USER PREFERENCES REGARDING INTERIOR VERTICAL GARDENS

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STATEMENT OF NON-PLAGIARISM

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

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ABSTRACT

USER PREFERENCES REGARDING INTERIOR VERTICAL GARDENS

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Landscaping is added to the architectural design of a structure in order to increase its unity with nature, integration with the environment, and create intimate eternal concepts. Therefore, concepts such as vertical gardens and living walls were used since the ancient history in order to add a natural aesthetic effect, as well as providing positive vibe to the external and internal spaces. In this research, the usage and impacts of the vertical garden concepts are examined through a theoretical review of the literature, where many aesthetic, psychological and physiological effects are found. Increasing property value, reducing stress, enhancing indoor air quality and beautifying dull walls, are some of many added values by the vertical gardens. Moreover, the case study of this research evaluated the effects of interior vertical gardens on space users through developing three dimensional computerized models based on an actual space for assessment using environmental appraisal methodologies. The results of the study show that the model with the vertical garden design has a more positive effect on space users, which is significantly different from the model without the vertical garden. Furthermore, using Spearman's rho correlation factors, weak to medium correlations are established between vertical garden perception and gender, age, occupation, cultural background, and space familiarity. In conclusion, there are several positive effects of integrating the vertical garden to the interior space that would encourage architects to integrate them into their designs.

Keywords: environmental appraisal, interior vertical garden, landscaping, perception, user preference

ÖZ

İÇ MEKAN DİKEY BAHÇELERLE İLGİLİ KULLANICI TERCİHLERİ

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Bir yapının mimari tasarımına, doğayla olan bütünlüğünü artırmak, çevre ile bütünleşmek ve samimi sonsuz kavramlar yaratmak için peyzaj eklenir. Dolayısıyla, doğal estetik bir etki yaratmanın yanı sıra, dış ve iç mekanlara olumlu bir hava kazandıracak şekilde, eski çağlardan beri dikey bahçeler ve yaşayan duvarlar gibi kavramlar kullanıldı. Bu araştırmada, dikey bahçe kavramlarının kullanımı ve etkileri, estetik, psikolojik ve fizyolojik etkilerin bulunduğu literatürün kuramsal bir incelemesi ile incelenmiştir. Mülk değerinin arttırılması, stresin azaltılması, iç hava kalitesinin arttırılması ve donuk duvarların güzelleştirilmesi, dikey bahçeler tarafından kat kat değerler arasındadır. Dahası, bu araştırmanın örnek olay incelemesi, iç mekan dikey bahçelerin, çevresel değerleme metodolojilerini kullanarak gerçek bir alana dayalı olarak geliştirilen üç boyutlu bilgisayarlı modeller geliştirerek mekan kullanıcıları üzerindeki etkilerini değerlendirmiştir. Çalışmanın sonuçları dikey bahçe tasarımlı modelin, mekan kullanıcıları üzerinde, dikey bahçe olmayan model ile karşılaştırıldığında daha olumlu bir etkisi olduğunu gösteriyor. Ayrıca, Spearman'ın korelasyon katsayılarını kullanarak, dikey bahçe algısı ile cinsiyet, yaş, meslek, kültürel arka plan ve mekân benzerliği arasında zayıf-orta korelasyonlar kurulmuştur. Sonuç olarak, dikey bahçeyi iç mekanla bütünleştirmenin, mimarları tasarımlarına entegre etmeye teşvik edecek çeşitli olumlu etkileri vardır.

Anahtar Kelimeler: çevre değerlendirmesi, iç dikey bahçe, peyzaj, algı, kullanıcı tercihi

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1. INTRODUCTION

There are many concepts in architecture that are meant to support the functionality of the space. One of these concepts is landscaping architecture, which is mainly added in order to support the comfort and spiritual calmness of the space users. Landscaping concepts and design have been adopted by civilizations since the beginning of humanity for several reasons, such as:

1. To increase the unity and interaction with nature's elements
2. To integrate environmental elements into urban spaces
3. To imitate eternal concepts such as paradise, which was either a product of human imagination or description by holy books (Boults & Sullivan, 2010; Farahani, Motamed, & Jamei, 2016).

Moreover, the attention to beautifying concepts in architecture is an ancient subject illustrated by the different civilization's inclusion for ornamental pieces and landscaping feature. Many civilizations pioneered in developing irrigation systems that emerged from the realization of the importance of water for providing continuity. This resulted into art pieces in many civilizations such as Babylon, China, Persia, Greece and Rome (Boults & Sullivan, 2010).

Landscaping within human environments has many benefits to the health and wellbeing of the space users that can cause short-term and long-term effects. The main type of landscaping that has a strong effect on humans is the plantation features that can create psycho-comfort, release pressure and increase the pleasantness of any space. Furthermore, humans use plants in several ways; one of the main reasons for interior plantation is to improve the indoor quality of the environment for its occupants to work better. Therefore, there are countless benefits for indoor plantations that can be summarized as the following (Lohr, 2010):

1. Enhancing indoor air quality: indoor plantation was proven to clear indoor environments from pollutants, normalize relative humidity, reduce dust

accumulation up to 20%, and increase the absorption of high frequency sounds for less noise.

2. Increasing the wellbeing of the space occupants: it was also proven that indoor plantation can trigger positive feelings, increase productivity and reduce stress.
3. Improving health conditions: indoor plantation was proven to reduce pain and relief discomfort in studies performed in healthcare facilities.

Vertical garden is another landscaping concept that brings greenery and beautifying features to dead planes, such as walls. Therefore, many efforts are put and technologies are developed to empower the functionality and effectiveness of their use to exterior and interior spaces. In recent years, there is an increasing interest on the implementation of vertical gardens into interior spaces, especially in spaces that are associated with high levels of stress and discomfort such as libraries, study rooms and offices.

1.1. Aim of the Study

The aim of this study is to study the effect of vertical gardens on the students' attitude and psychology in the Faculty of Architecture building of Çankaya University, Ankara, Turkey, in order to understand the contributing factors and the most effective vertical garden design. Therefore, the objectives of this thesis are as follows:

- Research the history of development of the vertical gardens (also called as green walls or living walls).
- Understand the different types of vertical gardens and latest developed assemblies.
- Study the different assemblies and usages of vertical gardens in different interior environments and functionalities.
- Study the effect of vertical gardens the wellbeing and psychology of the space users.

- Conduct a field study on university students and discover their attitude changes and psychological effects when exposed to interior environments with different types of vertical gardens through a questionnaire methodology.

1.2. Structure of the Thesis

As this study focuses mainly on the psychological and attitude effects of the vertical gardens on the space occupants', the structure of the thesis is formulated as the following:

In the first chapter, a general idea about the landscape concept, development and influence on human wellbeing and psychology are provided. In addition, the benefits of landscaping and vertical gardens are stated. This section gives a broad idea about the elements and the factors that contribute to an effective vertical garden design, and examples and illustrations about the targeted study subject are provided. Moreover, this chapter specifies the aim and objectives of the study.

The second chapter contains a theoretical study on vertical gardens, their definition, history of development, types, usage, aesthetical and psychological effects on the interior space users. This part is very important to the study as it provides the theoretical framework and establishes the necessary knowledge for the performed case study.

Furthermore, the third chapter continues with the theoretical review of the human preferences and psychological effects of the vertical gardens and their benefits. Moreover, the chapter reviews the judgment and design criteria that were followed by other studies to design a successful vertical garden.

Thereafter, in the fourth chapter, a case study is conducted where students at the Faculty of Architecture at Çankaya University are introduced to the three dimensional computerized remodeled walls of the faculty. Subsequently, students

answer a designed questionnaire that measures the effect of these designs on their attitudes and psychology. The findings of the questionnaire are presented and correlation factors (Spearman's rho) and variance analysis (T-test) are conducted. A discussion of the case study findings and the different factors that affected the students are provided.

Finally, the last chapter provides an understanding of the influences of different elements that form the vertical garden assemblies and the best design according to an educational facility. Conclusions that are based on the theoretical and field study performed within this research are stated with further recommendations for future work.

2. LANDSCAPING AND VERTICAL GARDENS

2.1. Development of Landscaping

Landscaping is one of the most important concepts in architecture that is often defined as greenery areas integrated with the urban development of human. The general meaning of the term landscape describes an area where human interact with nature. Therefore, this term includes any human-nature interactions including mining, land acquisition and creating a land representation that depends on the cultural background of the term user (Bigell, 2014). From the English language linguistic point of view, the term landscaping refers to the process of increasing the attractiveness of a piece of land by changing its current design, adding beautifying features, and planting trees, earth covers and shrubs (Oxford, 2016).

There is a claim that the Egyptians were the first to think of landscaping concepts due to the fact that they are the first known civilization in the world, as well as their developed methodologies for irrigation, geometric planning and labyrinths. It is also known that the concept spread through the surrounding regions to Assyrians and Persians, who further developed the concept and provided examples from the ancient world. The concept continued to evolve from the Eastern Japanese Zen gardens, which contained symbolism, to the Middle East, where Greeks integrated landscaping with fountains and sculpture (Wallace, 2015).

The most developed landscaping concept in history is the concept of garden that developed within two directions as public and private manners. The Assyrians established hunting parts in 2500 BC, where exotic plantation and animals were put together, along with water surfaces and stone features (see Figure 2.1). The concept continued to influence Persians, Romans and Greeks, who added many features to the garden concept (Boults & Sullivan, 2010).

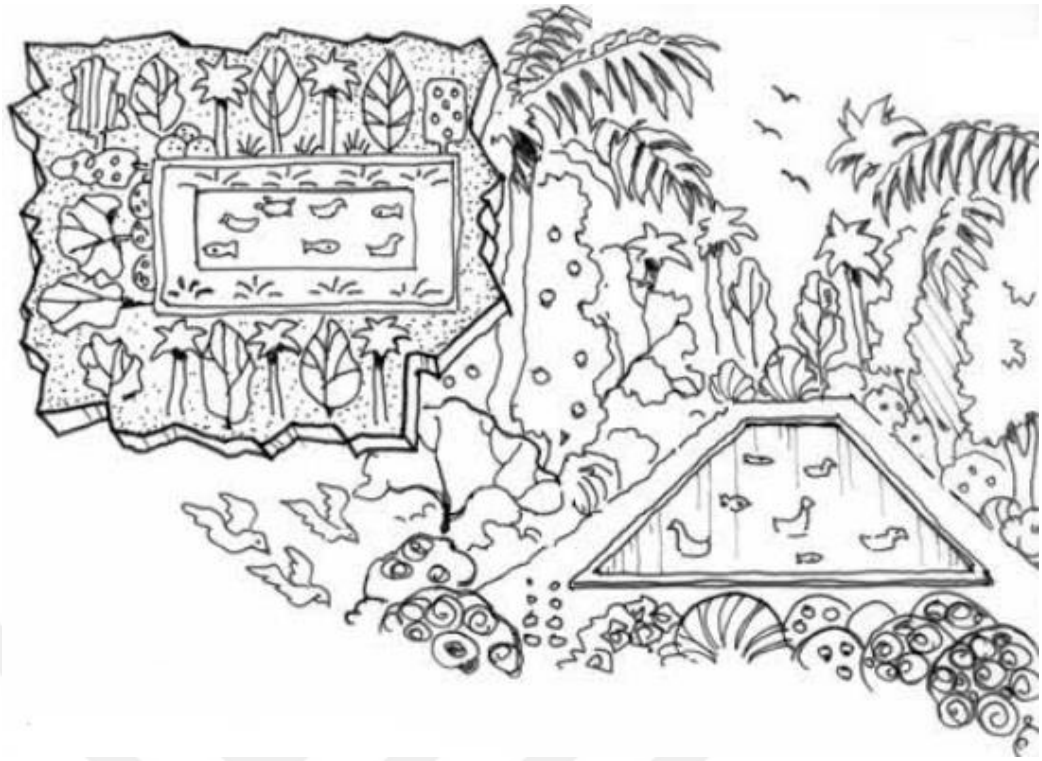


Figure 2.1: An illustration of the hunting parks from 2500 BC to 600 BC (Boults & Sullivan, 2010)

Another concept that added to the garden landscaping was in Spain. Established by the Andalusian Arabs, the Moorish gardens that were built in palaces showed architectural beauty by adding fountains, private pools and advanced irrigation systems. Figure 2.2 shows an illustration of the Moorish gardens. In the European medieval and modern history, there are also examples of unique garden architecture with high symmetry and spaciousness such as in villa Aldobrandini in Italy (see Figure 2.3) and Hampton court in England (Boults & Sullivan, 2010)

