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Editorial

Mehmet Topçu (Editor in-Chief)

Journal of Design for Resilience in Architecture & Planning (DRArch) began its broadcast life with the excitement, enthusiasm and assertiveness with clear goals, emerging from need and a strong team with editorial experience in different journals. DRArch is a free, open access, scholarly international, e-journal considers original research articles, viewpoints, book reviews in peer-reviewed. DRArch provides a new forum to bring together existing design accumulation with futuristic approach to create better and happier built environment. DRArch aims to fill that gap. In other words, design for resilience is related with future. Resilient design and resilient city are deal with better living. DRArch is interested in designs and design methods the approach of foreseeing the future, long-term, sustainable, being able to synthesize technological developments with inspiration and aesthetics. We would like to thank everyone who contributed to the first issue of DRArch as author, rewiever, graphic designer by sharing their opinions, criticizing, and being brave to step forward.

DRarch is a multi-stakeholder independent organization with wide participation from different institutions and different countries gathered in the awareness of these sudden changes, the need for adaptation, the idea of unity and integration.

Due to the Covid-19 virus suddenly affecting the whole World expressed as a "pandemic" by the World Health Organization, we encountered a situation that changed our communication, shopping, socialization, healthcare, entertainment, worship, education, production and consumption relations in March 2020. A small virus we can't see proved that homo-sapiens are not as powerful and knowledgeable as they thought. We have faced the consequences of our selfish and domineering attitude that destroys animals, natural environment and others. We have seen that we have connections, relationships and interactions with each other in that we either noticed or not. We realized that the world is one. The paradigms of the current order in every field have changed rapidly. It was like a digital revolution.

Resilience means the capacity to recover quickly from difficulties with the ability of adaptation. The image on the cover of the first issue of the journal is “The Theodosius Cistern” one of many ancient cisterns of Constantinople that lie beneath the city of Istanbul, Turkey. This historical cistern built 1600 years ago, offers beautiful columns, brick domes and arches actually reflect the main idea of being resilience, durability to time. In this context Journal of Design for Resilience in Architecture and Planning (DRArch) is not only on the concept of resilience design mentioned in the literature, but also on the anticipation of future designs because in the rapidly changing and transforming modern world, it is of vital importance to be able to adapt to change, to develop innovative tools, to use technology for people and the environment, dealing with flexibility, durability, mobility, humanity. The future of urban societies would be probably built on this basis. Today, buildings and cities are under various pressure of the destructive forces of natural disasters and urban warfare such as extensive fires, storms, destructive earthquakes, floods, military conflicts. Architects, planners, landscape architectures, interior designers and industrial designers must gain competence in dealing within such crisis condition through great exposure of sudden changes -like COVID 19 we have been currently experiencing-, increased uncertainties and instabilities within the societal and economic and cultural systems.

The volume begins with Eman Albraifkanni and Kağan Günçe’s study titled “Hybrid space as a conceptual framework for adaptation” which based on the possibility of investing the concept of hybrid to consider different dimensions of architectural adaptation. The power of this study comes

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from the lack of interests in explaining the relationship between the hybridity theory and architectural adaptation. The authors suggest concepts that accommodate new patterns of adaptation to preserve more than one character within the original space and provide a comprehensive theoretical framework for adapting architecture to changing cultural and social requirements and desires.

The fascinating piece of work comes from Hasan Mutlu with the article titled “Optimization of multi objective land-use model with genetic algorithm” in which the author addresses planners’ main issue of effectively locating integrated land use types for various objectives. The author developed The Multi Objective Land Use Planning Model to maximize land value and minimize transportation by using a genetic algorithm method to find the optimum layout. The performance of the process tested with artificial data additionally, the usability of the model investigated in real issues that makes an innovative contribution to this issue.

Another interesting paper titled “Examination of vertical green systems in educational buildings: a field study in Çukurova University’’ comes from Ülkü Şimşek and Özlem Şenyiğit, in which they focus on vertical green systems in the context of sustainable design. In recent decades, there has been a significant growth in the amount of research on this topic. They argue that applying the systems in school structures help to impress the sustainability concept on the students. Moreover, it makes the systems more understandable since the youths have advanced experimental skills.

Kerem Yavuz Arslanlı is the author of the fourth article titled “Analysis of house prices: a hedonic model proposal for Istanbul metropolitan area”. The article based on the nature of housing price differences in Istanbul Metropolitan Area. The author investigates the factors that affect house prices in the city by Hedonic Regression Model with spatial variables such as house characteristics, neighborhood characteristics and transportation infrastructure.

Nevset Gul Canakcioglu’s paper “A discussion of child-friendly cities through a critique on the experience of the body’’ argues the role of making streets more pedestrian friendly to reduce the possibility of danger for children. The author's argument marks how the urbanites, especially children, are affected by the rapid change of urban space in the context of environment and behavior theories. Woonerf and home zone global models used to explain how the city can regulate physical and social components that can contribute both to the socialization of adults and children’s development and freedom concerning their age and needs.

The article “Measuring the relationship between spatial configuration, diversity and user behavior: A Post Occupancy Evaluation study in Istanbul’s peripheral districts” by Ayse Ozbil Torun, Demet Yesiltepe, Sertac Erten, Ozlem Ozer, Tugce Gurleyen and Ezgi Zunbuloglu identifies the extent to which spatial configuration of public squares is related to users’ behavior namely modes/distances of access and level of satisfaction. They scrutinize four peripheral urban squares located in Istanbul, Turkey to apply the methodology includes a synthesis of three types of specialty, which are a behavioral mapping of urban squares (through the analysis of patterns of use based on direct observation), cognitive evaluation of spaces based on perceived factors (through user questionnaires), and quantifying urban public spaces objectively (through the methodology of space syntax and urban morphology).

The last work of the issue written by Serkan Bayraktaroğlu has the title “Bridging roles of social innovations in rural development: craft initiatives from Kutch, India”. The author focuses on two textile craft organizations from rural India to trace the linkage between social innovations and resilience. As a part of sustainable development, the study demonstrates the relationship between rural business, social innovations, and rural capital by applying the concepts of bridging organizations and rural capitals.

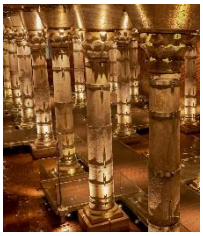
E-ISSN: 2757-6329

As the editör in-chief of this first issue DRArch, I would like to extend my deepest gratitude to Havva Alkan Bala and Ayşe Sema Kubat, co-editors of the DRArch Journal; and also, to İrem Kurtuluş, Abdulkadir Saday and Mojtaba Karimnezhad for their support throughout the publication process. I would also like to express my sincere gratitude to the following people for their efforts in helping me throughout the peer review process: A. Ahu Gülümser Akgün, Aslı Özçevik Bilen, Ayşe Sema Kubat, Burak Asiliskender, Burçin Yazgı, F. Duygu Saban, Havva Alkan Bala, Ozan Önder Özener, Ürün Biçer. I am also very thankful for the unique cover photo of Aslı Aydın for this firs issue of DRArch.

As it always has been, my last thanks go to all our readers for the support they provide to the Journal. We really look forward to your comments, contributions, suggestions, and criticisms.

Journal of Design for Resilience in Architecture & Planning will be more advanced and stronger with your support. Enjoy your reading and meet with us again in the next issue of the forthcoming year, 2021.

Best regards...



Cover photo: Image copyright © Aslı Aydın, İstanbul, 2020. The image on the left is "Şerefiye Cistern" in Istanbul which is known as "Constantinus or Theodosius Cistern" in the past, was built approximately 1600 years ago.
Cover and logo design: Mojtaba Karimnezhad

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DRArch's objectives are:

- to question how future building technologies are revolutionizing architectural design, city planning, urban design, landscape design, industrial design, interior design and education,

- to catalyze the processes that lean on interdisciplinary and collaborative design thinking, creating a resilient thinking culture,

- to improve the quality of built environment through encouraging greater sharing of academicians, analysts and specialists to share their experience and answer for issues in various areas, which distributes top-level work,

- to discover role of the designers and design disciplines -architecture, city planning, urban design, landscape design, industrial design, interior design, education and art in creating building and urban resilience,

- to retrofit the existing urban fabric to produce resilience appears and to support making and using technology within the building arts,

- to discuss academic issue about the digital life and its built-up environments, internet of space, digital in architecture, digital data in design, digital fabrication, software development in architecture, photogrammetry software, information technology in architecture, Archi-Walks, virtual design, cyber space, experiences through simulations, 3D technology in design, robotic construction, digital fabrication, parametric design and architecture, Building Information Management (BIM), extraterrestrial architecture, , artificial intelligence (AI) systems, Energy efficiency in buildings, digitization of human, the digitization of the construction, manufacturing, collaborative design, design integration, the accessibility of mobile devices and sensors, augmented reality apps, and GPS, emerging materials, new constructions techniques,

-to express new technology in architecture and planning for parametric urban design, real estate development and design, parametric smart planning (PSP), more human-centered products, sustainable development, sustainable cities, smart cities, vertical cities, urban morphology, urban aesthetics and townscape, urban structure and form, urban transformation, local and regional identity, design control and guidance, property development, practice and implementation.

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Editorial Team

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Table of Contents

JOURNAL OF DESIGN FOR RESILIENCE
IN ARCHITECTURE & PLANNING

Research Article
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Hybrid space as a conceptual framework for adaptation

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Kağan Günçe**

Abstract

Adaptive reuse is a common formula for reliving life in spaces that are no longer used for their original function, whether through physical adjustments or by incorporating virtual environments into space to Create hybrid spaces with a new dimension in which the data of memory, culture and space identity interact. Although the trends of the studies vary in their approach to deal with the concept of adapting architectural spaces, they remain in the same theme that the process of space adaptation is seen to be based on either one or the other, Oblivious to the fact that the process of building adaptation generates tension and creates hybrid spaces which belong to neither. Thus, the studies that focused on this subject does not reach the creation of a clear and specific theoretical framework for adapting architecture to changing cultural and social requirements and desires. This research attempts to examine the possibility of investing the concept of hybrid to consider different dimensions of architectural adaptation. The relevance of hybridity theory to understanding architectural adaptation is a subject that has hardly been explored. An objective of this research is to investigate this research gap represented of absence of specialized studies help to understand the relationship between the concept of hybrid and architectural adaptation and lack of the proposed concepts that accommodate new patterns of adaptation to preserve more than one characteristic (perhaps in conflict) within the original space. In light of this, the research problem is represented in the absence of a clear and comprehensive theoretical framework that enables the identification of forms of adaptation that respond to changing cultural and social requirements and desires. Hence, this research seeks to combine Bhabha's concept of hybrids and adaptation of architecture to build a clear and comprehensive perception of this concept, by using architectural studies that dealt with these subjects.

Keywords: adaptation, adaptive reuse, culture, hybrid space, hybridity.

1. Introduction

The discussion of space returns back to a Greek philosophy and has been seen in significant changes over time. It is transferred from being an abstract, standalone image to a physical image where then a relationship between things take shape by people organizing their relationships with each other and with their environment (Casey, 1997, Schulz, 1971, Bartel, 2014, Heidegger, 1996,

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Dyson, 1998, Al-Juboori & Mustafa, 2014). Today, there have been several studies confirming the mutual influence of space, society and culture (Lefebvre, 1991). As Soja points out, that most of our lived spaces are socially constructed indicating that humans have an impact on other human beings and the ways in which our cities and social spaces are constructed, can have a big impact on our daily lives. Thus, space became" reflective mirror of societal modernization." (Jagannath, 2018). The different languages, customs, traditions and the way of how people react to their environment represent a manifestation of cultural diversity based on the presence of more than one influential group "Diversity is nothing more than a difference from the majority" (Lee, 2018) that expresses its identity. This diversity affects people and how they shape cognitive maps, which in turn are used to influence the behaviour of the individual within the same environment or in similar environments (Haq and Griotto, 2003). Thus, the identities of people that can be determined by difference from the other more than the similarities as Huyssen indicates (Huyssen, 1995) can lead to identify hybrid spaces, it corresponds to a cultural diversity that creates hybrid images and drives the need for a building adapted to these requirements rather than denied them. Than here, architecture - buildings, cities, spaces - can be conceived according to Bhabha, as a subject in the "hybrid space", that area where culture is at its most productive, because buildings (and cities) are always metaphorically in the middle between architects' interests, developers' economic expectations and planning laws, while also being continually re-signified by users (Hernández, 2010). For this reason, the question is raised about how and under what conditions the processes of Building adaptations occur in a manner that aligns with the concept of hybrid space as an image of the cultural diversity and cultural difference that associated with modern design methods and practices.

Homi Bhabha, an Indian English scholar and critical theorist and can be consider as one of the most highly renowned figures in contemporary post-colonial studies (Huddart D, 2018). His idea of hybridity suggests an approach to reading adaptations that accommodate these stimuluses. In the context of this study, it questions what form does hybridity take in architecture, what is a 'hybrid' space and how might one identify it? The relevance of hybridity theory to understanding architectural adaptation is a subject that has hardly been explored. An objective of this research is to investigate this research gap. In order to give a more solid understanding of hybrid, the research focuses on a number of research topics that accompanied the adaptation of architecture to the requirements and desires of contemporary societies and builds links between them, including the hybrid space generated by the combination of public and private spaces, and the hybrid place that allows for multiple layers of users and use across time, and the overlap between cyberspace and physical space. The research adopts the qualitative approach in its study due to its compatibility with the nature of the subject under study. Qualitative research tends to emphasize a holistic exploration of complex situations and environments where testing and deduction of sequenced or causal relations are unlikely. Creswell notes that qualitative research usually aims to "involves reporting multiple perspectives, identifying the many factors involved in a situation, and generally sketching the larger picture that emerges" (Creswell, 2007). Depending on the analysis of architectural studies that dealt with these vocabularies, in addition to studying a number of contemporary adaptation projects (as part of the qualitative research Tactics (Miles & Huberman, 1994), this leads to a finding of a solid interpretation of the adaptation processes in light of the concept of hybridity. Qualitative research typically aims "to develop a complex picture" that "involves reporting multiple perspectives, identifying the many factors involved in a situation, and generally sketching the larger picture that emerges" (Creswell, 2007).

2. Adaptation in Architectural Studies

The concept of adaptation has led to widespread interest in different science, such as sociology and biology. It was also the focus of a wide range of architectural studies due to its relevance for the theoretical field and the practical reality of the architecture. It has acquired different meanings depending on the trend of each study, yet we can classify these trends into three categories: The first category covered topics such as extending the life cycle of the building (Kohler and Hassler,

2002) and the possibility of adaptive reuse unoccupied buildings (Douglas, 2006). Over time buildings are exposed to the possibility of losing their original functions for various reasons which required a number of modifications to ensure that the building can used to achieve the new purpose, (ICOMOS, 2013) Adaptation begins with changing the function or using building to respond changes in the economic influences such as (market situation, low value of the building and exploitation it economically) or by social effects such as (user desires to leave building due to bad condition ,renewal, and changing the usage type) .This will following by a physical adjustment of the building to suit the changing function (Kincaid, 2002). This category of studies has been focused on the concept of adaptation as Modifications to the building in response to a variety of motives, it's about overcoming aging and redundancy in buildings, and to ensure the long-term future of buildings threatened with demolition and vacancy at the end (Douglas, 2006).

The second category of studies dealt with the concept of "adaptation" in relation to the flexibility. Where it refers to the ability to adapt the environment with changing needs of the occupants in a timely manner however these modifications become possible if the original design of the building has flexibility enough to adapt a new requirement (Douglas, 2006), meaning the possibility of providing a state of laxity between the events and spaces to accommodate the changes that can occur over time without any need to modify the building. This happens either by providing spaces more than the requirements of the events at the time of occupancy called (Over Capacity) or by providing spaces with general or similar characteristics that can be used by different events called (Neutrality) (Al-Nijaidi, 1985).This property is known as flexibility and is described by Hillier "as the ability of a complex to accommodate functions in general and therefore potentially a range of different functions, rather than any specific function" (Hillier, 2007). This category pointed out the benefits of adaptation to the environment and the reduction of pollution and its contribution to environmental sustainability through flexibility and Thoughtful design (Kincaid, 2002). While, the third Category of studies deal with modifications to an architectural type to suit the natural, civilizational and semantic environment, As with changes in the Bungalow type in India at the level of the plans and structure of the building (Photo 1, Photo 2), along with decorations, ornaments and changes to the type of the residences on Penang Island in Malaysia (Desai, M., Miki D and Jon L., 2011, Abel, 1997).

Photo 1 The erstwhile Tata Palace in Mumbai is now the corporate headquarters of Deutsche Bank. This building exemplifies an adaptation of Using of Baroque Embellishment with indigenous Indian architecture. (Desai, M., Miki D and Jon L., 2011)

Photo 2 An Art Deco building off Shahrah-e-Faisal in Karachi (Desai, M., Miki D and Jon L, 2011)

Although the trends of the studies vary in their approach to deal with the concept of adapting architectural spaces, they remain in the same theme that the process of space adaptation is seen to be based on either one or the other. Oblivious to the fact that the process of building adaptation generates tension and creates hybrid spaces do not belong to either, contrary to the goal of adaptation by owning the building and transferring it to new culture, separated on both allowing for continuity and discontinuity at the same time (Alsayyad, 2001). This paper claims that, at present architecture adaptation and their space head to generate hybrid space impelled by the need to address different requirements, desires and provide multifunctional spaces. As noted in recent years, multifunctional buildings adaptation has been increased where spaces become more complex than their predecessors and it can be observed that the interaction of separate functions has been strengthened, and the internal boundaries of space begin to dissolve.

3. Hybridity and Adaptation

Homi Bhabha and Richard Sennett claims:

The word “hybridity” has its origins in biology and botany where it designates a crossing between two species by cross-pollination that gives birth to a third “hybrid” species. While Darwin praised the fertility of the process of cross-pollination, others pointed to the risk of degeneration when the term was applied to the field of genetics and racial interbreeding (Guignery, 2011). The historical context of the "hybrid", had a negative concept, while today the concept is everywhere, however today it has begun to take widespread acceptance on the cultural and global levels. Due to technology grow, many hybrid areas appear, Hybrid cars, hybrid plants, and hybrid materials which become increasingly common terms in today's world. In the twentieth century, the term hybrid extended beyond the biological and racial framework to embrace linguistic and cultural areas.

The concept of hybrid returns to its understanding the difference between "cultural diversity" and "cultural difference", according to Bhabha. The first refers to the possibility of different cultures coexisting side by side in one space without being influenced or be affected, while "cultural

difference" refers to a form of declaration of cultural diversity that may lead to non-coexistence within space if interaction does not occur on the basis of showing hegemony. This leads to create the concept of hybrid space as a compound space trying to adapt to maintain more than one property (possibly in conflict) of the original space, allowing the overlap of two cultures or two different concepts that maintain a kind of interaction (Bhabha, 2006). Today's world imposes us to adapt on the basis of: Create complexity and interconnectedness in a city tends to differ rather than change, A city where people withdraw behind walls of difference. Contemporary world adds Sennett, pushed toward overlapping different activities in the same area. For instance, Create a family activity in the workspace. This brings us back to the issue that had characterized the appearance of the industrial city itself. A city that shattered the pre-emergence spatial relationship Industrial capitalism combines family, work and ceremonial public spaces and more informal spaces.

Consideration of adaptation through the concept of hybrid space is consistent with the nature of the era in which people appear more flexible in the way they move and, in the way, they adapt to the new environment. The common use of spaces and presence with strangers can have a positive effect “about the sociability of living with strangers: the mark of the civic realm now is mutual accommodation through dissociation. That means the truce of letting one another alone, the peace of mutual indifference." (Sennett, 2008) and here Richard Sennett points out that “There are more and more people who feel the urge to live the life of a nomad, who would live anywhere in the world and who could hardly remember where they lived just ten years ago.” (Sennett, 2008)

A hybrid space is often understood as a location for exploring issues of dominance, power and emancipation. It is a means to imagine new ways of working, new ways of talking and original, transformative ways of relating (Loveday, 2008). the term hybrid refers to an interaction of two unlike genes resulting in a new breed that is different and unique in nature (Sargın G, Savas A, 2011). Technically, speaking, the product of zoological hybridization is often a sterile animal, but the term is often used metaphorically to designate creativity, the creation of new specimens (Guignery, 2011). From this standpoint, it could find new understanding of the subject of building adaptation based on the combination of contradictions in one space without one being dominant over the other.

4. Hybrid Adaptation

The concept of hybrid space allows an understanding of adaptation in positive terms. Like an accordion instrument, it is able to adapt easily to accommodate the constant change that accompanies the cultural diversity and difference which is a feature of contemporary societies as well as changing concepts related to attachment to place. Where Hybridity becomes one of the ways to Re-adaptation of buildings. Hybridity broadens the field of innovation, not by making them available through traditional boundaries- These boundaries can be physical or cultural and are places, real or imagined-only, but by defining boundaries as a hybrid, flexible, and multi-layered space, not just a place to merge differences, but as a place for transformation and innovation. From this vision, it could be stand on by three aspects of tension that form a conceptual framework for hybrid space as an adaptation of contemporary buildings

Public-Private access:

Hybrid concept has become more and more frequent at internal and external spaces where the border between public and private began to fade in favor of hybrid spaces do not belong to either. For example, most people are convinced that Railways are considered as public spaces, but today it can be found that many of these stations have been integrated into arrival and departure areas

with the spaces of various shopping centers under private ownership and retail stores under the same roof (Nissen, 2008) thus, the public space is divided into private properties .This redefines modern railways stations as a hybrid space (neither public nor private) .This conviction that people have spaces such as transport stations and heritage or historical buildings are based on their memory of the stereotype of this type of space which allows continuity and discontinuity at the same time.

Moreover, the proliferation of imaging and broadcasting techniques has contributed to bringing public space to private and vice versa, create new spaces between the two spaces. While today, changes the concept of privacy have influenced the way of understanding identity. Separation between interior and exterior or between public and private is no longer clearly evident. People live as Bhabha pointed out in between (hybrid) area: 'the zone of occult instability where the people dwell' (Bhabha, 1994) where public space is brought to private and virtual space to reality with preservation the properties of each one. In reality television shows such as (Big Brothers) a model of hybrid spaces, Where the public access into the house and family's private rooms through TV cameras, in sharp contrast to the "privy chamber" concept which first appeared in the bourgeois era and accompanied English literature in the 17th century to denote private place and place of soul (Private Identity) (Lukacs, 1970).

In the project for "Room 202 at the Gladstone Hotel", which designed by , Maggie Greyson, and Christine Lieu, identifying the Public-Private access by adapting one rooms of the hotel to be an area where quests exchange personal memories, each person shares a piece that represents his memory, which is placed in a transparent glass box with a comment explaining what it represents (or what it symbolizes) and another piece that represents the memory of another person is taken in exchange for it, but without meeting them. "The playful take on memories and storytelling was arranged like a simple library with long shelves of rough planks mounted from floor to ceiling lined with mason jars each housing an object and an identifying tag. In this case, semi-anonymous object-story-memories are the focus of the art, but in a very ephemeral way. They become commodities with exchange value, and they float in and out of the archive, like they would in the mind of a person or community" (Photo 3) ("Undertaking Acquisition," n.d.).

Photo 3 Room 202 at the Gladstone Hotel ("Undertaking Acquisition" n.d.)

The concept of hybrid space based on the combination of antipodes of public space and private space becomes a fundamental concept in buildings with overlapping functions, in office buildings,

for instance, as a result of changing the work culture based on the individual towards team-based work it could be notice that reduction in the individual area in favor of creating an unallocated space that provides the possibility of daily change. And the XYZ Works building in Manchester, which opened in 2017, goes a step further by providing hybrid workspaces and spaces (open work space) shared by more than one companies that operates in the city's tech, technology and digital (FinTech) communities in one open space (Photo 4) ("XYZ Works, Manchester's newest hybrid co-work space to launch in August - Invest in Manchester," n.d.).

Photo 4 "XYZ Works is set to define a new era in co-working spaces in Manchester. Opening in August 2017, XYZ Works represents the evolution of flexible work spaces to the next level and has been specifically designed to cater for FinTech, digital, professional service and tech-enabled businesses in the landmark XYZ Building at the heart of Spinning fields." ("XYZ Works, Manchester's newest hybrid co-workspace to launch in August - Invest in Manchester" n.d.)

On the other hand, there is another attraction of public spaces towards private spaces, monitoring cameras surrounds public spaces and turns it into a space for the municipality. And residential spaces with fences and gates that are guarded by security men and are limited to a certain group of people, carves out public space, roads and parks to redefine it as a public but fenced "hybrid". What is thought to be a public park (public space) is actually a different space today, the garden is fenced and closed at specific hours. Even its furniture is made of materials that cannot be slept on with metal cushions, and its public bathrooms are open only during the day. Thus, these "hybrid" spaces receive the desired people and exclude others (Nissen, 2008). The principle of "unlimited access" And the principle of "usability" in the sense that it can be used by the general public without restrictions in the light of its specific function (Low & Smith, 2006), the definition of public space, have been displacement in favor of a hybrid space reflecting a profound cultural shift that replaces stereotypes with a flexible identity based on difference and interconnection, where this type of adaptive is required. Thus, a new aspect of building adaptation has emerged through a hybrid perspective based on a combination of the two space (public and private) under one roof, allowing them to be present and continue to play their roles without allowing those two overtake each the other.

Hybrid - Adaptive Reuse:

Today's architectural spaces offer multiple models of hybrid spaces that can be found everywhere around us, industrial areas transformed into new cultural landscapes, cemeteries used as public parks, places of various events and activities with temporary installations or light structures, vertical gardens, interchanges and transportation hubs, pedestrian passages, large scale urban sculptures, experimentally revitalized historical spaces, public spaces combined with hybrid

buildings (Pluta, 2016). Due to relatively long age of the building, it is possible to undergo partially or totally changes in the function, form or use, which adds a new layer of memories and meanings of the building. This paradox, or multiplicity of fossils, allows to generate new concepts and meanings as well as to recognize existing fossils, which give the new class special importance (Peterson & Rutherford, 2006). Thus, created hybrid space that holds the characteristics of past and present at the same time and place and allows continuity and interruption in the cultural environment. Memory and images of the past are constantly evolving; it is woven through the dialectic of remembering and forgetting, it exists to choose what suits them and focus on it whether it is space, building or gesture (Nora, 1989). In the Museum of Glass and Ceramic For the architecture Hollien in Theran, brings an ancient palace to life in a complex and rich way in Ambivalent meanings. It is considered one of the examples in which a building is adapted, allowing memories to coexisting side by side permitting multiple reading generated sensory meanings. Hollien, uses large display boxes (or black columns) each generates a completely different psychological state against a background of Rococo plaster (Jencks, 1993) (Photo 5). The building is a hybrid space presenting ancient art in post-modern containers within different historical contexts under one roof.

Photo 5 The Museum of Glass and Ceramic in Theran. (Jencks, 1993)

The building which houses Glassware and Ceramic Museum of Iran was built 90 years ago upon the order of Ahmad Qavam (Qavam-ol-Saltaneh), the premier of Qajar King Ahmad Shah as a personal lodging (residence-cum-office) “Later, the building was sold to the Egyptians as the new location for the Egyptian Embassy and remained in their possession for seven years. When relations between Iran and Egypt were severed during the rule of Gamal Abdul Nasser, the Egyptian Embassy in Tehran was closed and the building was purchased by the then Commercial Bank. However, it was sold in 1976 and turned into a museum jointly by Iranian, Austrian and French architects. The museum was opened in 1980 and was registered on the National Heritage List in 1998 The architectural style of the building is a combination of Iranian style and European architecture of the 19th century (Jencks, 1993).

Another manifestation of the building's adaptation to “changing needs through reuse based on the accessibility of the space and its elements by multiple people at different times throughout the day and night, form different types of memories. In 2009 Zecc Architects is adapting the old Droste Silo to a hybrid space with Changeable identity by day and night. The Droste chocolate factory in Haarlem is an icon of industrial architecture in Haarlem. The complex, founded in 1897 along the Spaarne waterway. During the Second World War a bombing by an Allied aircraft, caused considerable damage to parts of the Droste site. The old factory is abandoned in 2004 and reconverted into housing in 2006. This old Building transformed by Zecc Architects to a hybrid space

with Changeable identity by day and night for "Studio Heldergroen". Their ground floor studio "Studio Heldergroen" in the old Droste Silo looks like a smart, modern office by day. But within a matter of seconds, the space can be transformed into a yoga studio, a communal eating area, a DJ set and a dancefloor (Steeds, 2014). Every evening the tables and the computers disappear in the white acoustic ceiling landscape with Led lighting. Only the chairs on the black concrete floor reminds of a hard-working day". ("Studio heldergroen | Zecc Architecten," n.d), (Photo 6, Photo 7). Throughout the day, the building is combined with different interest users. In the morning, the building is known as offices, and by the evening the building is known as a dance floor. Thus, a hybrid space is formed that carries in its fossil layers the industrial building next to the office building whose employees do their work in the city square.

Photo 6 The ground floor studio "Studio Heldergroen" in the old Droste Silo, modern office by day. ("Studio heldergroen | Zecc Architecten" n.d)

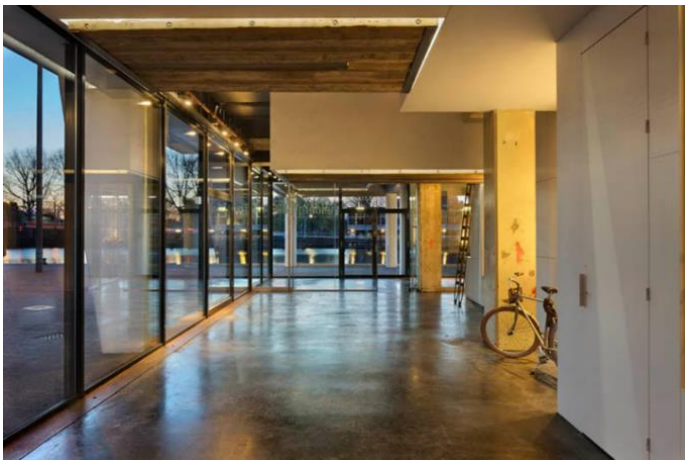

Photo 7 The ground floor studio Studio Heldergroen in the old Droste Silo, can be transformed into a yoga studio by night. ("Studio heldergroen | Zecc Architecten" n.d)

In this context, buildings and their spaces will be part of the network of relationships woven into memory over time and will contribute greatly to building memory. As buildings that extend for a relatively long period of time with their environment, it linked to this environment with a very complex network of relationships. Which gives this relation a stronger link to the environment compared to other elements (Dalton & Bafna, 2003) and memory formation, becomes a confirmation of meaning than to be as material stabilizations of past times (Guggenheim, 2009). The multiplicity of communication patterns through the integration of historical spaces into

contemporary solutions and the change of function over time, creates new features of space adaption from hybrid perspective based on expressive identity, providing flexibility at both the functional and design levels and providing a kind of cohesion that allows users to perform stationary and variable activities.

Adaptation with Flowing Spaces:

Following Lebebvre's theory with the understanding of space as a combination of different 'fields' - physical space, mental space, and social space, Cicognani (1996) adds that cyberspace can be considered as the 'fourth partition' of space that is in co-existence with the other 'fields. (Chan, 2010). Cyberspace can be viewed as a real space rather than a mere thing where communities interact, grow and evolve within it (Cicognani, 1996). New communities are created within Cyberspace - such as social spaces which described according to Lefebvre-Located outside the traditional spatial coordinates. With mobile devices, the private is drawn into public spaces through communications and with augmented reality feature it accumulates layers of information about the surrounding environment which affects our choices and behavior. These spaces become aa a place of consciousness, characterizes by constant change and movement and allows people to move between its worlds continuously, which is reflected in the people's attachment to a space. It is also comparable to Lefebvre's mental space; both of them represent the reality we live in. Mental space representation of the outside world can be accessed through the individual whose image resides in the mind; while cyberspace space can be envisioned though it disappears between networks online through screens (Dyson, 1998).

Today, in the light of Information and communications technology (ICT) a new space is being created that has a radical impact on the way in which people interact with each other in their societies and in how they shape and define space. Castells refers to the invasion of mass media and networks of our physical environments. Where these spaces enter architectural spaces in competitive relationships and sometimes as interactive frameworks (Castells, 1996). Where the latter becomes (architecture and its space) as a reference points used by people as starting points guiding himself to explore the surrounding environment and to build his perception of the spaces and the connection between spaces (Schulz, 1971). A. Scarponi, S. Massa, F. Pedrini, A. De Luca, in their project called "Dreaming Wall" in Italy, present a representation of a hybrid space that combines the digital world and the information network with the physical space (Photo 8). Where the multiplicity of events successively released each other-as day released night and the attachment of space becomes as a transient event. "The Dreaming Wall is a project for a blank wall in an historical square of Milan, originally submitted for a competition. The wall is conceived as an Info Forum: a public vertical space reflecting the dual character of the city which has a double life as the city and the piazza do – white and subdued during the day and glowing phosphorescent green at night." The project presents a new picture of the adaptation of an old building with the changing of the city and cultural of contemporary society, as the wall is seen as "The Wall is seen as a tool of cultural, simultaneous, and random collective communication, creating a visual buzz. As a public digital billboard, the wall surface at night randomly displays text messages sent by people standing on the square or from anywhere else in the world through the Internet. The messages are generated in real time by a chemical reaction between a computer-controlled UV laser projection and phosphorescent panels on the wall. This release the text provoked by the UV light, which is actually invisible. A message would last fifteen minutes before being re-absorbed by the wall. Its constant transience metaphorically suggests the sub consciousness of a city asleep." ("The Dreaming Wall. Collective Buzz in Town. — Conceptual Devices" n.d).

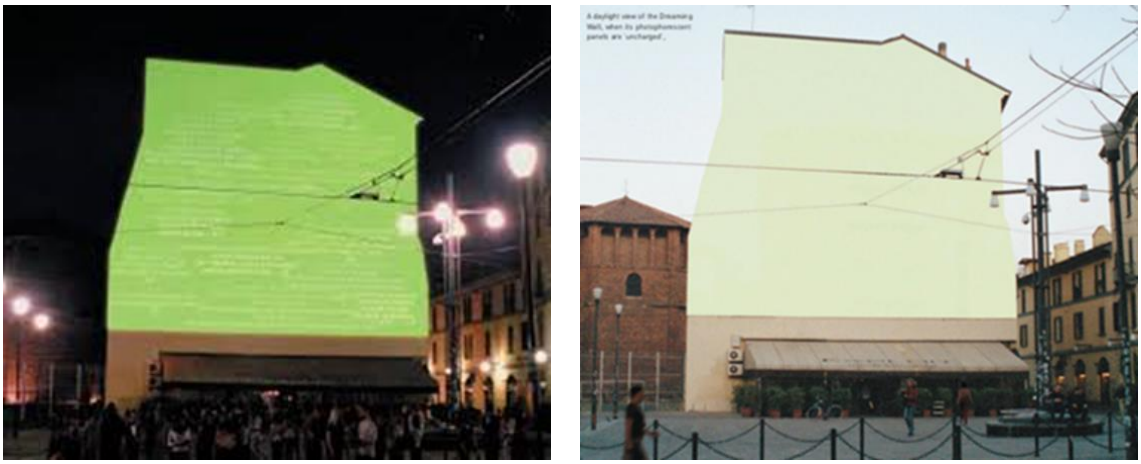

Photo 8 "Dreaming Wall" in Italy ("Conceptual Devices" n.d)

In MOCA occupies a former machine shop, Maya Lin a Chinese-American architect provides her experience integrating media with a building. She provides an experience of a hybrid space that integrating media with a the "Museum of Chinese in America" space. In an interior loosely inspired by a traditional Chinese house, with rooms radiating off a central courtyard and areas defined by screens, the images flicker on monitors set into the crumbling red brick, "MOCA's core exhibit traces the development of Chinese communities on these shores from the 17th century to the present through objects, images and video. Maps on the floor connect to a further history in objects suspended from above. More often, though, the museum relies on images and text, including light boxes set into the walls. A mocked-up Chinese general store evokes the multipurpose spaces that served as vital community lifelines for men severed from their families under the 1882 Exclusion Act, which restricted immigration" (Photo 9) (E.B. Boyd,2009, Ridhika Naidoo, 2009).

Photo 9 Museum of Chinese in America, 2009, Maya Lin (E.B. Boyd, 2009, Ridhika Naidoo, 2009)

This combination of digital telecommunications network and architectural space generates a third space that can be described as "Hybrid Space" based on a building adaptation aspect allowing architectural space flowing within Cyberspace space and vice versa without obstruct each other in the form of continuous succession and existence at the same time.

In light of the above, Table 1 shows that in addition to the formulas that mentioned previously, the new formulas of adaptation can be identified in the light of the concept" hybrid", which appears

as a result of the response of architecture and its spaces to various requirements and desires. Building adaptations have become more complex than their predecessors, along with the interaction between different functions, and the blurring of internal boundaries of spaces.

