Research Paper

AN EVALUATION ON THE IMPLEMENTATION OF VEGETATED ROOF SYSTEMS IN URBAN TRANSFORMATION AREAS

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Received: October 7, 2020
Accepted: December 7, 2020

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ABSTRACT

Today, it has become necessary to increase urban green areas in order to ensure sustainability and adaptation to climate change in urban areas with high building density. Planting roof surfaces is a sustainable approach to increase green areas and maintain ecosystem continuity in urban areas. Urban transformation can provide an opportunity for Vegetated Roof System (VRS) to become widespread in areas where Istanbul has a densely populated and dense building settlement.

It is aimed to increase the "construction area / green area" ratio in order to ensure sustainability and adaptation to climate change in urban areas with high building density. For this reason, it is aimed to draw attention to the benefit of VRS in roofs that occupy a significant place on the urban surface.

In the research, first, a literature review was conducted on the concepts mentioned in the research. And then, a case study was carried out. Within the scope of case study, 110 sample projects from Vegetated Roof System projects implemented in Istanbul were examined. Of these projects, those built within the scope of urban transformation were filtered. Evaluations were made for the projects obtained as a result of filtering. In the final stage of the research, in-depth interviews were made with stakeholders who were influential in the design and production processes of the 110 VRS applied projects, which were accepted as data in the case study.

As a result of the case study, it turns out that VRS has become a marketing tool in luxury projects built with urban transformation in industrial areas that have lost their function. In the in-depth interviews, business developers confirmed this conclusion. Business developers interviewed in-depth explained the reason for applying VRS in buildings in the case-study as the increase in building value due to the positive visual impact and social space opportunities provided by VRSs.

Key words: Istanbul, urban transformation areas, vegetated roof systems, sustainability, global warming
Word count: 6069

1. INTRODUCTION

The population of cities is increasing day by day and there is an increasing trend towards urban life. According to the recent report of United Nations, the population living in cities is expected to increase up to 67%, by 2050 (Raji, 2015). Cities, on the one hand, trying to adapt to the urbanization dynamics of population growth, on the other hand have to adapt to climate change. In adapting to climate change, open and green areas play an important role in ensuring sustainability by preserving the continuity of the urban ecosystem and natural structure in cities such as Istanbul, which has a population of more than 10 million people and a high building density.

Open space is defined as openings or empty spaces other than architectural structures and transportation areas. Green area can be defined as open areas covered with vegetal elements. Open and green areas and urban designs and strategies integrated with these areas are among the sustainable adaptation strategies that can be implemented in cities within the framework of adaptation to climate change. In addition to increasing open areas and green areas in the city, vegetated roof surfaces of buildings in the built environment can be useful in the process of adapting cities to climate change. Roofs account for nearly 20–25% of overall urban surface areas. Therefore, greening the roofs has a great potential to affect the building and urban environment (Raji, 2015).

It can be said that the amount of open and green areas has decreased as there are already many buildings in the densely populated areas of the cities. At the same time, the construction of new buildings in these areas has been significantly reduced. In addition, the fact that the lands are small in densely populated urban areas and the roof surfaces of the buildings to be built on these lands may cause VRS not to be preferred. While the roofs are converted to VRS in existing buildings, insufficient load carrying system, implementation difficulties, economic difficulties and legal restrictions cause VRS not to be preferred. These reasons significantly prevent the use of VRS in urban areas with high building density. Whereas, urban transformation may create an opportunity for VRS to become widespread in high-density urban areas.

After the earthquake in Turkey in 1999 for high-quality and low-risk structures in urban areas it was initiated urban transformation. Subsequently, demand for decentralization of industrial zones into urban fringes increased the momentum of urban transformation practices. By vegetated the roof surfaces of buildings in urban transformation areas, the negative effects of the built environment can be reduced; the recreation area can be increased for the user.

VRS provide environmental benefits such as mitigation of urban heat island, rainwater management, and economical benefits such as reduction of energy requirement due to heating and cooling in buildings, and social benefits such as recreational spaces for users. **In this context, it can be said that it will be beneficial to spread the VRS and turn them into urban development strategies.**

In this study, it is aimed to increase the “construction area / green area” ratio in order to ensure sustainability and adaptation to climate change in urban areas with high building density. For this reason, it is recommended to vegetation of roof surfaces that reserve a significant place in the urban area.

2. SUSTAINABILITY AND CLIMATE CHANGE

The concept of sustainability gains importance day by day due to reasons such as the increasing environmental problems that threaten human life, the rapid depletion of resources, climate change and its effects are visible.