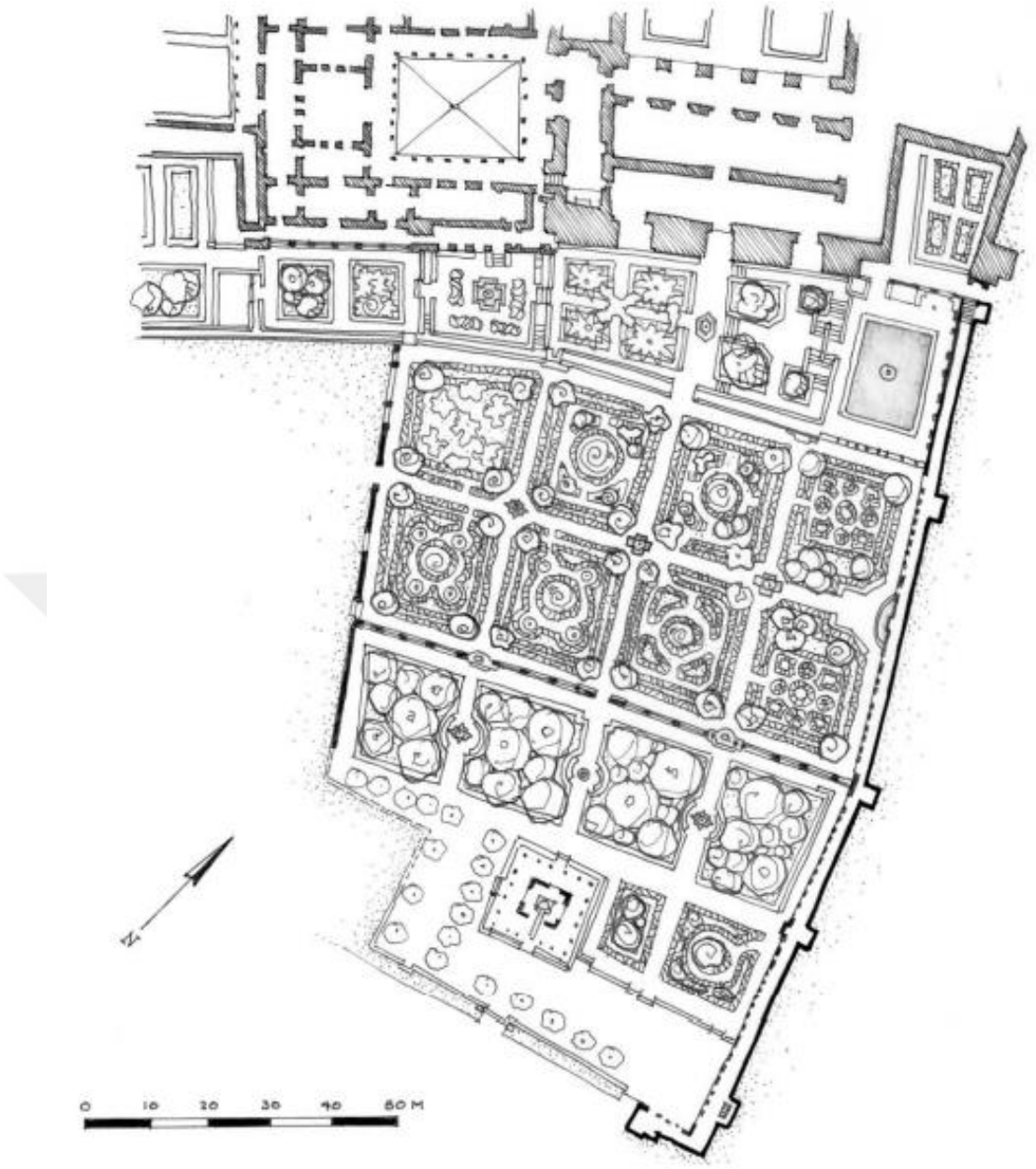


Figure 2.2: Plan view of the Moorish garden at Alcazar complex (Boults & Sullivan, 2010)

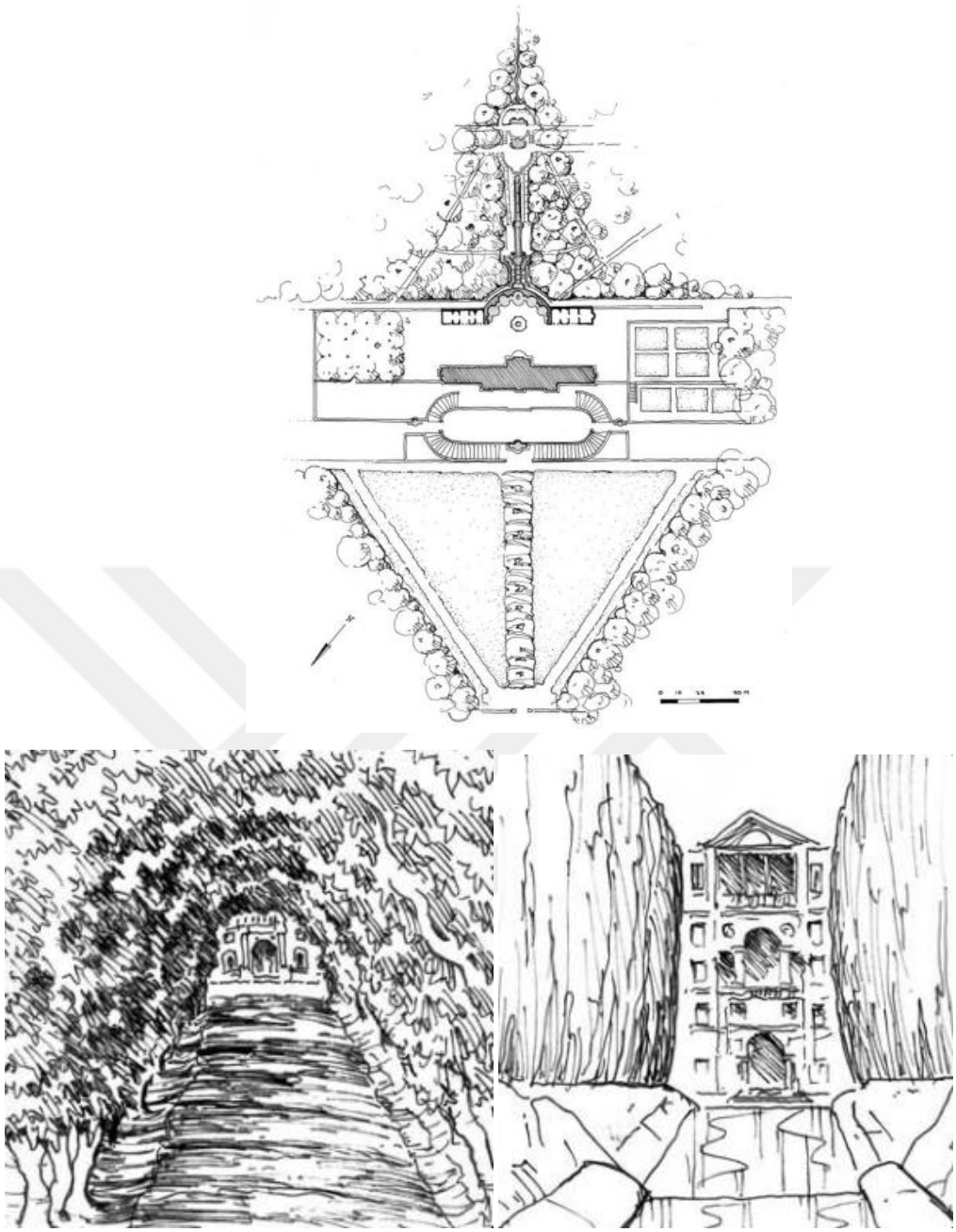


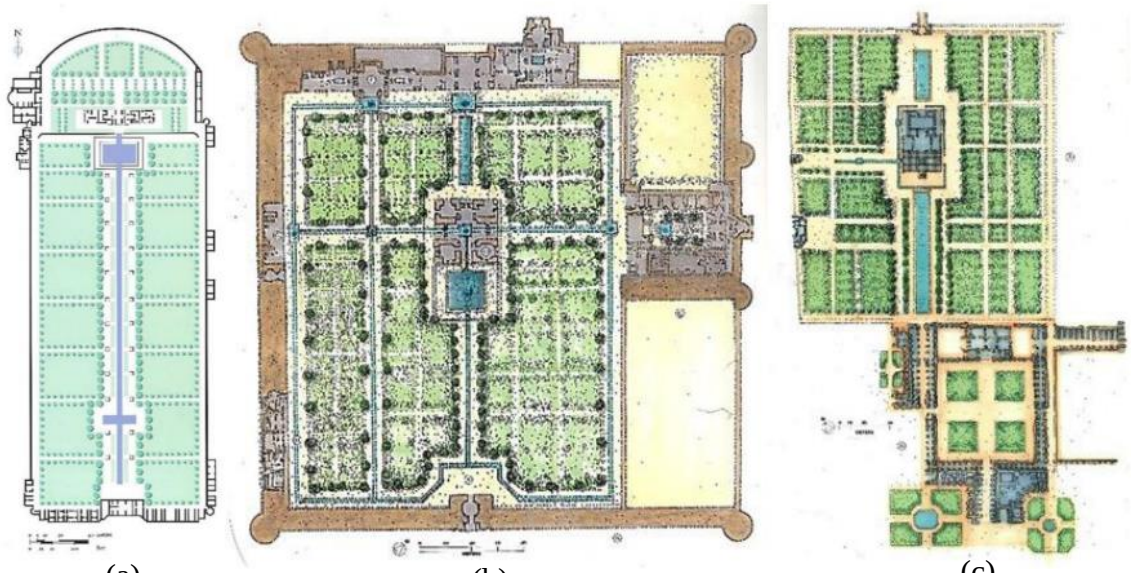
Figure 2.3: Villa Aldobrandini in Italy from 15th century (Boults & Sullivan, 2010)

2.2. Worldwide Landscaping Concepts

The connection between human and nature is ancient as a result this led to the development of many landscaping concepts and designs throughout history. The landscaping designs spread from China, Japan, Persia, Rome, England and Spain. In

this section of the study, two main landscaping concepts are reviewed; Persian gardens and Japanese Zen gardens, as they are famous for their geometry and psychological calming impacts.

The Persian gardens have unique designs and geometry that establishes the connection between the materialistic world and the eternal life. With the introduction of Islam in Persia, the Islamic holy book "Quran" provided many pictures through words about paradise that encouraged architects to imitate their understanding of the concept into square pieces. The geometry of the Persian gardens empowers the unity and integrity of all the garden elements. Figure 2.4 provides three plan types of Persian gardens that are classified by UNESCO (Farahani, Motamed, & Jamei, 2016).



(a) (b) (c)

(a) Shahzadeh Mahan Garden, (b) Fin Garden, Kashan, (c) Chehel Sotun Garden

Figure 2.4: Plans of Persian gardens classified by UNESCO (Farahani et al., 2016)

The Persian gardens are unique with their special irrigation and fountain system by creating slopped channels along the gardens connected to the pools at the front of the garden. The ancient Persians understood that the availability of water, even in desert environments, could bring better possibilities for green landscaping. Figure 2.5

shows a view of Shahzadeh Mahan Garden that was built in a desert environment (Farahani et al., 2016).

Figure 2.5: Shahzadeh Mahan Garden (Farahani et al., 2016).

In Japan, several gardening concepts were established to reflect the culture and lifestyle of the people. The first landscaping concept is called Momoyama that was built to compliment the tea drinking experience of the Japanese inhabitants in Koyoto, the historic capital of Japan, and to bring the village experience into urban contexts. The garden consisted mainly of water surfaces networked with stone and hard passages, in addition to adding rich green coverage with stone and timber features (Boults & Sullivan, 2010). Figure 2.6 provides an illustration of the Momoyama garden.

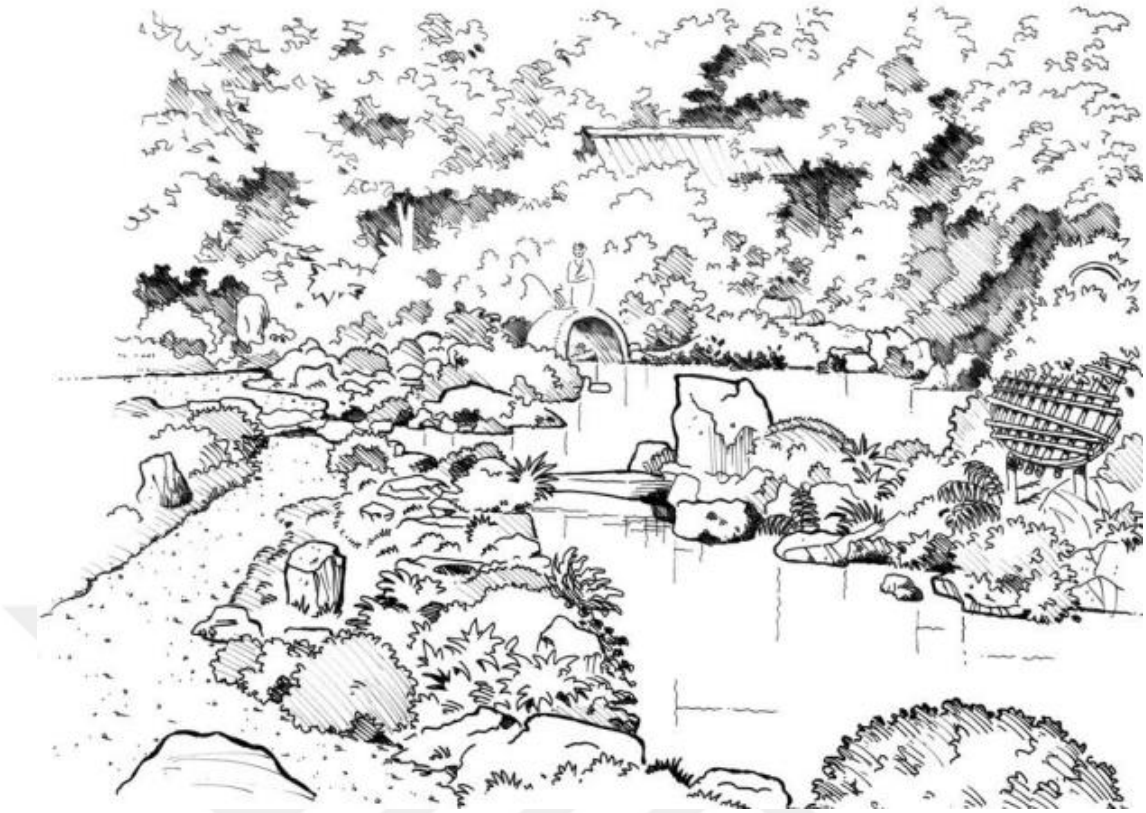


Figure 2.6: An illustration of Japanese Momoyama gardens (Boults & Sullivan, 2010)

Another Japanese landscaping concept is the Zen gardens that were built with simple elements from nature, with the goal to bring peace and harmony into the spirits of people. The concept developed around the 13th century from Buddhism, with “emptiness” as part of its elements. The Zen garden contained water or gravel surfaces with white and grey stones, and plantation around the stone features and on the sides of the garden (Boults & Sullivan, 2010). Figure 2.7 shows an illustration of the Zen garden from Tenryu-ji.

