study on urban public space (Part 2). Journal of Architectural Planning, AIJ, 596, pp.59-66.
19) Wilson, M. A. (1996) The socialization of architectural preference. Journal of Environmental Psychology, 16, pp.33-44.
20) Yazdanfar, S. A., Heidari, A. A., Aghajari, N. (2015) Comparison of architects' and non-architects' perception of place. Procedia - Social and Behavioral Sciences 170, pp.690-699.

PUBLISHED PAPER

TITLE: Evaluating public spaces though immersive virtual environment: real and virtual environments differences

AUTHORS: Avalone Neto, O., Munakata, J., Jeong, S., Yoshida, Y

PUBLISHED IN: AIJ Summaries of technical papers of annual meeting, 173-174 (2016).

Evaluating public spaces though immersive virtual environment: real and virtual environments differences

Member ○ Olavo Avalone*1 Jun Munakata*2
Sinwon Jeong*3 Yushi Yoshida*4

Privately Owned Public space | Head mounted display | Activities
Immersive virtual environment (IVE) | Semantic differential method | Impressions

1. Introduction

Recently head mount display technology has become affordable, providing designers with a new visualization tool that allows the environment to be experienced instead of merely understood through graphical renderings.

As a design tool, virtual environments may be used to evaluate different design proposals and provide designers with actual data about the environment before it is built.

For the data to be reliable a relationship between real and virtual environments has to be unveiled. Different visualization methods, evaluation methods as well as environment types will probably yield different relationships between real and virtual environments.

The present study evaluates 4 real public spaces and the immersive virtual environment (IVE) equivalent of those four public spaces, experienced through head mounted display. Then it explores the differences between those methods and how it can be used by urban designers.

2. On site survey

Four sites within walking distance from one another were selected in Tokyo, so that subjects could evaluate them on the same day. Site selection considered variability of the amount of sitable area, amount and variation of vegetation and scale. From the four selected sites, one was of small, two of medium and one of large scale. Sites that had potential confounding variables and sites that did not allow for a clear perception of floor area such as connection with underground and areas with restricted access but with visual permeability were discarded. Noisy areas were also discarded as a way to control sound environment, which would not be simulated on sub sequential experiments, as a confounding variable. Selected sites and their respective elements ratio may be seen in Table 1.

Table 1 – Selected sites and its compositions.

Site	Est. Area	Seats	Bushes	Trees	Cover	Water	Grass
S1	2050m^2	1.5%	18.3%	26.2%	5.5%	1.9%	0%
S2	2650m^2	2.6%	22%	23.7%	0.4%	2.4%	0%
S3	600m^2	1.4%	40%	30.6%	0%	0%	0%
S4	4000m^2	1%	6.3%	12.5%	1%	0.5%	25.7%

For the *on site* survey, participants received orientations about the survey purpose, evaluation method and how to answer the questionnaire, after which they walked to the first site and perform the evaluation.

After arriving at the site, participants were instructed to walk freely around the site for about 5min. and then answer the questionnaire. The questionnaire consisted of 21 questions as a 7 point semantic differential scale followed by 2 multiple choice questions (Table 2) presented to the participants on their smart phones. They were instructed to check both sides of each scale before answering it.

Table 2 – Measurement scales adopted.

		Measurement	Scale
1	Behavior	Suitability for stay	Unsuitable – suitable
2	Behavior	Suitability for eat/drink	Unsuitable – suitable
3	Behavior	Suitability for resting	Unsuitable – suitable
4	Behavior	Suitability for meeting	Unsuitable – suitable
5	Behavior	Suitability for reading	Unsuitable – suitable
6	Impression	Appeal	Not appealing – appealing
7	Impression	Interestingness	Not interesting – interesting
8	Impression	Enclosure	Do not feel enclosed – feel enclosed
9	Impression	Ambiance	Gloomy – cheerful
10	Impression	Relaxation	Not relaxing – relaxing
11	Impression	Spaciousness	Not spacious – spacious
12	Impression	Oppression	Do not feel oppressed – feel oppressed
13	Impression	Liveliness	Not lively – lively
14	Impression	Diversity	Uniform – diverse
15	Physical	Size	Small – large
16	Physical	Greenery amount	To little greenery – a lot of greenery
17	Physical	Greenery placement	Badly placed – well placed
18	Physical	Seat amount	To little seats – a lot of seats
19	Physical	Seat placement	Badly placed – well placed
20	Physical	Seat design	Badly designed – well designed
21	Physical	View	Bad view – good view
22		Price of a cup of coffee	From 0 to 1000 yen or more
23		Stay time	From 0 to 2 hours or more

3. IVE survey

The four sites with their surroundings were modeled using SketchUp and Unity software. The virtual environment models were as simple as possible, with special attention to preserve size and proportion of the original environments. Building facades, and surrounding streets were textured with photographs taken on site and/or using the Google Street view database. Since the availability of vegetation models was limited, virtual environments did not had the same species of the real environments but tried to maintain the same heights, texture and volumes of the original designs as much as possible.

Virtual models were presented using an Oculus Rift DK2 head mounted display (Figure 1) and participants would move around the environment using a Logicool gamepad

IVE を用いた敷地内における公開空地の評価：実空間と IVE の違い
＊1 アヴァロネ オラヴォ　＊2 宗方 淳
＊3 鄭 新源　＊4 吉田 雄史

controller. Each environment was loaded, observed and evaluated with a brief (around 3-4 min) eye rest between samples. Participants were instructed about possible side effects of the VR equipment and to stop at any time they felt discomfort. If necessary, they could rest for as long as they wished between samples or end the experiment at any time.

Figure 1 – Oculus Rift head mounted display.

Participants were allowed to walk around in the virtual space for as long as they deemed necessary to grasp it. Once they felt comfortable to evaluate it, they removed the headset and started the evaluation by filling, by hand, a printed questionnaire. Participants were instructed to either wear the headset again or use the screen in front of them to check any aspect of the environment they deemed necessary while answering the questionnaire.

4. Participants

Participants were university students, from varied fields.

A total of 20 people (12 male and 08 female) participated in the real environment survey, evaluating all four sites (80 observations in total). Average age was 23.35 years (SD=4.78). Virtual sites were also evaluated by a total of 20 people (10 male and 10 female) with 80 observations in total. Average age was 22.05 years (SD=2.19). There were 17 people that participated on both surveys. Sites were evaluated in the same two orders of the real environments so that the effect of evaluation order could be tested.

5. Results

An analysis of variance was used to determine whether the environment type (real or virtual) had any effect in each of the 24 evaluation scales.