Cities, while trying to adapt to the dynamics of urbanization, on the other hand, have to adapt to a situation that can cause many disasters such as climate change and create social, spatial and economic sensibilities.

Sustainability and environmental protection, the effects of climate change in cities and urban strategies compatible with climate change have been defined by global platforms such as IPCC (Intergovernmental Panel on Climate Change) and EAA (European Environment Agency), and have started to be on the agenda of many cities.

Climate change is a serious threat to cities, with the effects of extraordinary weather events, storms, floods, drought, heatwaves and sea level increase due to melting glaciers, which are the result of global temperature increase. **In the context of adaptation to climate change, green areas in the cities are important in ensuring the sustainability of the city due to the formation of buffer zones in reducing the heat island effect and carbon emissions occurring in the cities and preventing floods and floods.**

Today, the implementation of VRS, especially in urban areas with dense construction, contributes to increasing the “construction area / green area” ratio. Therefore, it is beneficial for VRS to be a strategic target in urban planning and implementation.

Due to the environmental, social and economic benefits of VRS, policies are being developed in order to spread VRS in different countries. These policies generally include practices such as financial incentives for investors and users, water consumption and a reduction in the cost of goods, in order to ensure that VRS is preferred. The incentive policies compiled from the study of Berardi *et al.* (2014) and applied to spread the VRS in different countries are given in Table 1.

In the examples compiled in Table 1, different incentives and legal arrangements are seen for the spreading of VRS. Although there is an incentive in this respect in Turkey as legislation, such as considering the 3194 Zoning Law arrangement was made at the Istanbul Zoning Regulations published in 2018. According to the 21 and 22 paragraphs of the 44th article of this regulation:

Tablo 1. Examples of policies for the promotion of green roofs (VRS) from Germany and USA (Berardi *et al*., 2014)

Germany	Munich: obligation to landscape all suitable flat roofs with a surface area >100 m2
	Esslingen: 50% of the cost of green roofs is paid back
	Darmstadt: owners receive up to €5000 for planting a green roof
United States	Austin, TX: Green Roof Density Bonus gives a density bonus of up to 8 sq/ft for 1 sq/ft of green roof
	Chicago, IL: The City of Chicago offers up to 50% of cost or $100,000 for development of green roofs covering 50% or more of a rooftop space
	Baltimora, MA: Stormwater Management Tax Credit is 10% of the cost for the new stormwater management techniques (maximum amount $10,000)
	Milwaukee, WI: Milwaukee Metropolitan Sewerage District Initiative is provides $5 per sq/ft as incentive to increase green roof coverage
	Minneapolis, MN: any building that improves stormwater management through green roofs receives a 50% credit in the stormwater fees
	Nashville, TN: is promoting the installation of green roofs by providing a $10 reduction in a property's sewer fees for every square foot of green roof
	New York City, NY: gives a one year tax credit of up to $100,000 (or $4.5 per sq/ft) for green roofs that encompass at least 50% of available roof space
	Philadelphia, PA: offers a credit against the Business Privilege Tax, of 25% of all costs incurred to construct a green roof up to $100,000
	Portland, OR: Through the FAR Bonus, the city offers a Floor Area Ratio bonus in its building code (extra 3 sq/ft per foot of green roof may be constructed without additional permits). A grant reimbursement of up to $5 per sq/ft for reducing stormwater infrastructure with a green roof is possible
	Seattle, WA: the city offers a Floor Area Ratio bonus of extra 3 sq/ft per foot of green roof
	Washington, DC: The District's green roof rebate program funds $5 per sq/ft of green roof

(21) In buildings with a total construction area of more than 60,000 m^2, including public buildings, to improve the urban ecology, to break the climatic air conditioning effect, to reduce the sudden floods by keeping rain water, to prevent the destruction of green areas of the constructions, to create a breathable natural environment and to It is mandatory to apply green roof systems (VRS) in order to provide heat and noise insulation. In addition, if a terrace roof is desired in buildings with a total construction area of more than 30,000 m^2, it is necessary to apply green roof systems (VRS).

(22) In green roof applications (VRS) to be organized as a common area serving the building; At least 0.50 meters of landfill will be created where grass, plants, flowers and small tree species will be grown. The building's load bearing system will be solved by calculating the soil load, and water and heat insulation will be provided on the roof. The earth fill to be made is not added to the parapet height.