Table 1 Different formulas of building adaptation from the perspective of hybrid space

Formulas	Literature review	New formulas(author)
Relation to changing function: This will be following by a physical adjustment of the building to suit the changing function	(Kohler and Hassler, 2002) (Douglas, 2002)	
Relation to the flexibility: by providing spaces more than the requirements of the events at the time of occupancy or by providing spaces with general or similar characteristics that can be used by different events	(Al-Nijaidi, 1985), (Kincaid, 2002), (Hillier, 2007)	
Relation to the architectural type: As with changes in the level of the plans and structure of the building, decorations, and ornaments.	(Desai, M., Miki D and Jon L, 2011), (Abel, 1997).	
Public-Private access		Bringing public space to private and vice versa, without allowing those two overtake each the other
Hybrid -Adaptive Reuse		Multiple layers of users and their change over date and time
Adaptation with Flowing Spaces		allowing architectural space flowing within Cyberspace space and vice versa without obstruct each other in the form of continuous succession

5. Conclusions

The current paper dealt with building adaptation from the perspective of hybrid space in the contemporary buildings and took different formulas, concluding that dealing with building adaptation from hybrid perspective can create new understanding of the relationship between architecture and society accepting diversity and difference as a manifestation of life Which is accompanied with people change their attachment to space, where people live in places that are constantly changing. In hybrid spaces, people tend to accept the participation with strangers in different ways and within diverse spaces and architecture must provide its interpretation of the economic, political and cultural conditions that accompany the growth of cities through their walls and spaces.

Building adaptation from a hybrid perspective does not attend to be as a single course to generating space, and respond to contradictions and expectations required but as an activity allows to preserve the preservation of developments (bringing public space to private and vice versa, Multiple layers of users and their change over date and time and Living between flowing spaces Architectural spaces) critically involved with issues of contemporary requirements such as non-attachment of space, emancipation, non-personalized and property topics.

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Resume

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Optimization of multi-objective land use model with genetic algorithm

Hasan Mutlu*

Abstract

The first task of the city planner is to effectively locate integrated land use types for various objectives. The Multi Objective Land Use Planning Model developed to achieve this goal, aims to maximize land value and minimize the transportation. The genetic algorithm method developed to find the optimum layout according to the Multi-Objective Land Use Planning Model has been explained, the success and performance of the process has been tested with artificial data, and its usability in real problems has been examined. According to the results of the study, using this method, it is revealed that layout plans that are very close to the maximum efficiency value can be found within 1 day in cities with a population of up to 1,000,000, within 1 week in cities up to 5,000,000, and within 1.5 months in cities close to 16,000,000. By examining the results, the deficiencies of this method are determined and the suggestions for improvement of this method are stated. The problem chosen in this study is a problem that most city planners have to solve and the developed application has been opened to the use of other experts. This makes this work unique as it allows planning experts who are incapable of developing such methods to experiment.

Keywords: multi objective land use planning, spatial optimization, genetic algorithm

1. Introduction

A city consists of various functions that serve different objectives and affect each other differently. The spatial organization of the city includes a wide network of relationships formed by these interconnected elements. For example, shopping malls want to be close to the customer first, commercial companies want to be close to their workforce and other companies they are related to, and individuals want to be close to workplaces, schools and shopping places. The first task of the city planner is to effectively locate integrated functions for various objectives. This is an important task, and sometimes even a mistake made in the decision of insignificant land use can be an important factor in the functional and economic development of the city in a long time (Dökmeci, 2015).

Haque & Asami (2014) stated that the urban land use decision-making process is always complex and the reasons for this complexity are the increased participation of stakeholders, the variety and variability of interests and priorities, as well as the contradictory, non-linear and non-aggregable nature of goals. They stated that land use allocation is a multi-objective optimization problem.

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In recent years, there has been an increase in models developed for the solution of land use problems. The developments in heuristic algorithm methods and the increase in computer computing power allow the development of such models and produce usable results.

This study aimed to examine how these developed methods can be beneficial for experts through a sample application. The optimum solution of the Multi-Objective Land Use Planning Model, which was described by Dökmeci (2015) as a problem was determined, the methods that can be used to solve this problem were evaluated, an application using genetic algorithm was developed, the success rate of this application was analyzed and the usage possibilities were evaluated. In order to determine the parameters of the genetic algorithm, a model was created with the multiple regression analysis method, and a statistical relationship was determined between the value of the parameters and the success rate and processing time.

While explaining land use allocation optimization techniques, special applications developed are taken as reference and these applications cannot be tried by the user. The problem chosen in this study is a problem that most city planners have to solve, and the developed application has been opened to the use of experts. This makes this study unique as it allows planning experts who are incapable of developing such methods to try it out. Rogers (2003) stated the characteristics that will be determinant in the spread of innovations as relative advantage, compatibility, complexity (simplicity), trialability achiveand observability. Simple and understandable model in this study which can be tried will help these methods to become widespread.

Dökmeci (2015) considers two objectives in this model. 1) Maximum profit 2) minimizing the distance between interrelated functions.

According to the first objective, the value of a land is considered to depend on the land use surrounding it. The city structure is shaped according to the most efficient land use resulting from the competition of urban functions for location selection.

There are movement of goods and people between each land use unit and its surrounding units in the city. The location of each unit is very tightly dependent on the location of the other units. The second objective is to minimize the transportation between various land uses.

$$Max\ z = \sum_{i=1}^{r} \sum_{j=1}^{r} \frac{V_{ij}}{1 + d_{ij}^{\alpha}}$$

z = Total income from land use in the area.

V_{ij} = Interaction of land use types i and j in terms of value

d_{ij} = Distance between land use types i and j

α = Distance influence coefficient

r = Land use type count

$$Min\ T = \sum_{i=1}^{r} \sum_{j=1}^{r} u_{ij}\ d_{ij}\ b_{ij}$$

T = total transportation

u_{ij} = transport demand between land use types i and j

b_{ij} = if there is a transport link between land use types i and j, 0 otherwise

There is a need for a multi-objective decision making method that will evaluate the result by balancing two different objectives. This multi-objective evaluation method is given in the figure below.

$$E(a) = \sum_{k=1}^{n} u_k \, e_k(a)$$

E(a) = Total efficiency of alternative a,

u_k = coefficient indicating the importance of the objective k,

e_k (a) = the effectiveness of alternative a for objective k,

n = number of goals

Our problem is to find the most efficient distribution of r numbers of land uses to c numbers of cells. According to the brute force method, this problem consists of calculating the efficiency values of r^c layout and choosing the best one. In a region consisting of 4 land use types and 20 cells, the effectiveness of 4^{20}, ie 1,099,511,627,776 layout should be calculated. If we assume that we calculate each plan in 1 second, we will need 34,865 years for all.

2. Optimization Approaches and Methods in Land Use Decisions

Arslanlı (2016) using the Hansen Model, cost-benefit analysis and multi-objective land use location model, aimed to place the population of 3,000,000 in Istanbul in suitable districts and locations in their research. Land use location selection model was used to determine how many sub-centers in districts is more effective.

Cao et al. (2011) defined land use optimization as different activities or land uses assigned to land area units that usually takes place at the city, sometimes neighborhood or urban scale.

Eldrandaly (2010) defined land use planning as a specific allocation problem which the planner tries to achieve the determined goals by changing land use rates and locations.

Tong & Murray (2012) stated that it is not appropriate to use exact methods in the optimization problem, because of the lack of a definitive solution method, the allocated time phase of the computation time, to focus on a single solution and not produce near-optimal alternatives. They stated that the heuristic method is an approach based on the practical rules, strategies and temporary procedures to be developed for the solution of the optimization problem and this method aims to determine the solution space in a way and find the best solution among the feasible solutions in this space.

Loonen, Heuberger, & Kuijpers-Linde (2007) stated that the most commonly used methods for land use are mathematical programming methods (linear programming, nonlinear programming, mixed-integer programming) and pseudo-heuristic methods (genetic algorithms, evolutionary programming, simulated annealing, neural networks).

Stewart, Janssen, & van Herwijnen (2004) stated that recent trends in land use planning cause the need to develop different types of algorithms. These trends; increasing stakeholder participation, increasing the complexity of the decision problem, using geographic information systems and using interactive decision support systems.

Liu et al. (2015) divided existing land use optimization models into three categories:

1. Linear programming models
2. Cellular automata models
3. Models based on intelligent algorithms

Xia, Liu, Liu, He, & Hong (2014) classified the current methods used to create land use zones on a regional scale in 4 categories:

1. Spatial superposition analysis
2. Multi-criteria analysis
3. Integer programming
4. Heuristic approaches

Linear programming models can quickly determine the most suitable land use structure based on specific land targets and constraints. However, these models cannot change the land use of the parcels and cannot make spatial optimization. Cellular automata models are based on land use conversion rules for local areas and can produce different land use patterns under different conditions using a bottom-up approach. Irrational land use in local areas can be adjusted using well designed land use conversion rules. However, optimization goals and other important macroeconomic factors cannot be easily incorporated into cellular automaton models (Liu et al., 2015).

Liu et al. (2015) created a land use spatial optimization model by combining a genetic algorithm and game theory. The genetic algorithm is continuously executed to optimize the spatial layout of each land use type separately. Using competitive zones as core units, the model draws on multi-stakeholder games and land use planning information to coordinate local land use competitions. The land use model of the solution is more rational than the current land use.

Li & Parrott (2016) prepared an advanced genetic algorithm that solves a model that aims maximum benefit, maximum ecological benefit, maximum convenience and maximum compactness in Okanagan (Canada). This model also contains constraints on housing demand and various regulations. The results of the study showed that the proposed method is consistent and can create an optimal land use scenario according to the preferred goals of stakeholders, thus having the potential to provide interactive technical support for land use planning. In this study, they also stated that future studies on land use optimization should focus on parallel computing to increase productivity and how to adequately consider future macro factors during the goal-constraint definition process.

Masoomi, Mesgari, & Hamrah (2013) used the multi objective particle swarm optimization algorithm, which is a type of genetic algorithm, for optimum land use placement at parcel level. They aimed to maximize compatibility, dependency, convenience and compactness. In this study, it was stated that the best alternatives could be determined for these 4 objectives and the most suitable among them could be determined from the Pareto Front chart. It was observed that the results produced significantly more successful results than current land use. In this study, they stated that good results can be obtained if the algorithm runs for a long time. It will be useful to investigate how the population number can be determined to increase the convergence speed of the algorithm.

Schwaab et al. (2018) examined different combinations of different crossover and mutation operators to improve the performance of genetic algorithms for multi-objective land use problems. As a result of the study, it has been shown that the use of different mutation operators, which includes at least one heuristic algorithm is more successful because it makes it possible to produce more different layouts.

3. Developed Genetic Algorithm and Application

According to the literature research, it was observed that using heuristic algorithm gives better results for optimum land use assignment and a special application was developed for this problem by using genetic algorithm approach. Details of this application will be explained later. The application can be reached from the following link: *http://www.hasanmutlu.com/index.php/land-*

use-optimization/ . The figures about the application are given at the end of the article. To use the software, first which land use types will be used should be selected. The number of rows and columns in the layout plan, the amount of transportation between these land use types and the value effect are entered (Figure 17). Later, in the land use drawing, the current situation is assigned to the cells or a random initial plan is generated (Figure 18). The efficiency value of the first assigned layout is calculated, the total value of the transportation, the total land value, the transportation importance coefficient and the land value importance coefficients are entered for the multi-objective decision and the efficiency value is calculated. In order to calculate the best layout, the layout plan and genetic algorithm parameters to be used are specified and calculations are made (Figure 19). The success of the process is evaluated by examining the resulting layout plan and the activity chart according to generations (Figure 20).

While developing the application, during the calculation of the location efficiency, the highest performance was obtained from the existing hardware by using the parallel algorithm.

Inputs:

- Basic layout map. In this map, the starting locations of land uses, prohibited areas, areas where land use will never change are indicated. Total cell count for each land use type will maintain.
- Total amount of transportation between each land use
- Value impact between each land use
- Alpha coefficient to be used for the effect of distance
- Maximum value of transportation, importance coefficient of transportation, total land value, importance coefficient of land value in order to calculate efficiency value.
- Number of populations in generation: Specifies the number of random layouts that will be created in each generation.
- Number of generations to be produced.
- Mutation Rate: It is the mutation rate to be applied while generating a new random layout plan.

Algorithm:

- Basic layout map is obtained.
- In the first generation, random layout plans are produced as much as the population number with the mutation rate determined from this map.
- Each layout plan is ranked according to its activity.
- If there are not as many generations as the number of generations produced;
    - The worst generation is removed from the list, the best generation is added one more.
    - Effectiveness of the layouts in the population is calculated.
    - Each layout plan is ranked according to its activity.
    - 1 child placement is created by applying the Partially Matched Crossover (PMX) method to 2 parents randomly selected according to the roulette wheel method as much as the population number. (Those with higher efficiency are more likely to enter the crossover process.)
    - Mutation is applied to the child layouts at the determined mutation rate. The new generation is formed.
    - The layout plan activity of the new population is calculated.
    - Each layout plan is ranked according to its activity.
    - The cycle continues.
- If the specified number of generations is reached, the process is completed, and the most efficient layout in the last generation is found as a result.

Details of the crossover process are shown in the Figure 1. This process explained by Taşkın & Emel (2009).

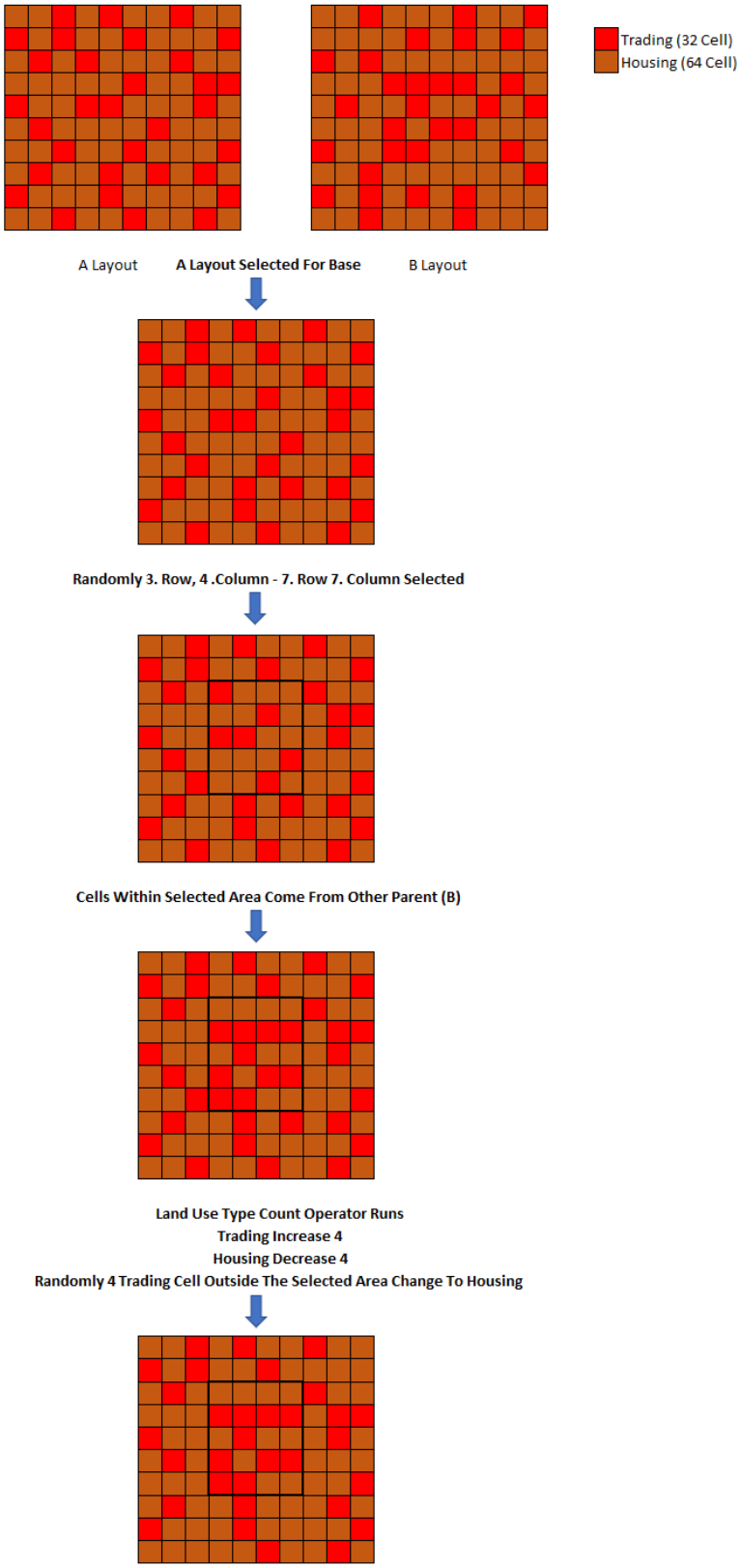

Figure 1 Details of the crossover process

By examining whether the solution of the determined problem is possible with the genetic algorithm, it has been evaluated whether this method can be used in land planning spatial decisions.

An artificial layout area was created in 2 different size and data prepared; the efficiency values were calculated by running the application with different parameters on these data. The parameters and efficiency values in the same data were examined by regression analysis and it has been tried to determine whether the real result (the most effective layout) can be achieved with this method.

Model Parameters:

Since an imaginary data is produced, transportation and value effect parameters are determined according to the general approach. According to these parameters, there is not much transportation between residentials, there is no transportation between tradings and the amount of transportation between residentials and tradings is high (Table 1 and Table 2). There is high level of transport between the residentials and industry. Recreation area is moderately accessible from residential and trading areas. Residential area has moderate positive impact on residential land value, trading has high amount of positive effect on trading and residential land value. The industry has negative value effect on residential and recreation areas, and the industry has high positive impact on other industries. Being close to residential has high effect, being close to trade has positive effect on industry. Importance of transportation is defined as 0.25 and importance of land value is defined as 0.75. Thus, residentials with high land value will be more effective.

Table 1 Transportation values

	Residential	Trading	Industry	Recreation
Residential	2	8	10	6
Trading	8	0	5	0
Industry	10	0	0	0
Recreation	6	5	0	0

Table 2 Land value impacts

	Residential	Trading	Industry	Recreation
Residential	5	10	-7	10
Trading	10	10	0	5
Industry	10	5	10	0
Recreation	10	5	-10	0

4. Data and Analysis

All processes were run on an Intel(R) Core (TM) i7-8750H CPU @2.20 2.21 GHz Windows 10 computer.

First Artificial Data

Most efficient layout of 64 residential area and 35 trade area is calculated with these 10 rows, 10 column data.

With the parameters, the application reaches which efficiency values is seen in Figure 2.

The trend line is logarithmic and the R^2 value is set at 0.7439. The time graph is also shown in Figure 3. Trend line is linear and R^2 value is set at 0.9998. When the layout plans are examined

according to their generations (Figure 4), it is observed that as the number of generations increases, the trade clusters in more centers as expected.

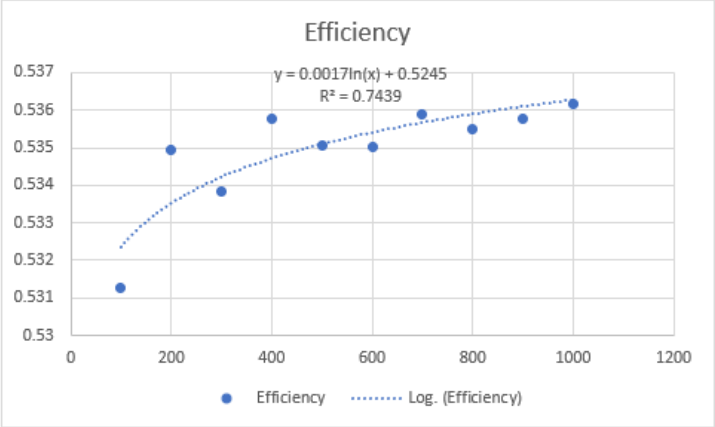

Figure 2 Efficiency chart by generation number

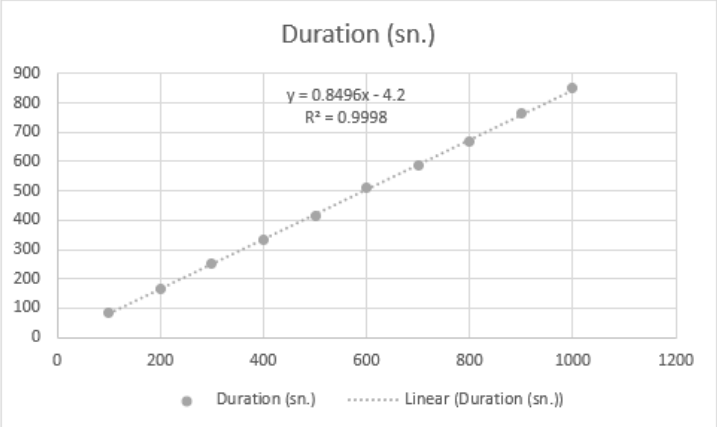

Figure 3 Time graph according to the number of generations

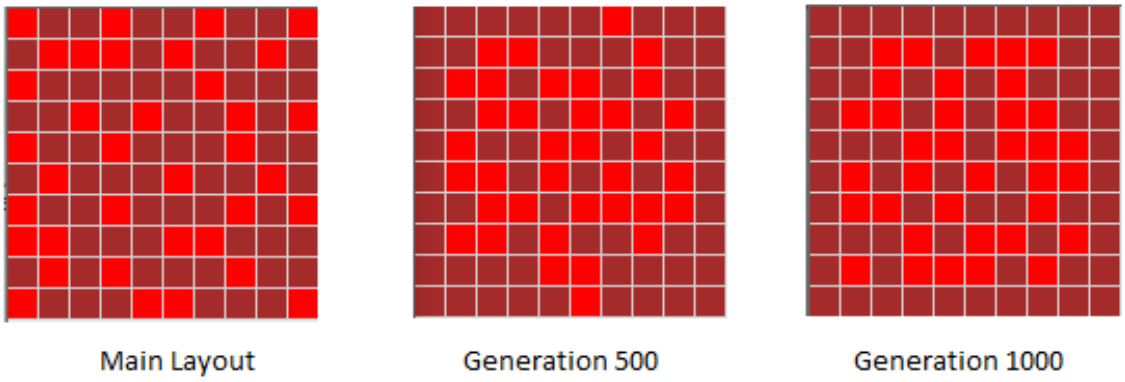

Figure 4 Layouts according to generations

In a 100-cell layout, a result close to what was expected was obtained in 900 seconds. It is getting more difficult to get more efficient results according to efficiency chart (Figure 2). However, who use this method and examine the layout plans according to the increase in generation values, they can predict the best layout pattern.

Second Artificial Data:

In this data, a 400-cell layout consisting of 20 rows and 20 columns was created, the best layout pattern of 252 residences, 64 trade, 64 industry and 20 recreation cells was tried to locate. As a result of this analysis, the following efficiency chart is created (Figure 5). The trend line of this graph is logarithmic and the R^2 value is determined as 0.4699. This value has shown us that generations with 200 populations in so many cells will not produce consistent results. For this reason, the application was run for 500 populations. As a result of this study, the R^2 value was found to be 0.823 (Figure 6). The trend line of the process duration was formed linearly and the R^2 value was found to be 0.9998 (Figure 7).

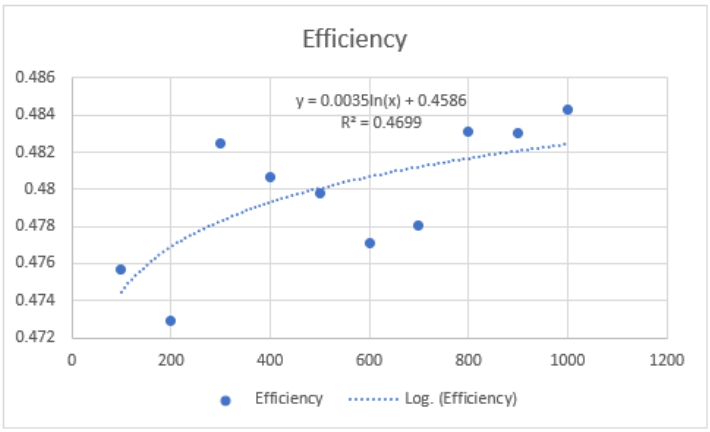

Figure 5 Efficiency chart by 200 population and generation number

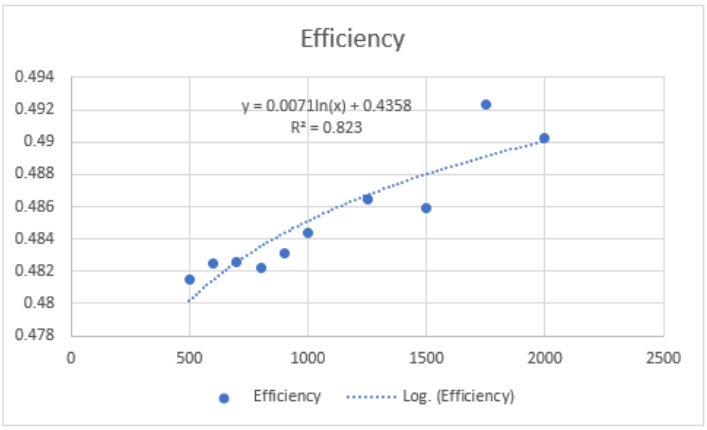

Figure 6 Efficiency chart by generation with 500 population

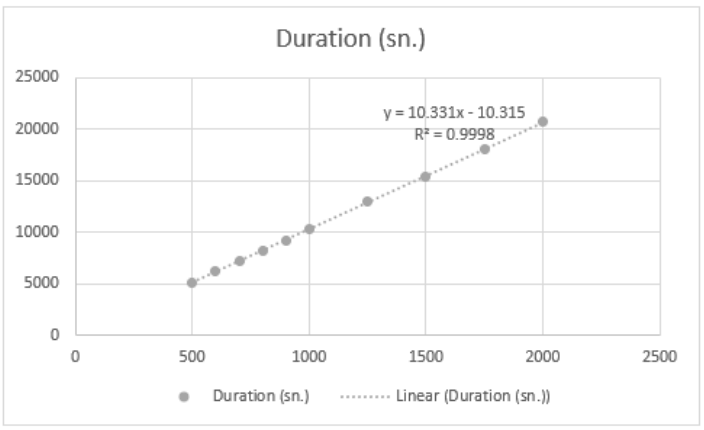

Figure 7 Process duration graph according to the number of generations with 500 population

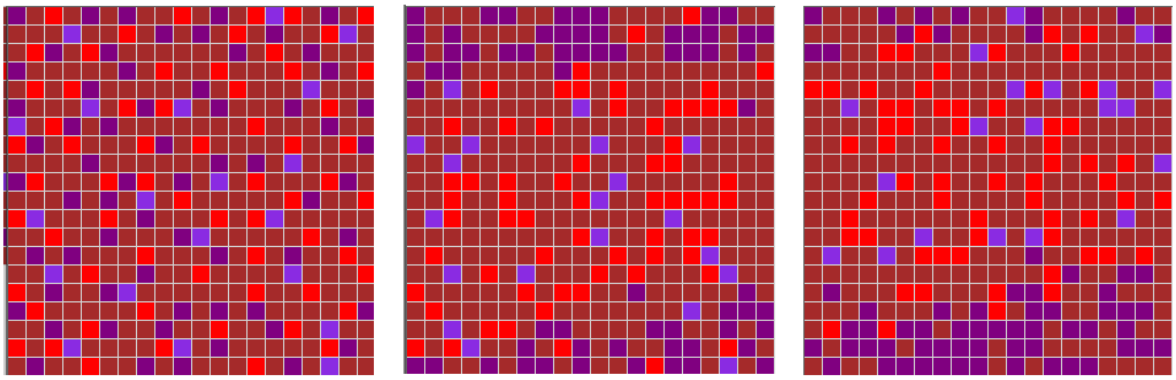

Figure 8 Layout patterns with 500 populations (Main layout, 500 generation, 2000 generation)

When the results of the analysis with 500 populations are examined, it seems that the industry tends to settle by clustering at the outermost part of the area, small clusters have formed between the trade and residentials, and the recreation areas are located in such a way that they are not very close to the industry and each other (Figure 8). These results are reached by running the application with 10 different generation numbers and the analysis lasted 31.5 hours.

According to these studies, it has been tried to create a statistical model that will provide a suitable population and number of generations according to the cell number. The software was run 100 times with different parameters and the results and parameters were analyzed.

The ratio of the efficiency value to the possible maximum efficiency value was determined as the dependent variable, and a multiple regression analysis was performed by multiplying the number of cells, population and generation. In this model, since the nature of the process is exponential, the R^2 value was found to be as low as 0.18 nevertheless the coefficients were found to be at the correct sign and appropriate. Also, it was observed that this correlation gave generally correct results in trials. (Figure 9).

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.417686088
R Square	0.174461668
Adjusted R Square	0.15744026
Standard Error	12.15110642
Observations	100

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	3026.677592	1513.338796	10.24954335	9.15707E-05
Residual	97	14321.99057	147.6493873		
Total	99	17348.66816			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	81.22112752	1.395285437	58.21111963	2.96348E-77	78.45187216	83.99038287	78.45187216	83.99038287
Cell Count	-0.003325265	0.001151078	-2.888827186	0.00476957	-0.005609835	-0.001040694	-0.005609835	-0.001040694
PopGen	4.51272E-06	1.38535E-06	3.257454674	0.001549806	1.76318E-06	7.26226E-06	1.76318E-06	7.26226E-06

Figure 9 Multiple regression for efficiency success rate

$$ERatio = 81.22113 + (\text{CellCount} * \ -0.0033252) + (Pop * Gen * 4.51272E - 06)$$

ERatio = Percentage of efficiency success (significant between 0 and 100)

CellCount = Cell Number

Pop = Population in a Generation

Gen = Generation Number

PopGen = Population in a Generation times Generation Number

The process duration was determined as the dependent variable, the efficiency rate success percentage, cell number, population and generation number multiplication and the number of land use types were determined as independent variables, multiple regression analysis was performed. The R^2 value of this model was found to be as high as 0.78 and the coefficients were formed in the expected sign. (Figure 10)

Regression Statistics	
Multiple R	0.885397033
R Square	0.783927907
Adjusted R Square	0.774830134
Standard Error	3317.426167
Observations	100

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	3793181142	948295285.5	86.16701723	9.46055E-31
Residual	95	1045505055	11005316.37		
Total	99	4838686198			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-10900.83322	3382.775754	-3.222452213	0.001741687	-17616.49218	-4185.174254	-17616.49218	-4185.174254
Efficiency Ratio	90.37696245	32.29970263	2.798074134	0.006224716	26.25394539	154.4999795	26.25394539	154.4999795
Cell Count	3.622790945	0.465145335	7.788513975	8.37824E-12	2.699360702	4.546221189	2.699360702	4.546221189
PopGen	0.00435792	0.000398493	10.93601084	1.67962E-18	0.003566812	0.005149028	0.003566812	0.005149028
Land Use Type Count	1307.332994	401.9883973	3.25216599	0.001585942	509.2851247	2105.380863	509.2851247	2105.380863

Figure 10 Multiple regression results for process duration

$$Dur = \text{-10900.83322 + (ERatio * 90.37696) + (CellCount * 3.62279) + (Pop * Gen * 0.0043579) + (LandUSeCnt * 1307.33299)}$$

Dur = Operation Time (seconds)

ERatio = Percentage of Activity Success Rate (0-100)

CellCount = Number of Cells

Pop = Population in a Generation

Gen = Number of Generations

PopGen = Population in a Generation times Generation Number

LandUseCnt = Land Use Type Count

Using the above two equations, it has been examined how successful the application can yield in real cities. 6 cities of various sizes in Turkey are analyzed by dividing into cells of 300 meters width and height and how many cells will be used for analyses is determined. For analysis of 8 different land use types and 99% effectiveness success rate, how many population and generations are needed is determined and the duration of the processes was calculated with these parameters. According to the Table 3, it is estimated that a result with a successful efficiency value of 99% can be achieved with a processing time of about 1 day in small cities, the result can be achieved in 2 days in large cities, in a week in very large cities, and in 1.5 months in metropolitan-scale cities.

Table 3 Application's estimated success performance analysis by cities

	Very Small	Small	Medium	Large	Very Large	Metropolitan
City Population	55,300	125,000	306,000	900,000	3,000,000	16,000,000
Cell Count	176	289	1,156	1,500	6,318	41,648
Land Use Type Count	8	8	8	8	8	8
Population (Genetic Algorithm)	500	650	800	1500	2500	4500
Generation	8000	6500	6000	3500	3500	7700
Efficiency Success Ratio	98.687	99.326	99.038	99.925	99.698	99.096
Execution Duration (second)	33533.468	45135.970	129139.563	163436.542	631580.074	4065461.494
Execution Duration (hour)	9.315	12.538	35.872	45.399	175.439	1129.295
Execution Duration (day)	0.388	0.522	1.495	1.892	7.310	47.054

A similar study with artificial data was also applied on Eskişehir in order to better understand this issue, and its real-world equivalent was examined.

Eskisehir is a city in Türkiye's Central Anatolia Region where population is 783.611 and 141 km² urban area with well-developed industry and trade. Eskişehir's urban area is divided into 1000 meters wide and high (100 hectares) cells and existing land uses are assigned to these cells. 630 cells were created with 18 rows and 35 columns. Industry, trade-service, and residential areas have been determined as the land uses for which optimum layouts will be determined. 50 cell (5.000 h.a) housing, 7 cell (700 h.a) trade, 21 cell (2.100 h.a) industrial area have been determined in existing 2020 layout. (Figure 11) By examining the Eskişehir Master Plan for 2030, it was determined that the distribution of these land uses was planned as 70 cell resident (7.000 h.a), 15 cells (1.500 h.a) trade, 47 cells (4.700 h.a) industrial area. (Eskişehir Municipality, 2015) Using the application, the best distribution of 20 residences, 8 commercial and 26 industrial cells was tried to be determined. In this scenario, it is accepted that the existing residential areas can be transformed into trade and industry, but the functions of the existing commercial and industrial areas will not change. The transportation and land value parameters in Table 1 and Table 2 were used, and the effect alpha parameter of transportation was taken as 2. The application was run using the values in Table 4.

Table 4 Optimum plan parameters used for Eskisehir

	Value
Max Value For Transport	1,500,000.0
Max Value For Land Value	12,000.0
Importance Ratio For Transport	0.25
Importance Ratio For Land Value	0.75

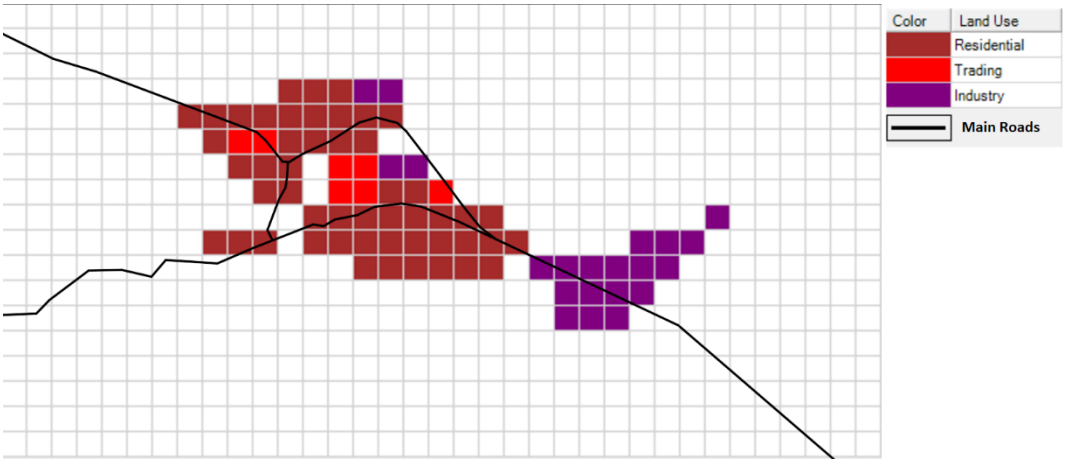

Figure 11 Eskişehir 2020 existing land use

The land use types to be added for the first layout of the application were randomly placed and population and generation numbers were found using the above efficiency and duration equations. The application was run with the parameters in Table 5 and the results in this table were obtained. The alternatives formed as a result of the analysis are shown in Figure 12, Figure 13, Figure 14, Figure 15. The analysis with 5700 generations reached the highest efficiency value. Later, the result of 5700 generations was accepted as the initial layout and analyzes were made. In these analyzes, the best layout after each analysis was used as initial layout and this layout was tried to be improved. The results of these studies are shown in Table 3. Result of these studies, the layout with the best efficiency value of 0.50411 was reached after approximately 15 hours of calculation. This layout is shown in Figure 16.