There was no main effect or interactions from environment type in four of the five behavioural scales (Table 2). The exception was *read* activity ($p<0.0001$), where, although there was no main effect, an interaction ($p<0.05$) between *environment type* and *sites* could be seen (Fig. 2).

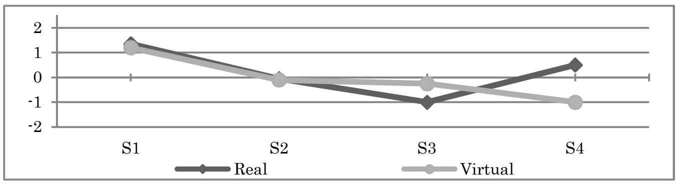


Figure 2 – Read Activity.

The scales chosen to access impressions had no effect of environment type, except for *ambiance* ($p<0.05$) and *interest* ($p<0.05$), both of which had main effect of environment type (Fig. 3 and 4).

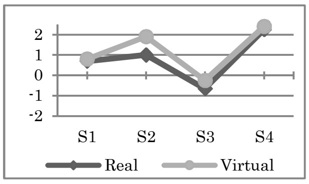


Figure 3 – Ambience.

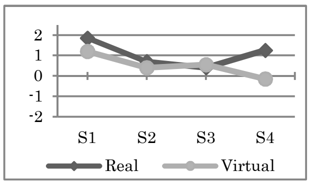


Figure 4 – Interest.

Between the physical scales, *size* had main effect ($p<0.05$) while *greenery placement* had interaction ($p<0.001$) with *site type* (Fig. 5 and 6).

The other two scales – stay time and coffee price – also had no effect of environment type

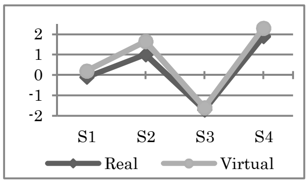


Figure 5 – Size.

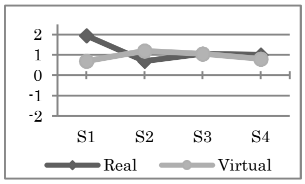


Figure 6 – Greenery placement.

6. Conclusion

Overall, there were no effects caused by the way a user experience the environment: whether it is virtual or real, answers were very similar.

Impression scales that showed some effect from environment type (i.e. ambiance and interest) were probably due to the level of detail of the virtual environment (shop facade used glass material innate to the modelling software instead of photo texture).

Size and greenery placement divergence between real and virtual is not unexpected since the greenery utilized in the virtual models was different from the actual species present in the real environments.

Whenever virtual environments are used, there is a *tradeoff* to be considered between the level of detail production cost and the improvement in response, which is why this experiment tried to not over detail it. Future research may explore the relation between different detailing levels and measurement scale accuracy to determine the optimal CG cost ratio to each measurement scale.

*1 千葉大学大学院工学研究科建築・都市科学専攻　博士課程・修(工)
*2 千葉大学大学院工学研究科建築・都市科学専攻　教授・博(工)
*3 東京理科大学工学部建築学科　助教・博(工)
*4 日建設計総合研究所　主任研究員・修(工)

*1 Doctoral candidate, Dep. Of Arch. And Urban Sci., Grad. School of Eng., Chiba Univ. M. Eng.
*2 Professor, Dep. Of Arch. And Urban Sci., Grad. Sch. of Eng., Chiba Univ., Dr. Eng.
*3 Assist. Professor, Dept. of Arch., Fac. of Eng., Tokyo Univ. of Science, Dr. Eng.
*4 Senior Consultant, Nikken Sekkei Research Institute, M. Eng.

SUPPORTING PAPER

TITLE: Seat Choice and Distance Judgment in Public Spaces.

AUTHORS: Avalone Neto, O., Munakata, J.

PUBLISHED IN: Perceptual & Motor Skills 121, 2, 548-567 (2015).

Perceptual & Motor Skills: Perception
2015, 121, 2, 548-567. © Perceptual & Motor Skills 2015

SEAT CHOICE AND DISTANCE JUDGMENT IN PUBLIC SPACES[1]

OLAVO AVALONE NETO AND JUN MUNAKATA

Chiba University

Summary.—This research assessed whether public space users will adopt a least-effort approach and choose a less suitable seat nearby or seek the most suitable seat, even if it is farther away from them when the decision is made. How distance assessment affects seat choice was investigated through an observational survey, which allowed the identification of behavioral patterns. Those behavioral patterns were then tested in a paired comparison experiment with 40 participants. The results showed that the effect of distance on seat choice is related to the difference in distance between the options and that a sufficient difference can cause trade-offs between distance and seat properties. The necessary difference in distance is conditioned by the activity and the seat properties.

Public spaces ought to provide opportunities for encounters, discussions, deliberation, and socialization, while allowing for a diverse viewpoint of the world (Lefebvre, 1991; Németh, 2009). In recent decades, the production of public spaces, such as plazas and squares, has been gradually transferred from the public to the private sector through government policies of exchanging floor area ratio for the provision of publicly accessible spaces. When unregulated, these policies allow for the design of spaces that will become neglected or underused and with no public function. Furthermore, it allows for designs that actively segregate the population or purposefully inhibit its usage (Németh, 2009). Alongside the changes in public space production, technological advances continue to change our social relations and our conceptions of place and location (Banerjee, 2001) that also contribute to lower public space attendance.

To ensure the public function of a place, it is necessary to increase people's attendance in a democratic way and maximize interactions in such spaces, making them livelier. While an increase in the number of users will make a place livelier, an increase in the users' stay time will be more effective in generating encounters (Gehl, 2011). Researchers have investigated the effects of several factors in people's attendance in public spaces, such as comfort (Walton, Dravitzki, & Donn, 2007; Lin, Tsai, Liao, & Huang, 2013), amount of sittable space and the presence of food stands (Whyte, 1980; Abdulkarim & Nasar, 2013), seat properties, placement and materials (Whyte, 1980; Abe, Hayashida, Tetsuo, & Watanabe, 2009; Li, Chen,

[1]Address correspondence to Olavo Avalone Neto, Bldg. 10, 3F, Room 303, Department of Architecture, Division of Architecture and Urban Planning, Faculty of Engineering, Chiba University, Nishi Chiba Campus, Chiba City, Chiba Prefecture, 263-8522, Japan or e-mail (avalone@gmail.com).