In order for the VRS to become widespread, the size of the total construction area of the building specified in paragraph 44/21 of the zoning regulation remains high at the scale of a single building. It would be beneficial to encourage the implementation of VRS in small and medium sized projects with less construction area than the construction area defined in the regulation. On the other hand, in addition to the definition of the total construction area, definitions of the size of the roof surface in relation to the floor area and height of the building are required. In this context, the central and local governments arranging the construction activities on parcel basis while preparing 1/1000 implementation zoning plans will contribute to the widespread, effective and efficient use of VRS.

Considering the complexity of the 44/22 paragraph in the zoning regulation, it is not an orientation that will be sufficient in common practice. In terms of VRS applications, this narrow frame carries the risk of giving erroneous results in the productions.

In accordance with the Law No. 6306, new zoning plans are developed for urban areas that have disaster risk and / or have been constructed inappropriately to the zoning plan and have lost their industrial function. In this study, it is recommended to arrange the roof areas that will emerge in the zoning plan to be created as a result of urban transformation as VRS.

3. URBAN TRANSFORMATION AND TURKEY

Urban transformation aims to provide a long-term improvement of the urban area to be transformed in economic, physical, social and environmental dimensions.

According to Alpopi and Manole (2013) the most important urban regeneration principles there are:

- the need to establish clear and measurable objectives of urban regeneration process and their according with the objectives of sustainable development;
- adequate analysis of local conditions;
- the need of the efficiently use of natural, economic and human available resources;
- participation and cooperation among stakeholders, leading to improve physical condition of buildings, social structure, economic base and environmental conditions (Roberts and Sykes, 2000), (Alpopi and Manole, 2013).

Turkish cities differ considerably in urban transformation, with similarities to the West. These differences, along with Turkey's economic and political conditions, historical, social, cultural stems from the structure (Akkar, 2006).

In Turkey, the most significant transformation particularly for the big cities was through the immigrations in the 1950s, resulting in housing, employment, and transportation becoming the main problems of the metropolitan areas (Özden, 2008). In the 1990s, changes in the urban space began with the influence of globalization, and large office buildings and shopping malls led to extensive transformations in the urban space (Özden, 2008), (Güzey, 2016). For example, several changes were made in the residential areas in Istanbul and their usage: With the construction of the second bridge over the Bosphorus and peripheral highways, financial centers were built on these axes (Ergün, 2006).

Until the early 2000s, there was no systematic urban transformation policy in Turkey. During this period, mostly small-scale developers practiced renewal at the single-building scale (Turk and Korthals, 2010). Especially after the 1999 Marmara earthquake, the aging texture of the cities, the low quality of the building stock, and the existence of areas prone to geotechnical risks highlighted the importance of city-scale urban transformation practices (Özkan and Turk, 2016). Earthquake is one of the most important factors that triggered the urban transformation project in Turkey. According to AFAD (Ministry of Interior Disaster and Emergency Management Presidency)'s earthquake scenario, if there is a 7.5 magnitude earthquake in Istanbul, 44,802 buildings are expected to be demolished (https://www.hurriyet.com.tr/ekonomi/riskli-binayi-yikin-41452874). Additionally, in beginning of the 2000s, the government adopted a housing-oriented policy. This policy has led to a construction boom with increasing investment pressure on inner city areas, which became important investment locations for the real estate sector (Tarakcı and Turk, 2018). Laws relating to urban transformation in Turkey has entered into force from 2004. However, the law, which accelerated urban transformation practices, came into force in 2012 and promotes both urban transformation on a single building scale and urban transformation on a spatial scale. 6306: Transformation Law for Areas at Risk of Natural Disaster.

The concept of risky building in the law conducts urban transformation on a single building scale, and the concept of risky area conducts urban transformation on a spatial scale (Tarakcı and Turk, 2015). Within the scope of this law, industrial buildings and buildings that are not resistant to earthquakes have become priority areas for urban transformation projects, especially in the city center. According to the information announced in the Istanbul Urban Transformation Consultation Meeting held on 21 February 2020; There are 1.5 million houses in Turkey to be converted into an emergency across and 300 thousand of them are located in Istanbul. Since 2012, 68,256 buildings in Istanbul have been included in the scope of urban transformation under risky building status and 56,898 of these buildings have been demolished. The districts with the highest number of risky buildings that have not been demolished yet are Kâğıthane, Küçükçekmece, Maltepe, Şişli, Bayrampaşa, Üsküdar ve Esenler. As for urban transformation on a spatial scale, 59 risky areas with a size of approximately 1,273 hectares have been declared in Istanbul. There are 35,606 buildings in these areas, of which only 5,547 have been demolished. (https://www.hurriyet.com.tr/ekonomi/riskli-binayi-yikin-41452874).