Table 5 Analysis parameters and results made with different generation numbers

	Population	Generation	Mutation Rate(%)	Duration (hh:mm)	Efficiency
1. Try	800	800	20	00:55	0.46836
2. Try	800	1250	20	01:23	0.46316
3. Try	800	2500	20	02:46	0.46942
4.Try	800	5700	20	06:07	0.46430

Table 6 Parameters and results of analyzes made to optimize the 5700-generation layout

	Population	Generation	Mutation Rate(%)	Duration (hh:mm)	Efficiency
5. Try	500	2500	20	01:45	0.47978
6. Try	500	2500	20	01:44	0.49097
7. Try	800	4000	20	04:18	0.49965
8.Try	500	2000	20	01:22	0.50411

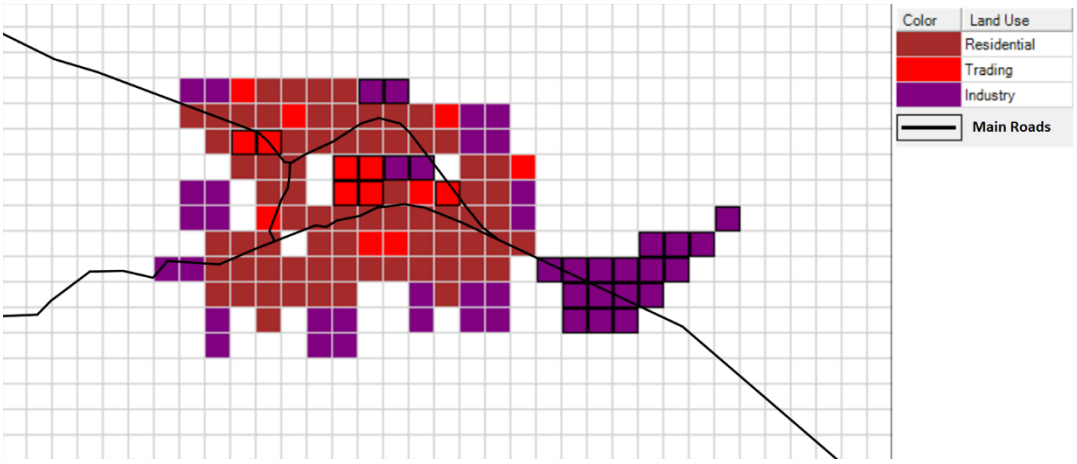

Figure 12 800 Population, 800 generation layout

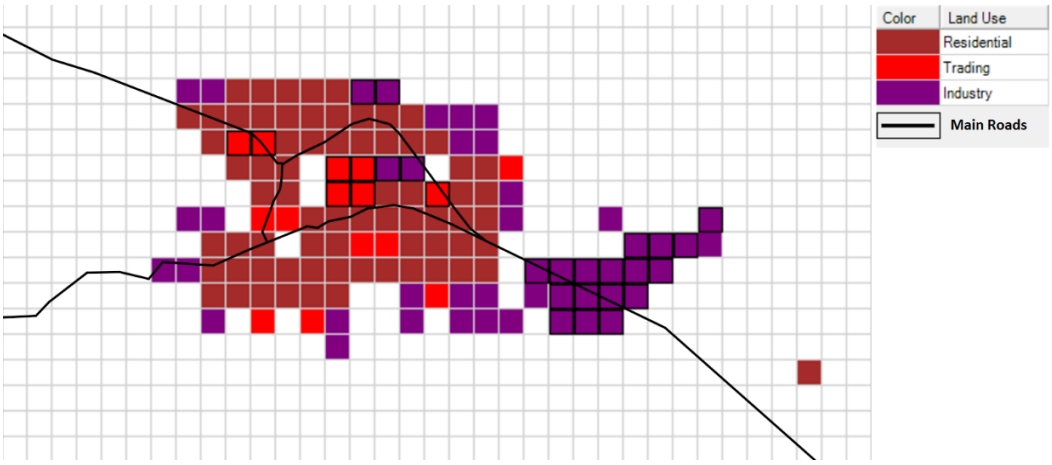

Figure 13 800 Population, 1200 generation layout

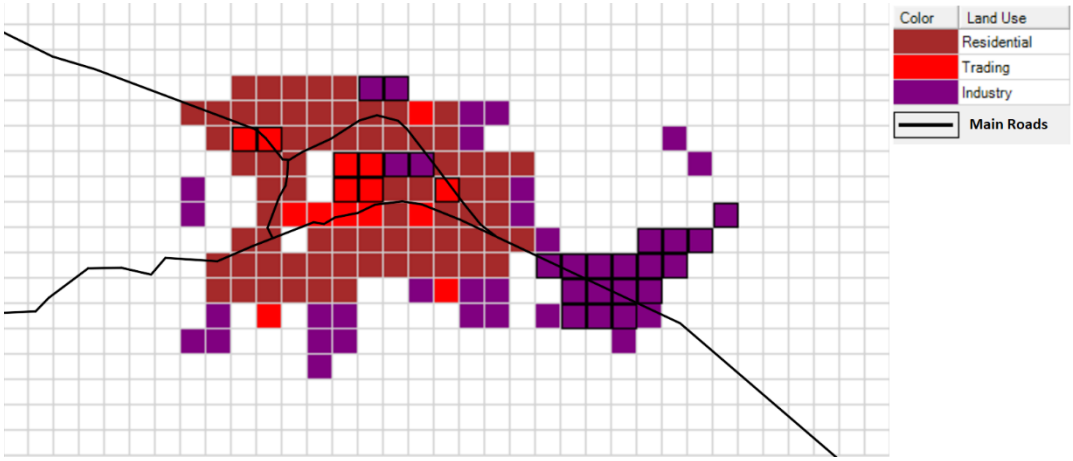

Figure 14 800 Population, 2500 generation layout

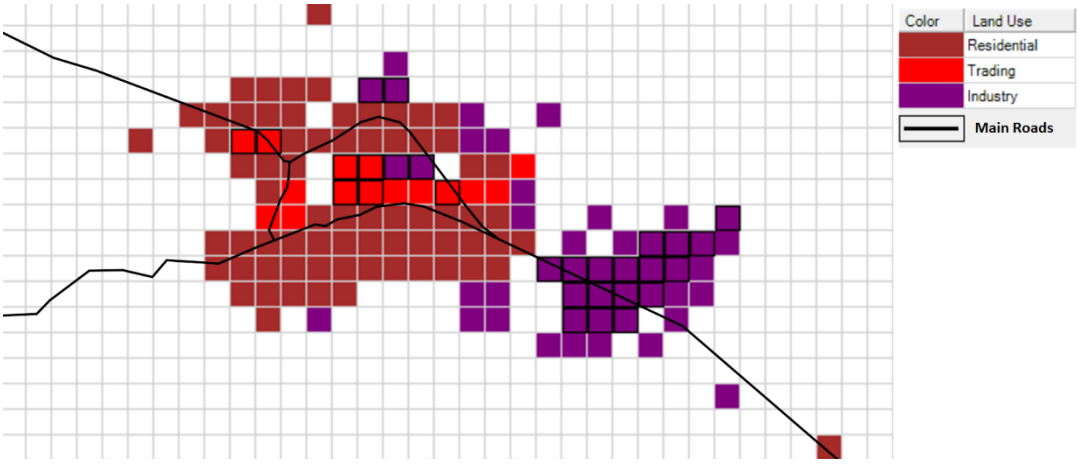

Figure 15 800 Population, 5700 generation layout

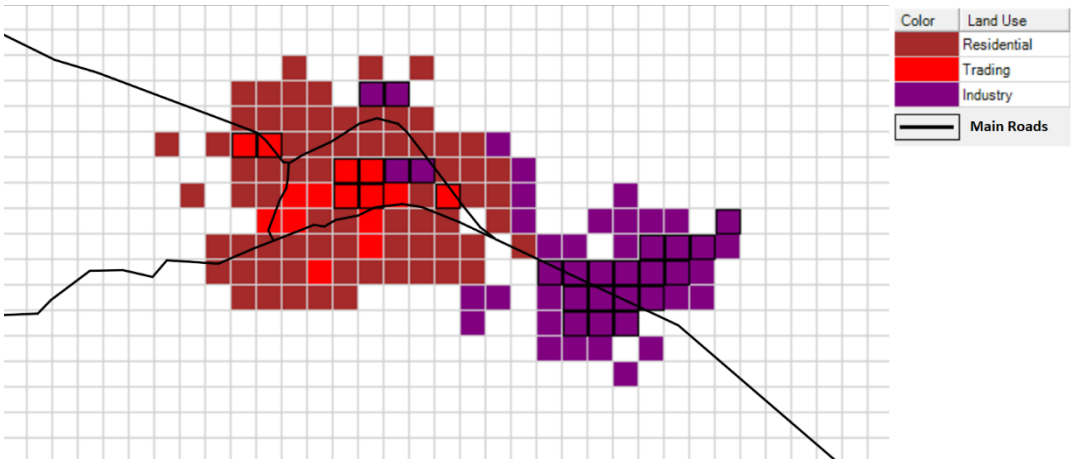

Figure 16 The layout with the highest efficiency value

When the results and layouts produced by the application are examined, it is thought that this method and application will be useful in order to produce more efficient layout alternatives in acceptable time.

5. Conclusion

As a result of this study, it has been shown that the problem of finding the best layout plan according to the transportation and land value effect can be solved in a reasonable time with the genetic algorithm, even if the best layout cannot be found, with the best layouts produced and analyzed with different parameters, the features of the most effective layout can be determined. Klosterman (2008) accepts 4 design principles regarding planning tools. All models are wrong, some models are useful, it is difficult to predict the future, the models should be simple, the present model is the best available data. It is thought that the method developed according to these principles can be useful to experts with its simple use, less data requirement and reasonable performance.

Tong & Murray (2012) stated that spatial optimization studies will focus on the issues of abstraction and representation of data, evaluation of multiple goals and constraints and Geographic Information System integration in the future. Planners develop their designs by producing different alternatives and comparing them. With the additions to the developed genetic algorithm, instead of focusing on a single alternative, an algorithm can be prepared that produces different alternative results in a specified number. Feng & Lin (1999) and Cao et al. (2011) addressed this problem and tried to produce and evaluate different alternatives for their objectives. In addition, this method does not take into account the facility-location hierarchy observed in multi-center cities. More realistic layout plans can be produced by developing model constraints to simulate hierarchy in the city. By increasing the objective functions, it can be ensured that it includes features such as environment, economy and livability. Some more appropriate methods can be used to evaluate multi-objective functions and constraints together more accurately. As an example of these methods, Masoomi et al. (2013) use the Analytical Hierarchy Process method and structured binary comparison methods to optimize multiple objectives.

As Schwaab et al. (2018) stated by, developing problem-specific heuristic algorithms is critical for developing applications that reach the optimum solution in a shorter time. In order to develop such algorithms, it would be useful to examine the use of experts' domain knowledge. Performance increases may be experienced with the improvements in the calculation process to be made in parallel with the developments in software and hardware. Ensuring that the calculation of the efficiency value can be done on the Graphics Processing Unit (GPU) will shorten the operation time of the process and make it a more useful tool. Zhou & Tan (2009) developed an application of the

Particle Swarm Optimization algorithm using GPU and stated that this application can run 10 times faster than the version using CPU. It is thought that such a performance increase will greatly increase the possibility of using such methods in real problems.

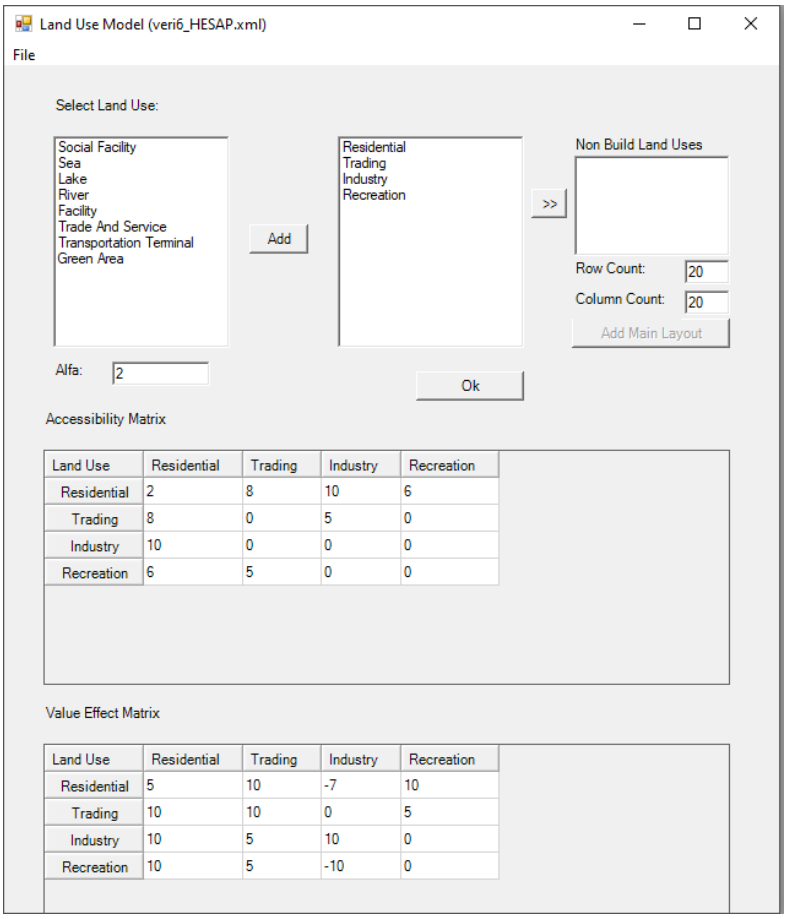

Figure 17 Inputs of the application

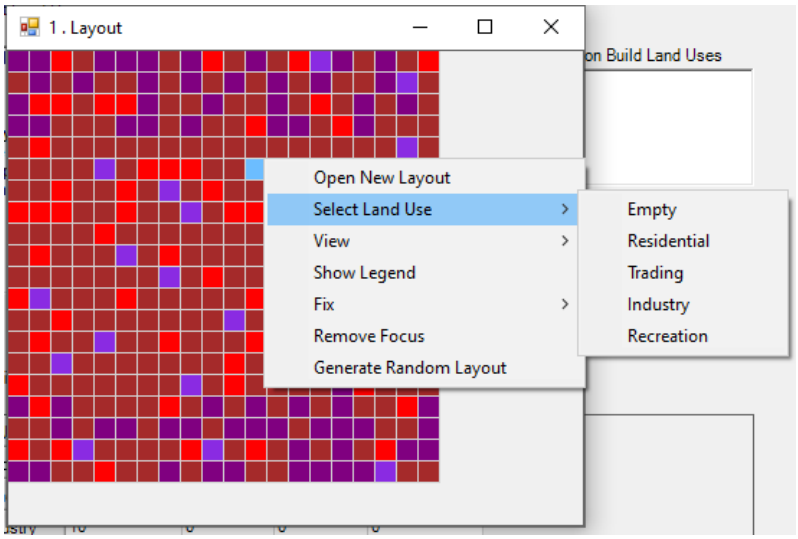

Figure 18 Layout preparation operations

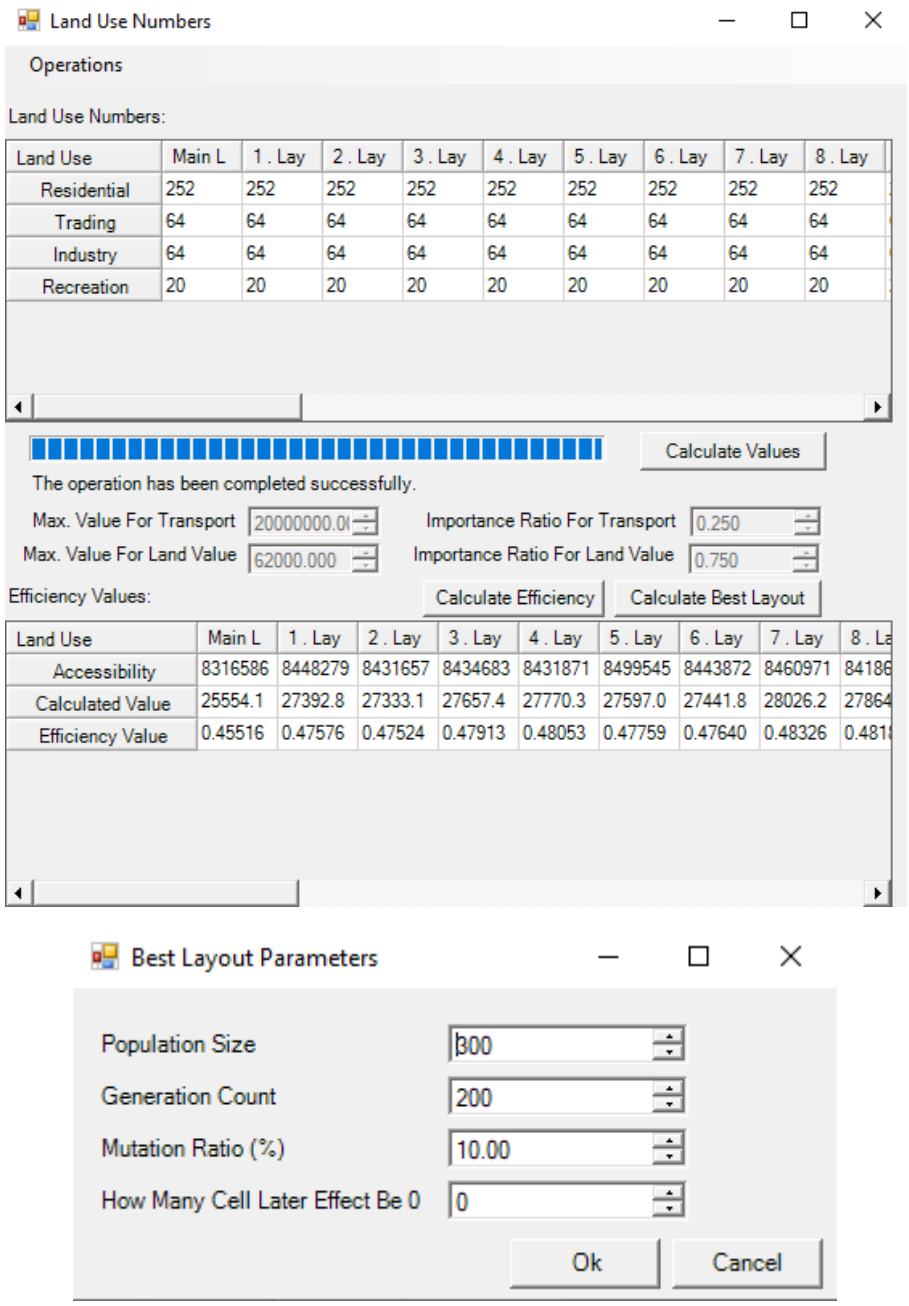

Figure 19 Results and best layout parameters

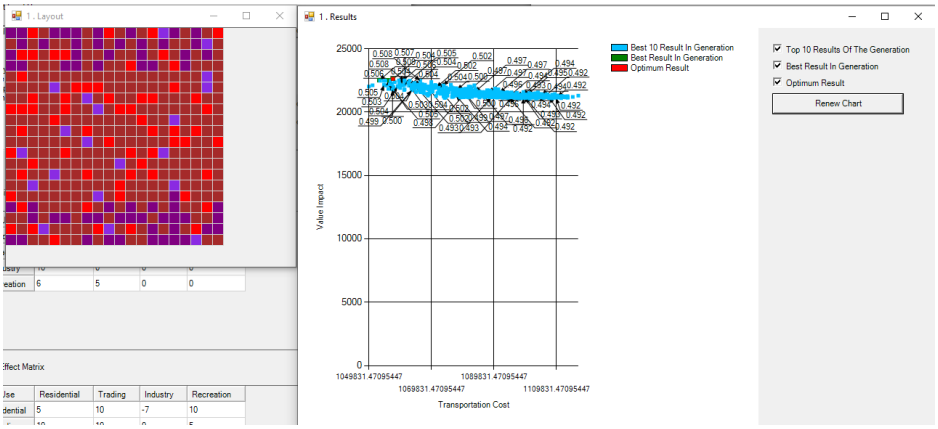

Figure 20 Best results graph of result layout and generations

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Resume

Hasan Mutlu has been working as a software specialist for 14 years for Netcad which has been developing GIS and CAD applications. He develops CAD and GIS based software related to civil engineering and city planning. He specializes in developing optimization algorithms on these fields. He took part in various Planning and Research Projects (İstanbul Metropolitan Area Plan (2005) – İstanbul Historical Peninsula Plan (2001)) as a consultant. He has academic articles in international/national journals and several conference papers in international conferences.

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Examination of vertical green systems in educational buildings: a field study in Çukurova University

Ülkü Şimşek*
Özlem Şenyiğit**

Abstract

The concept of sustainability, which is currently sitting on our agenda with increasing environmental pollution has gradually increased its importance. In order to leave a livable ecosystem for new generations, it is essential that individuals are given the necessary education within the scope of the issues that need to be done. The best training is hands-on training. A person can internalize the concept that he sees, touches, feels in the environment in which he is located, that is, lives with all his perceptions. In this case, building educational structures with the goals of sustainable architecture is an important step in terms of instilling the concept of sustainability in the younger generations. In the context of sustainable design, vertical green systems have taken an important place with the technological developments in recent years and it has been shown that they contribute to achieving sustainable design goals. It is believed that the application of these systems in school structures will make it easier for students to explain the concept of herd, because they are experiential. For these reasons, the aim of the study is to reveal the benefits of vertical green systems in terms of sustainability in educational structures and to present a study that can provide resources for sustainable school designs.In the study, the benefits of vertical green systems were discussed in the context of reducing the urban heat effect, improving air quality, absorbing noise and saving energy. Energy analysis was carried out through revit program by applying vertical green system to the educational buildings selected from Adana Çukurova University in order to demonstrate the benefits of vertical green systems within the scope of energy conservation with data. As a result of the evaluations made, the electrical energy savings of green vertical systems were revealed with numerical data and the criteria to be considered for an environmentally beneficial vertical green system application were explained.

Keywords: vertical green system, educational building, energy analysis.

1. Introduction

Today, environmental pollution and deteriorating natural balances threaten the entire world ecosystem. Whether many of the resources we have will exist in the future is considered from different perspectives and is a subject of discussion. In this context, the concepts of "sustainability" and "sustainable architecture" come to the fore. Sustainability refers to a balance that adapts to human needs without reducing the productivity of health and natural systems (Mendler and Odell, 2000). AIA (American Institute of Architects) defines the concept of sustainability as: “the continuity

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***This article is based on the MSc thesis entitled 'Eğitim Yapılarında Dikey Yeşil Sistemlerin İncelenmesi: Çukurova Üniversitesi Özelinde Alan Çalışması' that was conducted within Ç.U. Master of Architecture Program in 2018.

of the future functionality of the society without disrupting the balance regarding the depletion or overload of the basic resources needed by the system" (AIA, 2007).

It is imperative to provide individuals with the necessary education within the scope of the issues that need to be done in order for the balance of nature to continue without disruption, to be protected, and to be transferred to future generations in a livable manner. In order to achieve this, firstly, education policies aiming at raising conscious individuals should be formed. Afterwards, it is necessary to go beyond adding the sustainability issue to the education curriculum and to design the educational structures themselves in line with sustainable goals. Sustainable design goals include increasing air quality with natural ventilation, providing energy efficiency, waste management, and water conservation.

With the technological developments in recent years, vertical green systems have taken an important place within the scope of sustainable design, and it has been demonstrated that they contribute to achieving sustainable design goals. It is thought that the application of these systems in school buildings will make it easier to explain the concept of sustainability to the students due to their experiential nature. If vertical green systems are applied to the building, the benefits in terms of sustainability can be summarized as follows: It regulates the microclimate by reducing the average temperature of the environment and decreases the wind speed, it absorbs solar radiation and plants can reduce solar radiation with the effect of evaporation, which regulates humidity levels and surface temperatures. Also, vegetation provides building energy saving. For these reasons, sustainable education building design, which does not ignore environmental problems, was supported and the benefits of vertical green systems, when applied to educational buildings, were examined. The study also evaluated the effects of these systems on heating and cooling loads on educational buildings and their energy performance.

2. Basis of Study

The population in the world is increasing rapidly, and this increase brings along some problems with it. This rapid increase in the urban population causes the growth of cities and the construction excessive number of buildings. This increases the loss of green space gradually. Frequently encountered applications such as sustainable active systems, passive systems, integration of these systems into the design, green roof systems are practices aimed at replacing lost green space and solving these environmental problems. Vertical green systems are one of these applications. However, especially in our country (Turkey), there is an insufficiency regarding the application of vertical green systems, and its benefits to the environment are not exactly known.

Even if sustainable design practices are sufficient in number and quality, they will not provide a complete solution to environmental problems. It will be possible to be able to speak of success in achieving sustainable goals only through raising awareness of our people on this issue. In this respect, it is important to create education policies in line with sustainable goals. As Şahin EB, Dostoğlu N. stated; "Ensuring awareness of sustainability is attached utmost importance by educators, and "education for sustainability" programs are included in all levels of education starting from pre-school education so that children can learn the gains of this perspective at an early age. As a supporter of this understanding, it is thought that educational buildings themselves should be a laboratory where theoretical knowledge taught in schools can be experienced" (Şahin and Dostoğlu, 2015). It is believed that the application of vertical green systems, which are among the sustainable design solutions, in educational buildings will enable students to experience their theoretical knowledge since these systems will be directly observed. The thought that vertical green system applications, which we encounter frequently around the world, are not attached to the

importance they deserve in our country has been one of the factors that formed the basis of the study. In this respect, examples of vertical green systems applied in educational buildings were examined in the study, and it was aimed to demonstrate the benefits of vertical green systems within the scope of sustainability by simulating it.

3. Scope of Method

In the study, examples of vertical green systems applied in educational buildings were examined, and the benefits they provided in terms of sustainability were tried to be revealed. In this context, within the scope of the study, the answers to the questions,

- What is the concept of sustainability and sustainable architecture, and why are they important?
- What is a vertical green system within the scope of sustainable architecture? What benefits does it provide?
- What are the needs of educational buildings in terms of sustainability?
- What are the place and benefits of vertical green systems in educational buildings? were sought by the literature review method.

In the study, the benefits brought about by the application of vertical green systems examined within the scope of sustainable design in educational buildings were investigated. Within the scope of these benefits, the effect of vertical green systems on energy conservation was aimed to be revealed with data, and fieldwork was carried out for this purpose. Fieldwork was carried out at Çukurova University in Adana province in Turkey. Since the benefits of vertical green systems according to their facade directions were aimed to be compared, two educational buildings with similar facade proportions but differently positioned were selected. The study was carried using the Revit program on the BIM platform.

In order to perform the energy analysis of the buildings selected in the Revit program, a modular living wall system, whose modules can be supplied when an addition is needed and can be changed regularly, was preferred as a vertical green system type. The system provides ease of maintenance and enables repair in case of any malfunction. The modular living wall system type that was chosen was applied along the north and south facades of the A-block building of the Faculty of Economics and Administrative Sciences, whose north and south facades were wider. The east and west facades of the R2 classrooms building were wider, so the living walls were applied to the east and west facades of the building. Afterwards, the energy analysis of the buildings was made in the Revit program.

4. Literatur Review

4.1. Sustainability and Sustainable Architecture

Sustainability, in its dictionary meaning, is "the method of harvesting and/or using a resource so that the resource is not depleted or permanently damaged" (Merriam-Webster, 2002). The most common definition of sustainability was made in the Brundtland report as “Meeting the needs of today without compromising the opportunity of future generations to meet their own needs” (Brundtland, 1987). As Sylvan and Bennett (1994) pointed out in their work, being more green necessitates some commitment on the part of humans to limit or reduce their environmental impact on the world or its regions. This means that one of the following should be done in the future: reduction of the human population, or the majority of people adopting a lifestyle that has less impact on the environment or advances in technology to reduce the overall impact (Sylvan and Bennett, 1994). For these reasons, we should look for ways to transfer our resources to future generations, bearing in mind the deteriorating natural balances and the endangered world

ecosystem. At this point, the concept of sustainability gets into our agenda and is frequently discussed today.

The buildings, which are the products of architecture, and the building sector consume most of the resources produced in the world compared to other human activities, and indirectly have a great impact on issues such as global warming, acid rain, and excessive accumulation of waste. Buildings cover 10% of global economic activities, consume 40% of material and energy production in the world, are responsible for 17% of freshwater consumption and use 25% of annual global wood production (Curran, 2000). Since the construction sector is the only sector that has such a great impact on the global environment, it is a necessity to improve the environmental impacts of all building-related activities. In this context, the issue of creating a widespread awareness about environmentally sensitive and sustainable architecture and construction comes to the fore as the only solution in the field of contemporary architecture.

4.2. Vertical Green Systems in Sustainable Architecture and Their Historical Development

The concept of green walls refers to all systems which enable greening a vertical surface (e.g., facades, walls, blind walls, partition walls, etc.) with a selection of plant species, including all the solutions with the purpose of growing plants on, up or within the wall of a building (Manson and Castro-Gomes, 2014). Today, green systems are not just green surfaces covered with plants. Green systems are green walls and roofs used as passive cooling systems that can increase the scale of greenery in the city. Green walls and roofs contribute to vegetation throughout the urban environment. The first green wall can be traced back to the 11th century and the Vikings' period. The Vikings used stones, timber, and peat bricks to construct their habitations. Peat is an accumulation of partially decayed vegetation matter; it is formed in swamps or similar environment. When the Vikings used peat brick, grass naturally grew on this organic material. The habitation was therefore covered with vegetation (Bjerre, 2011).

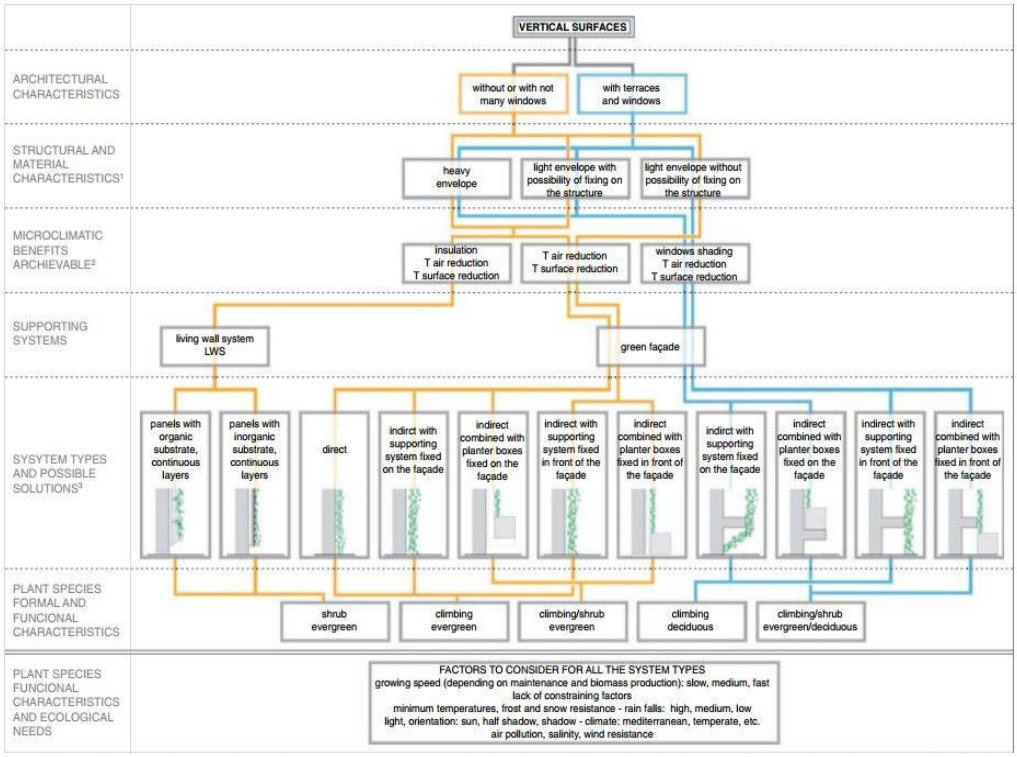
In the 1920s, Britain - through the well-known “Green City Movement” - and North America promoted trellis structures and self-climbing plants on houses and gardens, but the greatest evolution occurred in 1988, when the French botanist Patrick Blanc, who is the inventor of the Vertical Garden (Mur Végétal), started to use stainless steel cable system for green facades. Patrick Blanc introduced a controlled environment where the plants were in contact with neither the wall nor the soil. Load-bearing walls don't need to be stronger because the metal frame carries the load of the installation (Papadopoulou, 2013). An important “point of reference” to the evolution of the green wall systems is 300 green wall panels translated into 3,500 m2 of the planted wall became the landmark of the EXPO 2005 in Japan. (Papadopoulou, 2013) (Photo 1).

Photo 1 Bio Lung, Expo 2005 Aichi Japan World Fair (URL-1)

4.2.1. Vertical Green System Design Criteria

"In the design of greening systems, many issues such as integration with the building, sustainable material selection, environmental impact and symbiosis between the growth environment and vegetation, economy-related to costs and potential savings should be taken into account (Perini, Ottele, Haas, Raiteri, 2013). In addition to these, the most important point to be considered in a vertical green system design is the facade features of the building. It is important to know the parameters of the facade and to design accordingly in order to make a design suitable for the climate in a vertical green system to be applied. The compactness-gap ratio of the facade, whether it is terraced or not, its location relative to other buildings' facades, the facade direction, the features of the facade shell, and the solar control applied on the facade are parameters related to the facade. Among green facade types, cable, wire, mesh, net system, or modular cage system can be applied. Microclimatic benefits of these systems to the building will be in the form of shading the windows and decreasing air temperature and surface temperature (Table 1).

Table 1 Process tree for green facades and living wall systems (Perini et al., 2013)



4.3. Classification of Vertical Green Systems

There are various classifications of vertical green systems in the literature according to their structural designs, application areas, growth environments, and plant species. As a result of the examination of all types of vertical green systems that are classified according to different criteria, groupings of vertical green systems, application methods, structural designs, and classifications according to plant species were brought together in an effort to form a holistic table in order to provide a guide for future studies (Table 2).

Table 2 Classification of vertical green systems (prepared by the author)

VERTICAL GREEN SYSTEM	GREEN FACADE	Method of application	Modular Trellis Panel System	
			Cable and Wire-Rope Net Systems	
		Fixation principles against the facade	Direct	Direct systems rooted in soil
				Direct systems rooted in pots
			Indirect	Indirect systems rooted in soil
				Indirect systems rooted in pots
	LIVING WALL SYSTEM (LWS)	Plant growth the medium type	Loose medium system	
			Mat type medium system	
			Structural medium system	
		Method of application	Modular living wall	
			Mur Vegetal	
			Biofiltration wall	
			Landscape wall	
		Substrate material	Potted Systems	
			Foam based system	
			Felt layer based system	
			Mineral wool based system	
	VEGETATION WALL	Natural Vegetation		
		Application Of Wall Panel Suitable For Plant		
	LOCATION OF APPLICATION	Indoor Vertical Green Systems		
		Outdoor Vertical Green Systems		
	STRUCTURAL FEATURES	Free Vertical Green Systems		
		Integrated Vertical Green Systems		
	PLANT TYPE	Vertical Green Systems Used in Shrub Plant		
		Vertical Green Systems Used in Climber Plant		

4.3.1. Green Facades

Green facades are a type of green wall system in which climbing plants or cascading ground covers are trained to cover specially designed supporting structures. Green facades can be anchored to existing walls or built as freestanding structures, such as fences or columns (URL-2). Green facades are classified according to their application and the principles of fastening to the facade (Table 3) (Figure 1).

Table 3 Green facade classification

Green Facades	**Green Facades According to Application Type**		**Modular Trellis Panel System:** The building block of this modular system is a rigid, light-weight, three-dimensional panel made from a powder-coated, galvanized and welded steel wire that supports plants with both a face grid, and a panel depth. This system is designed to hold a green facade off the wall surface (Papadopoulou, 2013).
			Cable and Wire-Rope Net Systems Such systems are more suitable for the support of faster-growing plants with denser foliage (via grids) than for slower climbers. (GRHC, 2008).
	Green Facades According to the Fixing Principle on the Facade	**Direct**	**Direct vegetation rooted in the soil** Such green facades rooted in the ground take nutrients and water from the soil and grow by climbing the structure (Mir, 2011).
			Direct vegetation rooted in pots In direct vegetation rooted in pots, the plant is planted in prepared pot systems, not directly on the ground, and the plant grows again by climbing the structure (Mir, 2011).
	Indirect		**Indirect vegetation rooted in the soil** For the plant species, specially designed support systems can be applied to allow the plants to grow on the structure and cover the facade (Mir, 2011).
			Indirect vegetation rooted in pots The plant planted in pot systems grows on the above-mentioned modular cage panel systems and cable and wire mesh network systems (Mir, 2011).