DOI 10.2466/24.PMS.121c20x3 ISSN 0031-5125

Hibino, Koyama, & Zheng, 2009; Gehl, 2011), seat configuration (Hayashi & Ohno, 1995), group size (Golicnik & Ward Thompson, 2010), intended duration of stay (Gehl, 2011, p. 155), scenery (Gehl, 2011, p. 159), and the activity to be performed (Hayashi & Ohno, 1995; Li, *et al*., 2009). Overall, this subject is approached using a stated preference methodology that ranks such factors as more or less suitable. The present study investigates how users make a decision between two options and whether the most suitable option is chosen or if a trade-off favoring shorter distances occur.

Distance Judgment

Distance judgment is one of several ways for people to understand their surrounding environment and to orient themselves. Knowledge about distance derives from several, sometimes redundant, information sources, including the number of environmental features, travel time, and travel effort (Montello, 1997). Judgments are susceptible to biases, and perceived distances may differ from measured, objective distances.

Physical or objective distances can be objectively and consistently measured. They can be expressed in or converted into different scale systems and can be reproduced, while perceptual distance is the estimation of a distance in plain view from a single observation point, based on judgment of spatial and other cues (Montello, 1997).

Environmental or cognitive distance is a third term that, according to Crompton and Brown (2006), refers to our knowledge about how far places are away from each other. For a detailed account of cognitive distance and the three main theories seeking to explain distance judgment biases—feature-accumulation, segmentation, and scaling—see Montello (1997) and Crompton and Brown (2006).

The present study will focus on perceptual distance and its effects on seat choice. Given choice scenarios in which people are expected to estimate distances between themselves and several options from a single point of view, judgment biases may occur when the perceptual distances differ from the objective distances. An overestimation of distance will lead to an overestimation of the effort required for reaching farther options, which can, in turn, bias the decision-making process. Furthermore, because distance estimation is not the purpose in itself, the way people perceive each individual option may also affect their judgment and choice.

Decision Processes, Seat Choice, and a Decision Model

When faced with a decision, two processes start in the brain, one subconscious and one conscious. The subconscious process relies on intuition and generates impressions to be evaluated by the conscious mind in a quick and effortless manner. The conscious process uses part of the thinking capacity to consider different scenarios, necessities, variables, and options and to weigh possible results against one another in order to determine which is the most suitable. This process takes effort, concentration, and time (Kahneman, 2011, p. 24).

People have a limited amount of working memory, and anything that occupies working memory reduces a person's thinking capacity. To save thinking capacity, choices are simplified by breaking complex problems into smaller, easier ones, to which there are solutions that may be interpreted as the answer to the complex question (Kahneman, 2011, p. 97). Recalling different variables with the purpose of weighing their value is a conscious process, but the brain is always processing current stimuli and providing suggestions. According to Kahneman's (2011, p. 129–136) availability heuristic, for a complex decision only those variables that can be easily recalled by the subconscious will prompt the conscious mind with an option set. Because the suggestions that arrive in the conscious mind originate from the stimulus processed by the subconscious mind, it is possible to infer that those stimuli will determine which variables will be considered in the decision.

Studies related with seat choice (Hayashi & Ohno, 1995; Li, *et al.*, 2009; Gehl, 2010) evaluated stated preference, meaning that they presuppose a user will make a conscious choice and choose what he likes. Applying the ideas of Kahneman (2011), it is most probable that the choice is subconscious, and the subconscious suggestion is simply adopted using the availability heuristic. This means that variables that are causing discomfort will be prioritized and prompt the subconscious for a suggestion and an alternative that will mitigate the discomfort will be chosen.

As one example of the above choice process, Lin, *et al.* (2013) suggested that thermal comfort is responsible for attendance in parks, which means that when it is too hot people choose to be indoors so they can mitigate the discomfort with air conditioning. When there is a small discomfort, people may choose outdoor places, but comfort will be highly valued by the subconscious and people will choose to sit in shaded places to mitigate that discomfort. If there is no discomfort to begin with, other variables—such as seat properties, personal space, view, etc.—will be considered instead.

If nothing is causing a major discomfort, then the user may choose an ideal seat. The search for the best available seat or the better equipped seat works well in small public spaces because the user is physically able to be aware of all options—since all options may be in his field of view—and that no better choice is available than the one presented at the time of the choice. As the space becomes larger and the user can only perceive some of the options—as others may present themselves as the user enters and changes his field of vision—he has to keep searching for the best seat, regardless of distance, or compromise and choose a worse seat that is closer. If the user compromises, he is weighing distance against the seat's qualities and trading them in favor of a closer seat. Because people may trade some of the seat qualities in favor of closer seats, the range in which individuals are willing to search without compromising can offer designers a tool for stipulating the size of public spaces, dividing them into areas for different activities and providing guidelines for amenities and seat placements based on users' expected activities.

Stamps (2011, 2012) noted that perceived threat from visual clues gradually reduces with distance up to 30 m and ceases somewhere between 30 and 90 m, and Gehl (2011, p. 65) also indicated 30 m as the limit to perceive another person's expression. The increasing cognitive strain necessary to identify things farther away from us may explain possible effects of scale in searching for available seats.

The decision model in Fig. 1 is proposed as the process undertaken when an individual is weighing any variable against distance. Seat requirements refer to any seat properties that respond to a discomfort or necessity. A seat that offers more appealing attributes is seen as preferable to one that does not possess those same attributes. The letter "δ" stands for the distance ratio between the options and is obtained by dividing the distance to the closest preferable seat by the distance to the closest non-preferable seat. If $\delta \leq 1$, the preferable seat is the closest; if $\delta > 1$, it means that the preferable seat is not the closest and trade-off favoring distance may occur.

Observational Survey

An observational survey was conducted to identify behavioral patterns related to distance and seat choice and to assess the validity of the decision model proposed. Observation consists of systematically watching people's behavior in their environment, recording their actions, what activities they perform, how they affect others, how they relate spatially, and how the environment supports or interfere in their activity (Zeisel, 1981, p. 111). The observational survey method was chosen because it offers an unobtrusive method appropriate for natural settings while avoid-