The pressure to increase the capital/land ratio due to rising land prices in rapidly growing cities and the resulting demand for the high density reconstruction of non-functional spaces or decentralization of industrial zones into urban fringes, an increased demand for the reconstruction of licensed or unlicensed residential buildings, and competition between the projects of local administrations to receive capital in the era of globalization have raised the momentum of urban transformation practices (Kocabaş, 2005).

Although urban transformation areas identified in Istanbul are determined in line with market demands, consideration of environmental, economic and social sustainability is very important for the livability of cities while demolishing illegimate buildings. Therefore, especially the urban transformation areas in the city center have significant potential.

4. **VEGETATED ROOF SYSTEMS**

The roof is a building element that protects the building from atmospheric conditions such as rain, snow, sunlight, extreme temperatures and wind. As a roof system, it consists of sub-components such as roofing, load bearing system and insulation. VRS can be defined as plant cultivating on the roof surface instead of roofing material. A typical VRS consists of vegetation, plant growth layer, filter, drainage layer, insulation, root holder, waterproofing membrane and carrier layer. Apart from the floor area of the building, under the vegetated ground at the entrance level of the building, roof elevations of places such as shelters and parking lots are also accepted as VRS within the scope of this study.

VRS is commonly referred as "green roof" in literature. Because of the its cover layer consist of vegetation, the system was called as "vegetated roof system" (VRS) in this research.

VRS can be classified under two main groups as extensive and intensive, taking into account characteristics such as load capacity, soil depth, pedestrian access, irrigation and drainage system complexity, maintenance requirement and vegetation cover. On the other hand, it is also possible to classify VRS according to the level it is applied to in the building. On the other hand, it is also possible to classify VRS according to the level it is applied to in the building: roof top level, podium level and ground level.

The cost of building a VRS depends on the growing environment, type of insulation membrane, plant amount and drainage system components. To determine the current cost of the VRS units in Turkey, the construction market has been reviewed in the July 2019 price history. Accordingly, approximately 169-224 TL per m^2 including labor for extensive VRS; For the intensive VRS, it is around 195-245 TL per m^2 including labor. These costs are approximately $ 31-41 for extensive VRS, according to the Central Bank of Turkey's average exchange rate of July 2019; It ranges from about $ 35.50-44.50 for the intensive VRS.

VRS is not an urban open green spaces, but are areas that should be excluded from the "building area / green area" ratio. VRS may be a green space that serves the public, if implemented in public buildings. In private areas, VRS may be the green space that serves according to the definition of ownership in the building scale.

The beginning of specialization and commercial practices in VRS in Turkey corresponds to mid-nineties. Nowadays, VRS implementations are mostly encountered in shopping malls, offices and mixed buildings, parking lots under the soil level, for the purpose of producing social space and aesthetic value.

Forms of organization of the construction sector in Turkey is of the variability in different conditions and the actual situation can arise very different from each other in the relations of production. The decision of implementing the VRS in Turkey, mostly in the design phase of the project employers / owners and are taken jointly by the architect. VRS design generally starts with the preparation of a conceptual landscape project after the preparation of architectural preliminary project. The decision to get help from a landscape architect for VRS depends on the architect's vision.

Some of the environmental, economic and social benefits of VRS can be summarized as follows:

Urban heat islands (UHI) refer to the elevated temperatures in urban areas compared to rural surroundings. Urban surface materials and urban geometry are the main factors that contributes UHI. The materials such as asphalts, bricks and concretes in urban surface absorb more heat than vegetation and release less (Solecki *et al*, 2005). Ünal et al (2019) revealed in their research conducted throughout Istanbul that the estimated UHI based on land surface temperature at the most urbanized locations of Istanbul reach to 8 °C for daytime and 6 °C for nighttime. There are several ways to reduce the negative consequences of UHI. Among them, one of the potential and effective ways is to extend VRS implementations. VRS cool down the temperature because of the direct coverage of plants and the opening of stomata that allows transpiration during daytime (Santamouris, 2014).

In urban areas, the air usually contains fine dust particles that adversely affect the urban air quality. The vegetative roof is capable of trapping dust particles that are harmful to human health and comfort in urban areas. Zhang et al. (1997) research showed that a 1000 m^2 vegetated roof can capture dust approximately 160–220 kg per year results in improving the environment of an area.

Urban surfaces such as asphalt and concrete are impermeable to rainwater management. Heavy rainfalls can strain the combined sewer system and cause overflows. Vegetable roofs offer significant benefits in urban rainwater management: they store rainwater during precipitation and return rainfall to the atmosphere through evaporation-transpiration. In certain areas of Turkey stormwater is involved in into the sewage. With the widespread use of VRS, the amount of storm water entering the sewage can be reduced. With the VRS, heavy run off storm waters that caused floods can be gradually given to the network; also can be reused.