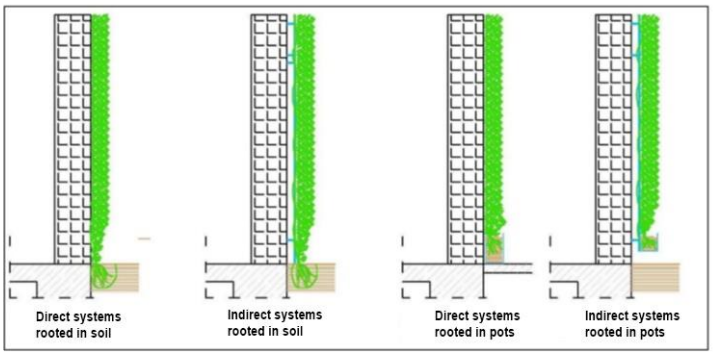


Figure 1 Green facade types (Mir, 2011)

4.3.2. Living Wall System (LWS)

Living walls; they are "living walls" specially constructed to provide a vertical growing surface for plants using. The base structure of a simple living wall consists of an irrigation system in a form of pipes, a corresponding framework which plays the role of a supporting system and stainless steel panels which contain the growing (or growth) medium. A living wall system (also referred to as a bio-wall, ecowall or vertical garden) differs from green facade in that it can be installed almost anywhere in or upon a building and may be freestanding or attached to an existing wall. It is typically more permanent and is composed of a structural framework supporting a layered assembly or modular panels that contain a growing medium — such as packed soil, fiber mats, or some other substrate — and an integrated irrigation system that cycles water through the panels as needed. (URL-3), (Figure 2), (Tablo 4).

Table 4 Living wall classification

Living Walls (LWS)	**To Plant Growth Environment**	**Loose medium system** Loose medium systems consist of a shelf ("soil-on-a-shelf" type system) or bag ("soil-in-a-bag" type system) installed onto a wall after being filled with soil.
		Mat type medium system Mat media are quite thin, and as a result, they cannot support the growth of mature plants for more than 5 years (Bjerre, 2011).
		Structural medium system It is the most robust option in terms of living walls as they have a lifespan of 10-15 years and perform well in areas where high winds, seismic activity or heights need to be addressed during the design process (Papadopoulou, 2013).
	According to the Application Type	**Modular Living Wall System** It is an evolution of green roof applications using modules. It consists of panels of different geometries that hold the growth medium.
		Mur Vegetal The 'Mur Vegetal' is a unique form of green wall pioneered by Patrick Blanc. It is composed of two layers of synthetic fabric with pockets that physically support plants and growing media (GRHC, 2008).
		Biofiltration wall An 'active' living wall is intended to be integrated into a building's infrastructure and designed to biofilter indoor air and provide thermal regulation (GRHC, 2008).
		Landscape wall These walls are an evolution of landscape 'berms' and a strategic tool in an approach to 'living' architecture (GRHC, 2008).
	Living Walls According to Substrate Material	**Potted plant system** It can be defined as creating vertical gardens with panels or pots placed in such plants (Figure 3).
		Foam-based system In this system, the foam-based substrate which is made of aminoplast resin foam is mounted to the above carrier profile. This medium which hosts plants is highly water-efficient and robust for a wide range of plants and climate types (Mir, 2011).
		Felt layer-based system Felt material provides a base for plants such as soil. It allows water to diffuse homogeneously, and it does not mold. Generally, nutrients and water are carried to the plants by using a drip irrigation system in this type of vertical garden (Örnek, 2011).
		Mineral wool-based system In this system, the panels which include mineral wool are mounted above to the carrier profile (Mir, 2011).

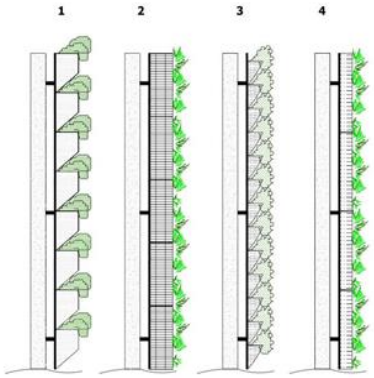


Figure 2 Green facade types (Ottele, 2011)

4.3.3. Vegetation Wall

Vegetation wall is a special type of vertical green that usually grows on surface walls and especially in joints or cracks. Self-growth of plants is a natural process. Vegetation wall can be divided into two categories (Mir, 2011) (Photo 2, 3) (Table 5).

Table 5 Wall vegetation classification

Wall Vegetation	**Natural Vegetation** These are walls formed by the spontaneous growth of plants at the buildings (Figure 4).
	Wall Panel Application Suitable for Vegetation Concrete panels with a wide variety of pores are new applications developed to create green buildings in a short time (1-2 years). These panels are also types of facade designed in accordance with the vegetation on them (Ottele, 2011) (Figure 5).

Photo 2 Self-vegetating wall example (URL-4)

Photo 3 An example of wall panel application suitable for vegetation (URL-5)

4.3.4. According to Location of Application

Green walls will be examined in two groups as indoor vertical green systems and outdoor vertical green systems according to the place of application of the vertical green system (Photo 4, 5) (Table 6).

Table 6 Vertical green system classification according to place of application

According to Place of Application	**Indoor Vertical Green Systems** Vertical vegetation is used for decorative purposes in homes and offices, public buildings, shops and restaurants. Indoor plants filter pollutants from the air, produce oxygen, and even reduce electronic pollution (electrosmog) (Helzel, 2012) (Figure 6).
	Outdoor Vertical Green Systems Outdoor green systems can be used for functions such as guides, shades, and curtains hiding visible installations and mechanical systems of buildings (Figure 7).

Photo 4 Indoor vertical green system example (URL-6)

Photo 5 Outdoor vertical green system example (URL-7)

4.3.5. According to Structural Features

This classification of vertical green systems is examined under two headings as free and integrated vertical green systems (Photo 6, 7), (Table 7).

Table 7 Vertical green system classification according to its structural design

According to its Structural Design	**Free Vertical Green Systems** Such systems can be located in front of a building or around it without any connection system, and they can also be individually used as restraining, directing, shading elements by which only plants can be carried and displayed vertically (Figure 8).
	Integrated Vertical Green Systems Although they are referred to as green facades in the literature, modular trellis panel, cable and wire-rope net do not necessarily have to be integrated systems. Such applications can also function independently from building walls (Figure 9).

Photo 6 Free vertical green system application example (URL-8)

Photo 7 Integrated vertical green system application example (URL-9)

4.3.6. According to Plant Type

Vertical green systems according to plant type are examined under two headings as shrub type and climbing-twining plant types (Photo 8, 9) (Table 8).

Table 8 Vertical green system classification according to plant type

According to Plant Type	**Systems Using Shrub Type Plants** These species are not climbers, but by attaching wide mesh grids to the wall, they can be made to gain twining feature. Soil nutritional value should be high in applications (MEGEP, 2016). Shrub type plants are plants that are not suitable for green facade applications, but are frequently used for living wall systems (Figure 10).
	Systems Using Climbing Plants For green facade applications, mostly climbing-twining plants are preferred (Khabbazi, Erdoğan, 2013) (Figure 11). Plant modules are fixed to the wall with screws without requiring construction on the application surface. It is an easily assembled system with its complementary structure and lightness (Khabbazi, Erdoğan, 2013).

Photo 8 Vertical green system example using shrub plant type (URL-10)

Photo 9 Green facade example using climbing plant (URL-11)

4.4. Benefits of Vertical Green Systems and Their Evaluation in Ecological Context

The ecological benefits of vertical green systems; Using water efficiently, cleaning the air, protecting the facade against external factors, acting as shading and insulation and reducing the heating-cooling load can be examined at the building and city scale under the headings. When evaluated at the city scale, the benefits of vertical green systems such as reducing the urban heat island effect, increase in biodiversity and reduction in carbon footprint can be mentioned (Table 9). In this context, the ecological benefits of vertical green systems are examined under common headings for both scales below.

Table 9 Benefits of vertical green systems (Papadopoulou, 2013)

	Energy	Environment	Economic	Social
Building	Reduction of heating and cooling loads	Efficient water use through storm water collection, water recycling	Energy savings resulting to reduced costs	Improvement in residents' wellbeing through better indoor air quality
	High building energy performance	Removal of dangerous pollutants through plant leaves	Less needs for envelope maintenance, protection from UV damage and general deterioration	
	Act as insulation material, heat loss management	Air purification and dust suppression	Increase of property/resale value, as it is considered design trend	Fulfillment of the EU sustainable targets
	Act as shading device, regulating internal temperatures		Earn additional points in LEED® credit system	
City	Natural air-cooling around the building	UHI mitigation	Local job creation	Reduction of urban noise pollution
		Reduced carbon footprint	Increase neighboring real estate value by up to 20%	Improvements in health and wellbeing of the society
		Air-pollution mitigation	Increase urban agriculture	Improve city aesthetics
		Increase biodiversity		Behavioral improvements: less violence, crime reduction

4.4.1. Energy Saving

During summer, sun radiation heats the building envelope, leading to an increased demand for cooling and energy requirements. Green walls can reduce indoor temperatures due to shading provided by the plants, resulting in decreased indoor cooling needs and costs (URL-12). These effects vary according to climatic characteristics. The energy efficiency of vertical green systems has been examined separately in terms of hot-humid climate and hot-dry climate properties.

4.4.2. Hot and humid climate

The climatic indicator of a hot and humid climate is excessive heat and humidity. The purpose of using ideal green walls in this climate is therefore to reduce the thermal load while avoiding an increase in humidity. According to Chen, using living wall systems reduces the indoor temperature by a maximum of 1.1◦ C, while the mean indoor temperature is 0.4◦ C less than spaces without LWS (Living Wall System). A common concern about the factor of humidity is that the LWS may increase relative humidity due to its humid bed as well as the plants sweating. The relative humidity of the air layer is higher than that in the environment during the day and lower at night (Chen, Li, Liu, 2013). The LWS creates therefore more stable relative humidity in the air layer near the wall surface without increasing the indoor relative humidity. The results indicate that the LWS has a high cooling effect on the wall surface and indoor space, and the exterior wall surface gives off heat to the environment instead of receiving heat.

An important effect of living walls is shadowing, which greatly affects the cooling period. The shadow effect also causes a temperature reduction and a radiation reduction, and also a proper design of the green cover can result in significant energy saving. The temperature fluctuations in the LWS with still air follows the temperature fluctuation rhythm of outdoor temperature in smaller intervals such that the wall temperature is less than the outdoor maximum temperature by about 5°C. While the layer investigated in living walls with still air chambers follows the air temperature fluctuations and does not exceed the hottest outdoor temperature, the layer investigated in living walls with ventilated air chambers reveals a temperature difference of about 10°C compared to outdoor, it is hotter on average by 10°C (Zarandi and Pourmousa, 2018).

4.4.3. Hot and dry climate

Excessive heat and very low air humidity are the two most significant climatic indicators in hot and dry climates. So, all efforts will therefore be made to control these two factors. Many studies confirm the thermal effects of vertical green surfaces on the building envelope. There is credible evidence indicating that vertical green systems can reduce the air conditioning load by shadowing walls and windows, reducing the temperature, and a significant amount of annual savings can be considered. Results of investigations indicate that green facades in hot and dry climates can maintain a temperature which is lower than that of a simple wall at the peak daily heat of summer. This affects the building cooling load and improves the energy performance. According to Alexandri et al. (2008), using plants is more effective on the urban temperature in hotter and drier climates. Saving in energy consumption for the cooling of buildings will be 23% -100%. The reasons why living walls cause temperature reductions are summarized as follows:

- Reducing heat absorption caused by the plants
- Evaporative cooling caused by irrigation
- Heat resistance due to low thermal conductivity (Haggag, Hassan, Elmasry, 2014)

4.4.4. Air Quality

Elevated temperatures in modern urban environments with increasing numbers of vehicles, air conditioners and industrial emissions have led to a rise in nitrogen oxides, sculpture oxides, volatile organic compounds, carbon monoxide and particulate matter. Green facades or Green Walls can capture airborne pollutants and atmospheric deposition on leaf surfaces. And it can filter noxious gases and particulate matter. A study shows that Approximately 1 square foot of vegetated wall area will filter the air for approximately 100 square feet of office area. Considered in a very general sense, planting one wall of any 50 buildings which are situated on the street is equal to planting 50 trees on this street (Elgizawy Ebtesam, 2016). For interior projects, green walls are able to filter contaminants that are regularly flushed out of buildings through traditional ventilation systems. The filtration is performed by plants, and in the case of bio-filtration, micro- organisms. Green facade can capture airborne pollutants such as dust and pollen. And it filters noxious gases and volatile organic compounds foam carpets, furniture and other building elements (Elgizawy Ebtesam, 2016).

4.4.5. Conserves Water

One of the biggest impacts of Green facade is how they manage water. For starters, watering is very efficient as it is done using a drip irrigation system or a hydroponic system. Any waste water is collected at the bottom of the garden in a special tray where it is drained away. Alternatively, it can be recycled and put back on the garden (Figure 3). This means that practically all the water is used up by the plants, and there is very little waste (Elgizawy Ebtesam M., 2016).

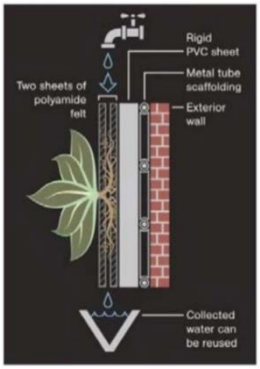


Figure 3 Schematic representation of rainwater management (Elgizawy Ebtesam, 2016)

4.4.6. Noise Reduction

Green facades have a noise absorption feature with their soil and plants which are used for planting. For this reason, they have a function of decreasing the noise occurring both in the building and its immediate surroundings. Green Walls provide a noise buffer which significantly reduces outside noise and vibration (up to 40 decibels) inside our homes and workplaces. A small indoor hedge placed around a workspace will reduce noise by 5 decibels (Elgizawy Ebtesam, 2016).

4.5. Vertical Green Systems in Educational Buildings

It is seen that the importance of sustainable design has been emphasized in recent studies in which the environmental conditions that schools are required to have are defined. Within the definition of sustainable school, energy and water conservation, minimization of waste, avoidance of potential pollutants, protection and support of natural life, effective use of financial resources, and respect for the participation of people are generally addressed (Murphy and Thorne, 2010).

There are several criteria for designing, operating and maintaining sustainable educational buildings that provide economic and environmental benefits as well as positively affecting students' health and learning (Frenette et al., 2003). These criteria are:

- Sustainable space planning and landscape design that reduce pesticide use and provide an outdoor learning environment for students.
- Building envelope design with high insulation value with windows positioned to provide air flow and increase the comfort levels of students and teachers.
- Lighting design that improves student performance and increases comfort levels, allowing daylight use at the maximum level.
- Ensuring good indoor air quality obtained from adequate air filtration and exchange systems, and introducing prohibitions that eliminate toxins, allergens and other sources of harmful pollutants. For example; prohibition of buses or distribution trucks operating near buildings.
- Design and maintenance of heating, cooling and ventilation systems that work silently and efficiently and do not distract students from learning by causing noise.
- Use of renewable energy sources on site such as photovoltaic that can be used as a teaching tool to increase students' interest in alternative energy sources.

An important development in education in the years between 1930-1945 was the introduction and development of the concept of student-centered learning, which is still present today. The student-centered learning method developed was first applied in Cranbrook Boys' High School and Tehtaanmaki School as an "outdoor school" movement (Baker, 2012).

Educational buildings in the outdoor school layout stand out with their bright, open-air learning and easy circulation facilities. The importance of clean air, which leads to physical health and well-being in mentally based activities, is emphasized in outdoor schools with a functional understanding. The best example of this is seen in the adult learning center at Impington College (Figure 4). In the 1930s, the importance and psychology of the student-centered system in the standardization of educational structures and open-plan school design were emphasized. Interior environmental quality standards were roughly determined but remained in the background due to economic problems. In the years between 1960-1980, educational researchers defined the connections between school facilities and their impact on students' learning for the first time (Baker, 2012).

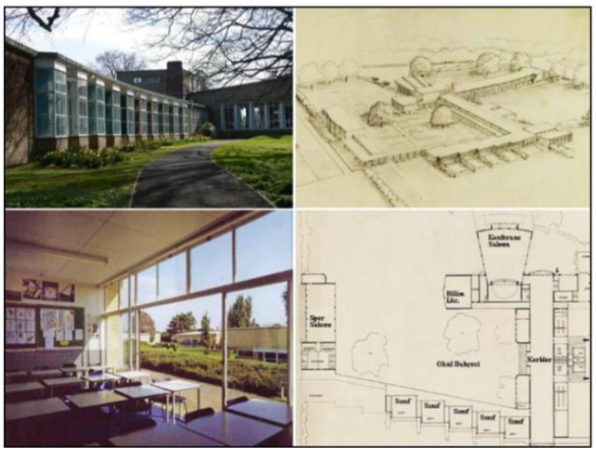


Figure 4 Outdoor school example - Impington School (Baker, 2012)

The major development in the 1990s was the emergence of green building or high performance building concepts (Figure 5). The LEED institute set standards largely for new school design and construction. In the 2000s, interest in high-performance educational buildings gradually increased.

In order to investigate the reliability of LEED certified buildings and to emphasize the green building concept, states started to measure performance (Baker, 2012).

Figure 5 Green Building Rating Agencies

Industrial organizations have researched the basic needs of the heating, ventilation and air quality of classrooms, and took some decisions regarding the realization of mental activities such as

- Humidity of the classrooms being between 40-70%,
- Temperatures being around 68-75 F (≈20-24 C),
- Maintaining 1,000 ppm and 1,500 ppm levels in order to keep CO2 levels low.

As a result of the increase in asthma cases in educational buildings, research on air pollutant particles and their effects was carried out by ASHRAE in 1990. ASHRAE, linking open air supply and indoor air quality with student performance, accepted ventilation rate per person as 10 cfm (minimum) (Baker, 2012).

With such importance attributed to air quality, the vertical green system concept has gained importance for educational buildings. The annex building of the Drew School in America, built in 2011, is one of the first LEED gold-certified schools with its 160-square-meter living wall system (Photo 10).

Photo 10 LEED Gold-Certified School Drew School-California (URL -13)

The benefits provided by vertical green systems are:

- Providing the acoustic comfort required for lectures with its noise absorbing effect,
- Providing indoor air quality by absorbing harmful gases and keeping the oxygen balance at a sufficient level,
- Supporting the thermal comfort of the training structure by providing energy efficiency,
- Providing positive effects on student psychology by integrating green and plant into the classroom environment,
- Providing students with a space that they can use as an educational space to study different plant and insect species (Photo 11, 12).

When we examine the examples, the systems that we see applications on educational buildings after the 2000s have also been taken as criteria by the green building rating agencies mentioned above.

Photo 11 Green facade - Educational building example with wire mesh net system application (URL -14)

Photo 12 Living wall - educational building example with modular system application (URL -15)

4.6. An Experimental Study on Th Energy Performance and Evaluation of Vertical Green Systems

Adana, where the educational buildings in the study are located, is located in the Mediterranean region between 36 ° 30-38 ° 25 north latitudes and 34 ° 48-36 ° 41 east longitudes located in the south of the Anatolian peninsula and on the Mediterranean coast (Figure 6). Adana-Çukurova region is in hot-humid climate zone. The region has Mediterranean climate characteristics; summers are very hot and dry, winters are warm and rainy.

Figure 6 The location of Adana on the map of Turkey (URL-16)

Çukurova University, one of the two universities in Adana province, is located around the dam lake and has a large campus with a dense green area. In the application phase of the energy analysis of vertical green systems of the study, it was planned to make a comparative analysis on these structures by choosing from the educational buildings in the campus area of Çukurova University (Photo 13).

Photo 13 Çukurova University campus view (URL-17)

These stages are listed below:

- Determining current educational buildings to be implemented
- Creating models and introducing parameters to Revit
- Calculation of heating and cooling loads for modeled structures
- Calculation of the total energy loads of the modeled structures
- Comparison of calculated energy loads

4.6.1. Determining the Models to be Applied in the Study

Since the benefits of vertical green systems according to their facade directions were also intended to be compared in the study, two educational buildings with similar facade proportions but differently positioned were selected, and the buildings were modeled in the Revit program (Figure 7, 8, 9, 10). The first analysis was made with the assumption that a vertical green system was applied to the north and south facades of the Faculty of Economics and Administrative Sciences Block A building where the surface area was large and the active areas of use were dense, and energy efficiency tables were created (Table 10).

Table 10 Faculty of Economics and Administrative Sciences Block A building project summary

Location Information	
Project	Faculty of Economics
Address	Adana
Calculation date and time	18 September 2020, Friday, 19:58
Latitude	37.06 °
Longitude	35.35 °

Figure 7 Map view of the Block A building of the Faculty of Economics and Administrative Sciences

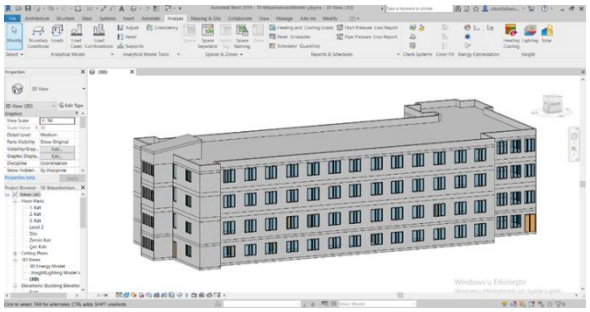


Figure 8 The Revit model of the current situation of the Block A building of the Faculty of Economics and Administrative Sciences

For the second analysis, the R2 classrooms building with an east-west facade, where the surface area was large and the active use areas were dense, was selected. On the assumption that a vertical green system was applied along the facades in the east-west direction, an energy efficiency table was created (Table 11).

Table 11 R2 classrooms building project summary

Location Information	
Project	R2 Classrooms
Address	Adana
Calculation date and time	11 October 2020, Sunday, 23:41
Latitude	37.06 °
Longitude	35.35 °

Figure 9 Map view of the R2 building

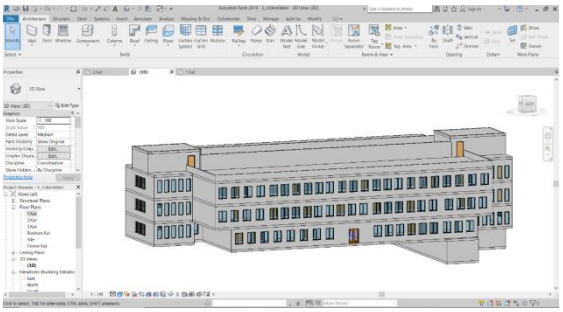


Figure 10 The Revit model of the current situation of the R2 building

4.6.2. Determination of the Vertical Green System to be implemented

Among the vertical green systems used in the study, modular living wall systems were applied to the north and south facades of one building and to the east and west facades of the other building. The reason why modular living walls were chosen was that there was artificially arranged vegetation on the vertical surfaces of the building and the planting environment within the module. Modules can be supplied and changed regularly when an addition is intended to be made. The use of felt as the substrate material for the planting medium also provides ease of maintenance in terms of the fact that the felt is not affected by water and therefore does not decay (Figure 11, 12). This situation also extends the life of the plant.

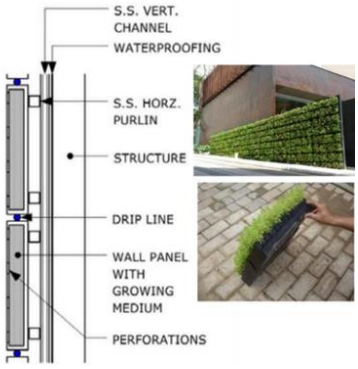


Figure 11 Vertical Green System Type selected for Analysis (Papadopoulou G.,2013)

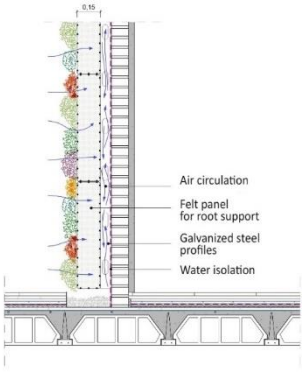


Figure 12 Modular Living Wall Detailed Drawing (URL 18)

4.6.3. Introduction of Parameters to the Program and the Results of the Energy Analyses Performed

In the vertical green system design to be applied, the most important issue that should be considered after the climatic characteristics of the region is the facade characteristics of the building. It is important to know the parameters of the façade and to design accordingly in order to make a design suitable for the climate in the vertical green system to be applied. In this context, the educational buildings selected from the Çukurova University campus has been taken and modeled in the revit program. The living wall system which is thought to be the most suitable for the working area has been applied on the existing reinforced concrete wall, and the necessary parameters have been entered into the program. For modeling, necessary parameters such as occupancy rate on the façade, wall layers and material information have been loaded into the program and the data was tried to be explained in detail under this heading (Figure 13).

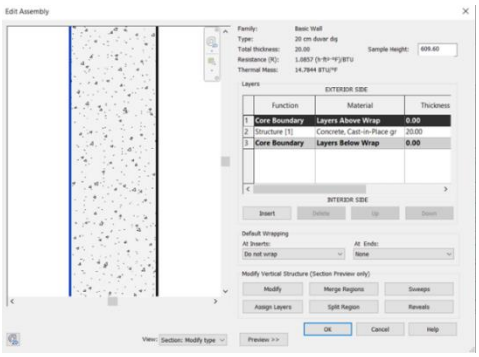


Figure 13 Reinforced concrete exterior wall defined for the existing building in the Revit program

Using the detailed drawings and photographs of the modular living wall system to be applied, the layers of the vertical green wall system were determined. The waterproofing layer placed on the reinforced concrete wall layer is initially positioned under the plant growth environment and protects the wall from the harmful effects of the moist environment. Later, the air gap between the plant support elements and insulation layer was added between the wall layers. Then, the felt layer on which the plant will be rooted on the steel support elements and the plant layer on it were entered into the program (Figure 14).

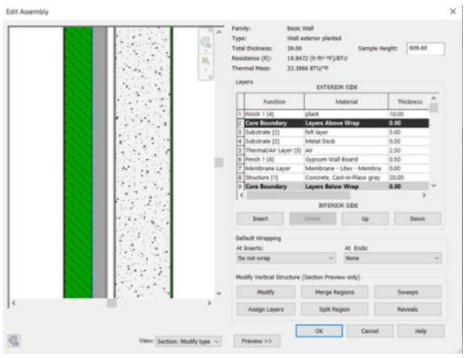


Figure 14 Living wall defined for the building with vertical green system in the Revit program

Energy analysis software can simulate the vegetation layer on the green facade as a kind of "insulation material" that is attached to the wall in the same way by adjusting the vegetation height, leaf area index, leaf reflection rate, leaf emission and minimum stoma resistance of the greening layer (Pan, Xiao, 2014). With this information, a new material was added for the plant layer, the thermal value of which we set (Figure 15). The thermal values of this new material were obtained from the article of Pan and Xiao. Equivalents of the parameter in the simulation, the absorbency coefficient of the green layer was 0.8; the density of the green layer was 300kg / m3; and the thermal conductivity of the green layer (λ) was 0.15W / m • k (Pan, Xiao, 2014).

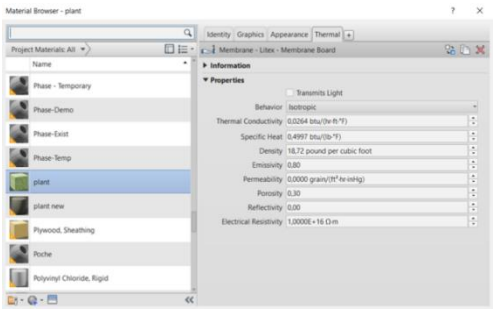


Figure 15 *Living wall vegetation layer thermal values defined for the building with vertical green system in the Revit program*

The plant layer was formed by converting these values according to the unit system of the program.

- Emissivity (Absorption coefficient)
- The Density Unit was taken as pound per cubic foot.
- The Thermal Conductivity Unit was taken as Btu/h er.ft.F.

The living walls were installed along the north and south facades of the Faculty of Economics and Administrative Sciences Block A building on the side where the classroom and administration areas are located (Figure 16, 17).

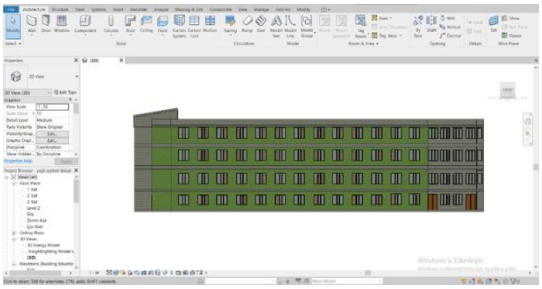


Figure 16 Faculty of Economics and Administrative Sciences Block A Building South Facade View with Vertical Green System Applied

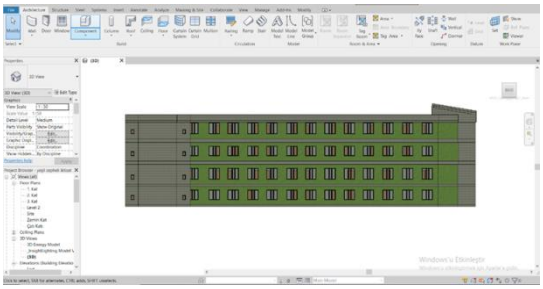


Figure 17 Faculty of Economics and Administrative Sciences Block A Building North Facade View with Vertical Green System Applied

The living walls were installed along the east and west facades of the R2 classrooms building on the side where the classroom and administration areas are located (Figure 18, 19).

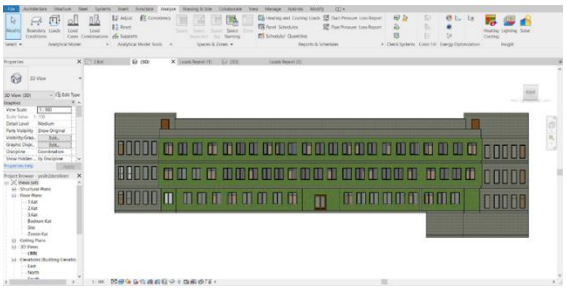


Figure 18 R2 Classrooms building west facade view with vertical green system applied

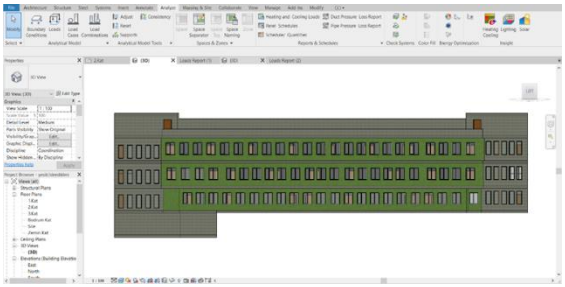


Figure 19 R2 Classrooms building eastern facade view with vertical green system applied

Location information of the project was entered. Then, heating-cooling loads were calculated over Revit, and tables were formed (Figure 20).

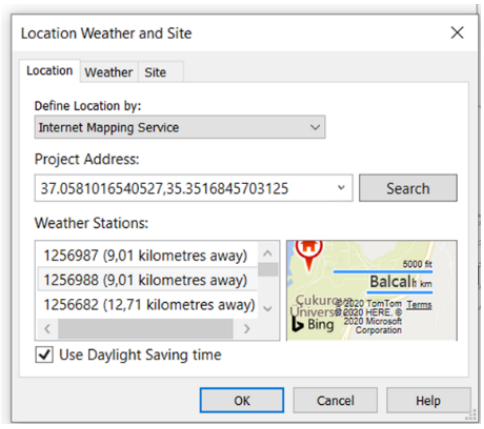


Figure 20 Defining location information in Revit program

4.6.4. Calculation of Heating Cooling Load

After entering the necessary parameters (type of building, weekly active usage time, thermal values of wall layers, location information of the building, etc.) to calculate the heating and cooling load, energy simulation was performed through the Revit program. The obtained heating-cooling load analysis charts are as follows (Tables 12, 13).

Table 12 Heating, cooling load analysis comparison table of the Faculty of Economics and Administrative Sciences, Block A building

Data	Current Situation	Situation with vertical green system applied
Building Type	University	University
Area (m²)	3,648	3,648
Volume (m³)	10,597.60	10,597.60
Results		
Total Cooling Load (Btu/h)	**1,842,839.8**	**1,534,215.0**
Month and Hour with the highest cooling load	September 16:00	September 14:00
Maximum Cooling Capacity (Btu/h)	1,640,583.0	1,303,107.7
Total Heating Load (Btu/h)	**1,365,406.5**	**1,107,296.3**
Inputs		
Cooling point	74 ° F	74 ° F
Heating point	70 ° F	70 ° F
Temperature Value	54 ° F	54 ° F
Number of people	913	913
Relative humidity	38.00% (calculated)	42.00% (Calculated)
Checksums		
Cooling Load Density (Btu / (h · ft²))	41.78	33.30
Cooling Flow Density (CFM / SF)	1.69	1.61
Cooling Flow / Load (CFM / ton)	485.36	581.29
Cooling Area / Load (SF / ton)	287.23	360.36
Heating Load Density (Btu / (h · ft²))	34.77	24.80

According to the results of the table data above, when the total heating and cooling loads of the Faculty of Economics and Administrative Sciences Building A were examined, the total current cooling load was approximately 1,842 Btu/h, while it was measured to be approximately 1,534 Btu/h as a result of vertical green system application. This means a reduction in cooling load by about 17%. The heating load was measured at 1,365 Btu/h in current situation. When the vertical green system was applied, it was measured to be approximately 1,107 Btu/h. This means a reduction in the heating load by 19%. Although the cooling-heating load decreased, the analysis results also showed that the relative humidity increased. Relative humidity increased by 4% due to the thermal values of the plant. A certain decrease in cooling-heating load and flow densities was determined (Table 12).

Table 13 R2 classrooms building heating-cooling load analysis comparison chart

Data	Current Situation	Situation with vertical green system applied
Building Type	University	University
Area (m²)	3,868	3,868
Volume (m³)	11,542.83	11,542.83
Results		
Total Cooling Load (Btu/h)	**2,210,365.5**	**1,862,742.8**
Month and Hour with the highest cooling load	August 14:00	August 14:00
Maximum Cooling Capacity (Btu/h)	2,210,365.5	1,806,742.8
Total Heating Load (Btu/h)	**1,151,838.8**	**933,944.2**
Inputs		
Cooling point	74 ° F	74 ° F
Heating point	70 ° F	70 ° F
Temperature Value	54 ° F	54 ° F
Number of people	974	974
Relative humidity	46.00% (calculated)	50.00% (calculated)

Checksums		
Cooling Load Density (Btu / (h · ft²))	52.74	43.40
Cooling Flow Density (CFM / SF)	1.22	0.83
Cooling Flow / Load (CFM / ton)	276.46	228.58
Cooling Area / Load (SF / ton)	227.51	276.51
Heating Load Density (Btu / (h · ft²))	27.49	20.25

Considering the total heating and cooling loads according to the results of the table data above, the total cooling load was approximately 2,210 Btu/h in the current situation, while it was measured to be approximately 1,862 Btu/h with the vertical green system applied. This means a reduction in cooling load by about 16%. The heating load was measured at 1,151 Btu/h in the current situation. When the vertical green system was applied, it was measured to be approximately 993 Btu/h. This means a reduction in the heating load by 19%. Results similar to the results of the analysis of the Faculty of Economics and Administrative Sciences Building A were obtained, and it was observed that the relative humidity increased by 4% in the energy analysis results of the R2 classrooms building. A certain decrease in cooling-heating load and flow densities was also determined (Table 13).

Figure 21 Revit-Insight building energy-cost analysis

In addition to the heating-cooling load analysis, Revit-Insight building energy-cost analysis was performed. While the energy cost for both buildings decreased by $ 15 per square meter per year over the total square meter of the building settlement, it was seen that it decreased to $ 13 per square meter provided that the vertical green system was applied (Figure 21). Therefore, the reduction in the heating and cooling load also decreased the annual energy cost.

As a result of the above energy analyses performed in the study, the following results were reached:

- Vertical green systems could reduce the heating-cooling load by about 16-19%,
- There was an increase by 4-5% in humidity as a result of perspiration caused by the plant and evaporation of water,
- For the hot-humid climate zone, there was no difference between the north-south axis facades and the east-west axis facades in terms of energy conservation, and
- It reduced the annual energy consumption cost.

Adana-Çukurova region is in a hot-humid climate zone. The results obtained revealed that vertical green systems displayed the same energy performance when applied in a hot-humid climate zone regardless of the facade. The information that vertical green systems applied in the

hot-humid climate zone have a high cooling effect on the building surface and in the interior, and that the exterior wall surface with vertical green system application gives heat to the environment instead of taking heat was supported by the analysis results. The most important and first reason for this is that the building surface is not directly exposed to sunlight thanks to the plant layer. The second reason is that the water in the system evaporates as a result of watering the plant, cooling the surface by taking heat from the facade surface. But the negative result of the second reason appears as the increase in relative humidity. However, this situation is negligible in consideration of the high cooling effect. In addition, vertical green systems will help reduce the urban heat island effect due to the cooling effect mentioned in hot-humid climates.

