ICONARP
International Journal of Architecture and Planning
Received: 06.01.2023 Accepted: 06.11.2023
Volume 11, Issue 2/ Published: 28.12.2023
Research Article *DOI: 10.15320 /ICONARP.2023.259 E- ISSN:2147-9380*
ICONARP

Investigating the Barriers to Implementation of Green Roofs in Izmir, Turkey

Burçin Burcu Doğmuşöz*

Abstract

As a sustainable approach to urban environmental management, green roofs are becoming more and more popular. They have been discovered to help reduce the urban heat island effect, insulating against noise and heat, managing stormwater, and eventually reducing climate change. Despite its established advantages and widespread use in most developed countries, green roofs have just recently gained popularity in the Izmir building sector. Izmir, a fast-growing city that may profit from green roofs, seems to have little idea of its potential. This study aims to determine the barriers to the widespread adoption of green roofs in Izmir. For this purpose, qualitative research was carried out and semi-structured interviews with government officials from different backgrounds such as architecture, landscape architecture, urban planning, and engineering were carried out to gather the primary data. Although there are prospects for the adoption of green roofs, the study revealed that these roofs are not common in the study region due to expense, technical difficulties, a lack of understanding, and standards. In light of this, it was also discovered that for the local sector to progress, government authorities must provide incentives and change regulatory settings to better promote the use of green roofs, while industry organizations must offer educational initiatives. Moreover, it is crucial to enhance technicalproficiency and conduct research related to green roofs' proven benefits in the context of Izmir.

Keywords:
Green roofs, sustainability, qualitative research, barriers

*Faculty of Engineering and Architecture, İzmir Katip Celebi University, Izmir, Turkey
E-mail: burcinburcu.dogmusoz@ikc.edu.tr

To cite this article: Doğmuşöz, B.B. (2023). Investigating the Barriers to Implementation of Green Roofs in Izmir, Turkey. *ICONARP International Journal of Architecture and Planning,* 11 (2), 672-691. DOI: 10.15320 /ICONARP.2023.259

INTRODUCTION

Rapid urbanization is leading to environmental issues in cities. These problems can be listed as water and air pollution, lack of water supply, loss of green spaces, etc. (Keeley et al.,2013). These issues are getting worse with the negative effect of climate change and global warming. Several measures have been attempted by municipal officials to address these problems and promote urban resilience. Many cities, for example, have developed strategies to transform themselves into sustainable cities by increasing green spaces, mitigating urban flooding events, and designing environmental-friendly structures (Tassicker et al., 2000). However, such initiatives might not be enough the meet urban areas' needs. More efficient strategies are required for sustainable, resilient, and healthy urban environments. Green roofing systems have been recognized as an environmentally friendly and long-term solution for enhancing the built environment and addressing major urban challenges (Shafique et al., 2018). Green roofs have been increasingly popular in recent years, particularly in Northern Europe and North America (Kohler, 2006). Among them, Germany is regarded as a clear leader in the usage of green roofs. Li and Yeung (2014) attribute Germany's leadership role in the usage of green roofs to favorable government policy in the form of laws, municipal subsidies, and financial incentives for green roof adoption. Green roofs are also being used in new construction on flat-roof buildings in other European nations and towns. The Swiss city of Basel has the world's largest number of green roofs per capita, thanks to a mix of financial incentives and construction regulations (Kazmierczak and Carter, 2010).

Green roofs (GRs) are well-known for their capacity to contribute to the environment and cities by mitigating urban heat island effects, reducing air pollution, and improving air quality (Susca et al., 2011; Goudarzi and Mostafaeipour, 2017; Gwak et al., 2017; Oguzturuk et al., 2018). Furthermore, green roofs provide economic benefits in terms of increased property value and energy savings (Mahdiyar et al., 2016). Extensive green roofs (EGR) and intensive green roofs (IGR) are the two most common forms of GRs (Figure 1.). Because only a few species of plants can be planted on extensive green roofs, they require little maintenance during their lifetime (Gargari et al., 2016). Furthermore, an EGR has a reduced installation cost and requires no extra structural support. On the other side, IGRs, such as roof gardens, can provide recreational spaces for the public, particularly in areas where parkland is scarce (Gargari et al., 2016).

DOI: 10.15320/ICONARP.2023.259

Figure 1. Examples of Intensive Green Roof (left) and Extensive Green Roof (right) (Gargari et al., 2016)

Although green roofing may help alleviate urban floods, reduce energy costs and improve environmental performance, their implementation is not so common (Zhang and He, 2021). Some study has focused on barriers in various countries with different climatic conditions and socio-economic position, while others have concentrated on other elements of GR installation. Barriers in the literature related to green roof installation are listed in the table below (Table 1).