Vegetated roofs in urban areas serve as a green corridor for natural life to come to life in the built environment. They can connect the fragmented habitats with each other so as to promote the urban biodiversity. A total number of 30 species or even more of organisms were observed in the green roof (VRS) (Li and Yeung, 2014).

Bianchini and Hewage (2012) used a probabilistic approach to measure the benefits of VRS and results indicated that the VRS with correct design are usually economically feasible. Most of the green roof's (VRS) benefits cannot be counted and it makes it very difficult to analyse the life cycle assessment of green roofs (VRS) (Tsang and Jim, 2011).

Green roofs (VRS) are proved to be a feasible solution in retrofitting to the existing areas because the old building has less insulation and takes a lot of energy required to cool and warm (Castleton *et al*, 2010). Moreover, lengthen the life of the roof and utilize the surface of the roof or multiple benefits in urban areas (Shafiquea *et al*, 2018).

VRS as the green space on the built surfaces can contribute to the increase of efficiency and environmental aesthetics in the buildings where it is applied, such as education, health and office. Even if the green area cannot be accessed by the user in the buildings where extensive VRS is applied, the limited green areas opened in the built area can create visual attraction for the users. Intensive VRS areas applied in densely populated and densely building settlements can be transformed into social areas and create attraction. In both cases, VRS is increase the property values as well as the aesthetic appearance of the building VRS can additionally create opportunities for urban agriculture.

5. METHODOLOGY

Istanbul, which is the city has Turkey's highest densely building settlement and densely population, has the potential to draw general trends in terms of the building construction and use of the roof surface in Turkey. In the research, first, a literature review was conducted on the concepts mentioned in the research. And then, a case study was carried out. Within the scope of case study, 110 sample projects from VRS projects implemented in Istanbul were examined. First of all, the location of each project was mapped with the help of Google Earth (http://maps.google.com) and Istanbul City Guide (http://sehirrehberi.ibb.gov.tr/) applications. Within the content of this mapping, it is examined whether it is done within the scope of urban transformation by making use of the map archives and the information on the website where the project is introduced. Of these projects, those built within the scope of urban transformation were filtered. The locations of the projects reviewed can be seen on map on Figure-1. Thus, their potential has been revealed by determining how much VRS practices were applied in urban transformation projects.

In the final stage of the research, in-depth interviews were made with stakeholders who were influential in the design and production processes of the 110 VRS applied project, which was accepted as data in the case study. Stakeholders who are effective in VRS design and production processes are identified as business developers, architects, landscape architects, consultants, suppliers, contractors and construction inspectors. 16 interviews were conducted with 2 experts from each of these 8 different stakeholder categories face to face.

During the in-depth interviews, stakeholders were asked about the reasons for VRS implementation in projects, concerns and difficulties experienced during VRS implementation.

6. DISCUSSION

Within the scope of the research, 110 projects with VRS implementations in Istanbul were examined. As a result of this review, the distribution of the projects in the city and the relationship with the urban transformation were revealed. Figure-1 shows the distribution of 110 projects dealt within the scope of the research by districts on the Istanbul map. According to this map, the districts where VRS is most commonly used in Istanbul are determined as Şişli, Bakırköy, Beşiktaş, Bağcılar.