5. Conclusion and Suggestions

In order not to be deprived of the environmental benefits of sustainable designs and to reveal the responsibilities that the society should undertake for environmental health, it is necessary to create and develop awareness by transferring knowledge from generation to generation through education. The method of teaching through experimenting, which is known to be more effective and permanent in teaching behaviors respecting the nature and the environment than teaching theoretically, should be emphasized in educational buildings. This can only be achieved by designing educational buildings in line with sustainable goals. In this context, vertical green systems are considered as one of the systems that contribute to achieving sustainable design goals in educational buildings due to their being visible and bringing nature and the green to educational environment.

Vertical green systems are solutions whose importance cannot be underestimated in order to develop new and environmentally sensitive understandings in architecture and to create more livable cities. The benefits of properly designed vertical green systems at the urban and building scale will return to us as concrete data rather than being only a concept in the literature. By introducing these solutions to educational buildings, a series of environmental problems that can be foreseen in the future can be prevented. As a result, in the study, classification of vertical green system types, examination of the examples of educational structures in which these systems are applied, and revealing the benefits obtained by simulating the vertical green systems applied in the study in educational structures are expected to support and guide future studies.

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Resume

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Analysis of house prices: a hedonic model proposal for Istanbul metropolitan area

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Abstract

The purpose of this paper is to explore the nature of housing price differences in Istanbul Metropolitan Area. Factors that affect house prices in Istanbul are investigated by Hedonic Regression Model with spatial variables. House Price taken in natural Log form as dependent variable and house characteristics, neighborhood characteristics and transportation infrastructure taken as independent variables. Location of houses on Europe continent has more impact on value than Asian part of the city as the Istanbul city spread out new neighborhood areas are also developed with new characteristics. And those houses are sold according to amenities they surrounded by are spatially autocorrelated. House prices are examined in Istanbul by taking into consideration sub-market characteristics to identify localized factors. In the model distance to green areas, ports, proximity to metro stations, shopping malls, hospitals have positive but insignificant; proximity to earthquake fault lines, public bus transportation, industrial zones have negative and significant effect on prices.

Keywords: house prices, hedonic modelling, neighborhood characteristics, pricing analysis, Istanbul

1. Introduction

House prices and its spatial distribution are important for metropolitan areas. Prices are affected by house characteristics as well as submarket conditions in space and time. Location factors are heterogeneous distribution of house prices studied in different aspects of House Unit properties, Neighborhoods effects and location factors (Dokmeci, 1996). Aim of this paper is to analyze the distribution of house prices within Istanbul metropolitan area which has a very dynamic structure and to determine factors affecting each housing submarket.

Wide literature and research on house price dynamics and indexes in developed countries. Early studies on real estate price index construction, repeated sales of same properties on utility information to single family houses (Bailey, Muth, Nourse, 1963). In repeated sales regression model repeated sales of same property generally represents small portion of house market and new and rapid urbanization could not be represented by model. Neighborhood Dynamics (Can, 1990) and spatial dependence of house price indices and spillover effects of comparable sales are important factors (Can, Megbolugbe,1997). Spatial component over house price indexes are very important in explaining house price distribution of houses over time and space frequency and

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pattern effects prices (Gelfand, Ecker, Knight, Sirmans, 2004) Incorporate with spatial dependence and Location matters, spatial autocorrelated error terms (Dubin, 1998; Basu, Thibodeau, 1998;).

Hedonic and Spatial-Temporal models are mostly employed to explain the housing markets. Repeated Sales approach to hedonic models since 1967 many contributions made by distinguished academics. After developing technologies on computer systems and Geographical Information Systems spatial interaction in housing market is widely discussed and studied among geographers and economics. Before economics try to avoid spatial autocorrelation as the geographers consider it to valuable information to investigate through. Fast and huge data computing capabilities of GIS system made those spatial autocorrelations be observed and modeled for better outcomes. The housing markets are temporally auto-correlated due to its nature of habit. The monthly prices of houses are affected by the previous months and many research support seasonality among house prices. To avoid this temporal autocorrelation AR models used to correct seasonality in the works of many academics. For spatial autocorrelation the main issue is that house prices are affected by near sales of residential units but the form function of near or neighbor effect differs among academics. Krigging and negative exponential functional form employed to explain interaction between house prices. Neighbor and submarket clustering among housing market on the other hand revealed reduced standard error terms. The difficulty of defining the submarket borders also another issue to define and aggregate.

Spatial Autocorrelation in hedonic modeling used to utilize in works of Clapp which are lagged in time and space to form a local regression model. In which to define time and space asymmetries other than hedonic model cannot utilize (Clapp, 2003). LRM model requires the assumption that the underlying space-time has smooth surface. House prices and the transaction data over time is related in the research that structural change in the macroeconomic status rather than the cyclic measures in prices (Andrew, 2003). Problems that are associated with the hedonic house price modeling that measuring house characteristics are hard to collect and expensive to obtain. Even some characteristics are omitted this causes error in the estimates. Repeated sales approach on the other hand requires more dataset to explain hose prices and assumption on the same house within timeline that represents small amount of market (Haurin 1991). Non-parametric regression a technique that is to calculate the price indexes in Meese and Wallace that locally weighted regression model is to construct an index without assuming the same functional form everywhere (Haurin, 1991) Quality improvements are accounting for much of the house price in the repeated indexes as the median based quantile estimator in the produced more accurate estimators in study on city of Chicago (McMillen, 2003).

Another external factor that affects the house prices in the market is found to be physical constraints, population, income and demographic variables (Malpezzi, 1997). Comparing among the house price index methodologies that hedonic, repeated sales found to have bias and inefficiency of the prices or the market and Hybrid model found to be avoiding these problems. But systematical differences between single and repeated transacted houses generates bias in all 3 models (Case, Pollakowski, 1991) House Prices and its spatial distribution are important for metropolitan areas. Prices are affected by house characteristics as well as submarket conditions in space and time. Location factors are heterogeneous distribution of house prices studied in different aspects of House Unit properties, Neighborhoods effects and Location factors (Dokmeci, 1994). Aim of this paper is to analyze the distribution of house prices within Istanbul metropolitan area which has a very dynamic structure and to determine factors affecting each housing submarket.

Many studies have been conducted to examine hedonic house price modeling. Maximum likelihood estimation to house prices with a residual autocorrelation found to be negative exponential form of distance between properties (Dubin 1988). Spatially lagged values are introduced by Can (1997) into model to explain house prices. A spatio-temporal auto regressive model for multi-unit residential market is analyzed (Sun, 2005) found that Bayesian estimation process is found to get better results than conventional OLS estimation. Long run house price index

is examined by Eicholtz (1997) that repeated sales of same residential units enable quality constant house price index. A semi parametric method for estimating local house price indices by Clapp (2004) using 3-dimensional space-time grid to estimate each point outcome performances has reduced out-of-sample mean squared errors compared to OLS. A varying parameters approach to construct house price index by Knight (1995) used both repeated sales data and single sale transactions while contributing more information of market on estimation process. Predicting spatial patterns of house prices using Bayesian smoothing is used by Clapp (2002) access to CBD and other neighborhood amenities. Bayesian framework gives hedonic framework better results in spatial variations. The measurement and determinant of single-family house prices and found the demographic factors that affect with recovering of market after-tax interest rates and lower unemployment rates (Peek and Wilcox 1991). The spatial proximity of metropolitan area housing submarkets (Goodman & Thibodeau, 2007) discuss the spatially adjacent neighborhood assumption for housing consumers could vary in metropolitan market. Findings suggest that performance of dwelling size as well as control variation for public school quality or provision of public safety. Spatially proximate within market yields better results but outcome is significantly higher mean squared prediction error.

House prices in Istanbul are spatially auto correlated as the same characteristic settlements build up around same areas. House properties are similar to the surrounding characteristics. As the Istanbul city spread out new neighborhood areas are also developed with similar characteristics. And those houses are sold according to amenities they surrounded by again spatially auto correlated. Government public service buildings and many like hospitals and local government offices are located around old parts of Istanbul those same houses use these facilities that affect the price.

As the hedonic model that proposed in this paper first stage residuals that are calculated are found to be spatially auto correlated. Many of the spatial characteristics are calculated after the public data is spatially located on the Cartesian coordinate system. Distance to active green space, distance to shoreline, distance to main highway entry nodes (other than distance to highways), distance to nearest public administrative facilities and nearest distance to railways and sea transportation port were calculated for the second phase of spatial model. For Istanbul identifying the neighborhood boundaries are much difficult process. Old part of the city has mostly divided by sub districts where new neighborhoods cover half of the historical peninsula with only one sub district. The main distinguishable border that city has is the Bosporus line that divides the city into two parts. Which the old city on the European side has majority (%68 of housing units) of residential property. The old city walls that surrounds historical peninsula also clear identifier of neighborhood boundaries. But other than that, it is very hard to find elsewhere in the city. As this is the main difficult part to formulate hedonic price model on the other hand Istanbul has no official house price index calculated before. Even with the ordinary least squares methods that eventually lead to spatially autocorrelation one cannot find any price index for Istanbul metropolitan area or any kind of house price index for turkey. As the proposed models first phase conducted in this paper OLS has spatially autocorrelation that violates the assumptions of residual statistics and t values to higher degrees.

2. Background for Istanbul

Previously analysis of residential prices in Istanbul at metropolitan level sub-market, floor area and Seaview; at district level location, socio economic factors and property characteristics are found important factors (Ozus, et al. 2007). Transformation of Istanbul CBD as the new highways and bridges across Europe and Asia has taken the importance of old historical peninsula to new developing sub-centers. As transformation of its economy into require more modern office buildings. Construction of new peripheral highways contributed to a poly-centric development of Istanbul (Dokmeci, 1994). House price volatility examined to and findings suggest several outcomes

that Istabul, Ankara and Izmir reveal different patterns. Istanbul showed lower and insignificant house price volatilities (Coskun, 2016).

Research on Housing values and rents for Istanbul revealed that green areas around property highly affects both value and rent. On the other hand, access to transportation and shopping facilities has only affect rent values for Istanbul. Also, spatial factors have more effect on rent than prices in district level (Dokmeci, 2000). Another research on housing market for public perception of earthquake risk found distance from fault lines is important factor explaining house values and increased after 1999 earthquake (Onder, 2004).

Hedonic analysis of house prices in Istanbul results reveal that living area size, low story building, secured site and age of building affected the market. Also, income of household, earthquake risk of area and neighborhood satisfaction has an effect on residential prices (Keskin, 2008). Residential location preferences according to demographic characteristics of Istanbul study reveal that in contract with other western studies that strong desire for mobility in middle and older age groups. While young people preferences concentrated in the periphery, where large percentage of middle and old people prefer to move to intermediate between core and periphery where most easily accessible zone in the city (Dokmeci, 2000).

Determinant of house prices in Istanbul with a quantile regression approach found that age, cable tv, security, heating system, garage, kitchen area, number of rooms and bathroom increases the house prices (Caglayan, 2009). Another research on house price determinants in Istanbul using classification and regression tree (CART) approach found that house size, elevator, security, central heating unit is the most important factors among 31 variables (Özsoy, 2009).

Istanbul has the largest population in Turkey and between 1950 and 2018, its population increased from 1,002,085 to 14.018.735, primarily due to rural migration. It is also the largest economic, cultural and tourism center in Turkey. While Istanbul accounts for 15 percent of Turkey's population, the share of its GNP is 22.1 percent of Turkey's GNP (State Institute of Statistics, 2019). Post 1980s, witnessed an increase in service sector as a result of economic restructuring, development of transportation and telecommunication systems, and globalization which all played an important role in the multi-center development of Istanbul as in the other large cities of the world (Heikkila et.al. 1989). These new sub-centers were furnished with modern retail facilities, office buildings and supported with modern housing complexes fitting for the middle- and upper-income groups supporting the growth of sub centers. Multi-center development of the city not only contributed to the decentralization of jobs and population but also effects house prices. Especially, large suburban sub-centers that rival the traditional CBD in size and scope have significant effects on suburban spatial structure as firms and households bid for nearby sites (McMillen and Lester, 2003).

The distribution of population associated with house prices and they can be investigated by taking into consideration the development of the city during different time periods. The core area covers up to 3 km. from the center, which corresponds to the old CBD with a 3000 year of history and has since been continuously redeveloped. While this zone used to account for 33 percent of service employment and 13 percent of manufacturing employment in 1985, these ratios decreased to 13.5 and 4 percent in 2002, respectively (State Institute of Statistics, 2002). In 2000, this zone held 13.75 percent of the city's GNP, and only 3 percent of the city's population (State Institute of Statistics, 2000). The core area is connected to the periphery by metro, rapid train, buses and ferries and thus, it has the highest pedestrian traffic due to its unique central location and being a major traffic exchange node. Its population has continuously decreased due to the area's transformation from housing into business. After the 1980s, with the help of national and international revitalization projects, it has continued to be an active business center due to its central strategic location.

3. Hedonic House Price Specification

House price is in the market is determined by house characteristics. These are grouped into 1 Housing characteristics (Number of Rooms, Car parking space etc.), 2 distances to neighborhood amenities (distance to green areas, distance to highway entry nodes etc.) General function of house price is given,

$$P = f(H, N, t)$$

Where P is the sales price of property, H denotes variables describing house characteristics are of unit in square meters, number of baths, heating system etc., N denotes for distance of the unit to neighborhood amenities like distance to shopping centers, distance to CBD etc. and t denotes for time period that house unit is sold. In the model semi log function is employed in order to regress the log transformation of prices on linear formulation of housing characteristics. It is well addressed in literature that a prediction error that tends to be larger in absolute value as the property values increases. The semi log functional form is given by

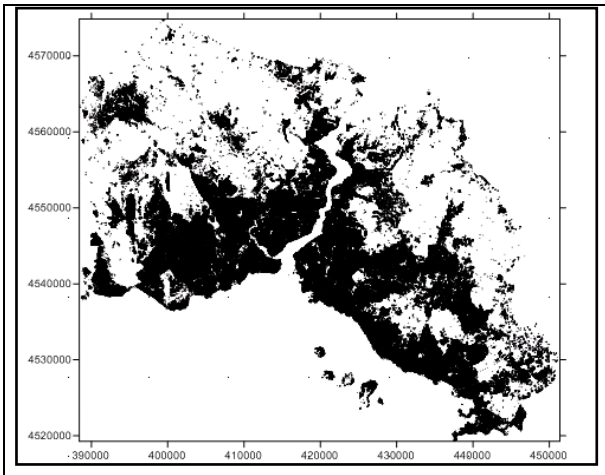
$$V=e^{(X\beta+\varepsilon)}$$

Where V is property value, X is a vector of housing characteristics, b is a vector of unknown hedonic coefficients, and ε is the residual. When the residual variance is constant and the residuals are spatially uncorrelated, ordinary least squares (OLS) yields best, linear, unbiased estimators of the parameters in the transformed equation.

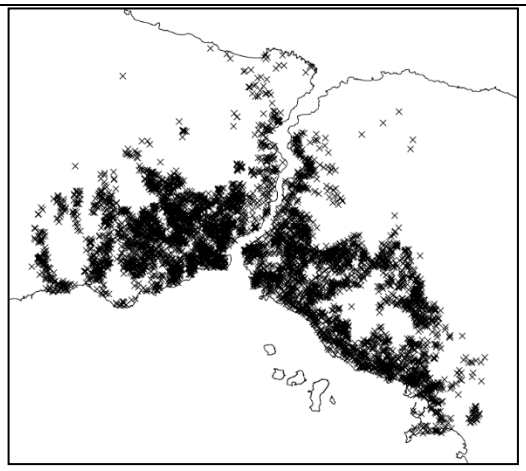
House prices in Istanbul are spatially autocorrelated as the same characteristic build up around similar locations. As the Istanbul city spread out new neighborhood areas are developed with new characteristics. And those houses are sold according to amenities surrounded by again spatially autocorrelated. Government public service buildings and many like hospitals and local government offices are located around old parts of Istanbul those same houses use these facilities that affect the price. As the hedonic model that proposed in this paper first stage residuals that are calculated are found to be spatially auto correlated. Distance to active green space, distance to shoreline, distance to main highway entry nodes (other than distance to highways), distance to nearest public administrative facilities and nearest distance to railways and sea transportation port were calculated for the second phase of spatial model.

For Istanbul identifying the neighborhood boundaries is much difficult process. Old part of the city has mostly divided by sub districts where new neighborhoods cover half of the historical peninsula with only one sub district. The main distinguishable border that city has is the Bosporus line that divides the city into two parts. Which the old city on the European side has majority (%68 of housing units) of residential real estate. The old city walls that surrounds historical peninsula also clear identifier of neighborhood boundaries. But other than that it is very hard to find elsewhere in the city. As this is the main difficult part to formulate hedonic price model. Even with the ordinary least squares methods that eventually lead to spatially autocorrelation for Istanbul metropolitan area. As the proposed models first phase conducted in this paper OLS has spatially autocorrelation that violates the assumptions of residual statistics and t values to higher degrees.

In this paper 5303 transactions data were examined both single-family and condominiums in Istanbul Metropolitan Area. 29 sub districts were defined by submarkets hedonic model is calculated that spatial autocorrelation is detected. Asian continent market found to be less spatially correlated than European continent as general terms historical part and new CBD is located on the European part of the city. The proposed spatial statistics most of the areas that has autocorrelation is improved afterwards. Distribution of housing units in Istanbul and sampling of model selection explained in Figure 1. Princes Islands has been excluded from the dataset due to fewer sampling points.



Istanbul Built Environment



Sample Distribution of Housing Units

Figure 1 Housing Units and Sampling Distribution

The house prices are collected in Turkish Lira (TL) and converted into US dollars at the exchange rate of from Central Bank of Turkish Republic. Prices are transformed in natural logarithmic function as widely accepted in previously modeling of house prices. PRC_LN as coded in the model has mean value of 12,078 and standard deviation of 0,4528. The room mean value is 2,75 with a standard deviation of 0.7927. The mean value of house age is 11.57 and with a standard deviation of 11,04. The FLOOR is which house is located 2.98 mean value to 2,01 standard deviation. The SQMT is area of house in square meters 122.76 mean value to 39.91 standard deviation. The BFLOOR is floor number of building that house is located 5.34 mean value to 2.39 standard deviation. BATH is the number of baths in house 1.26 mean value with 0.478 standard deviation. The DST_HWY is Distance to highway connection nodes in meters 1539,29 mean value to 1749,75 standard deviation. DST_PORT is distance to Public Sea transportation nodes in meters 4822.65 and 3087.92 standard deviation. DST_GREN is distance to public active green areas/Parks in meters 2517,84 mean value with 3104.71 standard deviation. DST_FLT is distance to Active Fault lines in meters 16417.85 mean value with 4943.43 standard deviation. DST_ADM is distance to nearest public administration buildings in meters has mean value of 4013.23 and 3357.31 standard deviation. CARPARK is 1 if house has a private car park; 0 otherwise. SEAVIEW is 1 if house has sea view, 0 otherwise. METRO is 1 if house has access to metro stations, 0 otherwise. PUBLIC is 1 if house has access to public transportation, 0 otherwise. ELAV is 1 if house has elevator system, 0 otherwise. SECU is 1 if house has security, 0 otherwise. GENERA is 1 if house has electric generator, 0 otherwise. SHOP is 1 if house is located near shopping mall, 0 otherwise. HOSP is 1 if house is located near hospital, 0 otherwise. INDUST is 1 if house located near industrial site, 0 otherwise. BALCO is 1 if the house has balcony, 0 otherwise. X and Y is the coordinates of house in decimal degrees. H_TYPE is type of house if condominium is 1, attach multi-family is 2, detached single family is 3.

The variables in Table 1 are coefficients between log transformation of house prices. Public transportation is negative correlated with price. This could be an indicator of only having public transportation is decreasing house price as keeping every other variable constant. This finding is also supported by the previous research the public transportation is negative effect on house prices (Özsoy 2009). Distance to sea transportation and active green areas are also negative correlation that indicates as the distance to green space and sea transportation increases the house prices. Distance to administrative buildings has a negative correlation that administrative also attracts commercial activity which also has negative effect on house prices.

Table 1 Housing characteristics

Variables	Mean	Std. Deviation	N
PRC_LN	12,0783	,4528	Log form of Sale Price in Dollars
ROOM	2,75	,793	Number of Rooms
AGE	11,58	11,041	Age of dwelling
FLOOR	2,98	2,010	Floor level of dwelling
HEAT	,18	,384	=1 if dwelling has central heating,
SQMT	122,76	39,916	Area of dwelling in squaremeters
CARPARK	,46	,498	=1 if dwelling has car park, 0 otherwise
SEAVIEW	,21	,407	=1 if dwelling has seaview, 0 otherwise
BFLOOR	5,34	2,391	Number of total floors of building
BATH	1,26	,478	Number of total bathrooms in dwelling
SEATR	,03	,159	=1 if dwelling is near sea transportation, 0 otherwise
ELAV	,43	,495	=1 if dwelling has Elevator, 0 otherwise
SECU	,45	,498	=1 if dwelling has Security, 0 otherwise
GENERA	,07	,253	=1 if dwelling has Electric Generator, 0 otherwise
BALCO	,71	,454	=1 if dwelling has Balcony, 0 otherwise
H_TYPE	2,58	,866	3 for multistory, 2 for attached, 1 for detached housing

Variables in Table 2 shows another expected outcome of correlation table is that distances to Active Fault Lines of Earthquake zone also little but negative effect that as the distance increases the price of house increases too. X and Y coordinate values also positive effect that house price increases as X decreases as a sign of European zone has higher prices than Asian part of the city. Mean distance to Fault Lines are 16,417 meters, Administrative buildings 4013 meters and Highway entrance points os 1539 meters which is almost 3 times less than sea port distance of 4822 meters and Green areas of 2517 meters of distance has been found in the sample units.

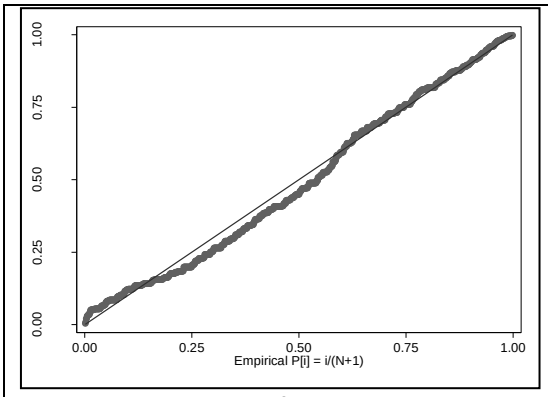
Table 2 X, Y Coordinates and neighborhood amenities distances

Variables	Mean	Std. Dev	N
X	416879,05	12917,053	X coordinates of Dwelling in decimal degrees
Y	4542992,38	7230,896	Y coordinates of Dwelling in decimal degrees
DST_PORT	4822,65	3087,921	Distance of dwelling to nearest Seaports in Meters
DST_GREEN	2517,84	3104,713	Distance of dwelling to nearest Green Area in Meters
DST_FLT	16417,85	4943,436	Distance of dwelling to nearest Geological Fault Lines
DST_ADM	4013,23	3357,310	Distance of dwelling to nearest Administrative Buildings
DST_HWY	1539,29	1749,751	Distance of dwelling to nearest Highway Entrance

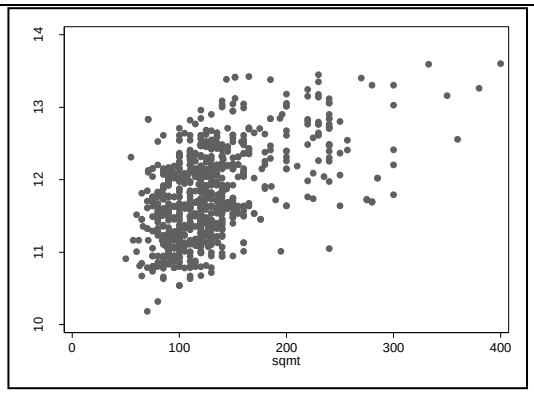
In the model in order to identify the Istanbul housing market spatial and temporal aggregated data is sampled using 0.05 confidence interval and %1 error terms. Spatially aggregated building data of 2.5 million geo-coded house database is randomly selected and stored both for Europe and Asia separately. Due to the geographically uniqueness of Istanbul the Bosporus line that divides city has to be considered. 6000 points are selected randomly on geo-coded dataset and quarterly sale information to nearest selection point is aggregated. After random selection of 6000 points. The main housing stock of Istanbul is not equally divided into two continents so the rate of random selection is match with existing stock. According to state institute of statistics there are 3.391.752 housing units is in Istanbul and %65 percent of them are in Europe and %35 is located in Asia. The random selection of points is weighted according to % 65-% 35 distributions. After geo-coded points selected and data is reduced according to assumptions of the model. Prices that are more than $400.000 and below $50.000, square meters higher than 300 less than 45, room number more than

10, building age more than 85 years, are eliminated from model calculations. After points were eliminated finally 5303 housing units remained.

The house prices were collected from local real estate brokers' sales database of 2018. In fiscal terms the brokerages fees are %3 of sales price both %1.5 from seller and buyer share. In order to taxation values up to %48 of income gains from property many owners avoid to declare the real prices. The prices of houses that are sold by real estate brokers are collected on street level of geo-coded address code. Aggregated data also cross check and outliers eliminated from each quarter period calculated separately. After collecting house prices and attributes general outline of aggregated data used to form price index function. Normal distribution of LogPrices has been tested and plotted in Figure 2 and found to be in boundries of normality. Also the most sensitive explanatory variable of housing area to log Price has been found to be in linear formation.



Normal Distribution of Log Prices



Price-to-Area Distribution

Figure 2 Log price to normal distribution and price to housing area scatter distribution

Model:

Hedonic function is important as the form of the hedonic model than in general terms:

$$P = f(S\beta, N\gamma) + \varepsilon,$$

P is the observed house prices; S is the matrix of properties of observed houses (house age, area of house, number of baths etc.), N neighborhood unit's environment and social-economical quality matrix, β, γ are the parameter vectors of the qualities and ε is random error term. At this point the hedonic model and its characteristics are very important that affects the model. In many model function form is taken as linear and parameter vectors are with an independent from covariance error terms $\sigma(\varepsilon_i, \varepsilon_j) = 0$ and homoscedastic $(\sigma^2(\varepsilon_i) = \sigma^2)$ (Can,1997).

As the dataset spatial and temporal form $\sigma(\varepsilon_i, \varepsilon_j) = 0$ assumption cannot be met and this is referred in literature as spatial dependence or spatial autocorrelation. House Price Model variables are examined and outliers and assumptions of regression model in general terms the model;

$$\ln(V_{i,t}) = \beta_0 + \beta_1 Area + \beta_2$$

$$Ln\,\mathrm{Price} = \beta x_1 + \beta x_2 + \beta x_3 .. + \varepsilon$$

$$\sum_{k=1}^{n} Ln\,\mathrm{Price} + \sum_{k=1}^{m} \beta x_m$$

$$\log\, p = \beta_0 + \sum_{j=1}^{K} \beta_j X_j + \varepsilon$$

Where p Log transformed of house prices in US dollars, Bo is the constant term, By is the attributes of houses Ax on hedonic function and E is error term with v=0 in normal distribution. Model at table 3 is run with 31 variables and R square is 0.5338 to Adjusted R Square 0.5286. The standard error of Estimate is 0.3108. As the Durbin-Watson statistics 1.310 there is evidence of positive serial correlation among datasets. Table 4 for model residuals found to be zero mean and standard deviation of 0.3. and standard residual mean also found to be zero mean and 0.99 standard deviation. In Table 5 Model coefficients are found that; Room, Age, Land Title, Car Park, Metro, Elevator, Generator, Distance to Highway, and Distance to Fault Line has found to be significant and positive effects, Public Bus Transportation and Near Industry Areas has significant and negative effect on prices.

Table 3 Model summary

Model Summary						
	R	R2	Adjusted R2	Std. Error	Change Statistics	
Model					R Square Change	F Change
1	0,730	0,533	0,528	0,310	0,533	101,829

Table 4 Model residual statistics

Residuals Statistics					
	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	11,040	12,971	12,077	0,330	5303
Residual	-0,943	0,884	-0,000	0,309	5303
Std. Predicted Value	-3,137	2,700	-0,002	0,999	5303
Std. Residual	-3,033	2,844	-0,000	0,994	5303

4. Conclusion

Factors that affect house prices in Istanbul are investigated by regression analysis with spatial variables. House Price taken in natural Log form as dependent variable and house characteristics, neighborhood characteristics and transportation infrastructure taken as independent variables. Data obtained from local real estate brokers and by the help of geographical information systems and spatial statistics this paper figures a distribution of house prices.

Location of houses on European continent has more impact on value than Asian part of the city. In the model number of rooms has slightly less affects prices with P values 0.318. If the house unit on rent, price is negatively effects -0.1842. Public transportation accessibility only houses have negative -0.1256 coefficients. Proximity to shopping centers and hospitals also has positive effects on house price. House prices in Istanbul are spatially auto correlated as the same characteristic settlements build up around same areas. House properties are similar to the surrounding characteristics. As the Istanbul city spread out new neighborhood areas are also developed with similar characteristics. And those houses are sold according to amenities they surrounded by again spatially auto correlated. Government public service buildings and many like hospitals and local

government offices are located around old parts of Istanbul those same houses use these facilities that affect the price.

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Table 5 Model Coefficients

	Unstandardized Coefficients		**Std Coefficients**	**t**	**Sig.**	**Collinearity Statistics**	
	B	Std. Error	Beta			Tolerance	VIF
Constant	-4,961	3,593		-1,380	0,167		
ROOM	0,019	0,009	0,034	2,189	0,028*	0,354	2,819
AGE	0,001	0,000	0,027	2,481	0,013*	0,742	1,346
FLOOR	-0,001	0,002	-0,005	-0,522	0,601	0,766	1,304
HEAT	-0,184	0,023	-0,156	-7,976	1,840	0,231	4,313
LAND	0,042	0,014	0,029	2,862	0,004*	0,811	1,232
CONDO	-0,007	0,010	-0,007	-0,717	0,473	0,818	1,221
SQMT	0,000	0,000	0,028	1,761	0,078	0,328	3,044
CRPARK	0,041	0,012	0,046	3,431	0,000*	0,493	2,024
SEAVIE	0,366	0,023	0,328	15,355	4,430	0,193	5,159
BFLOOR	-0,002	0,002	-0,014	-1,139	0,254	0,564	1,770
BATH	0,017	0,010	0,018	1,604	0,108	0,694	1,439
METRO	0,024	0,011	0,022	2,110	0,034*	0,781	1,279
PUBLIC	-0,022	0,011	-0,021	-2,073	0,038*	0,819	1,220
SEATR	0,001	0,028	0,000	0,037	0,970	0,906	1,102
ELAV	0,028	0,012	0,030	2,297	0,021*	0,491	2,034
SECU	-0,014	0,011	-0,016	-1,239	0,215	0,529	1,889
GENERA	0,052	0,019	0,029	2,700	0,006*	0,740	1,349
SHOP	0,022	0,019	0,012	1,159	0,246	0,820	1,218
HOSP	0,103	0,020	0,053	5,136	2,909	0,822	1,216
INDUST	-0,071	0,023	-0,032	-3,074	0,002*	0,811	1,232
UNIV	-0,044	0,065	-0,006	-0,675	0,499	0,951	1,050
GREEN	0,007	0,018	0,004	0,431	0,665	0,826	1,209
BALCO	-0,017	0,010	-0,017	-1,716	0,086	0,873	1,144
DSTHWY	5,796	2,490	0,022	2,332	0,019*	0,963	1,037
X	-1,994	5,420	-0,056	-3,679	0,000*	0,371	2,689
Y	3,924	7,750	0,062	5,062	4,207	0,579	1,724
DSTPORT	-3,952	2,060	-0,269	-19,738	1,083	0,476	2,097
DSTGRN	-2,967	2,450	-0,203	-12,131	2,330	0,316	3,163
DSTFLT	3,389	1,040	0,037	3,253	0,001*	0,686	1,455
DSTADM	-1,210	1,320	-0,089	-9,171	6,550	0,927	1,078
H_TYPE	0,037	0,007	0,072	5,197	2,107	0,458	2,182
Dependent Variable: PRC_LN							

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Resume

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A discussion on child-friendly cities through a critique on the experience of the body

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Abstract

Social changes resulting a significant shift in philosophical thinking in the renaissance brought the idea of individuality to the forefront, radically changing the social requirements and desires of individuals, the ideas of freedom of all individuals collectively, their relations with society and their environments, and also their participation in urban life. As a result of the industrialization activities, wars and migrations experienced in the twentieth century, this direct participation of the individual in the urban space was negatively affected. Especially due to globalization, the changing physical appearance and quality of life of metropolitan cities have created disconnections in human interactions with the city and their *bodily experience* with the environment. Monetary system which has dominated urban life, has taken business life to the forefront separating the residential fabric from the zones where business life has developed, and accordingly lively streets have been surrendered to motor vehicles over time.

One of the social groups mostly affected by these changes, is the young generation-children. The sacrificed areas in the cities, where the scale has changed radically, were usually the recreational environments, and children's play areas. Within this context, it is also mentioned in the literature that adults (politicians, planners and municipalities) easily ignore the fact that cities are also for children; the developmental characteristics of young people, their needs for age, play and experience necessary for their healthy growths are ignored.

Therefore, it should be admitted that cities should have a lot to offer children. It is necessary to organize the streets, to plan the transit routes of motor vehicles, redefine new speed limits, and re-evaluate the streets to make them pedestrian-friendly again taking into account the possibility of danger to children. So, as a part of the theoretical background discussed in the context of *environment and behavior theories*, the debate covers how the urbanites, children in particular – very urbanite is considered as a *body* in this paper– are affected by the rapid change of urban space.

Also, through the introduction of global models such as *woonerf* and *home zone* on how the city can regulate physical and social components that can contribute both to the socialization of adults and to children's development and freedom in relation to their own age and needs, a fruitful insight is endeavored to be provided to the potential for these kinds of practices to be implemented in metropolitan cities especially in the residential fabric.

Keywords: bodily experience, children's play, environmental psychology, home zone, woonerf.

1. Introduction

In Turkey, especially since the 1980s, increasing globalization movements have led to significant changes, especially in metropolitan cities where large companies have headquarters and economic

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activity is concentrated. But, with the new physical condition that changed the old neighborhood scale to a much different look in the city damaged the spatial interaction, dialogue and bodily experience of the individual between the pedestrian and physical environment that used to exist on the neighborhood scale, brought about by mixed use. Unfortunately, these changes in the city have hurt children the most who have been deprived of the opportunity to play on the streets in their neighborhoods.

Bettleheim (1987) suggests that adults (politicians, planners, and municipalities) often ignore the developmental characteristics of the children and young people, their needs for age, play, and active experience. As a matter of fact, for some adults, childhood is only a transitional stage, and therefore there may be many overlooked points in addressing urban planning on a holistic and participatory basis. For this reason, it remains unclear exactly which components of the environment are important to children. Failure in allowing children the opportunity to speak publicly about their wishes and needs (Spencer and Woolley, 2000), and perhaps their lack of political power because they do not vote, may also have an effect on this result (Churchman, 2003).

Arza Churchman (2003) questions whether children have a place in the city and she uses the concept of place here in both a physical and symbolic sense. In the physical sense, she questions whether the city offers safe and pleasant places for the bodily experiences of children, and in the symbolic sense, she questions whether the city gives children a message that they are equal members of the society, both within the framework of the city's design and planning and in the context of the attitudes and behaviors of adults living in the city.

This paper examines how the changing urban form has changed the individual's experience and perception of the body because of the disconnections of the individual's interaction with the city as a result of changes brought about by social and physical changes, especially at what level it affects the youngest people of society. In the study, the concept of the youngest generation of the society is defined with the first article of the Convention on the Rights of the Child (UNCRC, 1989, Article 1): “a child means every human being below the age of eighteen years unless under the law applicable to the child, majority is attained earlier.” Furthermore, the argumentation in this paper is based on the 31st article on the prioritization of the child's right to engage in play and recreational activities play as stated in the thirtieth article of the same declaration (UNCRC, 1989, Article 31): “States Parties recognize the right of the child to rest and leisure, to engage in play and recreational activities appropriate to the age of the child and to participate freely in cultural life and the arts.”

For the examination, first of all, the relationship between the body and the environment is endeavored to be evaluated through a philosophical point of view. In other words, this study aims to understand, how the bodily experiences of the individuals, especially children in particular, are increasingly ignored in globalized metropolitan cities through a philosophical debate concerning the perception of the body. Later on, recognizing the fact that these changes in progress will in fact be endlessly and inevitably continuing in cities, some opinions and models developed in the late 1900s in Europe –woonerf and home zone– are presented since it is thought that those models which have also been applied in many countries outside Europe and positive results have been achieved in evidence-based studies, might give a fruitful insight for the decision makers in metropolitan cities of Turkey.

2. Theoretical Background

Descartes, as the father of modern philosophy in the seventeenth century, suggested that the only way to discover one’s ontology is because the one knows that s/he thinks; as he expressed this idea with cogito ergo sum as his famous expression (von Leyden, 1962). But, in the twentieth

century, the phenomenological thinking in philosophy had ended the Cartesian method of analysis which was evaluating the world as consisting sets of objects and the relations of objects with other objects. The phenomenological ontology on the other hand, has spread widely and opened a new gate in philosophy, primarily considered with the study of the consciousness.