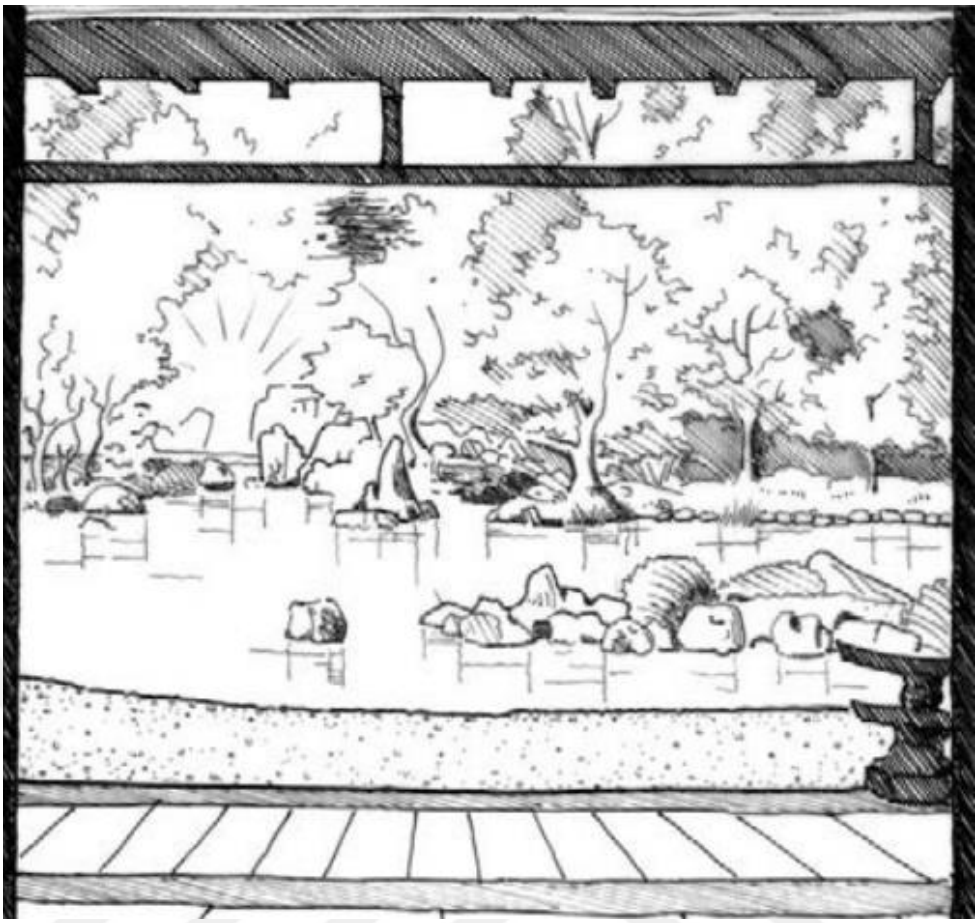


Figure 2.7: Illustration of Japanese Zen garden from Tenryu-ji (Boults & Sullivan, 2010)

2.3. Definition of Vertical Gardens

Identifying the vertical garden differs by its type; however, there are studies that defined the vertical garden in simple terms. For instance, Timur and Karaca (2013) equated the term "vertical garden" with the term "green wall", and defined them as all types, shapes and techniques of vegetation that are mounted on walls. There are many key benefits of the vertical garden such as eliminating high temperatures as it works on reducing it in different environments, in addition to its aesthetic effect and positive health impacts (Timur & Karaca, 2013).

A study defined the vertical gardens, interior and exterior, as a wall of plantation, whether it was an independent structure or part of an existing wall of a building, where a growing medium is provided and a suitable irrigation system to sustain the vegetation living (Bjerre, 2011). Nonetheless, many challenges face the concept of the vertical gardens due to:

1. The difficulty in retaining conventional soil usage at a vertical position,
2. The challenges in the irrigation system,
3. The issues related to the biological growth nature of many plants (Sharma, 2015).

Thus, special technology has been developed in order to resolve these issues to achieve the required aesthetic and functional gualities. Therefore, many new ideas emerged regarding:

1. Structural supports: by using lighter material that has an acceptable load bearing capacity.
2. Irrigation: by decreasing the surface area exposed to the sun and implementing injection drip systems, example is seen in Figure 2.8.
3. Lighting: especially used for indoor spaces in order to substitute the natural lighting need for vegetation quality.
4. Medium: using lighting and hard vegetation medium in order to reduce weight and resolve the angle issues.
5. Species: using species that are short legged and providing the aesthetic aspect and variety.
6. Special systems: implementing a ventilated subsystem in living walls depending on the need of the species and to increase the efficiency in enhancing indoor air quality as shown in Figure 2.9 (Timur & Karaca, 2013; Sharma, 2015).

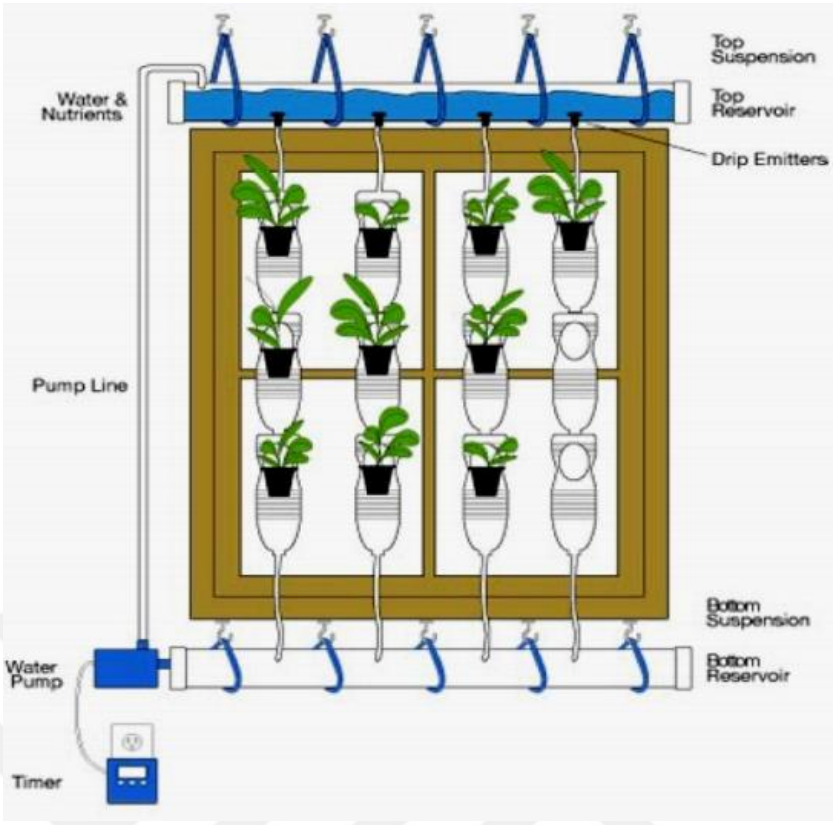


Figure 2.8: Injection drip irrigation system for vertical gardens (Sharma, 2015, p. 43)

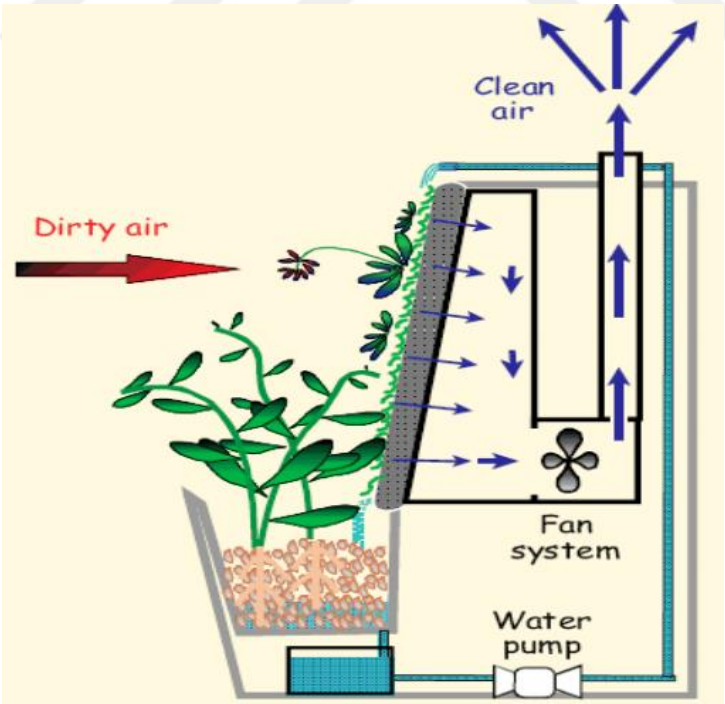


Figure 2.9: A living wall vertical garden with a ventilation system (Sharma, 2015, p. 46)

The most known application of vertical gardens is the hanging gardens of Babylon around 500 BC, which is classified as a world wonder, illustrated in Figure 2.10. The concept was also used by the Romans since 300 BC, where they used the grape plants to create shadows in their homes. The concept then evolved to using cable systems in the 20th century and more technologies were introduced to maximize benefits and minimize adverse effects (Timur & Karaca, 2013). Many examples for the usage of vertical garden can be given from the ancient civilizations and from different time era:

1. The ziggurats: the buildings established by the Mesopotamia civilization between the 40th and 6th century BC, plantations were installed on top of stone structures as a form of roof gardens, as shown in Figure 2.10 and plantations were extending on the bottom walls.
2. Babylon: the hanging gardens built by the Ashurian civilization in Iraq as discussed earlier and shown in Figure 2.11.
3. Pompeii: specifically, the villa of mysteries which is an extension from the Roman empire architecture from the first century AD. Figure 2.12 shows the villa of mysteries.

Figure 2.10: An illustration of the ziggurats of the Mesopotamia with the top gardens (Shimmin, 2012)

Figure 2.11: An illustration of the hanging gardens of Babylon (The Other Iraq Tours, 2014)

Figure 2.12: The villa of mysteries in Pompeii (Reflections, 2011)

Various reports talk about the historical origins of the vertical and hanging garden concept; however, the first modern innovation is attributed to the French botanist Patrick Blanc in the 1980s, who invented an assembly that allowed the plants to be

grown on vertical surfaces with no need for the conventional soil usage. The inventions of Blanc were the cornerstone to all the vertical garden modern technology in the past 20 years (Bjerre, 2011).

2.3.1. Types and Usage of Exterior Vertical Gardens

The vertical gardens are typically classified into two main categories:

1. Green facades: that uses placed objects on existing or new walls using a wall mounting system, the wall acting as a mounting system, where the vegetation survival is an independent factor from the wall structure.
2. Living walls: that integrates the vegetation component into the wall itself. This means that the wall does not only act as a carrier of the system, but also as part of it in terms of assembly and functionality.

Figure 2.13 shows the classification and types of vertical gardens (Timur & Karaca, 2013). A comparison of the different green wall classification is elaborated through different parts of this section.

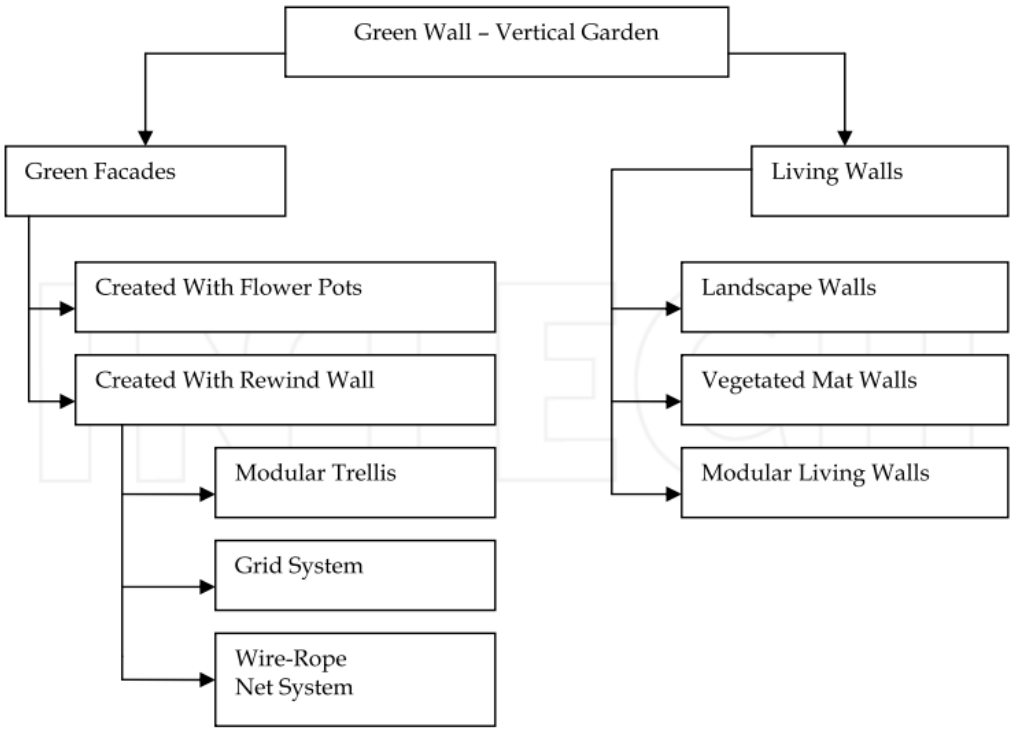


Figure 2.13: Classification of green walls (Timur & Karaca, 2013)

2.3.1.1. Green Facades

The tree diagram shows the different green wall categories that are mainly based on the way the vegetation element of the assembly interacts with the carrying wall, see Figure 2.13. Green facades can be created with flower pots or with rewind wall. The rewind wall consists of modular trellis, grid system and wire-rope net system. The modular trellis system is one of the preferred systems for usage, as it prevents the vegetation to interact directly with the actual building's walls, eliminating any damages that may occur due to that interaction, as they can even be used as separate structures. The system consists of galvanized steel wires that are formed into three-dimensional shapes, where plantations are mounted directly on the wires or under them to continue climbing (Timur & Karaca, 2013). Figure 2.14 illustrates the different shapes and assemblies of the modular trellis walls. As seen in the pictures, this type can be in various forms and have the possibility for innovative designs.