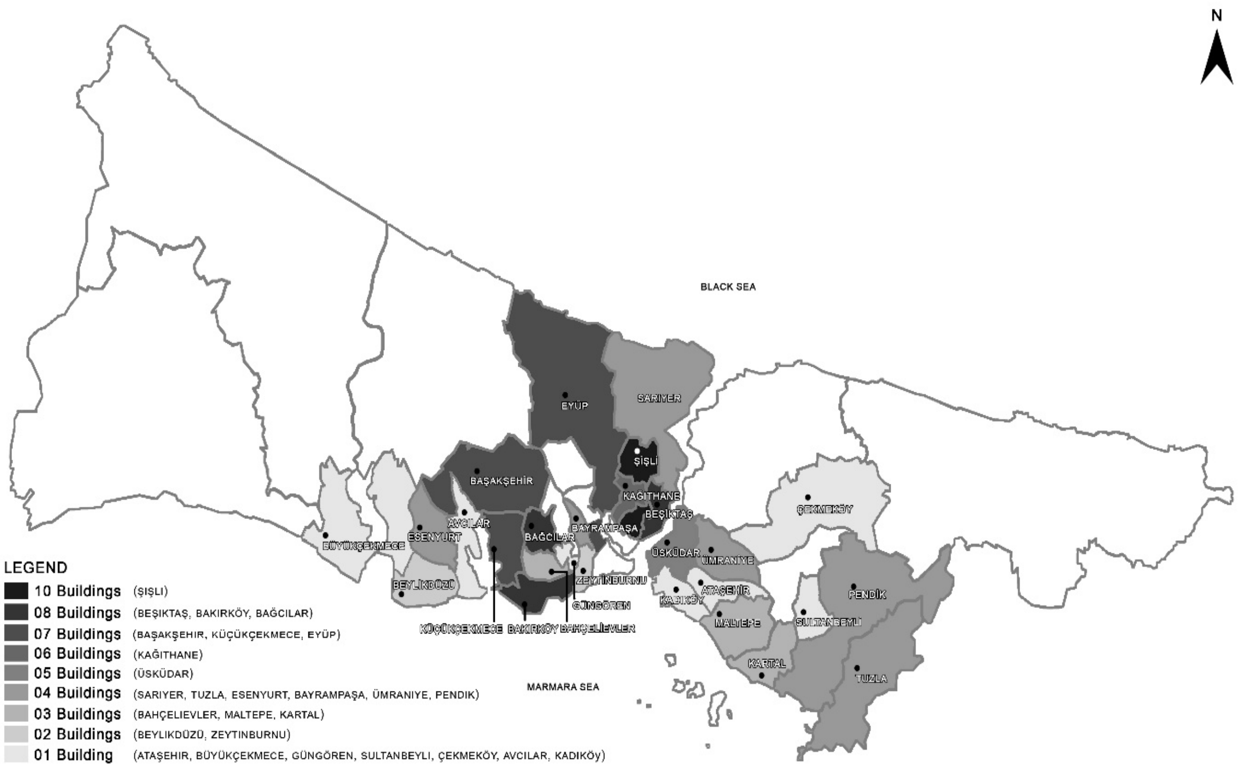

Figure 1: Distribution of 110 projects covered by the research by districts

It was determined that 28% (31 projects) of 110 VRS implemented projects examined within the scope of the research were carried out within the scope of urban transformation. 6 of the 10 VRS implemented projects in Şişli district, where VRS implementation is most common, were built within the scope of urban transformation. 4 of the 8 VRS implemented projects in the Bakırköy district were built within the scope of urban transformation.

In Beşiktaş and Bağcılar districts, only 1 of the 8 VRS implemented projects was built within the scope of urban transformation. 4 of the 6 VRS implemented projects in the Kağıthane District were built within the scope of urban transformation. Şişli and Kağıthane are among the districts with the highest number of risky buildings that have not been demolished yet. The widespread implementation of VRS implementations in the urban transformation in Şişli and Kağıthane districts, which are densely built, can help increase green areas.

In Turkey, legal sources have played important roles in urban transformation. These roles have been shaped by urban transformation that has gone into effect since the beginning of the 2000s. However, "Law No. 6306: Transformation Law for Areas at Risk of Natural Disaster", which came into force in 2012, has accelerated urban transformation practices. When the projects examined within the scope of the research are examined according to their years, it was revealed that they were built especially since 2012. It can be evaluated that the Law No 6306 in 2012 is an impressive power.

When evaluated according to the year of construction, VRS implementations can be seen in the projects built in the early 2000s, especially in Şişli and Beşiktaş districts and where there is an urban transformation from industry to service sector. Although urban transformation was not yet encouraged by law during these dates, the Şişli and Beşiktaş districts were planned as "Central Business Areas" and the land values in these districts were high, the users of the building in this district were socio-economically high income group, due to competition among projects / differentiation demands are evaluated as effective factors in VRS implementation.

75% of the lands of the buildings constructed within the scope of urban transformation and applied VRS were previously industrial areas. After urban transformation, mostly buildings with functions such as residences, offices and shopping malls were built on these lands. The rates of the functions of the buildings built within the scope of urban transformation and applied VRS are shown in Figure-2. Accordingly, the functions of the buildings constructed within the scope of urban transformation and implemented VRS are 61% residential, 12% shopping mall and 11% office.

The functions of the 6 buildings built with VRS within the scope of urban transformation in Şişli are determined as 2 offices, 2 shopping malls, 1 hotel and 1 mixed-use building. The functions of 4 buildings built with VRS within the scope of urban transformation in Bakırköy are determined as 3 residences and 1 mixed function. The functions of the 4 buildings built with VRS within the scope of urban transformation in Kağıthane are determined as 2 residences and 2 offices.