For Husserl, who can be considered as the father of the phenomenological thinking, the first battle was to rescue the judgment from the effects of metaphysics. According to Husserl, the mission of philosophy was to reveal judgment with its new freedom and characteristics; so metaphysical way of thinking must have been completely separated from judgmental way of thinking (Akarsu, 1994). According to French historian Bernard Andrieu, twentieth century can be characterized by an 'epistemological dispersion of the human body'. This shift of the body and the importance of the person as a being was primarily the result of theories emerging from psychoanalysis, phenomenology and cognitive science. The influence of these fields, moreover affected the artistic practices in the contemporary media art and in architecture as well. It is not an exaggeration to say that over the last decades the study of the body has dominated many critical disciplines in the humanities, to the extent that a new discipline has arisen: that of a body criticism (Wegenstein, 2006).

The 'body' debate becoming a current issue, owes its starting point to Merleau-Ponty. So, in this paper, the shift of thinking from pure absolute object world to a world of experiential and existential thinking and locating the man just in the center of everything is tried to be explained with the proceeding history of philosophy in the scope of environment and behavior theories. The theoretical part of the paper will be giving place to significant thinkers to cover the significant change in philosophy of experience and the body as a subject interacting with the entire world such as Merleau-Ponty, Husserl, and Heidegger.

The enactive approach to bodily experience and perception draws on a number of distinct traditions in philosophy, psychology and cognitive science. The character of vision plays an important role in Merleau-Ponty's philosophical writing and in other philosophical works of phenomenologists. According to Merleau-Ponty (2010), in psychology, like in geometry, in the 20th century, human body with its all characteristics and with its 'thrown into the world' situation –as Heidegger says- is replaced by the consciousness without a body. Human is in fact, not a body and a soul separated from each other but rather a body with a soul. We, as humans, can reach to everything by our body so that every existence becomes a mix of soul and body.

In the context of human experience, there are such qualities that are impossible since it becomes meaningless to isolate them from reactions that our bodies awaken to certain impacts (Merleau-Ponty, 2010). In this context, Merleau-Ponty (2010) exemplifies human's experience with honey as a metaphor; honey is a slow liquid and has a certain consistence -it cannot be held permanently in the hand, pours and continuously flows down from the hand. The experience of the human with the honey reverses the roles with the holder because it makes the hands so sticky. While the hand thinks that it is dominant to its object, it is immediately caught by its materialistic characteristic. Such an interaction between the human body and honey can only be understood through a dialog. The relationship between us and objects is not remote, every object appeals to us and our life, takes the role of humans; reverse is also valid, these objects live as symbols of our behaviors. Man invests to objects; objects invest to men (Merleau-Ponty, 2010).

So, according to Merleau-Ponty (2010, p.70) it should be accepted that, in science, art and even in our daily acts, neither is there dogmatism nor a sense of self-confidence in modern thinking. Thus, this intertwined, complex relationship of the kind depicted by Merleau-Ponty between the

body -individual- and the materialistic -built- environment can only be understood through an existential and experiential intellectual way of understanding.

2.1. Bodily Experience within the Context of Environment and Behavior Theories

Environment and behavior theories which analyze such an intertwined and complex relationship between the body and physical environment through a multi-disciplinary discussion such as psychology, sociology, and anthropology covers the research issues investigating design principles shaping spatial attributes. Werner and Altman (2000), similar to other researchers working on environmental psychology, define the relationship of humans with the environment as how humans affect the nature and built environment and also how they are affected from them. So, researches on environment behavior theories consists of research areas from wayfinding and privacy issues to how people use work spaces, entertainment and social places, functionality of spaces, neighborhood relations and etc.

So, it can be argued that people generally have a sense and perception of place depending on the process of their experiences and interactions in various environments which lead them to behave in certain ways, whether they are consciously aware of it or not. Hurley names the view of the relation between perception and action as the input-output picture (Noe, 2004). Perception is the input from world to mind, while action is the output from mind to world, and thought is the mediating process. On the other hand, Noe (2004) describes perception as something that we do and the world makes itself available to the perceiver through physical movement and interaction. On the other hand, being a perceiver is to understand, implicitly, the effects of movement on sensory stimulation.

However, the physical, social and economic changes experienced after the 1980s, especially in metropolitan cities, gradually increased the distance between the perceiver and the perceived. According to Keyder (2009), rapid globalization movements found reflections in Istanbul in terms of not only economically and sociologically but also physically, as was the case all around the world. Istanbul has been globalized by the intensification of global money, investment, and information circulation generally, and changed in terms of urban land, too.

2.2. Body and the City Interaction within the Context of Globalization

The globalization movements in most of the metropolitan cities made the construction field as the most profitable sector and turned the real estate properties to be used as an investment tool. Major construction companies have started to build office buildings, shopping malls, five-star hotels and also very large housing units mainly in Istanbul. Differentiation of the consumption habits, income levels and free labor market and change in workers' profiles encouraged people to travel to other global cities and achieve to purchase new houses through mortgage loans. So, the city, while it was being occupied by informal housing clusters of low-middle class migrating to the city since the 1950s on the one hand (Tas and Lightfoot, 2005; Dicle, 1983), it was also being covered by new gated communities (Kurtulus, 2011) where the residents expected a privileged urban experience that can be symbolized as a desire for "elite urbanism" (Geniş, 2007, p.773). Besides, high-rise headquarter buildings of international companies on fringe-belts (Kubat, 2019), and sky towers as residences were keeping the "urban elites" (Baycan Levent and Gülümser, 2004, p.6). The reflection of such a separation of social groups in the city had started to be symbolized more harshly in the physical space tough and vice versa.

Beside the globalization issue, internet and similar information technologies made the body to reach a lot of data easily, collect information from many sources and disciplines and made it easier to synthesize them with various ideas but on the other side alienating the body to experience, context and history (Moussavi, 2010). Within this context, in the scope of this paper, main reason of the heavy disengagement of the body and the city which is mainly observed in metropolitan cities are based on the reason of globalization which made most of the metropolitan cities as parts of capital market like some other worldwide capital cities. Accordingly, the physical appearance of today's environment in terms of architecture together with urban design resulted because of the continuous changes in urban lands is thought to be the reason that prevents the interaction of the body and the built environment causing the obstacle of the experience of the body. According to the researcher, such a phenomenon can be easily read through the flow of streets which are the capillaries of the city and also the sidewalks since sidewalks can be considered as in-between spaces where the body as a pedestrian interacts with the built environment.

2.3. In-between Space of the Body in the City: The Sidewalk

According to Jacobs (2011), objects in cities –whether they are buildings, streets, parks, districts, landmarks, or others- can have radically different effects, depending upon the circumstances and context in which they exist. On the other hand, streets are for many purposes as well as carrying vehicles and even pedestrians. *"A city sidewalk by itself is nothing. It is an abstraction. It means something only in conjunction with the buildings and other uses that border it, or border other sidewalks very near it. The same might be said of streets, in the sense that they serve other purposes besides carrying wheeled traffic in their middles. Streets and their sidewalks, the main public places of a city, are its most vital organs. Think of a city and what comes to mind? Its streets. If a city's streets look interesting, the city looks interesting; if they look dull, the city looks dull."* (Jacobs, 2011, p.106).

Jacobs (1992) argue the purposes of sidewalks under three main titles such as the concepts of (1) *safety*, (2) *contact*, and (3) *assimilating children*. Considering the *safety* issue, there should be a specific border between the public and private spaces. They should not penetrate into each other as it is done typically in suburban housing. The concept of '*eyes upon the street*' is also a very important issue according to Jacobs (1992), since the ground floors opening to sidewalks behave like the natural landowners of the street. On the other hand, the sidewalks should necessarily have users at all times of the day continuously to be a safe place. Regarding the concept of *contact*, she supports the idea that the sidewalks are places that bring people together who do not know each other intimately; a good street in the neighborhood should achieve a good balance between its people's determinations to have vital privacy and their simultaneous wishes for differing degrees of contact, enjoyment or help from the people around. Considering the concept of *assimilating children*, Jacobs (1992) had discovered that especially child gang battles occur in such places designed only for children like playgrounds and parks. Because the streets in the cities sheared the children play on the streets, where children are not in the sights of adults. So, the most significant change happened is that the children moved from the eye control of a high numerical ratio of adults. Even some of the children Jacobs interviewed told that if they had wanted to do anything antisocial, they had always gone to some parks because none of the grown-ups would have seen them there.

Consequently, the importance of sidewalk is so significant to create a lively and self-interactive city since interactivity means the close and direct relationship between the living and non-living one, the human, the building and, also the environment. In other words, interactivity brings safety on the street, affects preferences where people want to live and work, increases *sense of belonging* which all affects the *sense of place* and encourages different social groups come together from

different socio-economical levels and age groups which all together affect the social synergy in the society.

On the other hand, the scale of the built environment interacting with the pedestrian especially at the nearest level is the other significant issue since the use and facility of the building is the source of communication like the *eye* and *mouth* talking with the *body* on the street. For instance, whether the use of a high rise building is only an office building, another function added to that building like an art gallery, or an outdoor space, or a passage way beneath the building consisting of retail areas open to everyone in the city can wipe out the enormous affect that squeezes the human and can change the perception of the body.

According to Bilgin (2006), one of the development strategies of Turkey in 1980s was emptying the city center while opening it to new facilities without doubt. It is accepted to make such a gradation to separate Central Business Districts (CBDs) such as management, supervision, finance, service, national and international trade facilities from other kinds of business types so that the distance between home and workplace is shortened in maximum (Akgün, 2010).

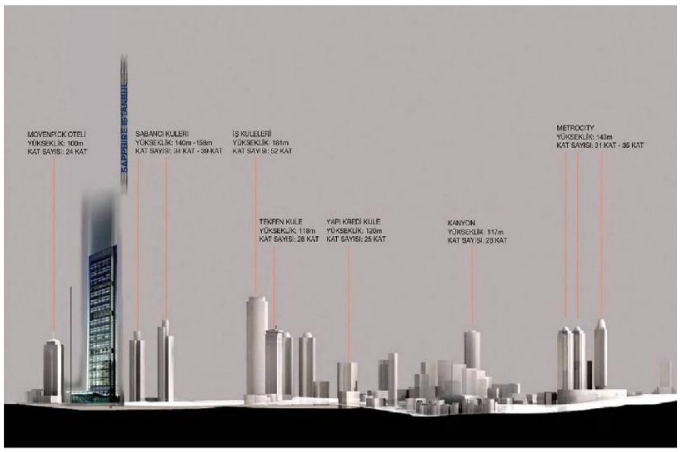

Figure 1 The scale comparison of Sapphire Building in the city of Istanbul (Akgün, 2010, from Tabanlıoğlu Archive)

As can be noticed from Figure 1, this strategy, which was implemented in metropolitan cities such as Istanbul especially after the 1980s, caused the homogeneous scale of the city to be interrupted. This rupture between the vertical rise of physical space and the horizontal plane damaged the sidewalk which is the threshold in public space and caused the *dialogue* between the built environment and the street to become increasingly reticent. This result could also be caused by the design pattern of predominantly large introverted and profit-oriented shopping centers on the lower floors of these high-rise business centers. Because these shopping centers direct a significant part of the pedestrians to arrive mostly by their cars and lead them directly to the parking areas located on the basement floors, and orient urbanites to spend a significant part of their time in the shopping center. Therefore, the horizontal capillarities that have somehow maintained the vitality of the city for centuries have gradually lost their liveliness, and pedestrians have begun to tend to maintain their encounters in artificial environments, mostly indoors. Besides, the intensive use of CBD areas during daytime, which are mostly working hours, have led these areas become mainly busy during the day, but uncanny areas during night times. When the topic is discussed in terms of the dialogue and interaction between the *body* and the object, it can be said that the physical effects in the city caused by globalization tend to reduce the *bodily* experiences due to the loss of vitality in the public domain.

The damage to the vitality of the city harms the younger generations who are the ones that have just started to perceive their nearby built environments, comprehend spatial characteristics and build their orientations in the city through their direct experiences, and would create their own unique urban image depending on their *bodily experiences*. Indeed, it is inevitable that children who

are confined to their own ghettos, lacking the experience that the city offers, will have problems not only with the urban environment, but also with social interaction that the urban environment is supposed to present. However, according to David and Weinstein (1987), all the built environment that are designed for children should strengthen personal identity according to the development of the child; should encourage the acquisition of a number of skills; should offer opportunities for growth and also support a sense of security. Moreover, built environments should not only provide certain common functions in the sense of social communication, but also allow the protection of privacy.

3. International Models to Re-Engage the City with the Body: Homezone and Woonerf Implementations

Despite the ongoing challenging globalization movements, there are many practices in the world that aim to make the urban environment much more livable for young generations and to give them the opportunity to experience especially for play and recreational activities. The most important initiative to increase the physical experience of the child in the city was the adoption of the concept of a *child-friendly city* by the end of the twentieth century.

As a part of the Habitat II Conference, which took place in 1996, the concept of a *child-friendly city* was defined, which aims to make cities livable for all (Tandoğan, 2014). According to the Child Friendly Cities Initiative (CFCI), it was targeted to respond the challenges of increasingly "urbanized and decentralized" world (UNICEF, 2018, p.5). A *child-friendly city* is defined as an urban domain that has characteristics that can support the child's physical and social development so that the child can become an adult who owns his or her own city in the future.

Within this context, the city needs to be a place where children not only can enjoy and feel safe in a physical sense, but also it can convey to children the message that they are an equal part of society with other people in a symbolic sense, through its design, planning and also the behavior of adults (Churchman, 2003). For this reason, in order for the child to be able to ride a bicycle or a scooter in an urban space, safely reach school and various recreational areas on foot and learn to share through play, the urban space should be able to provide an appropriate physical environment for children with all its spatial components. Besides, it is also necessary and indispensable for them to spend time together with their peers for their social development.

Therefore, it can be said that a *child-friendly city* should allow children to walk on the streets on their own, to freely meet with their friends, to interact with plants and animals, to live in a clean and sustainable environment, to freely participate into social life and even explain and make decisions about the city they live in (Riggio, 2002). After the concept of *child-friendly city* was announced at the Habitat II conference, local governments in many countries, from United States of America, to Spain and Sweden, from Croatia, to Bangladesh and India, have started implementing new action programs to ensure that the concept of the *child-friendly* city was adopted by communities (Riggio, 2002).

Some of these programs and practices were directly related to taking new decisions in urban planning and physical environment of the cities in street scale. Several remarkable decisions have been taken and implemented, especially in Northern European cities and England. These street-scale practices have prioritized the condition for streets to be livable for children again, primarily by making the street accessible to everyone. In other words, in livable street implementations, it is noticed that the safety of the street is not ensured by closing the street physically to prevent the flow of traffic, but rather the traffic is calmed down through design implementations so that the streets eventually admit all types of social actors of the city – children, teenagers, adults, elderly, disabled and etc. Within this context, two different types of implementations applied in Northern Europe and England to create livable streets – *Homezone* and *Woonerf* – are mentioned in the scope of this paper since it is thought that these kinds of implementations may also carry a positive

potential to be applied in metropolitan cities in Turkey where housing pattern is dense and families with children mostly live.

In the 1970s, the *Woonerf* implementation, which supported to integrate the vehicle traffic with pedestrians in a residential area in Delft, Netherlands, rather than isolating the traffic from pedestrians to keep it safer, was eventually given legal status by the local authorities and the national government due to the positive impact it had. Since the academic studies also showed that this implementation reduced the frequency of traffic accidents, but rather increased the satisfaction of the residents and also the frequencies of socialization and play on the streets, this model has been introduced not only in European countries but has been acclaimed and implemented in many countries on other continents in the world (Ben-Joseph, 1995, p.504). Ben-Joseph (1995) states that the issue of integrating traffic with the street was first raised by Colin Buchanan through a report published in the UK in 1963. Buchanan, a road engineer and architect, along with his team, supported that some streets in the city should be configured in such a way that traffic is separated from pedestrians, while other streets should be configured in such a way that pedestrians and vehicles safely mix. In time, German and Dutch researchers showed much greater interest in this new urban system, which was not accepted by the UK. Niek de Boer, professor of Urban Planning at Delft University of Technology and University of Emmen, developed a new cul-de-sac design based on Buchanan's theory to allow more children to play on the streets (Ben-Joseph, 1995, p.506).

According to van Gameren and Mooij (2018) this concept, which Niek De Boer called *Woonerf* in Dutch, literally meant "a house located in a yard". Therefore, this word, which evokes the social life in the old village times, furthermore tried to convey the message to urbanites that they can also socialize on the streets of the city with this nostalgic connotation. Although it seems to be a Dutch practice, Woonerf, which soon attracted interest, became a development that received worldwide attention and was practiced globally. Evaluating the *woonerf* as a revival of the plan configuration of the traditional Dutch village houses, Van Gameren and Mooij (2018, p.21) discuss the plan transformation through these words: "*With the arrival of the woonerf and the introduction of a collective intermediate space, shifts in the traditional ground plan became an important design theme. The relationship between public and private was redefined, bringing forward some striking contradictions. The space on the house's access side was designed as a communal lot, as an extension of the living area. The sheds and kitchen face the erf, reinforcing the informal character of the outside space, but also forcing the living room to the back of the house. This creates a house in which the living room turns its back on the erf and is oriented towards a protected, private outdoor space.*"

Figure 2 Principles of woonerf design by Appleyard and Cox (2006, p.31; Collarte, 2012).

The *woonerf* implementation, of which construction and use standards were set by the Dutch government in 1976 (Guttenberg, 1982), was first implemented in the city of Delft (Tandoğan, 2014). In the *woonerf* implementation, the street is shared by pedestrians, cyclists and commuters, but pedestrians are superior to the vehicles. This superiority is achieved by the fact that the curb is not continuous and the speed of the vehicles is reduced. Besides, socialization on the street can be more visible and residents' satisfaction is attempted to be ensured by the placement of landscape elements such as planters, trees and urban furniture (Figure 2). By reducing the speed of the car, the street is targeted to be more livable and satisfactory for the pedestrians, and especially for those who live on that street (Collarte, 2014; Dudek, 2019).

Woonerf system, where separating the parking spaces from the residential areas is also an important thought, the front areas of the residential areas can be a good meeting point and large play zones can be opened for children. The street, where hardscape is integrated with the landscape, greenery zones including trees and plants at the front of each residence are arranged in different widths and evaluated as unique in order to both reduce the speed of the vehicles and to eliminate the monotonous layout of the silhouette of the street (Kraaij and Mooij, 2010).

Another urban planning proposal for street design, where pedestrians and vehicles come together within the framework of certain design principles without being separated from each other, is *home zone* concept. The *home zone* concept, inspired by the *woonerf* concept and implemented firstly in the UK, is described on the website of the UK Department for Transport (2005) as follows: "*Home Zones are residential streets in which the road space is shared between drivers of motor vehicles and other road users, with the wider needs of residents (including people who walk and cycle, and children) in mind. The aim is to change the way that streets are used and to improve quality of life, by making them places for people, not just for traffic*." So, the term *home zone*, an English terminology instead of woonerf which is a Dutch word, is actually used to refer to the essentially same urban idea regarding the design of the street (Gill, 2006).

Howarth and Preston, who first used the term home zone in the 1990s in their project for a residential area proposal, state that the project prioritizes the child so that any driver who cause an accident should be considered careless (Preston, 1995; Gill, 2006). In 1999, the UK government decided to introduce the first pilot home zone applications in England, in the Wales region and Scotland, and then post-occupancy assessments were made regarding accident reports and residential satisfaction. In home zone applications, there are no strict rules depending on the design of the street, as compared to *woonerf*. Instead, the Department for Transport has created design guidelines for home area design and planning as Gill (2006) describes through the table below (Table 1). According to these guidelines, the involvement of pedestrians with vehicles is the main rule. Since it is necessary to reduce the speed of the vehicle in order to achieve this sharing, *home zone* applications also use visual materials and landscape elements that reduces the driver's field of view.

Table 1 The home zone vs. the woonerf (Gill, 2006).

	Home zone	**Woonerf or equivalent**
Legal status	Not explicitly defined in law: legislation enables local authorities to create home zones	Explicitly defined in law
Design requirements	No statutory guidance	Statutory guidance
Shared surface use	Not universal	Required by law
Legal change giving priority for pedestrians	No	Varies from country to country

Figure 3 and Figure 4 Home zone sign (left), an example of a home zone implementation showing Methley Drive (right) (Layfield et al., 2003, p.10).

Layfield et al. (2003), who worked on one of the pilot works in The Methleys region in Leeds describe the design considerations as follows: the entry points of the street are narrowed by physical barriers, with a *home zone* sign and another sign indicating that it should be driven at 20 mph (Figure 3 and Figure 4). A different color and also planting is applied in order to show how the shared domain of the street is distributed to both the drivers and pedestrians. Also, some design implementations were applied on some of the important streets in the region to slow down traffic. According to the researchers' study, people living on Methley Drive stated that they were satisfied with the practice in general, that they did not experience the danger of traffic as much as they used to, but that the time they spent on their streets did not increase significantly. Researchers (Layfield et al., 2003) consider the reason for this as the insignificant change in the frequencies of vehicles on the street compared to before and they emphasize that in order to increase the frequency and duration of socialization on the street, the results of interviews with children must be taken into account because the children have expressed their opinion that they especially want a play zone.

The results of interviews with residents about another home zone implementation in the Northmoor, Manchester area show that residents are satisfied that the appearance of the area has improved, that the time spent walking in the area has increased slightly and that there has been no significant change in the amount of accidents; the accident frequency, compared to the situation before the implementation, has reduced from 1.0 to 0.5 per year (Tilly et al., 2005, p.42). However, it is noted that the reduction of vehicle space on the street is considered a problem (Tilly et al., 2005).

According to another study that Biddulph compared the social interaction on two streets (2012), one of which is calmed street and the other is *home zone* street, it was found that on the street where *home zone* was applied, pedestrians spend longer time for arbitrary activities and even socialize with others. The results revealed in his study showed that *home zone* treatments have a positive impact on human interaction in urban life, especially for the families with children. Besides, it has been found that slowing down traffic on a street does not increase children's behavior to spend time outside as it is compared to home zone implementations, but the inclusion of spatial design features covered in *home zone* street makes the significant positive contribution.

4. Child-Friendly Urban Initiatives in Turkey

Turkey, after having adopted the Convention on the Rights of the Child in 1995, and hosted the Habitat II Conference in 1996, it was decided to launch child-friendly urban initiatives in twelve cities of Turkey. These pilot implementations were initiated in Sivas, Uşak, Gaziantep, Kırşehir, Karaman, Antalya, Kayseri, Erzincan, Konya, Tekirdağ, Bursa and Trabzon (Berkün, 2019, p.144). These projects which were all embraced in a different context than each other are listed as follows:

1. Tekirdağ: Children's Festival
2. Bursa: Science and Technology Center
3. Uşak: Child-Friendly Media Education
4. Antalya: Application to host the World Summit on Media for Children
5. Karaman: Child-Friendly School Project
6. Konya: Baby-Friendly Provincial Practices
7. Kırşehir: Provincial Children's Assembly
8. Kayseri: website service
9. Gaziantep: Child-Friendly Media Logo
10. Sivas: Nutrition-Friendly Schools Project
11. Erzincan: Street League
12. Trabzon: Baby-Friendly Hospital

When the scopes of these projects stated above are examined, it can be immediately noticed that they are not focused on extensive strategies covering the entire city in urban scale; some projects can be considered to be physical implementations in terms of a new building while some other ones such as establishing a web site or design of a logo can be considered to be service-oriented strategies in terms of communication programs to initiate the concept of a child-friendly city.

When the literature is reviewed, very little academic research was found on the above-mentioned projects. Regarding the child-friendly projects held in Tekirdağ, local news mention about the first Children's Festival launched in 2007 that children who were given a voice publicly in the festival raised their demands about new sports spaces from the local authority (Url-1). In the scope of the child-friendly project in Antalya on the other hand, Antalya Congress Bureau and Faculty of Communication of Akdeniz University applied to host the World Summit on Media for Children event at the 2017 Congress (Url-2). Within the context of the child-friendly project in Karaman, various health screenings were performed in schools (Url-3) while implementations were carried out within the framework of making baby-friendly hospitals in Konya (Url-4) and Trabzon. Additionally, regarding the child-friendly Kırşehir project, it was announced on the media that the construction of new parks would be started for children in high-population villages (Url-5), while it was noticed that a new web portal -www.cocukdostukayseri.org- was created where developments about the child-friendly Kayseri could be followed (Url-6). However, it has been observed that it is not possible to access the website in the present time. With the project prepared by the Gaziantep Metropolitan Municipality, it was aimed to create a Children's Council that would supervise the media coverage of children so that the children would be able to supervise the news published about them in the media (Url-7). As a result of the Nutrition-Friendly School Program conducted in Sivas, the city managed to take place within the first 20 cities reaching the number of 209 nutrition-friendly schools in the city (Url-8). Moreover, a football team from Erzurum was included in the street league that is organized specifically for the participation of children at risk (Url-9).

In addition to these service-oriented projects for children stated above, two new implementations in terms of children's spaces attract specific attention. The Science and Technology Center that was founded in Bursa in 2012 aimed to make positive contribution to the informal education of children allowing them to participate in recreational activities (Url-10). Another study within the scope of the child-friendly city projects (Topsümer et.al., 2009), which was

carried out in Uşak, was based on an interview with the governor of Uşak. The scope of the project carried out in Uşak focused on creating pocket parks near to the city center and also establishing a child-friendly media network.

In addition to these singular implementations mentioned above, the first *Children's Municipality* project which a whole city heads towards to gain the right of being a child-friendly city, came from Seferihisar, İzmir with the participation of the local government in the International *Child in the City* conference in 2018, in Wien. Within the scope of the project, it is stated that an old wedding hall was restored and the building with a multi-purpose hall, music room, photography and ceramic workshop, project and activity room was allocated to the Children's Municipality. The Children's Municipality has been directly involved in the work of the Municipality as a decision-making mechanism since 2011, and many projects for young people and children, ceramics, piano, violin, guitar, children's choir, folk dances, chess, painting and theater courses have been being carried on actively (Url-11).

Considering child-friendly initiatives launched since 1996 in Turkey, it is noticed that decisions have not yet been taken to revitalize the streets for children to play, to increase socialization on the streets, to slow down urban traffic, and for children to reach their schools safely on their bicycles or on foot. In this sense, the adoption of new urban strategies in order to make the children meet with the lively urban domain again and conducting concurrent evidence-based research can provide novel knowledge on how important urban-scale decisions are for children's physical, social and cognitive development.

5. Discussion and Conclusion

The problems caused by fast but irregular urbanization as a result of social, cultural and physical changes are the most important issues to be solved for the metropolitan cities. Not only industrial movements and migration but also globalization movements at the end of 20th century also affected especially large cities all around the world. This resulting speed and transformative acceleration, which affected the physical appearance of the city intensely, revealed a result that reinforced the affinity and similarity regardless of the typologies of the buildings in the city, where the diversity of mixed buildings on the scale of the neighborhood was lost and the buildings has started to become like each other.

According to Moussavi (2010), in the notion of architectural design, diversity does not only depend on spatial extensity, but also it depends and can be measured with the intensity of the form and the way it affects the *body*. One of the urban dynamics that most effected the experience of the *body* in the 21st century was the sharp separation of work spaces and housing fabric in cities due to sociocultural and economic changes. This segregation in cities and the alienation in the neighborhood scale also led to the disappearance of street vitality and “eyes upon the street”, which Jacobs (1992) mention that mix-used streets support and have a structure that attract various social groups of the community. Streets, that are the public domains that pedestrians of all ages encounter by chance in the daily life, have begun to lose their liveliness, especially in areas where the city's commercial areas are concentrated. One of the main reasons for this was the construction of highways, especially in metropolitan cities, and the streets were increasingly filled with large amount of cars. The increase in road width and, accordingly, the frequency of vehicles on the roads have also led to an increase in speed limits on the roads.

The main social group affected by this physical change in cities was the young generation, hence the children. In other words, the first social group that this strong change erased the visibility on the streets was unfortunately the children who used to play freely before. Over time, children who were deprived of the freedom to play on streets, that was an important part of their social, emotional, physical and cognitive development, were almost doomed to go to the children's parks only accompanied by their parents.

In some international cities where this inevitable fact was also experienced, some urban planning strategies have been implemented through academic studies. *Woonerf*, developed in the UK but implemented firstly in the Netherlands in the 1960s, and *home zone*, inspired by *woonerf* in the 1980s and implemented in the UK, were implementations aimed to bring back the social vitality of the streets. Both of these applications were based on reducing the speed of vehicles on the street, narrowing the street entrance with noticeable physical elements to reduce the speed of vehicles, disrupting the linear flow on the street, equipping certain parts of the street with landscape and urban furniture, so that pedestrians can safely spend longer on the street.

In evidence-based research, studies with those living on the streets where *woonerf* and *home zone* were applied, it is found out that both the residents socialized more on these streets, and the frequency of children going out and playing on the street increased over time. By means of the theoretical and practical infrastructures of these international experiences, pilot implementation studies can also be carried out in certain regions in our country. With a number of new strategies that local governments and decision-makers in the field of urban design might implement, and with new decisions that can be added to the regulations, pilot calm street implementations can be applied on certain streets dominated by residential areas. The potentials of such implementations can be examined through analysis that can be conducted through evidence-based academic research about these urban implementations, which can be applied with the support of local governments.

Whether positive results can be achieved, children can play with their friends again, ride bikes, and parents can get together more often on these calmed streets. Moreover, these streets can re-embrace not only children, but also all individuals of society such as the young, elderly, disabled and so on. Through evidence-based researches that can be done through these pilot applications, assessments of parameters such as safety, accident risk, and socialization can be made and the success of these applications can be assessed and the question of whether these models can be applied more widely can be analyzed in future studies.

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Resume

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Measuring the relationship between spatial configuration, diversity and user behavior: A Post Occupancy Evaluation study in Istanbul's peripheral districts

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Abstract

Post Occupancy Evaluation (POE) is a robust tool to systematically evaluate the effects of design decisions on spatial performance and to identify the relationship between the space and its users. Although there is a growing body of POE research on complex buildings, such as hospitals and education spaces, studies on the POE evaluation of public open spaces are limited. More importantly, few studies have investigated public squares designed at the periphery and how they are used.

This study aims to identify the extent to which spatial configuration of public squares is related to users' behavior (i.e., modes/distances of access, level of satisfaction). For this purpose, we focused on four peripheral urban squares located in Istanbul, Turkey. The methodology applied in the study includes a synthesis of three types of expertise: 1) behavioral mapping of urban squares (through the analysis of patterns of use based on direct observation), 2) cognitive evaluation of spaces based on perceived factors (through user questionnaires), and 3) quantifying urban public spaces objectively (through the methodology of space syntax and urban morphology).

The results identify associations between objective characteristics of public spaces designed at the peripheral districts, patterns of use and users' perception of these areas, to a certain extent. For example, the variety and intensity of activities within the square as well as the length of occupancy are highest for Avcılar square, which is most integrated within its urban surroundings with reduced average block size. An important finding is the association between the average street connectivity levels of these squares with their pedestrian catchment areas. In other words, the more integrated a public urban space is with its surroundings (800mt buffers), its users will access this space on foot from a larger distance. Based on these findings, spatial configuration as measured by space syntax measures appears to be an explanatory measure assessing the potentiality of public open spaces for bringing users together, hence, creating a lively, well-used space. However, the results also point to some disagreements between the perceived (users' evaluations) and objective (syntactic analysis) measurements, which indicate that both types of measurements are needed in POE research of public spaces.

Keywords: peripheral urban squares, Post Occupancy Evaluation (POE), space syntax, user perceptions, Istanbul.

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1. Introduction

Public spaces are platforms where people can come together or involve in different social activities individually and/or with others. In addition to the personal benefits they provide to the citizens, such as relaxation, transit and circulation, they also enable socially important random encounters and purposeful gatherings (Carr, Francis, Rivlin, & Stone, 1992; Cybriwsky, 1999; Madanipour, 2003). Good public spaces should offer opportunities for spontaneous activities (Francis, 2010) and different events (Lynch, 1981). Montgomery (1998) stated that places feel lively if they are used by people at different times of the day or if they host different cultural events and celebrations, creating opportunities for informal/casual meetings. Studies also highlighted that the main criteria for a successful space is the use of that space (Whyte, 1980) and if the space is not used by people, then it is not a successful one (Marcus & Francis, 1998). Similarly, Whyte (1980) and Gehl (1987) highlighted that if a space is used by people, this attracts other people and thus improves the performance of that space. As part of public spaces, urban squares can also be considered as spaces where ceremonial, religion based, social or economic events occur. Since urban squares are generally the focal spaces within cities and can provide their users opportunities of multiple activities, they can be preferred by a relatively higher number of users. Hence, it is quite important to understand different patterns of use and the intensity of uses/density of users within an urban square. Thus, it is important from a design point of view to identify the preferred areas of activities in urban squares, users' needs and perceptions as well as their behavioral patterns.

1.1. Post Occupancy Evaluation (POE)

Post Occupancy Evaluation (POE) is a robust tool to systematically evaluate the effects of design decisions on spatial performance and to identify the relationship between the space and its users. Previous research on POE of public spaces have employed observation and/or behavioral mapping techniques to analyze the occupancy of urban squares (Acar et al., 2020; Bin Roslan, Bin Noor Azman, & Zakariya, 2014; Goličnik, 2005; Goličnik & Thompson, 2010; Marušić, 2011). Direct observations help us to identify when and how people use these public open spaces whereas behavioral mapping helps us to understand different types of activities users are involved in. Studies using behavioral observations have focused on active and passive activities (Carmona, 2010), such as walking, cycling, standing or sitting, separately. On the other hand, user interviews or surveys were also used in POE literature to understand users' perceptions and their satisfaction levels (Bin Roslan et al., 2014; Fard, 2014). Roslan et al. (2014), for example, asked participants to describe what the urban square means for them. Fard et al. (2014) asked the level of satisfaction by focusing on different criteria such as accessibility, pedestrian safety, lighting or cleanness.

1.2. Environment and Behavior

Researchers from different disciplines have been studying to understand how the built environment shapes human behavior. An important part of the studies in this field, defined as environmental-behavioral sciences, is focused on urban open spaces (i.e., streets, squares, green areas). The common argument of this body of work is that in cities where open living spaces are limited, intra-community communication is weakened and individual relations are ignored (Tonkiss, 2005). Therefore, the relationship between social structure and space is mutual (Lefebvre, 1991). In his "Image of the City" (1960), Kevin Lynch, who is considered as one of the leading researchers in the field of environment-behavior, developed a model for the methods used in this field through his observations and interviews aimed at evaluating the perceptions of the citizens about their physical environment. Another important study dealing with the interaction between the built environment and user behavior is "The Social Life of Small Urban Spaces" produced by William Wythe (1980). A significant finding of this comprehensive study, which relies on direct observations and behavioral mapping of urban public spaces, is that the most significant factor in attracting

people to a space is the presence of other people and that the relationship of the square with the street is the most critical design factor. Applying Whyte's work to different public space typologies, Clare Cooper Marcus and Carolyn Francis showed that the success of a public open space is determined by the intensity of its use while the frequency of its use is directly related to the location of the space within the urban environment (Marcus & Francis, 1998).

1.3. Space Syntax: the configurative analysis of urban space

Space syntax, a set of tools and techniques to understand the relationship between societies and spaces, is a promising approach for measuring the interaction between built spaces and users' behaviors (Hillier & Hanson, 1984). The main assumption of the method is that any spatial organization has the potential of bringing people together or separating them from each other. In order to test this assumption, various configurational analyses are conducted. As used here, the terms "configurational analysis" refer to any kind of spatial analysis which characterizes the relation of each elementary spatial unit, here the road segment, to all others. The primary goal of these analyses is to measure the potential of spaces in bringing people together depending on the movement within the physical space. However, the distinction between meeting with others in a planned manner or randomly is important, because while the first is independent of the configuration of the space, the latter is the outcome of the spatial configuration (Peponis, 2001). Increasing the possibilities of people to come together randomly through the organization of spaces is important in order to create sustainable, safe and healthy cities by creating active spaces through design.

Studies conducted within the scope of this approach have revealed that there is a statistical relationship between the accessibility (movement areas) and the observed usage and movement patterns (where people are in the space) (Bendjedidi, Bada, & Meziani, 2019; Garau, Annunziata, & Yamu, 2020; Hillier, 1996; Hillier & Iida, 2005; Monokrousou & Giannopoulou, 2016). Studies investigating the impact of urban street networks on the accessibility of public open spaces highlight two aspects of urban fabric: metric accessibility (total route length) and directional accessibility (total number of changes of direction along the route). Metric accessibility measures the distance between origin and destination points. The connection density of an urban network increases accessibility in two ways. First, it reduces walking distances by creating short routes between any pair of origin-destination. Secondly, as street length in an area increases, the width of frontages, and thus the number of attractors, within walking distance also increase. The dense urban grid (relatively small block sizes and high density network) creates interfaces of varying densities between streets and premises, promoting pedestrian travel to maintain daily activities (Frank, Schmid, Sallis, Chapman, & Saelens, 2005; Kerr, Frank, Sallis, & Chapman, 2007; Lee & Moudon, 2006; Reilly & Landis, 2002). Directional accessibility measures the directness of the route. Empirical studies on spatial perception have revealed that people prefer routes with reduced number of changes when navigating an urban area (Hillier & Iida, 2005; Jansen-Osmann & Wiedenbauer, 2004). This is in line with findings of studies in the fields of cognitive neurology and environmental psychology, which have shown that direction changes limit the ability to navigate because they require cognitive effort (Crowe, Averbeck, Chafee, Anderson, & Georgopoulos, 2000).