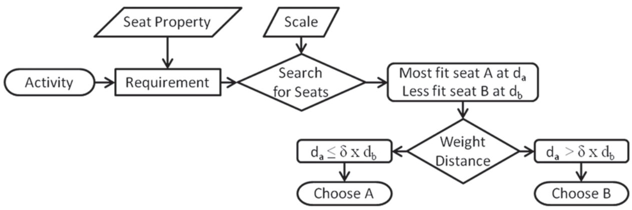


Fig. 1. Choice model based on activity and distance

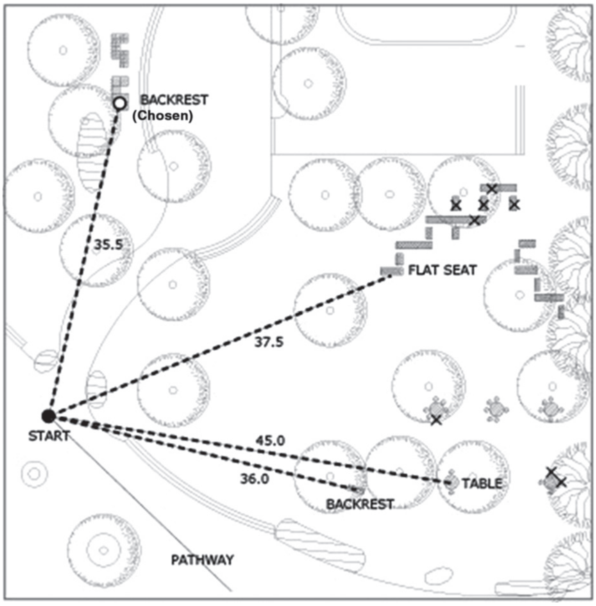


FIG. 2. Recorded behavior of Subject 08 on Chiba Univer. Plaza

ing non-representative findings caused by reactivity to being observed (Cherulnik, 1993). The place chosen was the central plaza inside Chiba University's campus (Figs. 2, 3, and 4).

Through careful measurement of the plaza, a floor plan was made with the exact measurement of pathways, seat locations, and properties, and tree and greenery locations (See Fig. 2). Observations were made dur-

FIG. 3. Picture from first camera

FIG. 4. Picture from second camera

ing one hour on two different days: October 26, 2012, from 15:07 to 16:07 and November 15, 2012, from 11:30 to 12:30. Observation periods were chosen to reflect high-use and low-use periods. The observations were made on sunny days with few clouds, with low wind, and with temperatures of 22˚C and 15˚C, respectively. The selection of observation days was made to minimize the effect of thermal discomfort, thus eliminating an extraneous variable.

The data were recorded in time lapse, with two tripod-mounted cameras and a 10-sec. interval shooting, allowing for observation of every seat on the main plaza as well as the path or entrance each user was using when approaching a seat (Figs. 3 and 4).

The starting point considered was the point at which a participant left the pathway around the campus plaza to move in the direction of the seats, because this point represents the moment that the decision was made. From each participant or group, the distance between the starting point and the closest seat with different properties (with a table, with a backrest, or flat) was recorded to evaluate if any trade-offs were being made favoring closer seats (Fig. 2).

Participants

The movement and choice patterns of a total of 37 users were recorded, along with the users' activity, age, sex, group size, stay duration, and the paths utilized to access the seating areas. From the initial sample, only individuals with stay durations over 5 min. and in groups of one to three persons were selected. Participants with stay times less than 5 min. were excluded from the analysis because their stay was so short that it did not require a choice from users, meaning that any seat would provide for a short stay. If stays under 5 min. were included in the analysis, results would be skewed toward trade-offs favoring distances but it would not mean that users are actually choosing distance over other variables. Stays under 5 min. were considered to be too short because of the assumption that distance was being favored above all other variables.

Also excluded from the analysis were participants who chose secondary seats (stair steps, small walls) when those choices were made under at least one of the two conditions: stay time under 5 min. or absence of close available primary seats, leaving no other option besides the secondary seats in question.

Data from 5 users were omitted for the above-mentioned reasons. The final sample consisted of 32 people: 14 individuals, six couples, and two trios. The participants were categorized by group size to evaluate behavioral changes, because groups have to consider the number of seats above other variables.

Because seats with tables offer a support surface and can be used as a backrest depending on the direction the user is facing, they were initially considered preferable to seats with backrests but without tables, which were considered preferable to flat seats, such as backless benches or stools. In the later paired comparison experiment this assumption was shown to be false, and users considered seat properties according to their intended activity (see the paired comparison experiment, below). This assumption was revised with seats with backrests and seats with tables being considered equivalent at the same distance, as shown in Table 1.

Of the 14 individuals observed, eight of them had the best option closest to them at the time of choice, making the occurrence of a trade-off impossible ($\delta \leq 1$). Of the other six, three chose a preferable seat ($1 < \delta \leq 1.32$) and three traded the preferable option for a closer seat ($4.62 \leq \delta < 7.65$). Additionally, only one seat was chosen beyond a 40 m radius, which may be the extent of an individual's distance judgment when making this type of decision (Table 1).

From the observed couples, the only trade-off occurred when a couple chose a flat seat at 11 m instead of a seat with a table at 24.5 m ($\delta = 2.23$), and preferable seats were chosen when the distance ratio (δ) was between 1.00 and 1.10. Only one possibility of trade-off was observed with groups of three people, and they chose the preferable seat at a distance ratio (δ) of 2.00. Groups of three people were immersed in conversation during seat selection, which may indicate that the participants argued among themselves regarding where they should sit, making it a conscious choice. Since the participants were not questioned about the subject of conversations, this may only be supposed. Another supposition about the difference in behavior between groups of three people may be the necessity of a minimal number of seats: as the group gets larger, the necessity for a matching number of seats apparently is considered before other variables.

TABLE 1
SUBJECTS' DISTANCES TO DIFFERENT SEATS

ID	Activity	n	Distance to Seat With Different Properties (m)			$\delta = d_a / d_b$	Behavior Assessment
			Table	Backrest	Flat Seat		
1	Rest	1	~~100.0~~	65.0	8.5*	7.65	Trade-off
2	Rest	1	~~100.0~~	69.0	11.0*	6.27	Trade-off
3	Rest	1	~~48.5~~	9.0*	33.0	0.27	Preferable is closest
4	Read	1	~~100.0~~	30.0	6.5*	4.62	Trade-off
5	Stay	1	~~55.0~~	12.0*	31.5	0.38	Preferable is closest
6	Eat	1	~~75.0~~	29.0*	22.0	1.32	Preferable over distance
7	Eat	1	~~16.0~~	12.0*	37.5	0.32	Preferable is closest
8	Meet	1	~~45~~	35.5*	37.5	0.95	Preferable is closest
9	Other	1	38.0*	~~34.0~~	36.5	1.04	Preferable over distance
10	Eat	1	41.0*	~~38.0~~	36.5	1.12	Preferable over distance
11	Eat	1		32.5*	39.0	0.83	Preferable is closest
12	Rest	1		13.0*	33.0	0.39	Preferable is closest
13	Other	1	11.5*	~~32.5~~	24.5	0.35	Preferable is closest
14	Meet	1	11.0*	~~73.0~~	21.0	0.15	Preferable is closest
15	Eat	2			44.5*		Preferable is closest
16	Eat	2	~~55.0~~	10.5*	33.0	0.32	Preferable is closest
17	Rest	2	~~46.0~~	11.5*	26.5	0.43	Preferable is closest
18	Eat	2	24.5	~~48.0~~	11.0*	2.23	Trade-off
19	Other	2	38.0*	~~34.5~~	36.5	1.10	Preferable over distance
20	Eat	2	34.5*	~~44.5~~	33.5	1.03	Preferable over distance
21	Eat	3	46.0*	~~57.0~~	23.0	2.00	Preferable over distance
22	Rest	3	27.5*	~~58.5~~	33.0	0.83	Preferable is closest

Note.—~~XXX~~: discarded distance (because there was a closer seat with the same utility). The tables and backrests were found as having the same utility, meaning that they are equally preferable. δ: the "trade-off ratio," which is acquired by dividing the distance to the closest preferable seat by the distance of the closest less preferable seat (flat seat). *Chosen seat.