Especially after 2012, the plots, whose function were transformed from industry to residence with the triggering of Law No. 6306, are widely available in Bakırköy and Kağıthane districts (Figure-2).

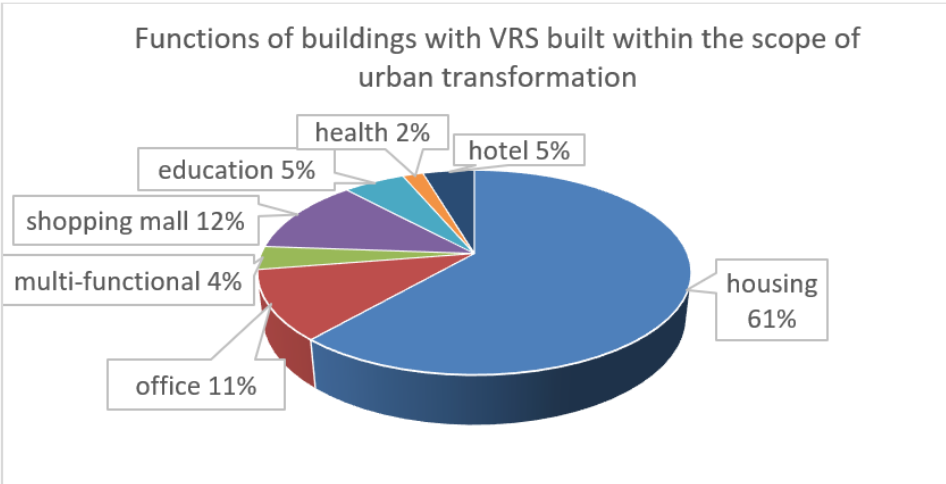

Figure 2: Functions of buildings with VRS built within the scope of urban transformation

Institutional determining the price of real estate in Turkey is not a restructuring. Information has been obtained from real estate companies in order to determine the real estate values for the buildings within the scope of the case study (https://www.hurriyetemlak.com) (www.emlakjet.com). Accordingly, it has been determined that in the projects with VRS applied in the same location, the m^2 value of the building increases when VRS is used as a social area. The m^2 sales value (average 3000 USD) of residential function buildings, which are constructed within the scope of urban transformation in Bakırköy and Kağıthane, are above the m^2 sales value (2000 USD) of the average residential projects in the same district. It is seen that it differs from similar projects by highlighting VRS implementation. Thus, VRS implementations are presented as marketing tools.In the case study section of this research, VRS implementations are evaluated in three categories according to their location in the building: (1) roof top level (Figure-3); (2) podium level (Figure-4); (3) ground level in underground buildings (Figure-5).

Figure 3: VRS implemented on roof top level - One Residental / Dormitory Ortaköy-Beşiktaş
https://www.gadarchitecture.com/tr/one--ortakoy (retrieved: 10.12.2019)

Figure 4: VRS implemented on podium level - Zorlu Center – Zincirlikuyu- Beşiktaş
https://tr.onduline.com/tr/homeowner/kesfet/galeri/ondugreen (retrieved: 10.12.2019)

Figure 5: VRS implemented on ground level - İncirli Konakları Bakırköy
https://www.incirlikonaklari.com/ (retrieved: 10.01.2020)

It is determined that VRS in buildings constructed within the scope of urban transformation is implemented on communal area's roof surfaces and podium surfaces with a rate of 36%. It was determined that VRS was implemented to ground level in underground buildings with a rate of 46% and implemented to the roof top level with a rate of 18%.

In Bakırköy, in 3 housing projects built with VRS within the scope of urban transformation, in VRS ground level; in one mixed-function project, it was implemented on VRS podium and ground level. In Kağıthane, within the scope of urban transformation, VRS was implemented at the ground level in 2 housing projects built with VRS, and VRS at the roof elevation in 2 office projects.

The implementations in all three categories are designed as areas where there is social life, where people can spend time together, while they can meet the need for recreation without getting too far from the area where they live or work.