1.4. Diversity

Diversity is directly connected to the concept of "spatial diversity", here defined as the presence of heterogeneous land-uses, which can harbor, support, and develop differences in human activity (Marcus & Colding, 2014). Urban form indicator of diversity is short blocks, mixed-use (Jacobs, 1993) and functional variety (Dovey & Polakit, 2009; Ramírez-Lovering, 2008). Mixed and compatible land-uses would bring a variety of forms, functions, and activities to the urban streets, which would consequently play a significant role in enhancing urban resilience quality of the area.

1.5. Research Focus

Although there is a growing body of POE research on buildings, such as hospitals (Marcus & Francis, 1998; Preiser, 1994), residences (Becker, 1977; Karagenç, 2001) and education spaces (Gürcan, 2002; Preiser, 2001; Rabinowitz, 1975; Sanoff, 1994), studies on the POE of public open spaces are quite limited (Churchman & Ginosar, 1999; Kılıç, 2001; Korkmaz, 2001; Sherman, Varni, Ulrich, & Malcarne, 2005; Whitehouse et al., 2001). More importantly, the majority of such studies have focused on the evaluation of public spaces located within city centers (Akad & Çubukçu, 2006; Kılıç, 2001; Malkoc & Ozkan, 2010). Few studies have investigated public squares designed at the periphery and how they are used (Çakılcıoğlu, Reyhan, & Kurt, 2010; Hepcan, Kaplan, Küçükerbaş, & Özkan, 2001). This is an important gap in the literature, because the physical and functional development of today's metropolises is based on their growth towards the urban periphery (Çalışkan, 2005). In this growth process, it is important to determine user expectations as well as the perceptual, aesthetic and functional characteristics of urban squares located in the periphery in increasing the spatial performance of these spaces to be designed in the future. Another shortcoming of studies on post-occupancy evaluation of public urban spaces is their tendency to investigate urban spaces as singular entities within their physical boundaries, isolated from their urban context. However, spatial performance is actually associated with the character of an entire area -a neighborhood or a district. Hence, behavioral patterns prevalent in an area cannot be described by analyzing the immediate neighborhood isolated from its global surroundings.

This study addresses the above-described shortcomings by focusing on peripheral urban squares and analyzing simultaneously objective (existing physical data/field observations) and perceived (questionnaires) environmental attributes to identify their relative impact on the use of these spaces. The objective analysis of the selected urban squares considers these spaces within their global urban context, using detailed, micro-level units of analysis. The main aim of this paper is to identify the extent to which spatial configuration of public squares located at the periphery is related to users' behavior (i.e., modes/distances of access, level of satisfaction).

2. Method

This study includes a synthesis of three types of expertise: 1) behavioral mapping of areas (through the analysis of patterns of use based on direct observation), 2) cognitive evaluation of spaces based on perceived factors (through user questionnaires), and 3) quantifying urban public spaces objectively (through the methodology of space syntax and urban morphology).

2.1. Study Areas

This study focuses on four urban squares located in Istanbul`s peripheral areas, which function as sub-centers for their surroundings. These areas –Küçükçekmece, Büyükçekmece, Beylikdüzü and Avcılar– are chosen since they are located in districts that have grown towards the outskirts between 1980 and 2000 parallel to E-5 highway, which functions as the major arterial of the city. After 2000, these districts have retained their peripheral characteristics yet at the same time served as sub-centers for the surrounding regions. All four squares are located nearby the E-5 highway to be easily accessible by pedestrians and by public transport. Küçükçekmece Square is the center of the region that acts as a link between the metrobus stop and the train station and that represents the center of the old district. Avcılar Square and its street arrangement offer a linear open space configuration within a traditional street character. Beylikdüzü Square is planned as a wide overpass that serves directly to the metrobus station and is a referenceless square where passenger movements are dominant. Büyükçekmece Square, on the other hand, is a public open space arrangement, which does not have a metrobus connection yet, but due to the transportation investments made, these connections will be provided in the near future, so it has the potential to

become a pedestrian attraction center. Figure 1 shows the four study areas on the map of Istanbul and Figure 2 demonstrates the squares within their immediate urban context.

Figure 1 Location of four squares.

Figure 2 The squares within their immediate urban context.

2.2. Observation and Behavioral Mapping

User behavior was measured through direct observations within 10-minute intervals using the methodology developed by Goličnik Marušić and Marušić (2012) and similar to previous studies (Hermida, Neira, Cabrera-Jara, & Osorio, 2017; Schwebel et al., 2018). Spatial behavior mapping was conducted for both passive and active occupancies within the squares on multiple days (weekend and weekday), repeated over 5 time intervals (from 8 am to 8 pm) during one day. Observations and behavioral mapping were conducted for one year to record seasonal differences. Figure 3 displays the set of activities along with their symbols recorded in Küçükçekmece square for one observation session. Activities are grouped under two categories, primary and secondary. Primary activities include walking, sitting, lying down, and standing. Secondary activities include sleeping, conversing, smoking and watching around. In line with previous studies (Long, Rain, & Ratcliffe, 2001), the results of observations and mapping were then translated into Geographic Information Systems (GIS) to quantitatively analyze the patterns of use, similar to previous studies.

Figure 3 Primary and secondary activities, including their attached symbols, specifying male and female users, used for recording activities in Küçükçekmece square within one observation session.

2.3. User Questionnaires

A questionnaire was designed in Turkish to explore users' perceptions about the squares. Data collection was undertaken from September 2015 to September 2016. To be consistent with the observations and behavior maps, face-to-face questionnaires were conducted with randomly selected users within the 4 squares on weekdays and weekends in the mornings, afternoons and evenings. During the survey, participants were asked to answer (1) demographic questions such as

education and gender, (2) the purpose and the frequency of using the square, (3) access mode and if accessed on foot, the distance walked, (4) questions about their level of satisfaction with the square in terms of safety, accessibility, walkability and design/maintenance. Of the 1,339 users who participated in the questionnaires, 558 were male (42%) and 781 were female (58%). A total of 337, 341, 329, and 332 users participated in the questionnaire in Küçükçekmece, Büyükçekmece, Beylikdüzü and Avcılar squares respectively.

The study protocol was approved by Ethics Commission, Özyeğin University (Ethics ID 2015/01) and relevant permissions were granted by the Municipality of Istanbul (ID 30872936-02-622.01) and the Governship of İstanbul (ID 47909374-16772.(31727).2015/5190).

2.4. Spatial Configuration and Diversity

As 800 meters, a 10-minute walking distance is considered as the walking threshold that people are willing to walk between origins and destinations within the city (El-Geneidy, Grimsrud, Wasfi, Tétreault, & Surprenant-Legault, 2014; Riazi & Faulkner, 2018), urban form within 800meter radius buffers around the urban squares is studied in this paper. The term 'square-areas' is used to indicate these buffers from here on. Urban form of square-areas is measured through evaluating spatial configuration of the surrounding street network and the land-use compositions within these areas.

The spatial configuration of street network within the study areas is evaluated using two basic descriptors of spatial structure of street networks applied in Space Syntax literature. Connectivity measures the number of spaces (streets segments) intersecting each space within the system. Segment Angular Integration measures how accessible each space is from all the others within the radius using the least angle measure of distance. Integration (radius n) and connectivity for 800meter radii were calculated for each square using Depthmap X (Turner, 2001; Varoudis, 2014). Figure 4 demonstrates the street network configuration of two square-areas using these two measures.

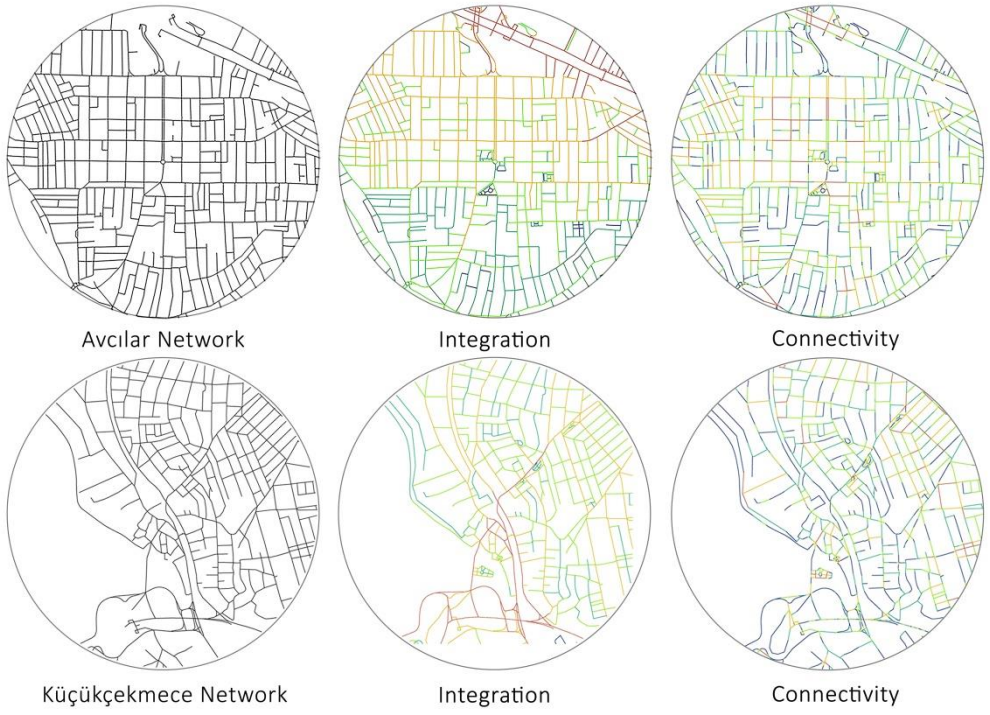

Figure 4 Avcılar and Küçükçekmece square-areas (800 meter circular buffer) represented with street network centerlines, Integration (n), and Connectivity measures.

In this study diversity is measured through the analysis of the ground-floor land-use patterns around the urban squares. Density of total land-uses as well as residential, non-residential (office + retail + commercial) and recreational land-uses are calculated separately within square-areas. Figure 5 shows the composition of land-uses within these areas. The study focuses on ground floor land-uses only since non-residential uses located on the ground floor act as 'movement attractors'.

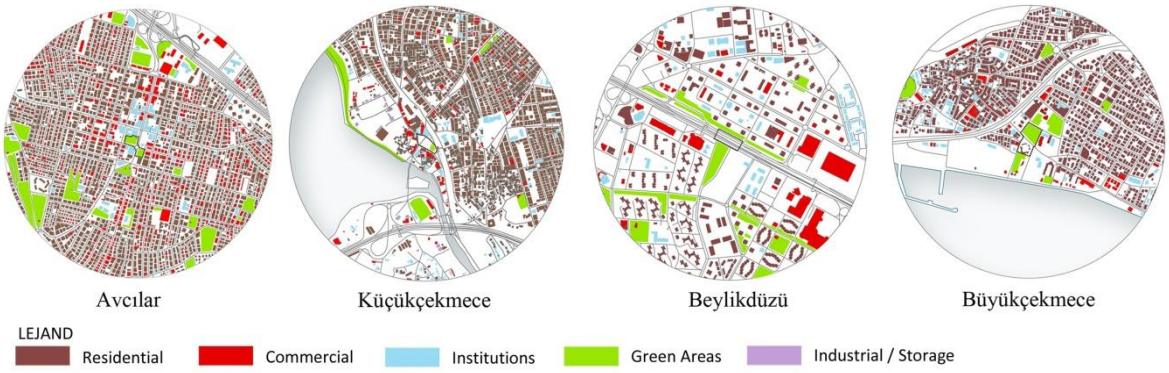

Figure 5 Land-use compositions within the square-areas (800 meter circular buffer).

3. Analysis and results

3.1. Observations and Behavioral Mapping

Figure 6 displays the set of activities along with their symbols recorded in all four squares for a typical observation session. Küçükçekmece square is mostly used for sitting and conversing by the elderly population. Hence, there is a limited variety of activities. The primary activities mostly include the passive occupancy of sitting, while the secondary activities consist mainly of conversing. Although the perimeter of the square is used as a transition route between origin and destination, the square itself serves as a space for passive usage (sitting on benches within the square). Büyükçekmece square, on the other hand, is an under-used open urban public space. This square has the least intensity in usage among the four areas and the variety of activities is limited within the square. The space is used mostly as a transition zone, where uses such as sitting or lying down are less likely to occur. The recreational park attached to the transition zone is mostly used for long-stay passive activities, including sitting, resting, and conversing. Similarly, Beylikdüzü square is predominantly used as a transition space that is in conformity with the frequency of use and length of occupancy. There is a limited variety of passive activities, such as sitting in trellises, since this square offers few street elements (i.e., benches, kiosks) and limited variety in its functional spaces (i.e., playground) and is just located above a bus rapid transit route. Limited long-term active uses mostly include roller-skating and skateboarding. Behavior mapping shows that Avcılar square has the highest intensity of usage both in short-and long-term stay. While the center of the square is used as a transition zone, the recreational park and the cafeteria area within the square are predominantly used for long-term secondary activities, including a wide range of active uses, such as children at play, and passive activities, such as sitting and reading newspaper, eating/drinking, conversing and photographing. Behavioral patterns show that activities are well distributed within the square.

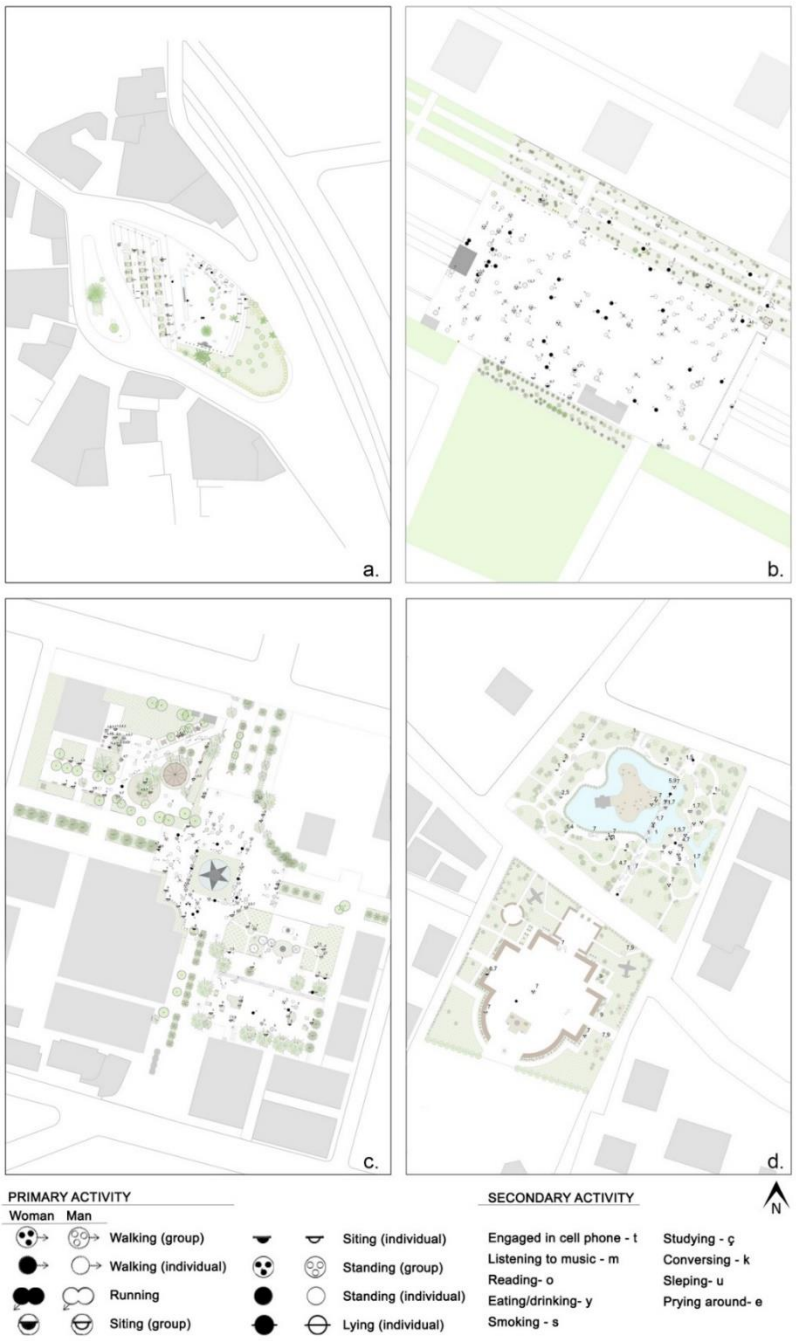

Figure 6 Behavioral mapping of the four squares (a. Küçükçekmece, b. Beylikdüzü, c. Avcılar and d.Büyükçekmece squares) during a typical observation session.

3.2. Survey Results

Table 1 lists the findings summarizing the percentages obtained from the user questionnaires in each square. Participants' age and education levels do not vary significantly between squares. Küçükçekmece square has the highest percentage of elderly users (aged 64+). While the level of education (with a college degree and/or above) among users is the highest in Beylikdüzü (31%), it is the lowest for Büyükçekmece (9%).

According to these results, the percentage of access to squares via bus rapid transit (Metrobus) is highest for Beylikdüzü Square, which is located directly on a bus rapid transit stop/route. Yet,

auto access to this square is the highest as well. The rate of people walking to the square is highest for Küçükçekmece Square, while this rate is lowest for Büyükçekmece and Avcılar Squares.

The walking catchment area, the distance people are willing to walk to the squares, is highest for Avcılar (more than half of the participants walk between 800 and 1600 meters (55%), and approximately 10% walk more than 1600 meters). Contrarily, the results indicate that participants perceive the surroundings of this square as the least walkable among the four square-areas (21% strongly disagree and/or disagree) and the percentage of users agreeing/strongly agreeing that this square is easily accessible is the lowest (64%). While the frequency of daily use is highest for Büyükçekmece (35%) and Küçükçekmece (38%), Avcılar square is used several times a day by more users as compared to other squares. The length of occupancy is the highest for Avcılar square (almost ⅓ of participants occupy the square between 2-to-4 hours, and more than 10% stay more than 4 hours). On the contrary, Küçükçekmece and Beylikdüzü appear to have the lowest length of occupancy, with almost 40% and 30% of users spending less than an hour respectively and almost half of them spending only 1 to 2 hours. In addition, users' rate of preference of squares as places for socio-cultural activities and socializing is highest for Avcılar. Surprisingly, accessibility to land-uses within the square-area are perceived to be the lowest for Avcılar while the number of users perceiving to have access to many shops and destinations within 5-to-10 minutes walking distance to the square is highest for Küçükçekmece and Büyükçekmece.

Table 1 Findings indicating percentages obtained from the user questionnaires in each square.

Statements	Categories	Küçükçekmece	Büyükçekmece	Beylikdüzü	Avcılar
Walking distance	>400m (0-5min)	32.93	31.30	31.85	21.82
	401-800mt (5-10min)	28.14	40.00	25.93	23.64
	801-1200mt (10-15min)	27.54	18.26	25.19	27.88
	1201-1600mt (15-30min)	9.58	6.09	15.56	17.58
	>1600mt (30+ min)	1.80	4.35	1.48	9.09
Access mode	metrobus	8.04	3.80	29.48	27.38
	bus/shared taxi	36.90	54.09	17.63	29.11
	automobile/taxi	5.65	8.19	11.85	10.37
	walking	49.40	33.92	41.03	33.14
Frequency of use	several times/day	0.59	0.00	1.83	6.27
	everyday	37.98	34.60	24.39	23.58
	2- 3 times/week	17.51	26.98	32.93	29.55
	once/ week	16.02	18.48	17.07	12.24
	once/ 10 days	4.15	3.52	7.32	3.88
	once/month	13.95	8.21	13.72	18.51
	1 or 2 times/year	8.01	7.04	1.83	3.88
	less than once /year	1.78	1.17	0.91	2.09
Length of occupancy	<1 hour	40.65	19.35	30.40	7.58
	1-2 hours	44.21	55.13	50.46	52.73
	2-4 hours	12.76	20.23	12.46	27.88
	4-6 hours	1.48	4.69	3.65	4.85
	>6 hours	0.89	0.59	3.04	6.97
Aim of use	Socio-cultural activities	1.53	2.92	4.87	5.88
	Socializing with other people	2.23	1.65	2.92	7.47
This square is accessible	SA	33.43	39.59	38.41	31.61
	A	38.21	37.83	43.60	33.13
	D	11.04	4.69	3.96	10.94

	SD	3.88	2.35	0.91	3.65
It is easy to walk around this square	SA	50.75	60.83	27.22	22.59
	A	19.40	21.36	48.62	26.81
	D	8.96	6.53	5.81	13.55
	SD	8.66	3.26	0.92	7.23
It is easy to access to the center from this square / its surroundings	SA	41.74	46.15	30.89	26.75
	A	31.78	32.84	51.07	26.75
	D	9.35	5.03	3.98	10.94
	SD	0.31	0.59	0.92	3.65
The distance between intersections within this square area is short	SA	31.93	38.81	29.23	20.73
	A	43.07	43.58	54.15	35.98
	D	9.64	3.88	3.08	12.80
	SD	2.11	0.60	1.23	2.13
There are many destinations within 5-10min walking distance	SA	17.51	20.71	29.57	31.52
	A	60.24	61.24	44.82	37.27
	D	4.45	2.66	3.05	7.27
	SD	1.78	0.89	2.44	2.73
There are many shops within 5-10min walking distance	SA	56.51	50.58	27.66	41.46
	A	30.77	34.80	51.67	28.66
	D	2.96	2.63	4.86	4.88
	SD	5.33	4.97	3.04	2.13
Gender	Female	53.71	55.43	63.22	61.14
	Male	46.29	44.57	36.78	38.86
Education	< college	87.41	91.11	68.90	87.63
	>college	12.59	8.89	31.10	12.37
Age	18-44	51.46	63.78	68.69	68.20
	44-64	36.04	28.93	26.87	25.12
	64+	12.50	7.29	4.44	6.68

SD: strongly disagree, D: disagree, A: agree, SA: strongly agree. For the purpose of this table, Neutral (N) values are not reported here.

In addition, participants reported their level of agreement with a set of statements, using a 5-point scale ('strongly disagree', 'disagree', 'neutral', 'agree', and 'strongly agree', coded from 1 to 5 respectively), regarding their perception of the square. Figure 7 shows the average values for the participants' satisfaction levels. This figure demonstrates that the level of satisfaction with the square itself is highest in Beylikdüzü square. Results of the survey highlighted Beylikdüzü square as a cleaner, safer, more spacious, more coherent, more dynamic, more intelligible, more relaxing, more attractive, more different and greener space perceived by its users than the other three squares. While Büyükçekmece and Avcılar squares have similar satisfaction levels, Küçükçekmece square has the lowest satisfaction level in all categories.

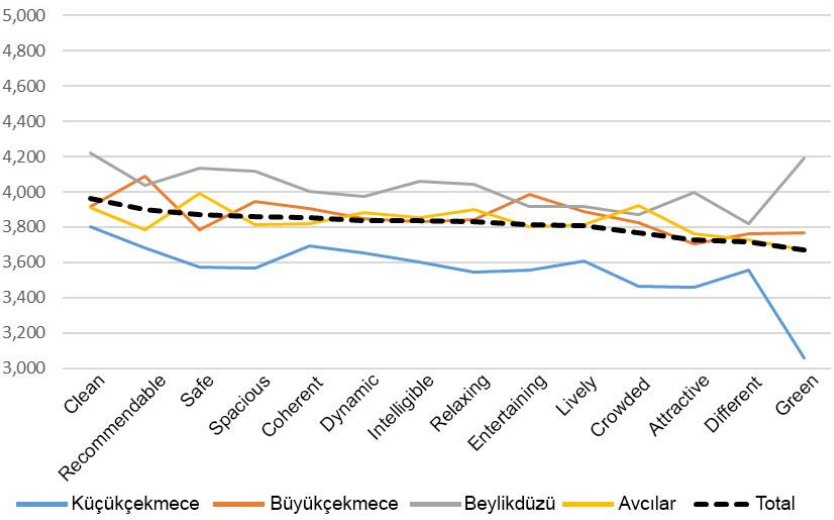

Figure 7 Participants' evaluation based on the survey. Lines show the average of the rates (higher scores show higher satisfaction level).

3.3. Spatial Configuration and Diversity within Square-Areas

Table 2 summarizes patterns of spatial configuration and diversity of study areas. Results indicate that Avcılar includes the shortest average block size with highest total street length and total number of segments, while Beylikdüzü has the largest average block size with the least amount of street segments within its buffer. Similarly, Avcılar has the highest number of intersections within its buffer whereas Beylikdüzü has the lowest. Küçükçekmece and Büyükçekmece square-areas are comparable in terms of intersection density. In terms of connectivity, Avcılar and Küçükçekmece are the most integrated public spaces within their urban context. Average connectivity values of all square-areas are comparable, with Avcılar having the highest average street connectivity within its buffer.

Table 2 Descriptive statistics summarizing urban form within study areas.

	Küçükçekmece	Büyükçekmece	Beylikdüzü	Avcılar
Morphology				
avg. block size (m)	62	61	82	57
total street length (m)	44.035	35.049	43.282	56.286
total # street segments	659	563	456	967
total # of intersections	260	262	168	394
Connectivity				
avg. Integration (n)	9,613	6,532	7,741	8,914
avg. Connectivity	3.12	3.3	3.15	3.34
Diversity (m2)				
total land-use density	476,974	411,491	455,033	604,3
total residential density	381,579	320,963	268,469	302,15
total retail density	38,158	32,919	59,154	151,075
total recreational density	38,158	41,149	100,107	114,817
Population (persons)	49,895	62,885	115,994	88,854

When the ground-floor land-use percentages are analyzed (Figure 8), Avcılar appears to include the most diverse land-use distribution, while Küçükçekmece and Büyükçekmece are predominantly residential. Beylikdüzü seems to possess similar densities of ground floor percentages to Avcılar. However, while the latter includes a fine-grained land-use pattern, Beylikdüzü encompasses coarse-grained active ground floor uses (i.e., large shopping malls).

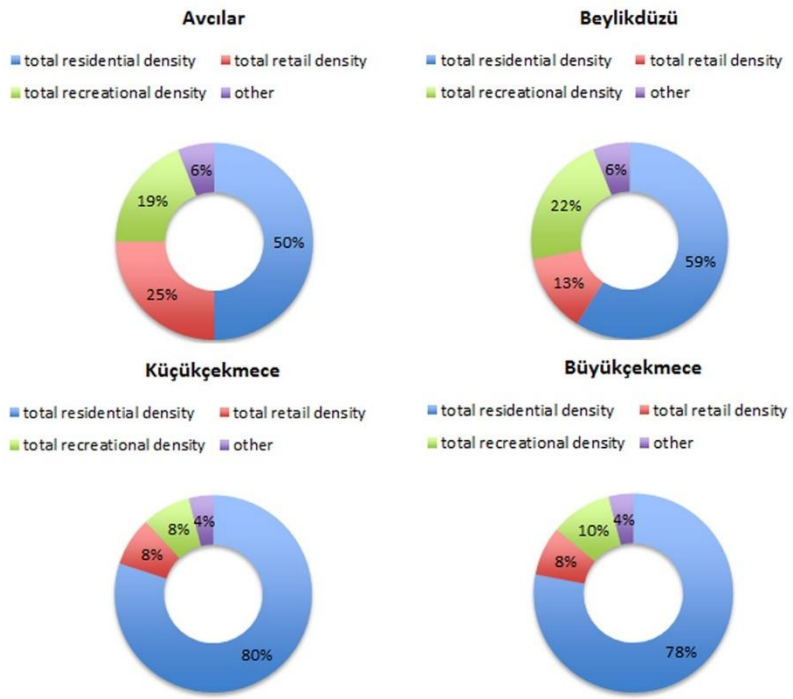

Figure 8 Land-use distributions within 800meter circular buffers of selected squares.

4. Discussions

The results of urban form characteristics of square-areas, users' perceptions, and user behavior within the squares indicate that there is indeed a correlation between these three sets of measurements of open public spaces. For example, the variety of primary and secondary activities within the square as well as the length of occupancy are highest for Avcılar square, which is most integrated within its urban surroundings with reduced average block size. Similarly, Avcılar square, which has the highest number of street segments and total length of street within its 800mt buffer, has the highest average walking distances among the four selected areas. Users, on the other hand, choose to spend less time in Beylikdüzü square, which has increased average block sizes and reduced Integration within its 800-meter radius buffer. Thus, it can be claimed that the increased integration of the square with its urban context (a 10 minute walking area or 800 meter radius) stimulates its users to occupy and to use the urban square for their pastime.

The findings of this research can be grouped under three main headings.

4.1. Significance of Spatial Configuration

When addressing usage-spatial relationships in open urban public design, spatial configuration of spaces within their urban context becomes important. Based on the analyses conducted within this paper, spatial configuration as measured by space syntax measures appears to be an

explanatory measure assessing the potentiality of public open spaces for bringing users together, hence, creating a lively, well-used space. The findings of this study indicate that the integration level of a peripheral urban square within its immediate urban context (10 minute walking distance) plays an essential role in supporting the life of the square. Integration provides us the ability of the square to get connected with other parts of the city, which is very important in terms of the intensity and frequency of its occupation. Our findings indicated that the more integrated a public urban space is with its surroundings (800mt buffers), its users will access this space on foot from a larger distance. These findings complement earlier research indicating that streets, which are highly integrated in the street system, attract a lot of movement (Hillier, Penn, Hanson, Grajewski, & Xu, 1993), but also significantly contribute to usage-spatial relationships.

4.2. Significance of Diversity

Diversity, as measured through the variety of land-uses, allows planners/designers to investigate the ability of the built environment to transform into a different land-use model and to sustain the activities of the city. When the distribution of land-uses is analyzed, Avcılar has relatively increased diversity of uses within its 800meter buffer. This is in conformity with the behavioral patterns of urban space (i.e., increased intensity of use and higher variety of activities). Thus, it may be claimed that urban squares located within urban areas with relatively diverse land-use distributions appear to have increased capacity for creating sociable and dynamic spaces. However, the distribution of land-uses within an urban space should also be considered along with the grain of parcels, because as it is the case with Avcılar square-area, a more fine-grained land division seems to promote a well-used open space which eventually becomes an important social node for the city. In dense but loose-street pattern communities, like Beylikdüzü, urban squares do not function as the main gathering spaces. One reason is that this settlement type represents coarse-grain lots and point-block isolated building morphology, which damage walkable environments. Therefore, while spatial configuration of the street network layout around the urban squares is the primary planning parameter that shapes the user behavior within these public open spaces (i.e., frequency and intensity of use as well as the walking catchment areas to squares), diversity can be considered as a complementary parameter.

4.3. Significance of Objective and Perceived Measures of Built Environment

In POE studies of public open spaces, both objective and perceived urban form measures should be employed. The findings of user questionnaires point to some disagreements between the objectively measured and perceived built environment attributes. For example, even though Avcılar square-area has the highest street connectivity (i.e., highest total number of intersections, smallest average block size, highest Integration and connectivity levels) when measured through objective GIS-based measures, participants within this square perceived the surroundings of this square as the least walkable and less accessible among the four square-areas. Similarly, while Beylikdüzü square-area is less-integrated within its surroundings with the least number of intersections and highest average block size, the level of satisfaction is highest among four case studies. This rather surprising finding may be due to the fact that users appreciate more the existence of an urban square within an urban area that is relatively isolated from its surroundings with coarse-grain destinations scattered within the area. Another explanation may be regarding the strategic location of this square, located right above a densely used metrobus line/stop. This indicates that public spaces like urban squares need to be investigated at multiple scales (e.g., both locally -as individual entities within their physical boundaries- and globally -within their global urban context) and through a combination of both objective and perceived measures. In addition, the underlying reason of users' lower satisfaction levels of Avcılar square as compared to those of Beylikdüzü square might be due to the inadequacy of the usable space within this square, which has the highest density of users/activities among other study areas. Hence, apart from the strategic location of

urban squares within the urban context, designing flexible and adequate sub-spaces within the urban squares to meet their users' needs is also essential to increase the spatial performance of these public spaces.

4.4. Limitations and Strengths

Limitations of this cross-sectional study includes the lack of investigation of the detailed characteristics and physical design features within the squares (e.g., seating elements, public art works), which have been shown to influence user satisfaction and the length of occupation of the space (Gehl, 1987; Project for Public Spaces, 2008; Subiza-Pérez, Vozmediano, & San Juan, 2020). In addition, actual walking routes of participants to access the squares were not recorded. This would reflect a truer image of actual distances walked to the urban squares. Finally, other types of land-use measures (i.e., land-use mix, number of opening onto each street within square-areas) can capture fully the diversity of urban form within square-areas. Further research can include these variables, which may lead to stronger associations with environmental attributes.

Nevertheless, this study significantly contributes to the methodology applied in POE studies on the analysis of open urban spaces, such as urban squares. This study focused on urban squares located in peripheral districts, which is quite limited in related research. Moreover, the majority of studies investigate urban spaces as singular entities within their physical boundaries, isolated from their urban context. However, user behavior prevalent in an area cannot be described by analyzing the urban area isolated from its global surroundings. This study considered the spatial configuration of urban areas within their urban context, which has both theoretical and practical implications for design of open public spaces. Hence, the comprehensive methodology used in this study can contribute to the methods and criteria for evaluating and studying other urban squares, particularly those located at the periphery.

5. Conclusion

This study demonstrates the significance of the use of space syntax analysis to evaluate the built environment surrounding urban squares as a method to examine how the spatial configuration of square-areas is related to user behavior. The findings revealed that both the street network configuration and land-use patterns around a peripheral square are indeed related to its occupation and access. Hence, the focus as well as the findings of this study is directly related to sustainable urban development challenges facing rapidly growing cities such as İstanbul. The strength of this research lies in the fact that it focuses specifically on the concept and use of "urban square" designed in areas outside, in vicinity or surrounding of the city center and that it aims to evaluate simultaneously the objective and perceived attributes of the built environment. Findings of this study can contribute significantly to the design and planning of public open spaces specifically in rapidly sprawling metropolitan areas along main transportation axes. Besides theory building, this study has practical implications. Offering a comprehensive methodological approach, this research provides some insights into the design and policy interventions for prospective user-oriented public areas at the periphery. Designing urban squares that are integrated within their surrounding urban context would foster physical activity and social interaction, improving the urban quality of cities and creating sustainable urban forms. This piece of research might lay a base for succeeding in this crucial endeavor.

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Resume

Ayse Ozbil is an Associate Professor at the Department of Architecture and Built Environment, Northumbria University. Her research interests mainly lie in the fields of spatial modeling and urban form analysis using space syntax techniques. Her work is directed towards pedestrian-friendly neighborhood and street design strategies enhancing active transportation in cities. Her recent studies have focused on walkability and obesity, transit-oriented planning, post occupancy evaluation and design of sustainable cities. Dr. Ozbil has been a member of the editorial board of Urban Design International since 2012, and her work has been published in numerous peer-reviewed journals.

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Özlem Özer is a city planner specializing in spatial analysis of road networks, strategic planning and GIS technologies. She received her PhD in Urban and Regional Planning in 2014. She worked as an urban planner in national and international planning projects for 8 years before becoming an academic. After spending one year as a guest lecturer in Environmental Planning and Design graduate program in University of Georgia in 2010, she has started to work as an academic in Architecture and Urban Design departments in Turkey. She is currently working as a lecturer at the Architecture Department of Istanbul Gelişim University. Her research interests focus on the spatial analysis of the urban environment and the effects of spatial relationships on user behavior.

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Ezgi Zünbüloğlu graduated from ITU as an urban planner in 2015 and she received an acceptance from Urban Design M.Sc. in the same year. During the master's degree she participated in various research projects. Due to her interest in symbols in urban space and their effects on users and perception of urban space, she completed her master's thesis with the study "Semantics, Perception and Graffiti in Urban Space''. Lastly, within the scope of the project carried out with the Istanbul Metropolitan Municipality, she took part in the team established to digitize the land use plans and implementary development plans in order to create a 3D database, extracting plan notes, and determining and organizing the connection of lower and upper scale plans.