Considerations

The observational survey suggested that seat choice would be conditioned by group size, with larger groupings willing to walk greater distances for a seat. The survey also provided some baseline parameters to be further tested, such as the 2.23 distance ratio as the limit for distance trade-off. The survey had a small sample size, making it difficult to generalize. A longer observation time and site variety would be necessary to generate valid statistical conclusions and, even if an expanded survey were conducted, the presence of extraneous variables such as climate, familiarity with the environment, and groupings would always put the results under scrutiny. Here, the observational survey served as a pilot study for identifying likely variables of interest.

Paired Comparison Experiment

A second experimental study was done, controlling for extraneous variables in the real environment to test the hypothesis and to establish a proper trade-off distance. The experiment used computer-generated images and a paired comparison method to assess the effects of distance and seat properties in a controlled setting. Virtual environments allow for easy variability of spatial relations and afford control of the number, position, and nature of landmarks, avoiding the constraints of real-world experimental situations (Jansen-Osmann & Berendt, 2002).

Studies have compared real and virtual environments in the evaluation of seat choice, finding that they are highly correlated (Ohno, Soeda, Kondo, Hashimoto, & Sato, 2006). Experiments using desktop virtual environments to evaluate distance perception are shown to be a valid research tool yielding similar results as real-environment experiments (Jansen-Osmann & Berendt, 2002).

People find it difficult to assign a score to each option when judging between options (Tsukida & Gupta, 2011). The paired comparison method provides a means of evaluating a set of options through multiple direct comparisons between alternatives. The participant is asked to qualify or choose one of two options until every available pairing is evaluated (Tsukida & Gupta, 2011). From an analysis of those independent assessments, an overview of the participants' preferences, as well as their decision-making process, can be inferred.

Stimuli and Experiment Design

Stimuli consisted of computer graphic images generated in SketchUp and rendered in Lumion software. Two main variables were used with three levels each: seat properties, composed of flat seats, seats with backrests, and seats with tables; and the distance between the observation point and the available seats, which were 20, 35, or 50 m. This combination resulted in nine different alternatives, which were combined into pairs, resulting in 36 paired choices (Table 2). Those 36 images were presented to the participants in four different settings: two scale variations and two different activities.

The two scales were chosen through considering real-environment settings and based on how easily a user may visually perceive the environment from one point in its entirety, along with all available seat choices and with cognitive ease. Following Lynch's (1984) suggestion that public spaces with a small dimension up to 25 m will be perceived as comfortable and well dimensioned, the small scale environment was set as a 1,500 m^2

TABLE 2
SAMPLES MATRIX

	Table 20	Table 35	Table 50	Back-rest 20	Back-rest 35	Back-rest 50	Flat 20	Flat 35	Flat 50
Table 20		•	•	•	•	•	•	•	•
Table 35			•	•	•	•	•	•	•
Table 50				•	•	•	•	•	•
Backrest 20					•	•	•	•	•
Backrest 35						•	•	•	•
Backrest 50							•	•	•
Flat 20								•	•
Flat 35									•
Flat 50									

(25 × 60 m) public square enclosed by buildings (Fig. 5), while the medium scale followed Gehl's (2011) notation that perceptions of things at a 70 m distance is limited. Therefore, the medium scale was set as a 3,000 m^2 (50 × 60 m) public square enclosed in the same condition (Fig. 6).

The observation direction was adjusted to preserve as much as possible the feeling of an enclosed public space. Because it was not possible to maintain distance perception and show buildings on three sides in the medium scale, a diagonal view was adopted.

All other factors were kept fixed between scales whenever possible. In both scales, every seat was placed under a tree, all seats were rotated so they could be perceived from the same angle, and all seats had the same amount of sittable space (sufficient for four individuals) independent of seat properties.

The number of people present in one scene, independent of scale, was also the same. In both the medium and the small environment, 10 people were

FIG. 5. Table at 20 m (A) and backrest at 35 m (B) in a small-scale environment

FIG. 6. Table at 20 m (A) and backrest at 35 m (B) in a medium-scale environment

standing, and the same number in all samples displaying four seats, two of which were occupied. The number of trees was not kept constant because the medium scale had twice the area of the small-scale condition, and primary attempts to maintain a constant number proved to affect the impression of the smaller-scale environment as crowded and compromise the visibility of seats placed farther away; therefore, the medium scale had 13 trees and the small scale had nine trees.

To enable the evaluation of distance from computer-rendered images, they were made with reference to a wide-angle lens with a 24-mm aperture and a 35-mm film, rendering an 83° angle of vision. The images were presented on a 42-in. full HD television with a 93-cm wide screen.

The participants were seated with their eye level on the horizon line of the picture, and their heights were adjusted so they could look straight forward without having to move their heads up and down. Their faces were at 53 cm from the screen so that they would view the samples from the same distance from which they were designed, preserving distance perception. Samples were made with a 1920 × 1080 pixels and 428 pixels / cm resolution.

Participants

The participants were asked to choose one of the two available seats in each image—marked as A and B—to perform a specific activity—either eating or reading. All participants made decisions regarding the whole set of 72 images—36 samples for each scale—for one activity and responded to the set again for the other activity. The order of the activities was alternated between participants. The participants were instructed that they had approximately one hour to spend doing the specified activity.

TABLE 3
Analysis of Variance For Eating Activity, Medium Scale

Factor	*df*	SS	MS	*F*	*p*	R^2	Adj R^2
						.29	.28
Seat property	2	95.55	47.78	12.11	<.001		
Distance	2	325.35	162.68	41.23	<.001		
Property * distance	4	15.65	3.91	0.99	.41		
Model	8	577.15	72.14	18.28	<.001		
Error	351	1384.85	3.95				

A total of 40 people, 16 women and 24 men, participated in the experiment. They were all university students from different areas of expertise. Their ages varied from 18 to 30 years ($M = 23.0$, $SD = 3.2$). From the sample of 40 people, 30 were Japanese (20 men, 10 women) and 10 were foreigners who had been living in Japan for at least 2 years (4 men, 6 women).