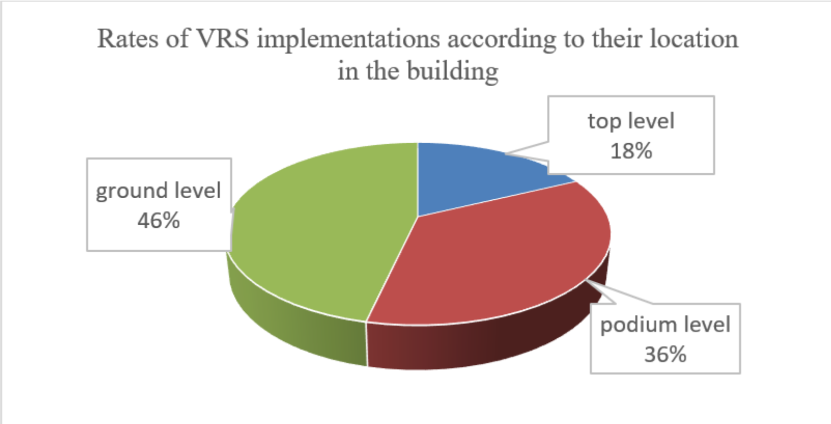

Figure 6: Rates of VRS implementations according to their location in the building

In order to better evaluate the findings obtained up to this stage of the study, in-depth interviews were conducted with the stakeholders in the design and production processes of the 110 VRS applied project, which was the subject of the case-study, about VRS applications.

As a result of the in-depth interviews:

- In in-depth interviews, investors and business developers were found to be concerned about VRS implementations to increase investment and maintenance costs. However, business developers explained the reason for applying VRS in buildings in the case study as an increase in building value due to the positive visual impact and social space opportunities provided by VRSs. This result also explains the reason for the increase in m^2 sales value in Bakırköy and Kağıthane, described in the case study.
- Investor and business developer stakeholders stated that they conduct regular surveys to determine the trends of the end-user. End-user's trends determine initiatives for VRS production in project development and design group stakeholders.
- As a result of these surveys, it has been revealed that there is a tendency for the users to prefer the vegetated surface as "open planted/green areas", implemented especially at the ground level, not over the building. Therefore, VRS implementations are more widely accepted on the flat roof of the underground places such as parking lots and shelters. This trend clarifies the result in the case study and shown in Figure 6. VRS on ground level in 46% of buildings built and VRS applied within the scope of urban transformation.
- Because VRS increases building construction and operating costs, industry stakeholders are stay away from VRS.
- Stakeholders emphasized that in Turkey, common insulation problems related with detail failure and/or faulty workmanship. Stakeholders stated that in case of encountering thermal and water insulation problems in VRS implementations, the repair process would be laborious and costly, and therefore, they kept a distance from VRS implementations.

7. RESULTS

Today, while trying to adapt to the dynamics of urbanization, cities have to adapt to climate change that can cause many disasters. In the construction of sustainable cities, adaptation to climate change and developing strategies based on this adaptation are becoming increasingly important. For this, besides preserving the existing green areas in cities, sustainable building design has become a necessity. The vegetation of roof surfaces, which has reached a significant size in cities, provides environmental, economic and social benefits. Supported by the policies developed by central and local governments in countries such as the USA and Germany, VRS is transformed into a strategy for the adaptation of cities to climate change. In 2018, arrangements were made in Istanbul and Bursa zoning regulations to spread VRS applications in Turkey.

In this study, In order to contribute to the spread of the VRS in Turkey, VRS implementations in urban transformation areas in Istanbul are discussed. The results can be summarized as follows:

It has been determined that the buildings undergoing VRS within the scope of urban transformation discussed in the research are located in densely populated and densely built districts such as Şişli and Kağıthane. Thus, VRSs applied within the scope of urban transformation are thought to provide environmental, economic and social benefits in the dense urban areas of Istanbul.

Despite the fact that urban transformation is not encouraged by law in Beşiktaş and Şişli districts, the demand for differentiation due to the legal definition of these regions as Central Business Area, high land value, their users being in the socio-economically high income group, and competition between projects have been effective in the spread of VRS in these districts.

As a result of the case study, it is concluded that VRS has become a marketing tool in luxury projects built with urban transformation in the industrial areas that lost their function.

VRS implemented in these buildings provided the recreation and social areas needed in the city center. In the in-depth interviews, business developers confirmed this conclusion. Business developers interviewed in-depth explained the reason for applying VRS in buildings in the case-study as the increase in building value due to the positive visual impact and social space opportunities provided by VRSs.

Sector stakeholders approach VRS distantly due to the fact that VRS increases construction costs and requires careful and expert workmanship during implementation. Also, end-users approach VRS distantly due to the fact that VRS's maintenance cost raises operating expenses.

It is thought that the location of VRS on roof top level is not attractive by the user. It has been determined that the implementation of the podium and on ground level is preferred by the users.

It is obvious that the urban transformation practices have accelerated especially with the law numbered 6306, which came into force in 2012. However, this law does not impose criteria for the implementation of VRS. Converting the implementation of VRS into legal requirement in buildings to be built under urban transformation will contribute to sustainable cities in terms of environmental, economic and social aspects.

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