Figure 2.14: Modular trellis shapes and assemblies (Timur & Karaca, 2013)

The other type of vertical garden under the rewind wall system is the grid, wire-rope net systems that are supported on walls that carry the anchorage by wires or ropes. The choice of grid versus wires and ropes mainly depend on the type of vegetation in terms of their growth speed, as the grids provide a heavier support for the plantation (Timur & Karaca, 2013). Figure 2.15 shows examples of vertical green walls and facades using the grid and wire-rope systems.

Figure 2.15: Examples of the grid system (left picture) and wire and rope systems (right pictures) (Timur & Karaca, 2013, p. 591)

2.3.1.2. Living Walls

Living walls are also called as “bio-walls”. This type of vertical garden is per-made from several materials ranging from steel and concrete to plastic and fabric, where plants are planted on them and installed as a unitized system on existing walls (Timur & Karaca, 2013). The innovative technology in these assemblies is that no soil is necessary. Simply by implementing a frame layer, followed by a PVC and air

layers, this system eliminates using soil, which eventually reduces the adverse effects of biomaterial on the building structure (Timur & Karaca, 2013). Moreover, the three types under this category have different assemblies and irrigation systems to support the plants; however, they all facilitate using a high variety of vegetation in terms of color and pattern that is hard to achieve via the previously discussed green walls and facade systems.

Therefore, the mat walls use fabric to support the attached to the media where the vegetation is growing, equipped with a moist membrane that gets the water from a water pumping system. An example of the assembly is seen in Figure 2.16. Furthermore, the modular living walls system unitizes the walls in the form of panels as explained earlier and illustrated in Figure 2.17.

Figure 2.16: Mat living walls example from Spain (Timur & Karaca, 2013)

Figure 2.17: Modular living wall in the United States (Timur & Karaca, 2013)

2.3.2. Usage of Interior Vertical Gardens

While constructing a vertical garden, there are many elements to consider in order to achieve a better aesthetic quality, a positive psychology and better health. There are various reasons why space users respond positively to such a concept in different contexts such as residential, commercial and public spaces. According to Lohr (2010), there are three main elements that affect the efficiency of a vertical garden assembly:

1. Color: the richer the colors of the vertical garden plantation are, the more positive effects they would have on the occupants while yellow color may have an adverse. Also, color contrasts and differences have positive results in this aspect.
2. Species diversity: this element has a positive impact on the wellbeing of the occupants as different types of plants possess different absorption and emission properties.
3. Pattern: organized, repetitive and complex patterns such as fractals all have different psychological effects.

Figures 2.18 and 2.19 show different examples of vertical gardens with rich colors, species diversity and fractal patterns in indoor environments.

Figure 2.18: Indoor vertical garden with rich colors (Eichmann, 2011)

Figure 2.19: Vertical garden in a hotel lobby with species diversity and fractals (Isaac, 2016)

Furthermore, in a research that studied the impact of interior gardens on library users by conducting a survey, it was found that the productivity of the students

increased by 12% and their anxiety was lowered (Timur & Karaca, 2013). Figure 2.20 provides an illustration of the interior vertical garden in the library.

Figure 2.20: Interior vertical gardens in libraries (Timur & Karaca, 2013)

2.4. Application Advantages and Judgment Criteria

There are several advantages for using vertical gardens that include its environmental effects, but extend to many benefits beyond that (Timur & Karaca, 2013):

1. Changing the aesthetics of low profile buildings to a more attractive appearance such as museum buildings and governmental buildings. Figure 2.21 shows the implemented vertical garden at the Quai Branly Museum in Paris that transformed the exterior appearance of the building.

Figure 2.21: Transforming the appearance of low profile buildings by vertical gardens (Timur & Karaca, 2013)

2. Covering the plain walls that have industrial appearances: there are many structures such as tunnels and bridges that have a concrete or steel industrial appearance, the vertical garden can transform them to have an aesthetic appearance. Figure 2.22 shows the transformation of the appearance of a bridge after installing a vertical garden.

Figure 2.22: Vertical garden installation on bridge sides (Timur & Karaca, 2013)

3. Enhancing acoustic comfort: vertical gardens have proven through studies that they have the ability to decrease the noise level up to 40 dB through absorbing the vibration of the sound waves in the space from outside sources.
4. Less water consumption for irrigation as the vertical gardens' current technology increases the efficiency by collecting excess water at the bottom of the assembly and pumps it up to be reused. Moreover, the green walls can utilize the greywater produced from building utilities such as toilets and kitchen after passing through a filtration process.
5. Improving the air quality by absorbing the carbon dioxide (CO_2) and volatile organic compounds (VOCs) and producing more oxygen as shown in Figure 2.23.

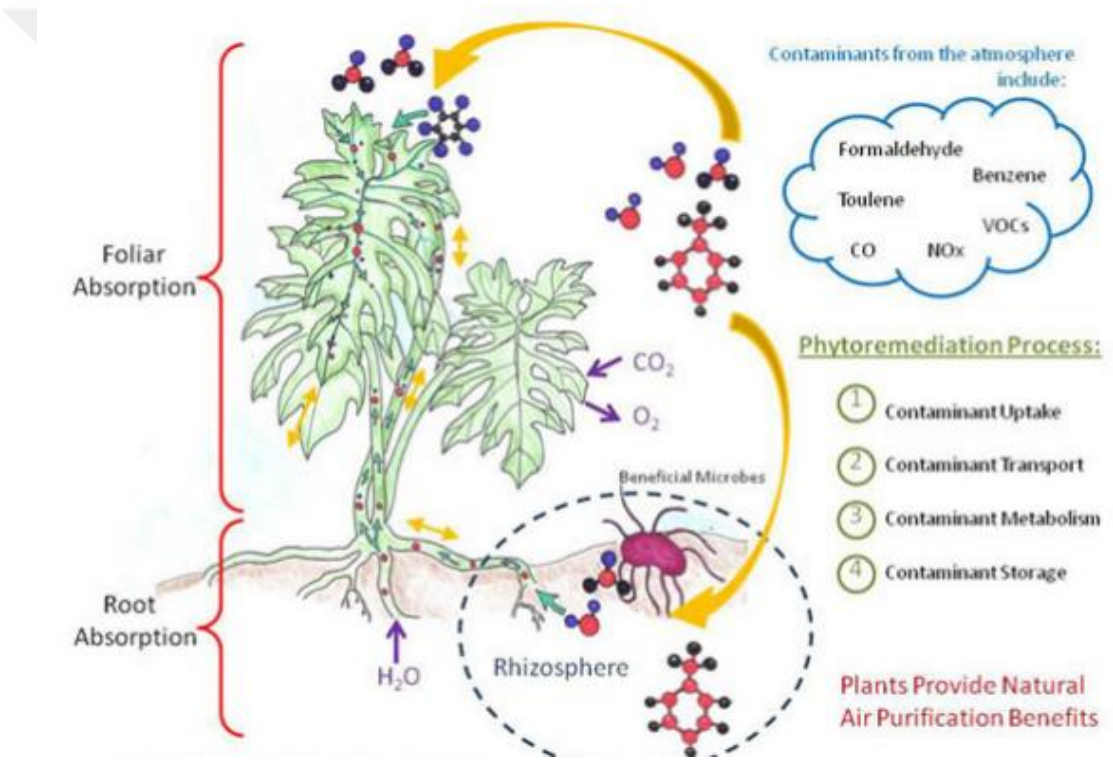


Figure 2.23: Enhancing indoor environmental quality through plantation (Timur & Karaca, 2013)

6. Reducing dust and airborne microorganisms using plantation that showed a decrease in sickness pattern of occupants with a reduction of up to 60% of the bacteria in the air.

7. Enhancing the thermal comfort of the space by providing insulation of up to 30% and supplying a cooling effect. A Japanese study showed a temperature drop of up to 10 °C and reduced energy consumption by 0.24 Wh/m^2.
8. Increasing properties' values, where studies showed that green vegetation increases the value of the property up to 15%.

A literature review conducted on 38 studies that researched vertical gardens, showed the efficiency and positive impacts of the technology by using both computer models and field experiments. These advantages were indicated as (Perez-Urrestarazu, Fernandez-Canero, Franco-Salas, & Egea, 2016):

1. Positive thermal effect
2. Better and optimized irrigation system
3. Enhanced acoustic insulation
4. Perception and aesthetics
5. Sustainability
6. Efficient landscaping system
7. Ecological enhancement
8. Improved aesthetic and social activities

Furthermore, vertical gardens have been judged based on many criteria in studies using a survey methodology. These criteria can be summarized as the following (Eroğlu & Özdede, 2014):

1. Coherence
2. Sustainability
3. Variety
4. Complexity
5. Color
6. Form
7. Texture
8. Visual effect
9. Beauty
10. Uniqueness

11. Increasing harmony
12. Resting and calming

These criteria can be added to the criteria discussed in section 2.4 of this thesis. Therefore, all these criteria are taken into consideration in designing the case study of this research in order to measure the effects of vertical gardens on the space users.

In the design perspective, producing a successful vertical garden design might be challenging without setting specific criteria that are aligned with the needs and desired impacts. Therefore, the success factors for the vertical garden design are defined as the following (Freed et al., 2008):

1. Considering a suitable attachment method and structure to the targeted building.
2. Producing sufficient calculations for loads on the bearing structure.
3. Calculating the plant growth rate as vertical gardens can take up to 5 years to be fully covering.
4. Ensuring a regular and sufficient maintenance for the plantation.
5. Selecting plants' species that are suitable for the targeted region.

3. EFFECTS OF VERTICAL GARDENS

3.1. Aesthetic Effects

Vertical gardens have apparent aesthetic effects on the interior and exterior space that are mainly positive as elaborated by researches (Jian, 2016):

1. Improving the aesthetic worth of urbanized regions by adding natural elements and color diversity.
2. Providing the required visual contrast in order to alleviate the eye from the continuous sights of concrete and steel environments.
3. Giving the city inhabitants the feeling of closeness to nature.
4. Implementing a natural visual beauty, which can indicate the seasonality in the city environment.

In a case study conducted in Antalya, Turkey, vertical gardens were implemented in one of the city's hotels and shopping malls. The results of the study showed a great transformation of the aesthetic appearance of the hotel's façade as shown in Figure 3.1. Moreover, the study also expects that implementing 200 to 450 m^2 of vertical gardens to more than 1000 hotels in the city would have a major and immediate impact on the city's ecology, tourism and economy (Kaynakçı, Kaya, & Elinç, 2013).

Figure 3.1: The aesthetic effect of vertical gardens in Erasta case study (Kaynakçı et al., 2013)

Furthermore, Sutton (2014) provided three dimensions to the aesthetic effects of vertical gardens as:

1. Enjoyable beauty: although he described it as a subjective and descriptive dimension, the vertical gardens can impose enjoyment in urban contexts that lack the connection with the nature, which can enhance the living experience in the city.
2. Admirable beauty: through the perception of vertical gardens as an art model, it can also be perceived and interpreted as art pieces similar to paintings and sculptures.
3. Ecological beauty: since urbanization has been always focused on bringing more concrete and steel into the city environment and destroying the green environment, vertical gardens are opportunities to compensate for the lost green surfaces.

Two examples of vertical gardens in Canada can be seen in Figures 3.2 and 3.3.

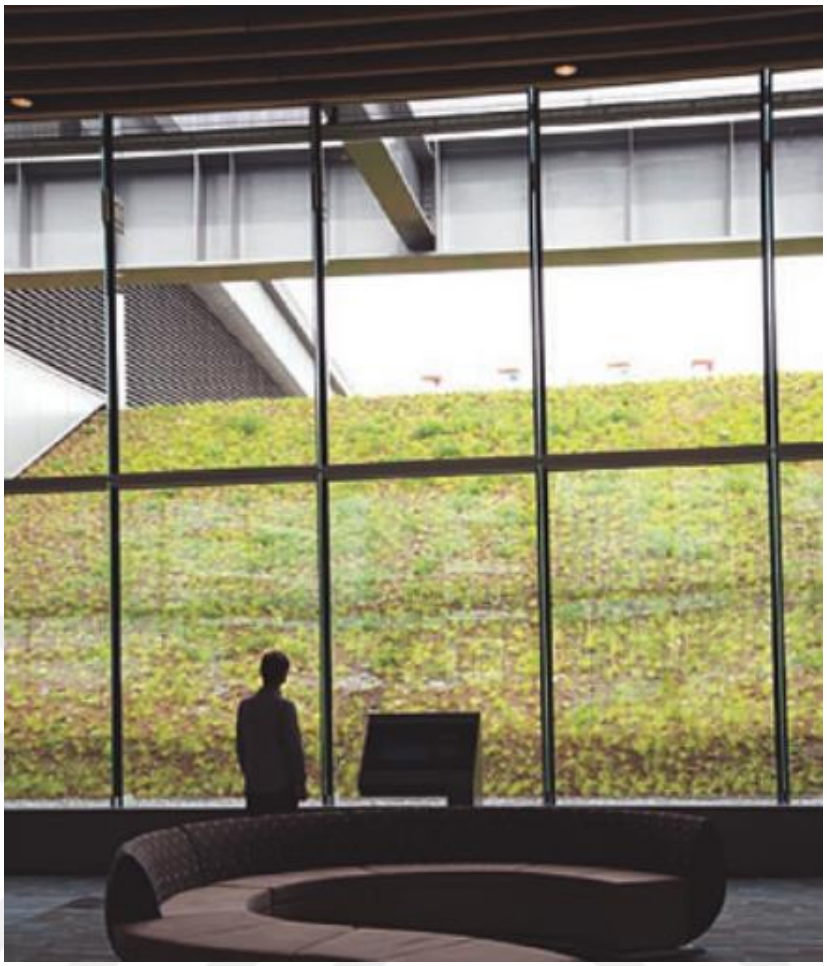


Figure 3.2: Enhancing the indoor and outdoor visual experience at the Vancouver Convention Center (Sutton, 2014)

Figure 3.3: Artistic green wall at Vancouver International Airport (Sutton, 2014)

3.2. Psychological and Physiological Effects

Due to many positive effects of indoor plantation elements, the concept was developed into different formations and assemblies that can have a more efficient space usage and better aesthetic in order to serve the same purposes. Therefore, the concept of vertical gardens emerged to empower better functionality of work, study or living spaces. Vertical gardens, as more sophisticated plantation assemblies that can simulate a natural environment, allow for more species and color diversity, increase the plantation area while preserving the area of the space, further increase in productivity that can reach up to 32%, and positively influence the psychological condition of the space users with more creativity and horizon broadening (Freeman,

2011). Several examples of more sophisticated indoor plantations and vertical gardens are shown in Figures 3.4 and 3.5.