A repeated-measures analysis of variance (ANOVA) was conducted using JMP software to determine the effect of seat properties and distance on seat choice given different intended activities and environments of different scales. Models that included the effects of sex and nationality were tested, but those factors were not statistically significant. Therefore, the final model adopted considered all participants under four different conditions, two of scale and two of activity. Tables 3, 4, 7, and 8 show the ANOVA and model fit for each condition.

The model constructed assesses the fit of distance and seat properties, as well as its interaction in predicting the number of times a seat would be chosen against every other available choice. With three levels in each variable, any given seat could be chosen from 0 to 8 times (Table 2).

Results

Although both variables showed main effects in the chosen model, no statistically significant interaction was found between distance and seat property across all activity and scale conditions (Tables 3, 4, 7, and 8).

TABLE 4
Analysis of Variance For Eating Activity, Small Scale

Factor	*df*	SS	MS	*F*	*p*	R^2	Adj R^2
						.41	.40
Seat property	2	118.05	59.03	17.60	<.001		
Distance	2	442.95	221.48	66.05	<.001		
Property * distance	4	5.53	1.38	0.41	.80		
Model	8	823.10	102.89	18.28	<.001		
Error	351	1176.90	3.35				

TABLE 5

Analysis of Variance For Reading Activity, Medium Scale

Factor	*df*	SS	MS	*F*	*p*	R^2	Adj R^2
						.42	.40
Seat property	2	183.52	91.76	28.14	<.0001		
Distance	2	237.65	118.82	36.44	<.0001		
Property * distance	4	28.63	7.15	2.20	.07		
Model	8	817.30	102.16	31.33	<.0001		
Error	351	1144.70	3.26				

Eating activity.—The models proposed for analysis accounted for 41% of variance in the small scale and for 29% of variance in the medium scale for the eating activity. Although there was not a strong fit, both models accounted for statistically significant variance as seen in Tables 3 and 4.

For the eating activity, seats with backrests were chosen as often as seats with tables in both scales, suggesting that seats with backrests provide the same utility as seats with tables for this activity. Tukey's HSD *post hoc* multiple comparison tests of seat properties supported this result for both scales. As both properties were weighted the same for this activity, the results show a predictable behavioral pattern, with tables and backrests being chosen over flat seats and closer seats with backrests and close tables being preferred over farther ones. Overall, there was a strong seat property effect, and seats with backrests and tables at 35 m were perceived as having more utility, being frequently chosen over flat seats at 20 m in both scale conditions (Figs. 7 and 8).

In the small-scale condition this effect was also observed, and seats with tables and backrests at 50 m were also frequently chosen over flat seats at 35 m, as seen in Fig. 7. Trade-offs favoring distance were observed when there was a considerable difference in seat distance, with flat seats at 20 m having more utility and frequently being chosen over backrest seats and table seats at 50 m. Some trade-offs favoring distance only occurred in

TABLE 6

Analysis of Variance Reading Activity, Small Scale

Factor	*df*	SS	MS	*F*	*p*	R^2	Adj R^2
						.40	.39
Seat property	2	134.82	67.41	20.84	<.0001		
Distance	2	251.22	125.61	38.84	<.0001		
Property * distance	4	7.67	1.92	0.59	.67		
Model	8	770.90	96.37	29.80	<.0001		
Error	351	1135.10	3.23				

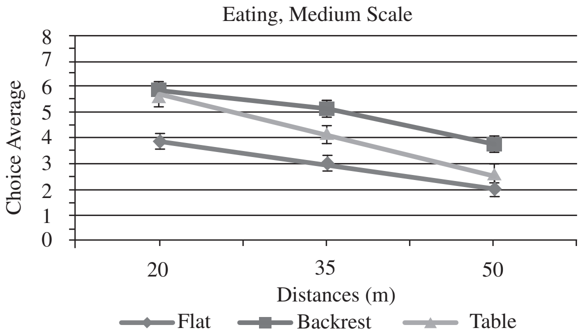


FIG. 7. Average seat choice for eating activity in medium scale

the medium-scale condition, with tables at 35 m frequently being chosen over backrest seats at 50 m, and flat seats at 35 m over table seats at 50 m, as seen in Fig. 8.

Reading activity.—In the reading activity, the model proposed accounted for 40% of variance in the small scale and 42% in the medium scale, as seen in Tables 5 and 6. When the activity to be performed was reading, seats with backrests at any distance and in both scales were preferred over all flat seats at any distance. They were also preferred over seats with tables, a finding that was supported by significant Tukey's HSD multiple comparison tests. The only trade-off favoring distance over seat property occurred with tables at 20 m being preferred over backrests at 50 m in both scale conditions (Figs. 9 and 10).

Considering only flat seats and seats with tables, trade-offs favoring distance were observed, with flat seats at 20 m being chosen over seats with tables at 50 m but seats with tables at 35 m being chosen over flat

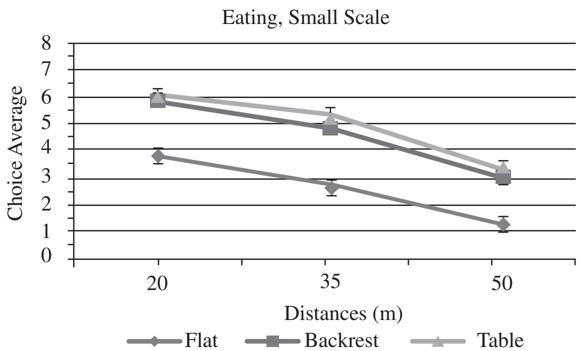


FIG. 8. Average seat choice for eating activity in small scale

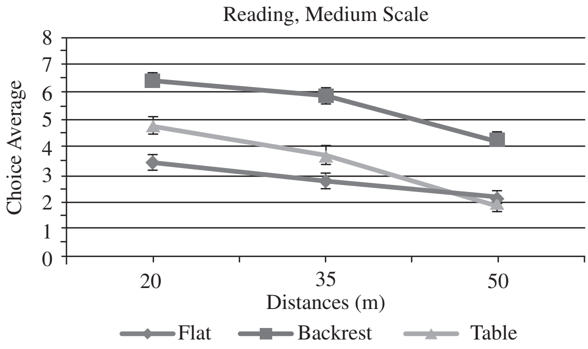


FIG. 9. Average seat choice for reading activity in medium scale

seats at 20 m in both scales. Flat seats at 35 m were also chosen over seats with tables at 50 m in the medium but not in the small-scale condition (Figs. 9 and 10).