Table 1. Barriers to Green Roof Implementation

Perspectives	Barriers	References
Socio-cognitive barriers	Lack of awareness and knowledge	Tabatabaee.et. al., 2019; Shafique. et al., 2018;Vijayaraghavan, 2016; Curry and Larsson, 2014; Yuen and Hien, 2005
Technical barriers	Lack of technical knowledge	Berardi et al., 2014;Hendricks and Calkins, 2006
	Lack of technical staff	
	Structural uncapability	Jim and Tsang, 2011; Berardi et al., 2014; Shafique et al., 2018
	Risk of failure	Berardi et al., 2014; Shafique et al., 2018
Cost barriers	High initial cost	Berardi et al., 2014; Chen et al., 2019; Hendricks and Calkins, 2016; Mahdiyar et al., 2018; Williams et al., 2010; Zhang et al., 2012
	High maintenance cost	Chen et al., 2019; Mahdiyar et al., 2018; Williams et al., 2010; Xiao et al., 2014; Zhang et al., 2012
Lack of government policy	Lack of policy pressure	Peck et al.,1999; Townshend, 2007; Vijayaraghavan, 2016; Williams et al.,2010
	Lack of incentives	Sanmargaraja et al., 2019; Teotonia et al., 2020
Lack of benefit assessment		Carter and Keeler, 2008; Nurmi et al, 2013

Some barriers have been certainly discussed in the literature. High initial and maintenance costs have been identified as the most significant

barriers (Chen et al., 2019; Mahdiyar et al., 2018; Williams et al., 2010; Zhang et al., 2012). Many developers often focus on the high cost of installation, ignoring the long-term benefits.

According to various research, the lack of awareness about the benefits of green roofs is mostly discussed as a barrier (Wong et al., 2005; Wilkinson et al., 2015). Even though green roof technology benefits the environment and cities, many stakeholders either do not know about or do not recognize these benefits. Many architects and developers are hesitant to design and build roof gardens, partly because inhabitants might not like them, which would result in a waste of space. This issue emphasizes the need of raising public awareness of and favorable attitudes concerning green roofs (Yuen and Hien, 2005).

Another barrier is related to structural limitations. Most buildings are not suitable for a green roof installation because of additional dead and live loads on buildings (Jim and Tsang, 2011; Shin and Kim, 2019). Additional to these barriers, some technical barriers have been discussed. Although green roofs can mostly be installed in different climate conditions, there might be some issues related to the plant adaption process, complexity in the maintenance process, and potential leakage problems during its lifespan (Berardi et al., 2014, Vahdati et al., 2017; Shafique et al., 2018). Furthermore, a lack of technical knowledge and expertise related to installation and maintenance is another barrier discussed in the green infrastructure literature (Berardi et al., 2014). Since green infrastructure is different from traditional stormwater management techniques, they require a new set of installation, operation, and maintenance strategies (Keeley et al., 2013). It means that technical staff with technical knowledge of green infrastructure are key elements to its successful implementation.

Major significant challenges to implementation were noted as a lack of government policy and government incentives (Zhang et al., 2012). Another research supports the same conclusion, claiming that favorable government policy and incentives are the main reasons for Germany's high percentage of green roof adoption (Liu and Yeung, 2014). Governmental regulations can control stakeholders' actions in both mandatory and optional ways. The most efficient approach to quickly bring the GRI into reality might be through mandatory rules that incorporate requirements, guidelines, and standards (Zhang et al., 2019). Additionally, without adequate direction and assistance from the government, private enterprises do not show a willingness to undertake GR initiatives (Tassicker et al., 2016).

GR application includes a wide range of stakeholders, including designers, engineers, urban planners, contractors, building operators, private property owners, and government agents (Zhang and He, 2019). Adaptation to green roofs needs action at all levels from the global to the local (Urwin and Jordan, 2018). For instance, green roofs also offer a variety of benefits to property owners on a personal level such as energy savings, increasing aesthetic value, etc. A study conducted by Dogmusoz

DOI: 10.15320/ICONARP.2023.259

(2023) demonstrated that the long term benefits of a green roof outweighed the installation cost based on benefit cost analysis. Given the size of private property, local governments might work with the private sector to obtain enough green roofs for stormwater retention, particularly in regions where populations are high, (green) space is limited, and traditional sewage systems have reached their capacity limitations. They all have a critical role in the implementation of green roof policies and technologies. Understanding these participants' attitudes, knowledge, and preferences toward green roofs is crucial for a green roof project to achieve its goal.