Figure 3.4: Interior trees in a seating area (Freeman, 2011)

Figure 3.5: Vertical plantation on a staircase wall (Freeman, 2011)

In a Canadian study, where the purpose and effects of interior plantation were examined through user survey, the study found that interior vegetation was meant to impose an impressive and positive indoor environment with an average voting rate of 60%. The usage of plantation in indoor environments results in absorbing the toxins from the air and imposes a visual comfort that increases the physical and psychological health of the occupants (Rayaprolu & Nashipudi, 2016). Other physiological oriented research has shown that natural elements in a space can positively affect the cortisol levels and hormones' balances that play a major role in controlling the stress levels of humans (Berto, 2014).

Many studies have proved the influence of greenery and plantation on the health and stress of occupants. In a study conducted in Washington State University, it was found that plantations in a work space can increase the work productivity and reduce the stress significantly. Being performed on 96 participants, the productivity rate increased by 12% while the blood pressure showed healthier results compared to the status of the room prior adding the plantation (Pearson-Mims, Lohr, & Goodwin, 1996). Such a study showed clearly that there are many benefits that can be obtained from plantation and indoor plantation in particular beyond its plain physical presence.

Moreover, in an experiment that was performed on 106 students in an American University, it was found that the road side vegetation and garden have successfully reduced the anger and frustration of the participants by 37.8%. The experiment used videos of built up roads and highways with side gardens and greenery on the side, where the participants were exposed to these videos for about five minutes (Cackowski & Nasar, 2003).

Furthermore, Edward Wilson presented the concept of biophilia to explain the human natural need for contact with nature. It is not only the human body that is in need of such a contact, but also the brain and psychology of a person. This concept

has been reported through several studies with the following results (Bell, Greene, Fisher, & Baum, 1996):

1. Better academic results for students exposed to natural elements through stress reduction.
2. Faster recovery rate for patients whom their rooms are exposed to trees compared to others whom their room did not have the same facility.
3. Reduction of pre-surgical stress and anxiety through exposing patients to natural scenes.

The human response to a certain design is explained by four main levels that are (Nasar, 2006):

1. The feeling about the design, which is the judgment given by the person on the design.
2. The feeling in the design, which is explained by the mood state that the person goes through when exposed to the design.
3. The thought about the design, which explains the feeling a person get by the aesthetic aspect of a design, such as getting the thought of being relaxed if the person would be in a certain space.
4. The behavior, which is the consequent activities, positive or negative that a person would commit as a result of the atmosphere imposed by the space.

3.3. Appraisal Design and Assessment of Vertical Garden Perception

In order to be able to evaluate the aesthetic and psychological effects of the interior vertical garden on the space users considering their perception, it is essential to build the evaluation method of the research based on proven evaluation methods in the environmental discipline. In environmental research, it is necessary to define the research method and the data collection method in order to support the reliability of the study. Bell and colleagues (1996) define three main research types in environmental studies that are:

1. Experimental research: where the researcher conducts measurements and observation in order to explain a certain phenomenon by including independent variables.
2. Correlational research: where the researcher attempts to explain a natural phenomenon through one or more variables that are associated with it.
3. Descriptive research: where the researcher seeks reactions, perceptions and preferences on a certain situation, which is adopted by this study. The two main factors to be considered in this type of research are the validity and the reliability of the results in order to represent reality.

Furthermore, data collection methods in environmental psychology research are defined into four types (Bell et al., 1996):

1. Observational method: involves observing an event or behavior and recording the outcomes.
2. Task performance method: requires setting up a procedure for a final objective and recording the performance of random or chosen subjects while they carry the task on.
3. Trace measurement: recording a certain parameter, factor or phenomenon through its physical traces, which could indicate the location or the extent of a certain event.
4. Self-report measurement: is the most effective method in measuring emotions, thoughts and behavior through directly asking the subjects to evaluate a certain event, situation or phenomenon through an interview or a questionnaire. Many challenges face this type of measurement as people are aware of the research and might change the way they answer according to their perceived consequences of the study, in addition to question interpretation issues. However, a questionnaire method is considered effective under this category as increasing the number of the subjects adds validity to the research and minimize these effects, while it is still important to ensure their minimization through the design of the questionnaire. Thus, this study adopts a questionnaire measurement.

Nasar (2008) defines the steps in environmental design assessment of perception through four points:

1. Choosing the environmental measures and attributes, where emotional appraisal is part of it.
2. Choosing and building a simulation of the assessed environment, which needs to accurately represent the case study in order to provide the most accurate perception.
3. Choosing the measures for response evaluation, which are the rating scales that the attributes of the environment are judged on.
4. Choosing the respondent category, who need to be the most representing for the end users of the design.

Gifford (2001) recommends starting the design of the assessment through defining the parameters that are affecting the process through Craik's framework as shown in Table 3.1.

Table 3.1: Craik's framework for environmental appraisal (Gifford, 2001)

Observer	Environmental Display Method	Appraisal Type	Appraisal Format
User group e.g. residents, Employees, Students, Customers **Experts** e.g. Facility Managers, Architects, Real estate critics **Special Group** e.g. Elderly, Introverts, Poor, Disabled **Everyone**	**In Person** e.g. walking through, Driving by, Aerial view Slides of photos Video or film Models Sketches or Drawings Audios No presentation	Description Evaluation Aesthetic Emotional Meaning Risk	Free (Blank paper) Checklist Scale Viewing Time Beliefs on consequences

The parameters of this research were defined as the following:

a) Observer: user group including students, professors and visitors.
b) Environmental display method: models presented through pictures
c) Appraisal: evaluation, aesthetic, emotional
d) Format: scale

Moreover, Gifford (2001) defines the description method as one of the most used appraisal tools for interior spaces with the aim to understand how and what people think about a certain interior environment, which is understood as the perception. Therefore, the description model of Cass and Hershberger was used in this study, which used a set of concepts and scales in order to enable interior environment users to express the way they think of a certain environment, as presented in Table 3.2.

Table 3.2: Cass & Hershberger's interior environmental descriptors (Gifford, 2001)

Factors/ Concept	**Primary Scale**	**Alternate Scale**
General Evaluation	Good-Bad	Pleasing-Annoying
Utility Evaluation	Useful-Useless	Friendly-Hostile
Aesthetic Evaluation	Unique-Common	Interesting-Boring
Activity	Active-Passive	Complex-Simple
Space	Cozy-Roomy	Private-Public
Potency	Rugged-Delicate	Rough-Smooth
Tidiness	Clean-Dirty	Tidy-Messy
Organization	Ordered-Chaotic	Formal-Casual
Temperature	Warm-Cool	Hot-Cold
Lighting	Light-Dark	Bright-Dull
Secondary scale including Old-New, Expensive-Cheap, Large-Small, Exciting-Calming, Clear-Ambiguous		

In appraising aesthetic and emotional perception of an environmental space, various models were reviewed with other descriptors that evaluated coherence, peacefulness and arousal, which all can indicate the preferences of the interior space users (Gifford, 2001). Furthermore, Bell and colleagues (1996) presented a descriptive model for emotional reaction to an environment by Russel and Lanius as presented in Figure 3.6. The model represents two main axes that are pleasantness and arousal, where all the adjectives fall within their plain. The perfect environmental design is the one that pulls its elements to simulate the positive quarter between pleasant and arousing. Thereafter, the adjectives are a balance between the two axes. Likewise, Nasar (2006) presented a similar model, where diagonal axes of excitement and calmness are added as shown in Figure 3.7.

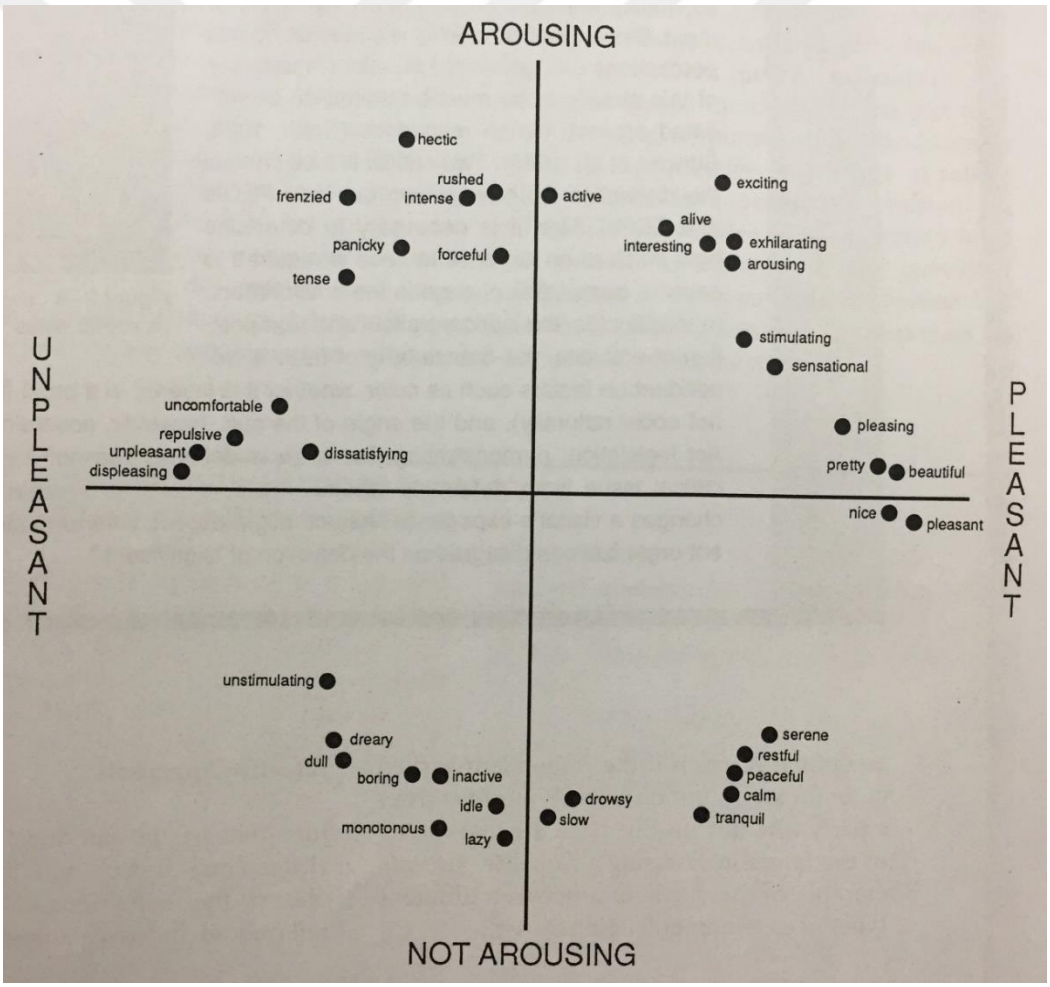


Figure 3.6: Russel and Lanius model for an environment's emotional reaction (Bell et al., 1996)

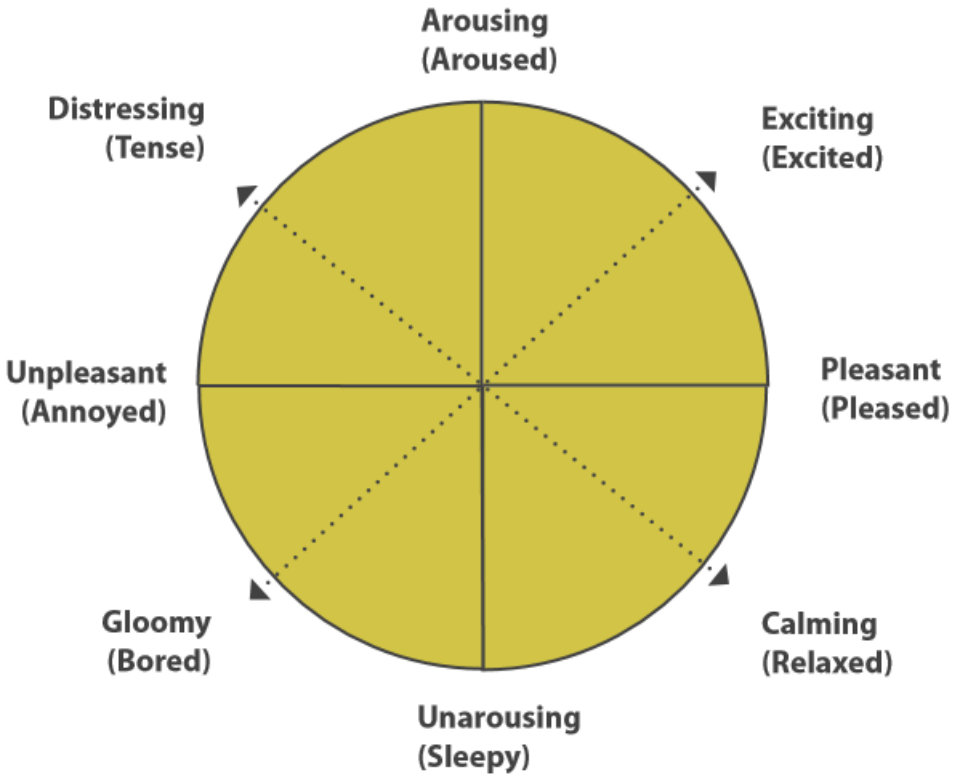


Figure 3.7: Interior space emotional reaction (Nasar, 2006)

4. CASE STUDY

This study focuses on studying the effect of vertical gardens on the perception of the space users and its psychologically and emotionally effects. Therefore, a site is selected, remodeled by a software program and then presented to the participants for assessment in accordance with the environmental appraisal methodologies reviewed in the previous chapter. Moreover, the study tools measure the way in which vertical gardens are perceived in terms of practicality, added value, benefits and aesthetic effects.