Trade-off Distance

Because no interaction was observed between factors in any activity or scale, a second set of models was created in which distance was treated as a continuous variable to estimate the distance at which different properties are traded in favor of a smaller distance. This model allowed prediction of choice outcomes from the pattern devised in the multiple regression analysis. The formulae for seat choices in each condition are shown in Table 7.

These formulae allowed prediction of the perceived utility (Y) a seat has, given its characteristics (flat, backrest, or table) and the distance from the user at the moment of the choice. When there is a choice between two seats, the one with the higher perceived utility (higher Y) is more likely to

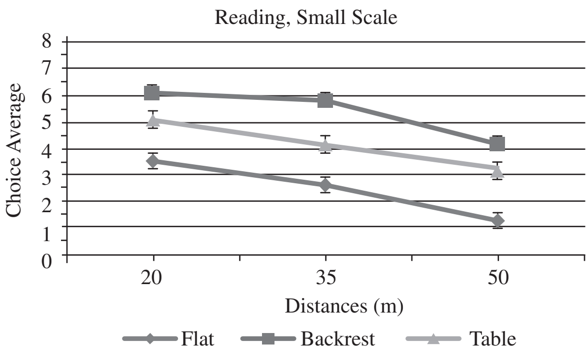


FIG. 10. Average seat choice for reading activity in medium scale

TABLE 7
SEAT CHOICE MODEL FOR BOTH SCALES AND ACTIVITIES

Scale/Activity	Intercept	Table	Backrest	Flat	Distance	Adj R^2
Eating Medium	6.71+	0	0.93	–1.04	–0.078 × [Distance]	.28‡
Eating Small	7.12+	0	0.58	–1.43	–0.089 × [Distance]	.40‡
Reading Medium	6.30+	0	1.70	–1.21	–0.065 × [Distance]	.40‡
Reading Small	6.35+	0	1.38	–1.53	–0.067 × [Distance]	.39‡

Note.—Y is the utility of a given seat. Y = intercept + [characteristic] – [z*distance]. For the utility of a given seat, add only the value corresponding to the seat's characteristics (table, backrest, or flat). Distance is in meters. ‡$p < .001$.

be chosen, and seats with very similar Y values are perceived as having the same utility.

For the eating activity in medium-scale environments, a flat seat at 20 m (Y = 4.11) is predicted to be chosen over a seat with a table at 34 m or farther (Y = 4.06) and over a seat with a backrest at 46 m or farther (Y = 4.06 m). In the small scale and for the eating activity, a flat seat at 20 m (Y = 3.91) is predicted to be chosen over a seat with a table at 37 m or farther (Y = 3.83) and over a seat with a backrest at 43 m or farther (Y = 3.87). For the reading activity, trade-offs in the medium scale are predicted to occur between flat seats at 20 m (Y = 3.79) and seats with tables at 39 m or farther (Y = 3.77) and seats with backrests at 65 m or farther (Y = 3.78). On the small scale and for the reading activity, trade-offs favoring flat seats at 20 m (Y = 3.48) are predicted to occur when seats with tables are at 43 m or farther (Y = 3.47) and seats with backrests are at 64 m or farther (Y = 3.44).

Considerations

Overall, a significant effect of seat properties was observed, with backrest seats preferred over seats with tables for the reading activity and having the same utility as seats with tables for the eating activity, as shown in Figures 7–10.

Flat seats were undesirable across both activities and both scales, with any seat with better properties being preferred in almost every instance. This finding supports Li, *et al*. (2009) that seats with backrests were widely preferred. This effect was observed in small-scale environments more than in medium-scale ones, which may be due to perceived visibility—the ease with which one can grasp the environment as a whole and consider its alternatives—in accord with Gehl's (2011) and Lynch's (1984) directives of comfortable public spaces, as well as Thiel's (1997) definition of "local" space (up to 60 m) and transitional space (over 60 m). The bigger the environment, the more cognitive strain is required for its assessment.

For the eating activity, distance-favoring trade-offs were found when the distance to a seat with a table was, on average, 15.5 m more than the

TABLE 8
OBSERVATIONAL SURVEY'S SEAT UTILITY

ID	Activity	n	Utility of Different Seats			Seat Chosen
			Table	Backrest	Flat Seat	
1	Rest	1	−0.20	3.78	4.55	Flat
2	Rest	1	−0.20	3.52	4.39	Flat
3	Rest	1	3.15	7.42	2.96	Backrest
4	Read	1	−0.20	6.05	4.68	Flat
5	Stay	1	2.42	6.71	3.21	Backrest
6	Eat	1	0.86	5.38	3.95	Backrest
7	Eat	1	5.46	6.71	2.74	Backrest
8	Meet	1	3.20	4.87	2.74	Backrest
9	Other	1	3.75	4.99	2.82	Table
10	Eat	1	3.51	4.68	2.82	Table
11	Eat	1		5.11	2.63	Backrest
12	Rest	1		6.63	3.20	Backrest
13	Other	1	5.81	5.11	3.76	Table
14	Meet	1	5.85	1.95	4.03	Table
15	Eat	2			2.20	Flat
16	Eat	2	2.42	6.82	3.10	Backrest
17	Rest	2	3.12	6.75	3.60	Backrest
18	Eat	2	4.80	3.90	4.81	Flat
19	Other	2	3.75	4.95	2.82	Table
20	Eat	2	4.02	4.17	3.06	Table
21	Eat	3	3.12	3.20	3.88	Table
22	Rest	3	4.57	3.08	3.10	Table

distance to a flat seat and when the distance to a seat with a backrest was, on average, 24.5 m more than the distance to a flat seat.

For the reading activity, trade-off distances were larger because seat properties had a greater effect on the user's decision. When the distance to a table seat was, on average, 21 m more, and the distance to a backrest seat was, on average, 44.5 m more than the distance to a flat seat, trade-offs favoring distance occurred.

Consistency Between Observed Behavior and Paired Comparison Experiment

Although not all activities observed on site were tested in the paired comparison experiment, those observed behaviors may be predicted through the formulae proposed in Table 7. Table 8 shows the data gathered in the observational survey and presented in Table 1, with the respective perceived utility of each alternative. For Table 8, the formulae presented in Table 7 for the medium scale were used (because the area of sittable space in the observed square was 4,240 m^2). For the reading and resting activity, the formula for the reading activity was used. For all other activities, the formula for the eating activity was used (Table 8).