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Bridging roles of social innovations in rural development: craft initiatives from Kutch, India

Serkan Bayraktaroğlu*

Abstract

Business practices are often highlighted by development studies for their contribution to the resilience of the rural population. However, business contributing to rural development has to fulfill distinct characteristics and roles compared with urban counterparts. Commercial organizations that are solely targeting economic growth and lacking social aspects of development might not contribute to the overall sustainability of the region. This paper draws on three notions discussed in the literature -social innovations, sustainable rural development, and bridging organizations- to illustrate the relationship between business activities and rural capital. Two textile craft initiatives from rural India, Kala Raksha and Khamir, were investigated in order to trace the developmental roles and characteristics of business in rural. The research identifies a set of rural social innovations and elaborates on their five bridging roles contributing to the development of the region. Findings indicate that social innovations playing bridging roles have the potentials to contribute to the sustainability of rural enterprises and the development of the region.

Keywords: bridging roles, business models, rural development, social innovation

1. Introduction

The dramatic rise in the population of urban settlements has been a global phenomenon. According to the United Nations, almost 68% of the world population will be living in cities by 2050. The major reasons behind the urban migration in the last decades are rather economic. Availability of job opportunities and access to a wide range of services attracts more and more people towards cities while rural areas, especially in underdeveloped countries, continue to struggle with a lack of livelihoods, technology, and basic public services. Nevertheless, problems faced in rural areas are not homogenous. While in underdeveloped countries rural backwardness might be a part of the debate, in developed nations, issues such as automation of agriculture and farming activities are seen as critical aspects driving urban migration.

Though agricultural activities tend to lose economic viability in many geographies, farming still constitutes an important part of rural employment. The critical share of rural in the overall

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sustainability of the world indicates that the resilience of cities is very much dependent on the existence of a resilient rural. Moreover, holding most of the natural reserves, rural areas in developing countries are fighting climate crisis and struggling to overcome adverse effects of globalization, which still keeps sustainable rural development at the political agenda (Ellis & Biggs, 2001; Pender et al., 2012; Yılmaz & Tolunay, 2007).

In the last decades, sustainable rural development approaches evolved in different forms, mostly from top-down to bottom-up initiatives, but often these approaches are focused on creating livelihoods for the rural population (Ellis & Biggs, 2001). Interpretations of the sustainable livelihoods approach specifically underline the critical role of entrepreneurship while bringing creative destruction and endogenous development theories into the debate (Krantz, 2001; Reinert & Reinert, 2006; Schumpeter, 1934; Scoones, 2009). Creative destruction is explained as a process of industrial mutation and a virtuous cycle of change in the economic structure which happens as the new continuously destroys the old (Reinert & Reinert, 2006). Today, fostering innovation and entrepreneurship is essential for most of the sustainable rural development practices. Particularly, neo-endogenous development approaches aim to mobilize rural resources through innovation and entrepreneurship (Atterton et al., 2011; Gkartzios & Lowe, 2019). Additionally, entrepreneurial initiatives enable resilience by increasing economic diversity. According to Steiner and Atterton (2015) rural businesses improves resilience (i) directly by creating local employment, availability of local products and services, (ii) indirectly by positive outcomes of increased employment such as reducing out-migration. This article focuses on the development of rural areas in developing countries while elaborating the discussion around neo-endogenous development approaches, rural enterprises and social innovations.

The positive impact of business and specifically social and inclusive business models on the reduction of poverty in developing countries were stressed by numerous papers and reports (Bayraktaroğlu, 2020; Borzaga et al., 2008; Nelson & Prescott, 2003; WBCSD, 2005). As the positive impact of local business is underlined by development studies, understanding the characteristics of rural enterprises has become more and more important. Though, agriculture is often accepted as the major economic activity in rural, non-farm employment is an important element of rural resilience and economic diversity. Increased consumerism and rapid technological changes compel us to rethink the agriculture-oriented understanding of rural business practices. Additionally, in the last decades, development plans solely focusing on farm employment have shifted towards more diversified models of livelihoods (Reardon et al., 2007). The strategy behind such a shift is not about reducing the role of agricultural production but on the contrary, increasing the resilience of the rural economy. According to UNDP (2014) resilience of a community help people dealing with crises and problems and in the context of rural development, resilience is about the development of institutions facilitating societal robustness (King, 2008).

Among all other non-farm livelihoods, craft production is still a potential economic activity for many rural communities. While rural crafts are strongly related to indigenous knowledge and regional resources, the success and revival of craft business often depend on vital connections of external networks. In order to survive in competition, craft enterprises need enhanced market knowledge and better production capacities. The aim of this paper is to improve understanding of how social innovations contribute to rural development. The paper uses bridging originations as a concept to define the role of social innovations and illustrates the linkage between social innovations and rural development through two cases from rural India. The first part of the article focuses on rural business and innovation, which is followed by a section describing rural social innovations and their bridging roles. Presented two cases illustrate and extend the debate on how social innovations enhance the sustainability and embeddedness of rural businesses.

2. Characteristics of rural business

Although it is often associated with agricultural production and low population, the meaning of rural is a considerably complex term and there is no agreement on a single definition for all purposes (Gülümser, 2009). General criteria used for definitions include aspects such as population, proximity, degree of urbanization, principal economic activities and work commutes (Cromartie & Bucholtz, 2008; Hart et al., 2005). Often relative inaccessibility of goods and services, disconnectedness from external networks describe rurality. Similarly, absence of infrastructure and technology compound, unavailability of market information, and limitedness of human resources are common obstacles of rural business. However, social cohesion and having a sense of community signify strong aspects of rurality in the context of business. Diverse farm activities, tourism, home-based businesses, and creative industries are business models frequently established in rural areas.

Increased interconnectedness and interdependencies between rural and urban economies make it impossible to identify a rural business just by its location. For instance, business models located in urban areas sometimes play a critical role in the development of rural communities. While, those established in rural areas, due to their strong connection and dependency to urban networks, might show limited embeddedness to local. A hotel located in a rural area serving tourists, and not creating employment for the rural population would not be a genuine example for rural businesses creating value for the region. At this point, it's necessary to recall that rural is not a geographic but a social term. Thus, debates discussing common characteristics of rural businesses should go beyond the simple geographic identifications. For instance, Bosworth and Turner (2018) offer three criteria to identify a business as rural. According to the authors, a rural business needs to fulfill two of the following three criteria; serving a rural population, selling a rural product, and being located in a rural area. However, being identified as rural according to those criteria doesn't necessarily assure positive impact to development of communities.

The social cohesiveness of small communities dispatched from the urban corresponds to the character of rurality. Thus, business models focusing solely on economic growth and overlooking social aspects of sustainability often fail to create a long-term impact in local. In this perspective, in addition to commercial innovations, social innovations are also critical for the long-term success of rural businesses. Thus, this article moves beyond the general definition of business focuses on social business models and their bifocal goals. Social business models often embody both economic and social value production in the core of their business logic. The relative ratio of social and economic goals, and types of the business model may vary for each organization. For instance, UNDP (2014) examines socialness of business models in four categories: Corporate Social Responsibility, Social Enterprise, Inclusive Business and Mainstream Business. According to this categorization, it is expected that the density of social and developmental goals would be maximum at corporate social responsibility initiatives and minimum at mainstream businesses. Those definitions are obliged to be rediscussed according to rural development context. In order to examine the interaction between rural businesses, social innovation, and development, we need to gain a deeper understanding of the nature of rural business. In this manner, this article employs a broadly accepted rural capitals framework to study the role of business activities in rural development.

Rural capitals framework coined by Castle (1998) is a comprehensive tool to study rural and specifically helpful to elaborate notion of creative destruction in neo-endogenous development approaches (Chevalier & Vollet, 2019; de Fátima Ferreiro & Sousa, 2019; Gamito & Madureira, 2019; Losada et al., 2019; Rantamäki & Kattilakoski, 2019). Rural capitals framework identifies the following four capitals: man-made, natural, human, and social capitals. Natural capital includes all kinds of natural resources. In the case of business, sustainability, quality and efficiency of natural capital are essential for the success of a rural enterprise. Moreover, natural capital often facilitates certain types of commercial activities and innovation in rural business models. A strong and respectful relationship between inhabitants and natural capital creates a deeper understanding of

the environment and its use. Such a profound relationship would also reduce the alienation from the work. While rural businesses are expected to exploit natural capitals for being embedded in the region, in return, they should enhance the sustainability of natural resources too. Degradation of natural capital would eventually terminate the economic activities of an enterprise. Moreover, unforeseen change in the quality and quantity of natural capitals also creates complications in business processes.

Man-made capital is identified as physical or embodied capital including the built environment, infrastructures and available technologies. In the context of business processes, man-made capital directly influences economic performance and success. However, specifically in rural business processes, technological appropriateness has a catalyzer effect for long term attainment. If a technology is not customized for the needs and capacities of locals, it would not be embedded in and eventually would create a dependency on external actors. For instance, if adopted high-tech water dripping technology is too complex to use and maintain for locals, and its spare parts are not available or economically viable for rural farmers, it would create an additional dependency on external actors. Instead, a sustainable and appropriate technology would increase the resilience and independence of rural initiatives. While human capital is principally related to the rural population and their capacities; social capital refers to networking, trust and relationships within communities. Embedded and autonomous relationships that constitute social capital, eventually foster local economic development (Woolcock, 1998).

Another aspect often discussed in the literature is the embeddedness of a rural business. Greenberg, Farja and Gimmon (2018) in their article describe double-layered network embeddedness for enhancing the growth potential of the local businesses. According to the concept of embeddedness, economic activity is described through interests and a system of social relations. Embeddedness in a rural business network catalyzes actors to collaborate, to be exposed to information, to build trust between members and groups, and to spread ideas and innovation. Steiner and Atterton (2015) describe community resilience as a combination of social, economic, and environmental factors such as a viable local economy, social capital, and engagement quality of the local environment. Socially aware rural initiatives and their owners consciously use and enhance the main aspects of social capital such as co-dependence, reciprocity, and collective activity (Shucksmith, 2010).

In summary, similar to urban counterparts, rural business models also necessitate innovation and creative destruction. However, social, economic and environmental sustainability should not be overlooked in business processes. Thus, facilitating social innovations in addition to commercial initiatives would eventually enhance rural capitals. Moreover, created social value is critical for the embeddedness and resilience of rural businesses. The next section discusses the role and types of social innovations in the context of rural development.

3. Identification of Rural Social Innovations

The characteristics of rural entrepreneurship are different from urban due to distinctive market forces and consumer demand. Resource unavailability and the absence of consumers able to pay higher prices for novel products and services often promote an environment in favor of necessity-based entrepreneurs (Sonne, 2010). In this manner, rural entrepreneurs tend to stand on existent resources and knowledge which limits the innovation potential as experienced in urban organizations. However, the intrinsic value of local knowledge and resources, specific expertise in local circumstances, and availability of region-specific tacit knowledge enhance numerous types of innovations such as frugal innovation, jugaad innovation, Gandhian engineering (Basu et al., 2013; M. B. Zeschky et al., 2014), bricolage innovations and pro-poor innovations (Berdegu, 2005; Paterson et al., 2007; Sonne, 2010). Though such bottom-up innovations are often expected to be inadequate to reach global markets, they have individual aspects fostering local development. For instance, frugal innovations provide economically efficient, appropriate, adaptable, affordable and

accessible products and services developed to solve challenges specifically in BoP markets (Basu et al., 2013; M. Zeschky et al., 2011).

Innovation studies in the last decades brought several taxonomies, from technical improvements to novelties in management or social problems, to discuss the popular phenomenon (Garcia & Calantone, 2002). In general terms, innovation refers to the alteration of the present situation in order to offer added value. According to OECD (1999) innovation process has a series of activities including scientific, technological, organizational, financial and commercial. Innovation is a crucial aspect of any developmental intervention intending to yield from creative destruction. However, innovation processes in rural organizations do not necessarily strive for a scientific breakthrough. Without compromising from rural-urban cooperation, primary goals of innovation in rural should be enhancing wellbeing, livelihood opportunities, socio-spatial justice and resilience (Gkartzios & Scott, 2014; Lowe et al., 2019).

Employing the concept of rural capitals, it is expected that developed innovation should exploit different forms of rural capitals while local knowledge has to be translated and shared between actors (Bayraktaroğlu, 2020). In this sense, social capital and quality of social networks emerge as a critical aspect in the utilization of resources (Bosworth and Atterton, 2012). Moreover, when innovations lose their connection with the local social needs, they refrain from embeddedness. Thus, not only the technological and commercial but also social aspects of innovations are essential to be discussed in the context of rural development. In this viewpoint social innovation acts as a bonding concept and in this article the bridging roles of social innovations are underlined to link rural enterprises and sustainable development.

Social innovations are often defined as a better, more sustainable or more efficient alternative (Howaldt & Schwarz, 2010; Hubert, 2010; Murray et al., 2010; Phills et al., 2008; White, 2008) that seeks behavioral change in the community (Jegou & Manzini, 2008), contains a clear social purpose (Cajaiba-Santana, 2014) in order to meet unmet needs (Cajaiba-Santana, 2014; Phills et al., 2008; Pol & Ville, 2009). United Nations Conference on Science and Technology (UNCSTD) coins three categories for the definition of social innovations:

- What it is definitions focus on innovation as an outcome. In such a definition social innovation can be a law, a social network, a profession or training, a value or a norm.
- Who can make it definitions focuses on the initiators of social innovations. In this case, actors might be entrepreneurs, policymakers, NGO's, managers and so on.
- How to make it definition focuses on the process of social innovation and comes up with definitions such as top-down, bottom-up, systematic or trial and error.

Social innovation is a distinct type of innovation that can occur in any sector and brings measurable improvements to existing structures, which are often context-specific and multi-layered. They change social relations with regard to governance, enhance societal resilience, and increase beneficiaries' socio-political capabilities and access to resources. However, those definitions don't really provide a clear distinction between profit-seeking business innovations and social innovations. One may easily claim that almost all product or service innovations seek to satisfy the needs and wants of consumers. In this manner, they all tend to meet unmet needs and aim to improve the quality of life for as many people as possible. The literature stresses that genuine social innovations don't really focus on the need that can be satisfied by market forces. On the contrary social innovations target problems neglected by the private or public sector (Borzaga & Bodini, 2014; Pol & Ville, 2009).

In any case, it is still hard to put clear borders between pure social innovations and commercial innovations. Frequently the initiator of social innovation, either from a not-for-profit or for-profit organization, fosters both commercial and social innovations together by providing bifocal changes (Pol and Ville 2009). While competitive forces are the main drivers of commercial innovations, social

innovations are often shaped with and for the community. In such a case society act as both the innovator and the receiver of the value.

Issues dealt with social innovations vary in different parts of the world. For instance, in Europe, austerity, budget cuts, unemployment, aging, migration, and climate change are common unsolved problems. Those issues are not profitable enough for the business to focus on while often the public sector is not capable to address them adequately (Pisano et al., 2015). In such a situation new structures and hybrid organizations are established by the collaboration of civil society and other sectors (TEPSIE, 2014). In the context of rural development, pure social innovations are frequently conducted by government and multinational development agencies. Such direct interventions often solve problems in short term but do not necessarily increase local capabilities to create long-term successful entities. This paper tries to draw a linkage between rural enterprises and developmental efforts through social innovations.

Social innovations might be tangible or intangible interventions. For instance, one of the most frequently discussed social innovation The Grameen Bank is a type of organizational innovation aiming to solve a common problem of inaccessibility to financial support. Microcredit in this manner is a new definition and change in the organizational structure of banks to make their services more inclusive. The introduction of new technology such as water wells established in arid habitats would be a tangible example focusing on a fundamental need. In the context of rural development, Butkevičienė (2009) identifies numerous possible social innovations, which are:

- New services
- New education courses for rural people
- New ways of farming such as ecological farming
- Formation of local action groups
- Electronic social innovations; public internet access points, digital promotion and advertisement
- The change in attitudes
- Consolidation, community development, making things together
- New knowledge for making a profit
- Environmental protection
- New organizational forms
- Improvement of life quality

Enhanced by tacit and explicit local knowledge, social capital and strong social networks improve the impact and emergence of potential social innovations. In this manner, rural enterprises can act as change agents of social innovations. This article applies the concept of bridging organizations to further elaborate the linkage between social innovations derived by rural enterprises and development efforts. Rural enterprises are expected to exploit rural capital while developing social innovations and bridging roles work as an organizing concept to discuss the links between social innovations to rural capital.

The concept of bridging organizations is discussed in adaptive governance literature. Bridging organizations are often highlighted with their capacity of dealing with uncertainty by fostering collaboration and trust between actors, and linking local communities with governments (Brown, 1991; Hahn et al., 2006; Ness et al., 2007). Moreover, bridging organizations foster the exchange and translation of knowledge between local and extra-local actors. According to Brown (1991) bridging organizations also works as a facilitator of the establishment of local organizations, horizontal linkages, grassroots influence in policy disseminating new visions, and organizational innovations. Castro-Acre and Vanclay (2020) in their study discuss the following five distinct roles bridging organizations play as social innovation initiatives for rural development.

The network enabler role is identified as creating a linkage between actors and networks interested in the development of the region. In this sense fostering collaboration in vertical and horizontal levels arises as central for the bridging function. Moreover, diversity and strength of network connections influence the economic and social success of business models. The more an organization infuses in distinct networks, the better utilizes knowledge flow. The knowledge broker role provides a forum for knowledge sharing, creation and translation. Organizations and actors identify different qualities of local knowledge and exchange translated knowledge between nodes of the network. In an innovation process, knowledge brokerage plays a key role in developing novel ideas. Similar to knowledge brokering, the resource broker role is related to enhancing a wider network to identify, provide and transform local and extra-local resources. Resources vary from tangible to intangible entities such as raw materials, development funds, agricultural products or traditional knowledge of making. Bridging institutions move beyond their self-interests and focus on the overall benefit of as many actors as possible. In this perspective, they understand the needs and expectations of all participants of the network to reach balanced transactions. The transparency and conflict resolution agent role is described as a part of organizational governance. Authors exemplify this role as project leadership, fair decision making, solving individual problems transparently, and convincing all actors of the network in the decision-making process. Organizational social innovations enhancing collaborative decision-making processes might realize this role. The shared vision champion role provides alignment of actors, knowledge, resources, goals, strategies and aspirations. Organizations often play this role by the introduction of training and educations, inclusive strategies, trademarks, and movements.

4. Methodology

Rural enterprises targeting regional development and having either commercial or social purposes in the core of their business logic has to conduct social innovations playing bridging roles. In order to discuss social innovations and corresponding bridging roles, this paper focuses on two successful examples established decades ago in rural India. Struggling with economic problems and political conflicts, India is a remarkable country with its unique socio-cultural fabric. The second-largest populated nation of the world encompasses a vast array of geography, history, and culture. Craft practice survives as a response to overcome the daily problems of the underserved rural population. Moreover, throughout history, India has employed numerous development approaches to improve the livelihood potentials based on craft to initiate sustainable rural development. Thus, two craft initiatives from rural India were chosen for this article. The cases discussed in this paper were first presented as a part of the Ph.D. research in 2014 (Bayraktaroğlu, 2014). The dissertation focused specifically on the designers' roles in enabling social innovations in seven rural initiatives practicing different craft traditions and facilitating sustainable rural development. However, for this article, two cases were selected and revisited for elaborating the rural innovation debate within the light of a new concept 'bridging roles'.

The case study method is an appropriate and frequently used approach to discuss and identify a phenomenon (Stake, 1995) such as the complex and unique nature of social innovations enabled by organizations in India. To understand the roles, capabilities and network of the organizations, several data collection methods were employed including face-to-face semi-structured interviews with key people, archival research, and personal observations. Selected cases are well known best practices creating social and economic development for local people. Moreover, they constitute the key actors of the craft ecosystem of the region. To have a comprehensive understanding of each business model, the analysis of collected data realized through the use of SWOT analysis, Activity System Maps, Business Model Canvases. and Actor-Network Maps.

The research focuses on the business models and actors of the reviewed two initiatives which are both not for profit organizations. The first level of analysis focuses on business models and strategies, the second level of analysis focuses on the craft network as the relationship of actors.

SWOT analysis reveals the overall strategic position of an organization through identified strengths, weaknesses, opportunities, and threats. Activity System Map, coined by Porter (1996), elaborates strategies and activities in a relationship model which allows examination of the logic of a business model. During the analysis phase, SWOT and Activity System Maps were followed by Business Model Canvas which were used to gain a better understanding of each organization. Osterwalder and Pigneur's (2011) Business model Canvas is a practical and effective tool to examine and visualize the relationship between business logic, resources, value propositions, and customers.

5. Bridging Roles of Local Craft Initiatives

Kutch, the largest district of India, is well-reputed with the great salt desert and rich handicraft traditions. The region is located at the Pakistan border of the country where the intersection of cultures and communities creates the unique socio-cultural fabric of the region. Inadequate economic activities of salt production and cement industry don't truly create livelihood opportunities for all inhabitants. In this manner craft production stands out as a prominent economic activity. The region takes its share from funds supporting the establishment of various organization types driving the craft sector. Another reason for the grants in the last decades was governmental efforts aiming to bind up wounds of the 2001 dated massive earthquake which heavily devastated the region.

Among all variety of Kutchi craft practices, textile artisans are well accepted by national and international markets. World-famous Kutchi embroidery craft had been mainly practiced by women and passed from generation to generation. The commercialization of handcrafted textile products of the region had been an important income generation activity since the 1960s. Especially after the earthquake, in order to survive, locals had offered their family heritage to local markets. Since last decades, diverse types of business models established in the region aiming to mobilize local artisans and to exploit rural capitals. This article focuses on two not for profit organizations maintaining a unique ecosystem of social innovations and development in the region.

The first organization, Kala Raksha was founded in 1993 as a not for profit organization aiming to preserve traditional arts and crafts. The organization's innovative branch Kala Raksha Vidhyalaya aims to support local artisans with formal design education. The school has been recognized by UNESCO's Artists in Development Program and received financial support from the world. Kala Raksha works with hundreds of artisans from seven communities living in 25 different villages. Additionally, the founder and former head of the organization, Judy Frater, was awarded an Ashoka Fellowship in 2003, the Sir Misha Black award in 2009, and The Pillar of Hindustani Society award in 2009.

Judie Frater, the founder of the organization, shows an immersive dedication to the preservation of local embroidery and craft culture since the 1990s. The organization established a resource center and a museum in which continuous research and documentation projects are conducted. Moreover, Kala Raksha's key activities include developing marketable products and providing artisans with links to external markets for generating regular income. In this manner, the organization doesn't replicate traditional designs and goes beyond them by employing continuous product innovation so that acts as a fashion brand. The initiative even conducts regular exhibitions in big cities to increase brand value. The design team of Kala Raksha focuses on analyzing market trends and using resources to answer those trends with marketable products. At this point, it is necessary to underline that Kala Raksha keeps its focus on traditional motifs and techniques to fulfill its main goal of preservation.

The second initiative, Khamir, was founded as a joint initiative of Nehru Foundation for Development and Kachchh Nav Nirman Abhiyan in 2005 with the goal of being a platform representing and fostering Kutch Craft Heritage as a whole. Khamir expands its focus beyond embroidery and textile craft by embracing all traditional handicrafts of the region including leather,

metalwork, pottery, printed and hand-woven fabric, namda and rogan painting. Khamir works with diverse artisan groups and focuses much more on product innovation. Being a part of a large network composed of various actors, the organization tries to promote local craft for generating income and expanding its developmental influence on locals through social innovations. Both organizations exploit rural capitals and enhance the development of the region by the introduction of numerous social innovations (Table 1).

Table 1 Identified social innovations

Types of Social Innovations	**Kala Raksha**	**Khamir**
New services	-Craft tourism.	-Craft tourism. -Designer residencies. -Craft studios. -Raw materials depot
New education opportunities for rural people	-Design courses for artisans to increase their capabilities.	-Training and education for artisans. -Fundamental education for children.
New and sustainable ways of farming		-Introduction of Organic Kala Cotton. -Supporting the use and conservation of plant-based dyeing. -Use of dye-free camel wool.
Formation of Local Action Groups	-KARVADA (the designer artisan alumni group)	-Supporting establishment of local Self-Help Groups
Electronic social innovations	-Online resource database. -Websites	-Online exhibitions. -Websites
Attitude changes	-Change in attitudes of artisans through increase in the pride of craft making. -Positive change in young generation's perception of craft. -Co-working with professional designers.	-Increased pride of artisanship. -Co-working with professional designers.
Community development	-Artisan designer community	-Involving local people and civil initiatives into the innovation process restores the community linkages.
New knowledge for making profit	-Craft tourism. -Introduction of new garment designs using traditional embroidery and motifs.	-Craft tourism. -Introduction of new designs, new materials used in textile production. -Organic cotton farming
Environmental protection		-Supporting organic farming. -Using recycled plastic as weaving material. -Supporting use of natural dyes.
New organizational forms	-Involving artisans in decision making process for design, marketing and fair wages.	-Relationship with designers to involve them in the innovation process.
Improvement of life quality	-Income generation and education opportunities for rural community. -Development activities aiming to improve health conditions.	-Income generation activities through employing artisans, training and employing them in the organization. -Social security programs, health and safety improvement activities. -Supporting artisans with finance and credits. -Supporting appropriate technology development.

Both organizations contribute to the development of the region by interweaving clear business purposes with goals to improve the needs of the local population. In this manner, listed social innovations mostly have bifocal character supporting economic and social developments. Moreover, both organizations manage to conduct a sustainable relationship between business goals and rural capitals. The listed social innovations (Table 1) are interlinked with vertical and

horizontal networking, business practices, sustainability interventions and capability improvements. The next part of the paper employs a bridging role as a framework to discuss how identified social innovations contribute to sustainability.

5.1. Network Enabler Role

Connecting actors and networks might be the essential role of any rural enterprise targeting sustainability. Actors who are either interested in the development of the region or simply benefiting from being a part of the network seek access points to the ecosystem. Both organizations discussed in this article, Kala Raksha and Khamir, have strong network enabler function for the ecosystem. In this ecosystem, major actors interested in the development of the region are local and national governments. But many other actors including designers, universities, artisans, and fashion brands enter the ecosystem through the access points provided by local organizations.

Primary access points of the network are physical facilities such as museums, design schools, resource centers, residencies, workshops and shops. Moreover, the websites of the organizations extend the range of the network for a wider audience. Locals find opportunities to interact with extra-local actors through the network. For instance, one of the interviewed hand-looming artisans educated by Kala Raksha design school was invited by a European textile design education institution to conduct workshops there. In this example, the artisan designer education as a social innovation provides new capabilities also enables artisans to lift up their community by connecting other actors. Through education opportunities, both vertical and horizontal linkages emerge in the innovation ecosystem. Access to national and global markets, access to designers' networks and the education network of the country are important catalyzers for artisans. Other social innovations provided by both organizations are touristic facilities such as museums, conducted workshops, residencies and shops. Those facilities both create income for the organizations and also increase awareness about the region and its values.

5.2. Knowledge Broker Role

Knowledge brokerage is a critical function in a successful innovation process, especially for the development of new products and services. Although craft practice is often understood as a non-innovative process of repeating old traditions, on the contrary, innovation is a crucial driver to survive traditional crafts and retrieve them from being mere souvenirs. India is a large country in which different layers of culture lived simultaneously. The western way of living goes hand in hand with traditional lifestyles. Especially in terms of fashion products, the market is quite heterogeneous and highly competitive.

Both Kala Raksha and Khamir put special emphasis on research and documentation. Their efforts for decoding, archiving and exhibiting local values including traditions, motifs, the evolution of products and endangered craft processes; provide the fundamental knowledge base for any innovation and economic activity utilizing craft production. Kala Raksha offers a digital version of their archives to spread the knowledge while Khamir presents well-curated and informative exhibitions and video documentaries offered at online and offline platforms.

Kala Raksha has a strong focus on the preservation of traditional artisanship and archived motifs. However, the organization recognizes the fact that in order to have a share from the contemporary market, they have to alter traditional products. In this manner, the main knowledge brokering role happens through the innovative organizational structure and education facilities. First of all, the artisan designer education facility attracts knowledge from faculties of highly reputed design universities. Continuously nourished knowledge flow from market and research institutions to the organization and artisans through this channel. Interviewed intern students highlight how the translation of knowledge between designers and artisans happens through delicate and fragile efforts. Such collaborations take weeks and sometimes months depending on the internship

program of the university and the structure of the conducted project. And during these periods of time, designers and artisans develop a unique new language through the act of making. Both organizations act as the facilitator of this process of knowledge sharing, creation and translation. Moreover, Kala Raksha has an organizational innovation to involve artisans and designers in the new product development committee.

Khamir has a relatively deeper thirst for innovation compared to Kala Raksha. Thus, they play the knowledge broker role in numerous channels. The offered craft studios and residency program allowing enthusiastic designers and artists to experience local craft practices and to work with artisans in person. Outputs of such collaborations are often novel and marketable products. Khamir promotes merging and interacting with distinct craft practices on products, which also facilitates artisans to learn from each other. Additionally, Khamir focuses on the co-development of appropriate technologies that are low cost, usable, effective and bottom-up grassroots innovations.

5.3. Resource Broker Role

The availability of rural capitals and financial supports are crucial resources of the ecosystem. Both organizations exploit and enhance accessible resources such as traditional craft practices, artisan as human capital and grants to create value while identifying and providing new ones. Nevertheless, Kala Cotton project is a comprehensive example of how Khamir acts as a resource broker by introducing social innovations such as organic farming and attracting grants for the project. In the history of the region, farmers harvested local cotton species adapted to the arid climate of the region for centuries. However, the local cotton species and the conventional way of cotton production had discarded by the introduction of more yielding imported cotton seeds which require a lot more water during farming. Throughout the time, changing climate and ongoing drouths made it impossible for farmers to make a profit from cotton production. Thus, the textile heaven of the country started to import cotton from other states. Subsequent to comprehensive researches, in order to revive organic cotton farming in the region, Khamir founds traces of traditional cotton farming and attracts funds from a multinational development initiative. Moreover, the organization product marketable products to create awareness about the resource.

Similarly, Khamir trained 12 women in 2010 to process discarded plastics collected from residential and industrial areas. The project mainly focuses on the waste problem of the region by utilizing trashed plastics as raw material for weaving. This is both social and commercial innovation which both enables local women for generating income and contributes efforts of overcoming a serious environmental issue. Moreover, in order to scale up the project, the initiative extended the network with new actors and collaborated with another local NGO, Sahjeevan, focusing on environmental sustainability.

5.4. Transparency and conflict resolution agent role

Both organizations emphasize fair governance and shared decision-making processes. For instance, Kala Raksha introduces a multidisciplinary committee composed of artisans, designers, and managers responsible for the decision-making process to design new products targeting both national and international customers. Moreover, concerning fair wages, the organization distributes the power to artisan trustees and all decisions are given in consensus.

Khamir offers a social security program for linking artisans with government schemes related to health and social security services. Similarly, Kala Raksha employs preventive health care programs and basic education for artisans and their families. Both organizations offer micro-loans and short-term financial solutions for artisans. Kala Raksha also supports artisans to form Self Help Groups in their villages. Additionally, Khamir offers raw materials depot providing small and medium-sized artisan initiatives with materials at competitive and fair prices.

5.5. Shared Vision champion

Kala Raksha's artisan designer mark is the crystallization of a shared vision drawn by Judy Frater and accepted by local artisans. This vision also forms the backbone of the organization and is shared by not only artisans but also their surroundings. During interviews all the artisans reflected the genuine pride of their work, crafting with design knowledge. Moreover, they proudly mentioned that their children are also willing to take a similar path. Such examples reflect how crafting as an economically viable and emotionally valuable activity could be revived and passed from generation to generation.

Similarly, Khamir builds a brand of Kutchiness to widespread traditional but also innovative encounters of numerous craft practices. Not only good artisans but also enthusiastic and talented designers are attracted to the innovation collective of Khamir. Experimentation with materials and craft techniques are the shared vision provided by Khamir. Consequently, sustainable material experiments are conducted such as the use of natural dye, using the natural color of camel wool as a design element, hand-looming recycled plastic material, mixing leather metal and textile.

Identified social innovations aim to enhance rural capitals through playing bridging roles (Figure1). In this relationship, rural business practices are expected to foster social innovations in addition to their commercial goals. Since the success of examined craft initiatives depends on the effective utilization of local assets, facilitating social innovations to foster the development of the region also contributes to the economic success of the organizations.

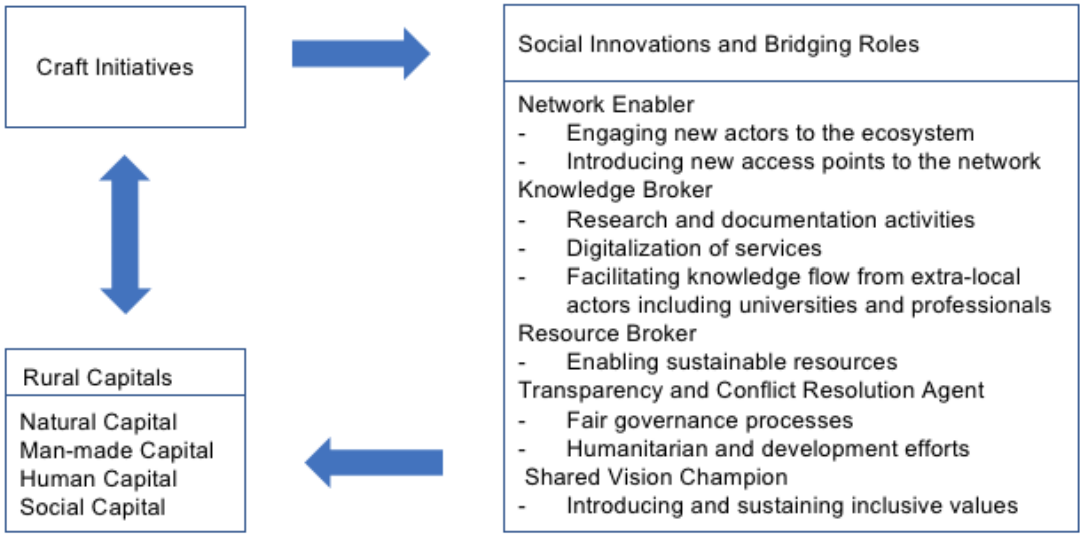

Figure 1 Identified social innovations and their bridging roles

Thus, it is possible to claim that the more a rural business model is embedded in rural capitals the more it could benefit from social innovations. In such a setting, social innovations have the potentials to enable locals to overcome their problems and to enhance the sustainability of business initiatives. For instance, the introduction of Kala Cotton or recycled plastic as raw material for weaving has both social and economic benefits. Similarly, preservation of craft heritage or training local artisans are introduced as pure social innovations initially but as the study points out eventually those social impacts influence the reinforcement of rural capitals which are exploited by the organizations for the development of the region and sustainability of the business. In this perspective, the local business models act as the initiator and also the beneficiary of the innovations.

6. Conclusion

Facilitating a vivid local economy is a vital element of the development efforts targeting a resilient rural. Such approaches optimally create livelihood opportunities providing mechanisms utilizing rural capital through creative destruction. However, the research stresses that the positive relationship between rural initiatives and resilient local communities is related to the specifications of a business model. Employing participative governance instruments, building an ecosystem containing diverse actors, and having a mutually beneficial relationship with rural capitals are prominent aspects of business models promoting sustainable development. Throughout history, rural development strategies evolved from top-down to bottom-up approaches utilizing local values and assets. In this perspective, the embeddedness of business and innovation would increase the locality and sustainability of development efforts. Rural businesses by nature focus on exploiting local and extra-local resources to develop marketable value. The more a business utilizes and enriches rural capitals the more its processes become embedded and sustainable in the context of rural development.

Triggered by local interests and needs, social innovations transmute and alter social relations in sustainable development processes. Rural social innovations emerge in various forms and mechanisms targeting the unmet needs of locals. Business initiatives embodying social purposes in their logic would be catalyzers of development where public interventions are not available. In this context, bridging institutions provide an organizing framework to further analyze social innovations and roles of rural business. Bridging roles connect innovation efforts of business practices with developmental needs. The research shows that the influence of social innovations will increase incrementally if the organization exploits assets of innovation ecosystems consist of diverse actors having vertical and horizontal relationships. Thus, development policies considering not only economic performance but also embeddedness and social innovation capacity of business models would be more successful in promoting sustainability, networking ability and resilience of rural communities.

The qualitative case study method was effective to understand the business models and interconnectedness of actors of the innovation ecosystem. However, this approach did not allow the study for a more precise assessment of the social impact of identified innovations. Moreover, the language barrier and time limitation were the main obstacles to develop a better understanding of the cases. Another limitation of the research stemmed from building the study upon existent data collected years ago. Extending the analysis with a new set of data would beneficial for the discussion of bridging roles.

Focusing only on craft initiatives to understand the bridging roles limits the outcomes of the study. Thus, the findings of the research cannot be generalized to all rural initiatives. Although discussed roles are not context-specific it is recommended to conduct further researches to elaborate the issue with different types of rural initiatives. Further researches should also employ social impact analysis to gain a deeper understanding of the relationship between innovations and social change. Such research could also increase the efficiency of policy recommendations for supporting rural initiatives.

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Resume

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