4.1. Description of the Selected Space and Developed Model

The selected space is located on the third floor of the Faculty of Architecture building at Çankaya University, Ankara, Turkey. This space is used by the Faculty of Architecture students as a studio or as a working area that consists of different shapes for design inspiration (see Figure 4.1). Moreover, the space has a total area of 48 square meters that consists of designed walls in the middle with openings and a staircase to connect the space to the other floors. On one side of the space there are windows, while the rest of the walls are blank with architectural features. Since the space is mainly used for working, the furniture used is mainly provided for this purpose. Figures 4.2 and 4.3 provide additional views of the space.

This space was selected in Çankaya University due to the lack of interior vertical gardens in the campus. Moreover, in this space there are few comfortable designated study areas and a lack of design features in it that can improve the student's experience. There are several architectural issues that can be seen in the selected space such as illuminance level, plain walls that cause echo, and the location of the space that hinders study comfort and relaxation.

Figure 4.1: Selected space used as a working area (photographed by the author)

Figure 4.2: View (A) of the selected space (photographed by the author)

Figure 4.3: View (B) of the selected space (photographed by the author)

Furthermore, View (B) shown in Figure 4.3 is chosen for the case study in order to integrate the concept of vertical garden. Therefore, a three-dimensional model is developed by a computer program. The furniture is substituted with modern designs, and the board on the right-hand side is designed as a vertical garden. Figure 4.4 presents the space after being modelled and before adding the vertical garden design, and Figure 4.5 shows the space after adding the vertical garden design.

Figure 4.4: Modelled case space before adding the vertical garden design

Figure 4.5: Modelled space with the vertical garden design

The design of the vertical garden is chosen according to the criteria reviewed in Eroğlu and Özdede (2014). These are:

1. Coherence: the vertical garden design is coherent as a unit by adopting the same design theme across the piece. The curvatures are used with the same degree, as well as choosing four plantation types with gradually increasing textures and colors.
2. Sustainability: while the assembly is not clear through the model picture, the design of the vertical garden is extended to the bottom of the wall and given an offset from the wall surface to allow for systems to sustain the garden and its survival.
3. Variety: a studied variety is presented through the design of the vertical garden through the different species used, while keeping the design within an acceptable range of colors and textures that does not confuse the eyes of the space users.
4. Complexity: the design is formed two dark green plantation species that represent a picture background with curved shapes meeting at random points, which are formed with light green plantations.
5. Color: four-degree green color plantations distributed on an equal basis across the vertical garden piece.

6. Form: the main forms and shapes used are curved lines forming flexible shapes that support the arrangement of the light-colored shapes.
7. Texture: plantations with different textures are used by using the roughest texture on the background and the fine texture on the curved shapes.
8. Visual effect: the vertical garden piece gives a liquid and flexible visual effect as the curvature and the color gradual change provides a calming and resting effect on the space users, as well as beauty, uniqueness and harmony.

4.2. Methodology

A subjective methodology is adopted for this research through a questionnaire in order to measure the perception of the participants towards vertical gardens. According to the framework of Craik for environmental appraisal provided by Gifford (2001), there are four elements that shall be considered in an environmental assessment methodology that are the observer, display method, appraisal type, and appraisal format. Thus, these elements are defined for this study as the following:

1. Observer: user group including students and staff at Çankaya University in addition to people who are not familiar with the selected space and who are not a member of Çankaya University.
2. Display method: a computerized three dimensional view of the space with the vertical garden and without the vertical garden are presented to the participants through pictures from two different viewpoints.
3. Appraisal type: evaluation of the two developed model with and without the vertical garden through an aesthetic assessment and its impact on their perception. Moreover, appraisal considers the perception of the participants towards the vertical garden and green walls through their value and benefits.
4. Appraisal format: scaled questions through choosing associated adjectives presented in Bell and colleagues (1996), Gifford (2001), and Nasar (2006), as well as vertical garden perception questions that are measured on a 7-point rating scale.

The participants of the study are selected randomly from different backgrounds, where it is ensured that the sample consists of a variety of profession, gender and age participation. However, the focus of the collection was to distribute the questionnaires between the Turkish and Arabic people in order to measure the cultural correlation with the vertical garden and space perception. Therefore, 97 questionnaires were distributed, of which 90 questionnaires were filled and returned, which gives the study 92.8% response rate. Thereafter, the results of the surveys were entered into the SPSS program and run for analysis. The reliability of the study is measured by calculating Cronbach's alpha as 0.812, which is considered as an acceptable level for reliability.

The main analysis performed is to compare the perception of the participants towards the two developed models, with and without the vertical garden, and to correlate the personal information and demographic factors with the perception towards green walls. Therefore, the questionnaire (see Appendix) is designed into three main sections:

1. Personal information and demographics: where gender, age, occupation, and nationality of the participants are collected. The aim of this section is to collect the demographic data that can be correlated with the environmental assessment and vertical garden perception.
2. Models and vertical garden assessment: the two developed models are evaluated on a 5-point scale of adjectives presented in the literature. The goal in this section is to measure the psychological effects of the vertical garden on the participants through changes in adjective assignment.
3. Vertical garden perception: the participants are asked to state their perception towards the different aspects of vertical garden through a 7-point rating scale. The main aim of this section in the questionnaire is to establish the evaluate the vertical garden perception and establish the relationship with the demographical data.

4.3. Results

This section presents the results of the questionnaire performed for the case study through a descriptive manner in order to show and compare the results of the different participant groups. The order of the section takes the same order of the questionnaire according to the different parts as explained in section 4.2 earlier.

4.3.1. Personal and Demographic Data

According to the results, 58.89% of the participants are male and 41.11% of the participants are female (see Figure 4.6) Moreover, as shown in Figure 4.7, the age range was between 18 to 65 years. Most of the participants are in the range of 36 to 45 years with 35.56%, followed by the age range of 18-25 years with 28.89%.

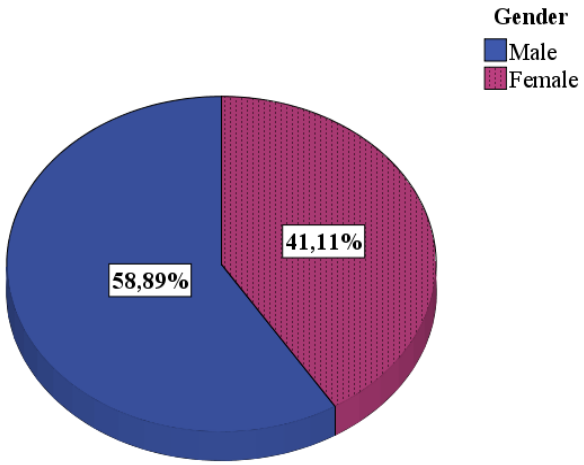


Figure 4.6: Gender distribution of the participants

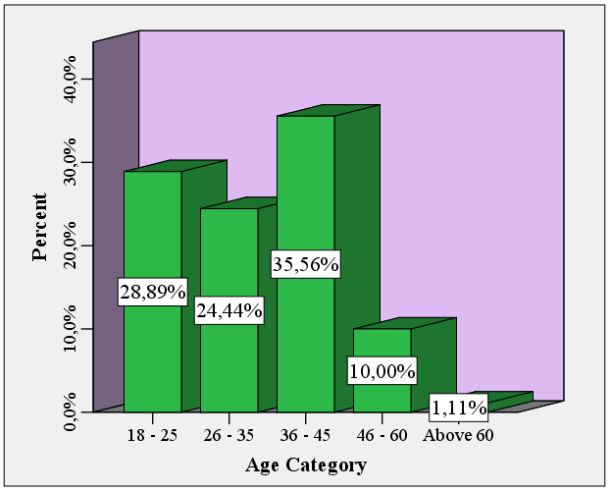


Figure 4.7: Age categories of the participants

Furthermore, most of the participants are students (61.11%), while the second largest group are classified as professors or university instructors (18.89%), as shown in Figure 4.8. As mentioned earlier, the collection of the data was focused on the cultural background of the participants, where 62.22% of the participants are Arabic and 36.67% are Turkish. Only one person is Canadian, as shown in Figure 4.9. Both occupation and cultural background, as aforementioned factors, are used in the statistical analysis section in order to establish relationships between the different groups and the assessment and perception for vertical gardens. In order to evaluate space familiarity, 63.33% of the participants came from Çankaya University, where the space is located (see Figure 4.10).

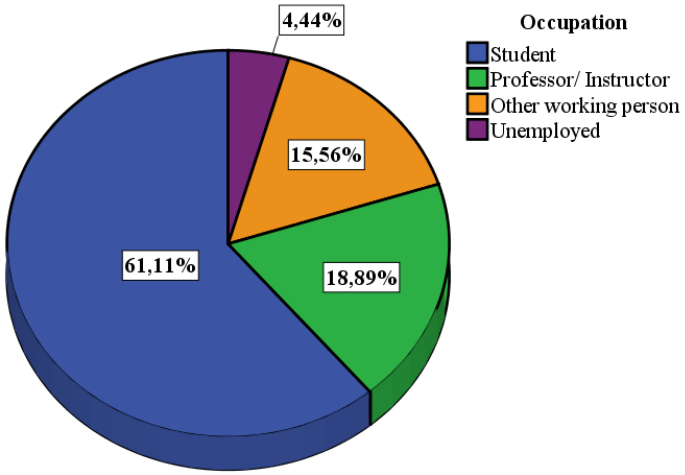


Figure 4.8: Occupation distribution of the participants

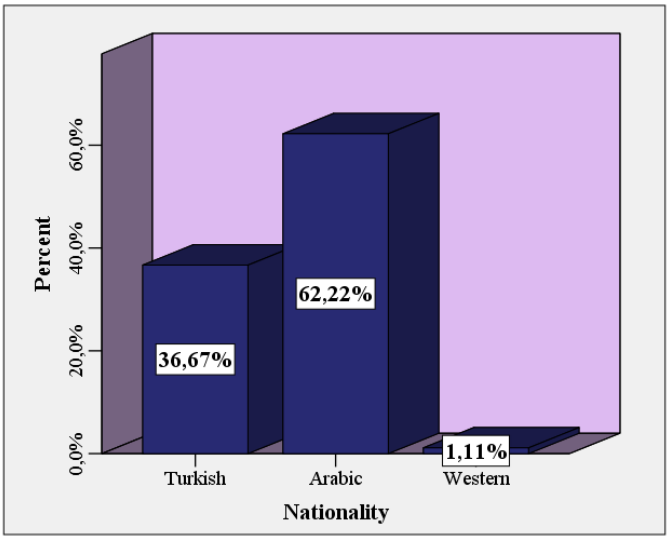


Figure 4.9: Cultural background of the participants

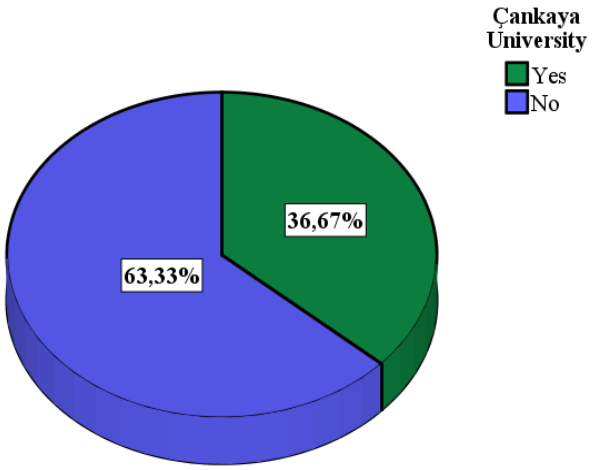


Figure 4.10: Familiarity with Çankaya University

4.3.2. Assessment of the Models

By using the developed models and through utilizing the different describing adjectives compiled from the literature, the means of the two models are compared as shown in Table 4.1. Moreover, a paired sample t-test is performed in order to evaluate any significant difference between the same adjectives for the models without and with the vertical garden. As seen in the results, the model with the vertical garden significantly scored differently from the model with no vertical garden. The highlighted adjectives are the psychological effects that increased with the addition of the vertical garden to the space. Therefore, implementing the vertical garden significantly added more pleasantness, usefulness, friendliness, uniqueness, interest, activeness, complexity, coziness, privacy, tidiness, warmth, hotness, brightness, comfortability, excitement, and peacefulness to the case space.