Only six of the 22 choices observed resulted in a behavior different from those expected from the formula. The differences are likely due to extraneous variables, such as the effects of seat design or seat materials, although further research with a wider sample would be necessary for any further generalization.

Conclusions

This study examined seat choice from a decision-making perspective, considering how people process distance against seat properties. In this process, the intended activity played a crucial role in seat selection, and seat properties are considered in relation to the intended activity, in agreement with Li, *et al*. (2009). Because in the experiment the only difference between activity settings was the instruction given to the participants while all other variables were the same, based on Kahneman (2011), it is reasonable to assume that intended activity will prime the subconscious to search for specific seat characteristics that fulfill such activity needs. To assess actual thought processes, further research is required.

Abe, *et al*. (2009) claimed that the distance to the entrance and the distance to pathways play a major role in seat choice, although they did not provide actual measures. Current results indicate that these distances play a role, albeit a minor one: a considerable distance difference between options is necessary for distance to have an effect on a decision. This research also provides actual distance measures that may be used by urban designers to create different zones in public spaces based on users' intended activities—creating zones that are separated by distances beyond the trade-off threshold or inducing users to enter the environment to perform specific activities by locating preferable seats within the trade-off threshold.

A more important role of distance may be the visual ease it provides for identifying closer seats. Farther seats may be neglected not for the effort required to reach them but simply because they are harder to identify than closer seats, and so having a lower probability of entering the choice set. This should be considered when dimensioning different sections of large public spaces.

The results from the paired comparison experiment were consistent with observed behavior, with some differences appearing when the perceived utility of a set of options was too similar. This consistency is restricted only to single participants, and considerations about pairs and other groupings require further research, since different groupings may provide quite different results. Also, differences between participants from different countries were not found. However, all participants had lived in Japan for a period over two years and might not be considered to be representative of their cultures. Cultural differences should also be checked in future studies.

In this study, only eating and reading activities were explored in depth. Further research can profit from exploring other activities and requirements as well as exploring other variables that were maintained constant in the present study such as seat materials and design, variations in sun/shadow condition, other variations in environment scale, and variations in the surrounding enclosure.

Considering the decision-making process, this study focused on the first seat choice. Future studies may want to explore how users who are dissatisfied with the first choice reassess and change seats or leave. Also, it is possible to divide the decision to stay in a place in several successive decisions: to enter a public space or not, in which area of the public space to stay, which seat in that area to use, and if there is a choice reassessment. Different stages of the decision may consider different variables from which users make their choices.

REFERENCES

ABDULKARIM, D., & NASAR, J. L. (2013) Do seats, food vendors, and sculptures improve plaza visitability? *Environment & Behavior*, 20(10), 1-21.

ABE, M., HAYASHIDA, K., TETSUO, E., & WATANABE, H. (2009) Research on place liked as place to sit on plaza. *Summaries of technical papers of Annual Meeting*, Architectural Institute of Japan. Pp. 769-770.

BANERJEE, T. (2001) The future of public space: beyond invented streets and reinvented places. *Journal of the American Planning Association*, 67, 9-24.

CHERULNIK, P. D. (1993) *Applications of environment-behavior research*. New York: Cambridge Univer. Press.

CROMPTON, A., & BROWN, F. (2006) Distance estimation in a small-scale environment. *Environment & Behavior*, 38(5), 656-666.

GEHL, J. (2010) *Cities for people*. Washington, DC: Island Press.

GEHL, J. (2011/1971) *Life between buildings: using public space*. Washington, DC: Island Press.

GOLICNIK, B., & WARD THOMPSON, C. (2010) Emerging relationships between design and use of urban park spaces. *Landscape and Urban Planning*, 94, 38-53.

HAYASHI, T., & OHNO, R. (1995) A study of affordance in outdoor space for choosing a spot to sit in an urban park. *Architectural Institute of Japan*, 851, 852.

JANSEN-OSMANN, P., & BERENDT, B. (2002) Investigating distance knowledge using virtual environments. *Environment & Behavior*, 34(2), 178-193.

KAHNEMAN, D. (2011) *Thinking, fast and slow*. Toronto, ON: Doubleday Canada.

LEFEBVRE, H. (1991) *O Direito à cidade* [*The right to the city*]. São Paulo, Brazil: Ed. Moraes Ltda.

LI, P-Y., CHEN, M-S., HIBINO, H., KOYAMA, S., & ZHENG, M-C. (2009) Rest facilities at commercial plazas through user behavior perspective. *Journal of Asian Architecture and Building Engineering*, 8(1), 134.

LIN, T-P., TSAI, K-T., LIAO, C-C., & HUANG, Y-C. (2013) Effects of thermal comfort and adaptation on park attendance regarding different shading levels and activity types. *Building and Environment*, 59, 599-611.

LYNCH, K. (1984) *Site planning.* (3rd ed.) Cambridge, MA: MIT Press.

MONTELLO, D. R. (1997) The perception and cognition of environmental distance: direct sources of information. In S. C. Hirtle & A. U. Frank (Eds.), *Spatial information theory: a theoretical basis for GIS*. Berlin, Germany: Springer-Verlag, Lecture Notes in Computer Science 1329. Pp. 297-311.

NÉMETH, J. (2009) Defining a public: the management of privately owned public space. *Urban Studies*, 46(11), 2463-2490.

OHNO, R., SOEDA, M., KONDO, Y., HASHIMOTO, N., & SATO, M. (2006) Seat preference in public squares and distribution of the surrounding people: an examination of the validity of using visual simulation. Dortmund, Germany: *Proceedings of the 7th European Architectural Endoscopy Association Conference*. Pp. 151-163.

STAMPS, A. E. (2011) Distance mitigates perceived threat. *Perceptual & Motor Skills*, 113(3), 751-763.

STAMPS, A. E. (2012) How distance mitigates perceived threat at 30–90 m. *Perceptual & Motor Skills*, 114(3), 709-716.

THIEL, P. (1997) *People, paths, and purposes: notations for a participatory envirotecture*. Seattle, WA: Univer. of Washington Press.

TSUKIDA, K., & GUPTA, M. R. (2011) How to analyze paired comparison data. (UWEE Technical Report) Seattle, WA: Univer. of Washington.

WALTON, D., DRAVITZKI, V., & DONN, M. (2007) The relative influence of wind, sunlight and temperature on user comfort in urban outdoor spaces. *Building and Environment*, 42, 3166-3175.

WHYTE, W. H. (1980) *The social life of small urban spaces*. New York: Project for Public Spaces.

ZEISEL, J. (1981) *Inquiry by design*. Cambridge, UK: Cambridge Univer. Press.

Accepted September 14, 2015.