Table 4.1: Comparison of means between adjectives assignment to the developed models and paired t-test significance ($p<0.05$)

High Score Adjective	Low Score Adjective	Without Vertical Garden	With Vertical Garden	Paired t-test sig. ($p<0.05$)
Good	Bad	3.37	**4.32**	**0.000**
Pleasing	Annoying	2.98	**4.09**	**0.000**
Useful	Useless	2.77	**4.13**	**0.000**
Friendly	Hostile	3.10	**4.10**	**0.000**
Unique	Common	2.20	**3.61**	**0.000**
Interesting	Boring	2.39	**4.12**	**0.000**
Active	Passive	2.43	**3.92**	**0.000**
Complex	Simple	2.32	**3.11**	**0.000**
Cozy	Roomy	2.57	**3.83**	**0.000**
Private	Public	2.37	**3.36**	**0.000**
Rugged	Delicate	3.10	3.01	0.578
Rough	Smooth	2.92	3.01	0.547
Clean	Dirty	4.01	4.07	0.611
Tidy	Messy	3.60	**4.04**	**0.001**
Ordered	Chaotic	3.62	3.77	0.223
Formal	Casual	3.20	3.22	0.888
Warm	Cool	2.74	**3.43**	**0.000**
Hot	Cold	2.60	**3.36**	**0.000**
Bright	Dull	2.96	**3.72**	**0.000**
Comfortable	Uncomfortable	2.73	**3.87**	**0.000**
Pleasant	Unpleasant	2.67	**3.94**	**0.000**
Exciting	Boring	2.41	**3.99**	**0.000**
Peaceful	Unsafe	3.02	**3.74**	**0.000**

Moreover, an overall evaluation for the two models was performed by the participants, where 92.22% and 93.33% of the participants preferred the space with the vertical garden for studying/working and spending time, respectively (see Figures 4.11 and 4.12).

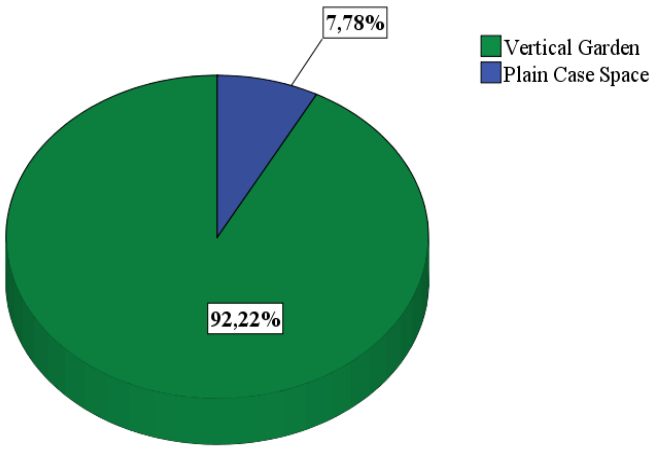


Figure 4.11: Preference of models for studying and working

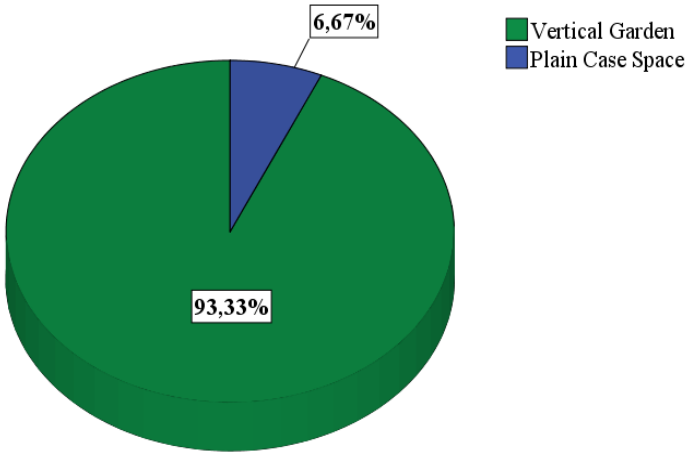


Figure 4.12: Preference of models for spending time

4.3.3. Vertical Garden Perception

The participants were provided with sixteen statements for their evaluation in relation to the benefits and the added value of the vertical garden in the space. Table 4.2 shows the mean scores of all the participants on a 7-point rating scale that was provided.

Table 4.2: Vertical garden perception evaluation

Statement	Mean Score	Overall result
The vertical garden is a new concept in landscape architecture for indoor spaces	6.07	Agree
Implementing indoor vertical gardens increases the cost of the space	5.11	Somewhat agree
Vertical gardens can be added to interior spaces in a large scale	5.63	Agree
The color of the vertical garden design is an important factor	6.23	Agree
The vertical garden enhances the acoustic insulation	5.57	Agree
The vertical garden increases the quality of the indoor environment	5.93	Agree
The concept of vertical garden is calming	5.72	Agree
The concept of vertical garden is exciting	5.60	Agree
The concept of vertical garden is peaceful	5.77	Agree
The vertical garden adds beauty to interior space	6.33	Agree
The vertical garden makes the interior space more active	6.10	Agree
The vertical garden makes the interior space more comfortable	6.11	Agree
The design of vertical garden allows the users to use the space more	5.27	Somewhat agree
The design of vertical garden allows the users to relax	6.09	Agree
The vertical garden increases the interior space users' satisfaction	5.81	Agree
The design of vertical garden effects the attitudes of the interior space users	5.67	Agree

The highest mean score throughout the statements is that the vertical garden adds beauty to the space (6.33) that confirms with the aesthetic benefits of the vertical gardens in interior space. Moreover, the results show that the plantation color used in the vertical garden is the most important factor for the space users (6.23), while comfort and making the space more active are the most increased effects by using the indoor plantations on the vertical surfaces (6.11 and 6.10, respectively).

Nonetheless, the participants showed hesitation in their answers regarding the increased cost that is imposed by the addition of the vertical garden, where the mean score was shown as 5.11. Moreover, the participants were not sure if the addition of the vertical garden addition would make the space users increase their use of the space, which reflects the lack of awareness of effects of the vertical gardens among the public.

4.3.4. Correlational Analysis

In correlating the gender factor to the adjective assignment of the vertical garden design, few weak correlations were found with friendliness, coziness, privacy, ruggedness, roughness, warmth, and hotness, as shown in Table 4.3. The correlations indicate that females perceive these effects more than males with the addition of the vertical gardens.

Table 4.3: Spearman's rho correlation between vertical garden assessment factors and gender

Assessment Factors	Spearman's rho Correlation
Friendliness	0.167*
Coziness	0.117*
Privacy	0.110*
Ruggedness	0.128*
Roughness	0.124*
Warmth	0.246**
Hotness	0.195*

*. Correlation is significant at the 0.05 level (2-tailed)
**. Correlation is significant at the 0.01 level (2-tailed)

Furthermore, Spearman's rho correlations show weak correlations between gender and some perception statements towards the concept of the vertical gardens (most significant results are presented in Table 4.4). The positive correlation shows that females rate these statements higher than males, which consists of believing that the vertical garden is a new concept and should be applied to interior spaces at a larger scale. Moreover, females agree more that color is an important factor in the vertical garden design, and makes the space more exciting and active.

Table 4.4: Spearman's rho correlation between vertical garden perception and gender

Perception to Vertical Garden	Spearman's rho Correlation
A new concept	0.206**
Implementation increases cost	0.111*
Addition in interiors on a large scale	0.208**
Color is an important factor	0.273**
Exciting concept	0.142*
Makes space more active	0.122*
Allows users to use space more often	0.108*

*. Correlation is significant at the 0.05 level (2-tailed)
**. Correlation is significant at the 0.01 level (2-tailed)

Furthermore, the age category is correlated with the environmental assessment factors used in the questionnaire using Spearman's rho, as shown in Table 4.5 that showed weak correlations with ruggedness, cleanness, formality, pleasantness, excitement, and peacefulness. The negative correlation factors indicate that the corresponding assessment factors mean score increases as the age category decreases, while the positive correlation factors show that higher age categories impact the increase in the mean score of the associated assessment factors. The strongest correlations are associated with formality (0.251) and pleasantness (0.222), where higher age categories believe that vertical gardens increase the impact of these effects.

Table 4.5: Spearman's rho correlation between vertical garden assessment factors and age category

Assessment Factors	Spearman's rho Correlation
Ruggedness	-0.133*
Cleanness	-0.104*
Formality	0.251**
Pleasantness	0.222**
Excitement	0.120*
Peacefulness	0.177*

*. Correlation is significant at the 0.05 level (2-tailed)
**. Correlation is significant at the 0.01 level (2-tailed)

In vertical garden concept perception, the lower age categories have a higher agreement mean score regarding the acoustical, calming and peaceful added values of the vertical gardens, which are reflected in the negative Spearman's rho correlations in Table 4.6. These results can be due to the limited knowledge within the lower age categories towards the importance of the acoustic parameter in interiors. However, the higher age categories agreed with a higher mean score as the vertical gardens being a new concept, making spaces more comfortable, and motivating the users to use the space more often.

Table 4.6: Spearman's rho correlation between vertical garden perception and age category

Perception to Vertical Garden	Spearman's rho Correlation
A new concept	0.175*
Enhances acoustic insulation	-0.129*
Calming concept	-0.129*
Peaceful concept	-0.136*
Makes space more comfortable	0.127*
Allows users to use space more often	0.126*

*. Correlation is significant at the 0.05 level (2-tailed)
**. Correlation is significant at the 0.01 level (2-tailed)

The next correlation using Spearman's rho was performed for the occupation data as shown in Tables 4.7 and 4.8 for the environmental assessment factors and vertical garden perception, respectively. Students and professors evaluated the vertical garden model as a tidy design that increased the quality of the indoor environment, while the other working people and unemployed people evaluated the model as formal, pleasing and allowing the users to use the space more often.

Table 4.7: Spearman's rho correlation between vertical garden assessment factors and occupation

Assessment Factors	Spearman's rho Correlation
Pleasing	-0.110*
Tidiness	-0.101*
Formality	0.142*
Pleasantness	0.125*

*. Correlation is significant at the 0.05 level (2-tailed)
**. Correlation is significant at the 0.01 level (2-tailed)

Table 4.8: Spearman's rho correlation between vertical garden perception and occupation

Perception to Vertical Garden	Spearman's rho Correlation
Increases the quality of indoor environment	-0.124*
Allows users to use space more often	0.239**

*. Correlation is significant at the 0.05 level (2-tailed)
**. Correlation is significant at the 0.01 level (2-tailed)

The cultural background was found to be one of the most affecting influencers on the perception towards vertical gardens. As shown in Table 4.9, weak correlation and close to medium correlations yielded from the Spearman's correlation testing, where fifteen out the twenty-three assessment factors indicated these correlations. The negative correlations indicate that the Turkish participants had the higher mean score, while the positive correlation indicate a higher mean score by the Arabic participants, which includes fourteen of the fifteen factors. The Arabic participants have the highest mean score for the activeness increased in the interior space by the vertical garden (0.299), followed by uniqueness (0.285) and comfort (0.275). Nonetheless, the Turkish participants had a higher mean score for roughness added by the vertical garden to the space surfaces (-0.152).

Table 4.9: Spearman's rho correlation between vertical garden assessment factors and cultural background

Assessment Factors	Spearman's rho Correlation
Goodness	0.237**
Friendliness	0.216**
Uniqueness	0.285**
Interesting	0.151*
Activeness	0.299**
Roughness	-0.152*
Cleanness	0.210**
Tidiness	0.146*
Order	0.160*
Formality	0.226**
Brightness	0.157*
Comfort	0.275**
Pleasantness	0.213**
Excitement	0.262**
Peacefulness	0.160*

*. Correlation is significant at the 0.05 level (2-tailed)
**. Correlation is significant at the 0.01 level (2-tailed)

Similarly, the relationship of the cultural background of the participants was tested with the vertical garden perception through Spearman's rho correlation test (see Table 4.10). All correlations yielded from the test are considered weak, where the negative correlations are rated higher by the Turkish participants to as increasing the cost of the interior space (-0.235), enhancing the acoustic insulation (-0.165), affects the attitudes of the space users (-0.154), and being a calming, exciting and peaceful concept. These results confirm the psychological impacts of the vertical garden on the space users. Moreover, the Arabic participants, results seen through the positive correlation factors, perceive the vertical garden as a new concept (0.283), makes the space more comfortable (0.209), and allows space users to relax (0.207), which confirms the positive physiological impacts of the vertical garden, and reflects the

lower level of awareness towards the architectural concept as it was implemented on many structures as an outdoor concept.

Table 4.10: Spearman's rho correlation between vertical garden perception and cultural background

Perception to Vertical Garden	Spearman's rho Correlation
A new concept	0.283**
Increases cost	-0.235**
Enhances acoustic insulation	-0.165*
Calming concept	-0.143*
Exciting concept	-0.128*
Peaceful concept	-0.129*
Makes space more active	0.185*
Makes space more comfortable	0.209**
Allows space users to relax	0.207**
Affects attitudes of interior space users	-0.154*

*. Correlation is significant at the 0.05 level (2-tailed)
**. Correlation is significant at the 0.01 level (2-tailed)

The strongest correlations were found with the space familiarity, where medium correlations were found. Table 4.11 shows the most significant results for the correlation between space familiarity and the environmental assessment factors used in the case study. All positive results show that participants who are not familiar with Çankaya University have a higher agreement rate to fourteen factors, with comfort being the only factor with medium correlation to space familiarity (0.305). Furthermore, other factors showed weak correlations including activeness (0.289), uniqueness (0.282), and excitement (0.220). Such results indicate that people who are not familiar with the space have a more positive assessment towards the vertical garden presented model.

Table 4.11: Spearman's rho correlation between vertical garden assessment factors and space familiarity

Assessment Factors	Spearman's rho Correlation
Goodness	0.189*
Pleasing	0.135*
Usefulness	0.110*
Friendliness	0.152*
Uniqueness	0.282**
Interesting	0.201**
Activeness	0.289**
Complexity	0.153*
Cleanness	0.104*
Formality	0.207*
Brightness	0.102*
Comfort	0.305**
Pleasantness	0.130*
Excitement	0.220**

*. Correlation is significant at the 0.05 level (2-tailed)
**. Correlation is significant at the 0.01 level (2-tailed)

Finally, Spearman's rho correlations were tested for the relationship between space familiarity and vertical garden perception, where all significant correlation had a negative sign. The participants who were familiar with Çankaya University had more positive perception towards the vertical garden concept (see Table 4.12). The only medium correlation is observed through the vertical garden being a calming concept (-0.318), while the rest of the presented relations are considered as weak correlations including enhancing the acoustic insulation (-0.255), affecting the attitudes of the space users (-0.229), and increasing the users' satisfaction (-0.227). These results indicate that people who are familiar with the vertical garden concept and the selected space tend to have a better perception of the concept.

Table 4.12: Spearman's rho correlation between vertical garden perception and space familiarity

Perception to Vertical Garden	Spearman's rho Correlation
Increases cost	-0.199*
Addition in interiors on a large scale	-0.125*
Color is an important factor	-0.173*
Enhances acoustic insulation	-0.255**
Increases quality of indoor environment	-0.202**
Calming concept	-0.318**
Exciting concept	-0.166*
Peaceful concept	-0.115*
Adds beauty to interior space	-0.139*
Increases interior space users' satisfaction	-0.227**
Affects attitudes of interior space users	-0.229**

*. Correlation is significant at the 0.05 level (2-tailed)
**. Correlation is significant at the 0.01 level (2-tailed)

4.4. Discussion

There are several studies that confirmed the positive effects of the vertical gardens on aesthetic, psychological and physiological levels. For instance, Kaynakçı and colleagues (2013) confirmed that by implementing a vertical garden on the hotel structure in Antalya, Turkey had impacts on the ecology, tourism and economy, in which its impacts would be clearer seen on a wider implementation. The aesthetic impact is also confirmed through the studies of Jian (2016) and Sutton (2014) by adding enjoyable, admirable and ecological beauty to the dead plain walls.

Moreover, the psychological and physiological effects of the vertical garden is also proven by increasing productivity rates, as seen in Freeman (2011), and reducing stress rates for students and employees, as shown through the studies of Rayaprolu and Nashipudi (2016), Berto (2014), Pearson-Mims and colleagues (1996), and

Cackowski and Nasar (2003). The psychological impact of the vertical garden is further confirmed through the present case study.

By developing two models representing a space with and without a vertical garden design, and using environmental appraisal indicators presented in several resources within the literature, the mean scores comparison between the two cases show significant difference between the adjectives' assignments between the two models. The significance of the difference is evaluated through a paired sample t-test at the 0.05 level, which showed that eighteen out of the twenty-three adjectives have had a higher rating towards the model with the vertical garden design. The nature of the impact of the vertical garden touched the three dimensions; aesthetic, psychological and physiological.

The aesthetic impact is apparent through the increase of the uniqueness, complexity, tidiness, and brightness of the space with the use of the vertical garden. Moreover, the psychological impacts are confirmed through the increase of the pleasantness, usefulness, friendly, interesting, activeness, privacy, comfort, excitement and peacefulness emotions and feelings of the questionnaire participants when evaluating the vertical garden model, in comparison with the original plain model. Finally, the physiological effects could be a result of the cozy, warm and hot emotions that increased with the vertical garden model. The previous conclusions resulted into having the vertical garden model chosen by the clear majority of the participants as a place for study, work or spending time.

Furthermore, the mean scores of the vertical garden perception evaluation showed an average agreement of the participants on the impacts of the design. The participants confirmed that the plantation color choice of the vertical garden is one of the most influential factors that impact the perception towards it. Moreover, there is a clear agreement from the participants that the vertical garden design concept has evident impact on the usage rate of the space, users' satisfaction and the attitudes of the space users.

In order to establish meaningful relationships between the demographic data and the vertical garden assessment and perception data collected, Spearman's rho correlation testing was performed on the different relations where weak to medium correlations were found. The most effective factors on influencing the assessment and perception results were the familiarity with the case space and cultural background, respectively. Participants who were not familiar with the case space had a higher correlation to the assessment of the vertical garden model, while participants from Çankaya University had a better perception towards the vertical garden concept. Such results imply that familiarity with the space has different impacts on the appraisal and perception of the environmental, architectural or interior designs.

Moreover, the cultural background tested in this research was between the Turkish and Arabic people. The results indicated that the Arabic study group had a more positive assessment for the vertical garden model with significant weak correlations at the 0.05 and 0.01 levels. Nonetheless, the Turkish participants had a better perception towards the vertical garden design concept with correlation factors that ranged between (-0.128) and (-0.235), showing significant weak correlations at the 0.05 and 0.01 levels. Furthermore, correlations with gender, age category and occupation yielded few significant relationships with weak correlations. Therefore, it was implied that females had a higher assessment in some of the appraisal factors, as well as the perception towards the vertical garden concept. Moreover, different age categories behaved differently towards the different elements of the study, while weaker and very few correlations were found with the occupations of the participants.

5. CONCLUSION

The vertical garden and green wall concept is an ancient landscaping tool that was used through leading civilizations and empires for the added natural element to the built structure and its tangible impacts on the health and physiological status of the space users. Therefore, and for many years, the engineers and designers worked continuously on developing well-studies and efficient designs in order to achieve the maximum positive impact awaited from the concept. Although systems are considered well-developed for the outdoor vertical garden and green walls, there is a lack of research on the impacts of the vertical gardens in the interior spaces.

Furthermore, through this research, it was proven that there are several factors to consider when designing for an interior space and the implementation of the vertical garden concept in it. Factors such as gender and age could be more considered during school design, while familiarity with the space and cultural background can be considered in working places and specialized buildings such as hospitals. Thus, it would be beneficial to implement as similar study in buildings' interiors with different functionalities in order to measure response differences for different users in order to provide the best fit design to empower the psychological and physiological status of the specific space users.

Through following the environmental appraisal and assessment techniques used in the literature, there are different methodologies that could be implemented to further support the findings of this study. For instance, the use of experts or special groups as observers, actual vertical garden designs in different spaces as a display methodology, and performing objective measurements such as heartrate and blood pressure on the space users could yield beneficial results, especially if correlated to the subjective assessments similar to the ones provided in this research.

According to the performed research and conducted case study on aesthetic, psychological and physiological effects of vertical garden on the interior space users, the following recommendations can be provided according to the final results:

1. Encourage the usage of vertical gardens in the interior spaces, especially for areas were productivity is required and stress levels may rise such as schools and commercial buildings.
2. Focus on vertical gardens as part of the landscaping and interior design disciplines by enforcing sustainability requirements on new designs.
3. Designers shall focus on key elements for vertical garden design, where color and texture are the main factors, as well as complexity, coherence and visual effect, as they impact the aesthetics of the design and subsequently have significant effects of the psychological and physiological statuses of the space users.
4. There are other positive impacts that are related to the vertical gardens that could be of a great interest to municipal and civil authorities such as enforcing real estate values and growing the tourism sector and ecology. Therefore, designers shall promote these aspects as key subjects through their communication with the governmental and sustainability certification bodies.
5. While technologies are well developed for vertical garden implementation on the outdoor surfaces, further development is required for indoor vertical gardens which should take into consideration the loads and impacts on the carrying structures, the coordination with ventilation systems and technology to be able to sustain vertical gardens within compact environments.

Finally, the impact of the interior vertical garden is apparent to be significant in comparison with the original space, as several differences were found in the preference and perception of the participants. As mentioned earlier, an actual implementation of the vertical garden could allow future studies to obtain objective measurements in regard to the indoor environment impacts of the assembly. Moreover, future studies could implement different designs and colors for interior vertical gardens and compare the different perceptions for those designs.

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APPENDIX

Dear Sir/ Madam

This questionnaire is performed as part of a master's thesis with the title "User Preferences Regarding Interior Vertical Gardens". Kindly, take 5 to 10 minutes to evaluate the concept and the provided design.

Appreciating your time and effort

Part A: Personal Information and Demographics						
1. Gender	Male □			Female □		
2. Age Category	Below 18 □	18- 25 □	26 – 35 □	36- 45 □	46 – 60 □	Above 60 □
3. Occupation	Student □	Instructor □		Unemployed □	Other work	
4. Nationality	Turkish □	Arabic □		Other		
5. Are you in Çankaya University. If yes, please indicate your department		Yes □ ……		No □		

Part B: Factors Evaluation					
Evaluate the shown space according to each item please (indicate what you think about the photos shown)					
					
1	Very good	Good	Neutral	Bad	Very bad
2	Very pleasing	Pleasing	Neutral	Annoying	Very annoying
3	Very useful	Useful	Neutral	Useless	Very useless
4	Very friendly	Friendly	Neutral	Hostile	Very hostile
5	Very unique	Unique	Neutral	Common	Very common
6	Very interesting	Interesting	Neutral	Boring	Very boring

7	Very active	Active	Neutral	Passive	Very passive
8	Very complex	Complex	Neutral	Simple	Very simple
9	Very cozy	Cozy	Neutral	Roomy	Very roomy
10	Very private	Private	Neutral	Public	Very public
11	Very rugged	Rugged	Neutral	Delicate	Very delicate
12	Very rough	Rough	Neutral	Smooth	Very smooth
13	Very clean	Clean	Neutral	Dirty	Very dirty
14	Very tidy	Tidy	Neutral	Messy	Very messy
15	Very ordered	Ordered	Neutral	Chaotic	Very chaotic
16	Very formal	Formal	Neutral	Casual	Very casual
17	Very warm	Warm	Neutral	Cool	Very cool
18	Very hot	Hot	Neutral	Cold	Very cold
19	Very bright	Bright	Neutral	Dull	Very dull
20	Very uncomfortable	Uncomfortable	Neutral	Comfortable	Very comfortable
21	Very unpleasant	Unpleasant	Neutral	Pleasant	Very pleasant
22	Very boring	Boring	Neutral	Exciting	Very exciting
23	Very unsafe	Unsafe	Neutral	Peaceful	Very peaceful

Part C: Factors Evaluation

Evaluate the shown space according to each item please (indicate what you think about the photos shown)

1	Very good	Good	Neutral	Bad	Very bad
2	Very pleasing	Pleasing	Neutral	Annoying	Very annoying
3	Very useful	Useful	Neutral	Useless	Very useless
4	Very friendly	Friendly	Neutral	Hostile	Very hostile
5	Very unique	Unique	Neutral	Common	Very common
6	Very interesting	Interesting	Neutral	Boring	Very boring
7	Very active	Active	Neutral	Passive	Very passive
8	Very complex	Complex	Neutral	Simple	Very simple
9	Very cozy	Cozy	Neutral	Roomy	Very roomy
10	Very private	Private	Neutral	Public	Very public
11	Very rugged	Rugged	Neutral	Delicate	Very delicate
12	Very rough	Rough	Neutral	Smooth	Very smooth
13	Very clean	Clean	Neutral	Dirty	Very dirty

14	Very tidy	Tidy	Neutral	Messy	Very messy
15	Very ordered	Ordered	Neutral	Chaotic	Very chaotic
16	Very formal	Formal	Neutral	Casual	Very casual
17	Very warm	Warm	Neutral	Cool	Very cool
18	Very hot	Hot	Neutral	Cold	Very cold
19	Very bright	Bright	Neutral	Dull	Very dull
20	Very uncomfortable	Uncomfortable	Neutral	Comfortable	Very comfortable
21	Very unpleasant	Unpleasant	Neutral	Pleasant	Very pleasant
22	Very boring	Boring	Neutral	Exciting	Very exciting
23	Very unsafe	Unsafe	Neutral	Peaceful	Very peaceful

Part D: Preference

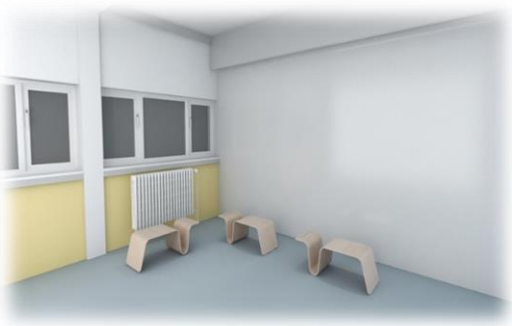
- In which space would you prefer to study / work
  - A. □
  - B. □

Please indicate your reason

- In which space would you prefer to spend your time
  - A. □
  - B. □

Please indicate your reason

Space A **Space B**



Part E: Vertical Garden Perception								
Please rate the following statements according to your perception of vertical gardens for the provided design								
Statement		**Strongly agree**	**Agree**	**Somewhat agree**	**Neutral**	**Somewhat disagree**	**Disagree**	**Strongly disagree**
1	The vertical garden is a new concept in landscape architecture for indoor spaces	□	□	□	□	□	□	□
2	Implementing indoor vertical gardens increases the cost of the space	□	□	□	□	□	□	□
3	Vertical gardens can be added to interior spaces in a large scale	□	□	□	□	□	□	□
4	The color of the vertical garden design is an important factor	□	□	□	□	□	□	□
5	The vertical garden enhances the acoustic insulation	□	□	□	□	□	□	□
6	The vertical garden increases the quality of the indoor environment	□	□	□	□	□	□	□
7	The concept of vertical garden is calming	□	□	□	□	□	□	□
8	The concept of vertical garden is exciting	□	□	□	□	□	□	□
9	The concept of vertical garden is peaceful	□	□	□	□	□	□	□

Statement		Strongly agree	Agree	Somewhat agree	Neutral	Somewhat disagree	Disagree	Strongly disagree
10	The vertical garden adds beauty to interior space	□	□	□	□	□	□	□
11	The vertical garden makes the interior space more active	□	□	□	□	□	□	□
12	The vertical garden makes the interior space more comfortable	□	□	□	□	□	□	□
13	The design of vertical garden allows the users to use the space more	□	□	□	□	□	□	□
14	The design of vertical garden allows the users to relax	□	□	□	□	□	□	□
15	The vertical garden increases the interior space users' satisfaction	□	□	□	□	□	□	□
16	The design of vertical garden effects the attitudes of the interior space users	□	□	□	□	□	□	□

Figure A1: Examples of interior vertical gardens