This study focused on government agents' side because they play an important role to overcome financial barriers. As mentioned, the government can provide incentives and also, regulations which are important for wide installation. Moreover, the government appears to need to play a more active role in encouraging societal actors to install green roofs on their structures (Mees et al., 2012).

The existing barriers to GR adoption must be thoroughly examined separately for each country (Brudermann and Sangkakool, 2017) because there are legislative, human-related, climate-specific, and cultural barriers that have to be investigated for any region. There are not many studies in the City of Izmir related to green roofs. Most studies focused on the benefits, but barriers to its installation are mostly ignored. Only a few research have directly and partially addressed this subject in the context of the City of Izmir. As a result, any research in this direction might be seen as a big step forward. Understanding the perception, knowledge, and attitudes of green roof involvers toward green roofs can affect their success. This paper seeks to fill this gap by reporting on new research examining government officials' perceptions of green roofs in the city of Izmir.

METHODOLOGY

Study Area

There are several reasons for choosing Izmir as a study area. Firstly, the city has a significant history of urban flooding and water pollution. In Izmir, rapid urbanization increased population and an insufficient infrastructure system with the consequences of global climate change have led to urban flooding, decreased water quality, and changed water dynamics (Kutluca, 2006). The city's population has been gradually growing and has already reached 4 million people as a result of migration from other counties. New structures were built to accommodate the growing population. For instance, in the Karşyaka district, 50.000 new buildings were built between 1987 and 1995 (Figure 2.). More soil became vulnerable to storm runoff as a result of the increasing construction.

ICONARP – Volume 11, Issue 2 / Published: 28.12.2023

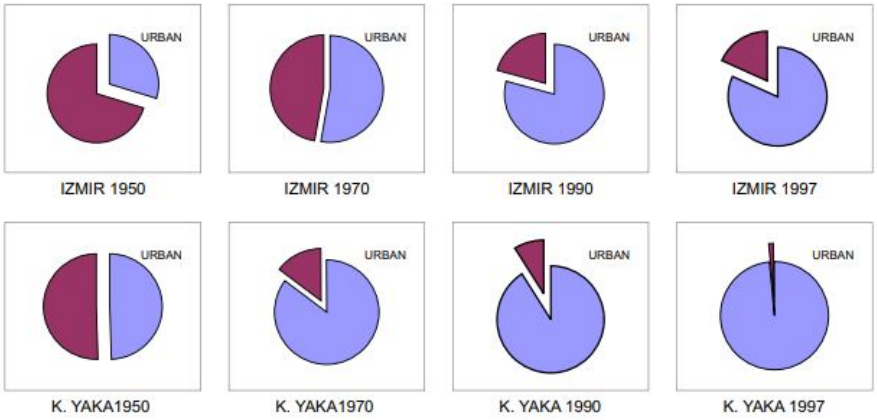

Figure 2. Urban Population Growth Rate in Comparison with the Izmir Province, and the Karsiyaka District by Census Results, 1950-1997 (SIS, 2001)

Secondly, the city of Izmir has made substantial efforts over the past ten years to improve its environmental performance, via the establishment of strategies and investments in green infrastructure. The Izmir Metropolitan Municipality (IBB) has indicated a willingness to handle its current and future urban environmental concerns with a more integrated strategy. Green roofs were defined as one of these strategies. To improve the ecology of the city, break the negative effect of climate change, reduce sudden urban flooding and create a natural environment in highly dense areas, the zoning regulations have been reorganized with a sustainable environmental understanding in new buildings. Finally, policymaking related to the sustainability and resilience of the city of Izmir has now entered into municipal planning and redevelopment processes. For this purpose, the use of green roof systems is now required for buildings with larger than 60 thousand square meters.

Research Design

The study was conducted during three stages as shown in the methodology process diagram (Figure 3). To begin, academic literature was used to identify the commonly regarded barriers to the building of green roofs, followed by an examination of legislation and guidelines in existence to assist the use of green roofs, and finally an evaluation of green roofs in Izmir. Following, interviews were conducted with government officials and finally, results were analyzed, and planning recommendations were developed.

Interviews

To answer the main inquiry of this paper, semi-questioned interviews were used as a method of data collection. When time restrictions prevent persons from being questioned more than once, semi-structured interviews are widely utilized. The order and wording of the interview questions were not predetermined; rather, the respondents' replies determined the path of the discussion and its conclusion. They allow for more probing and follow-up questions than unstructured interviews (Bernard, 2011). Because of their great time-management abilities,

DOI: 10.15320/ICONARP.2023.259

Bernard (2011) claims that this form of interviewing works particularly effectively when interviewing high-level bureaucrats and elite members of society. This might be handy when interviewing municipal employees. Interviews may help reveal specific in-depth information about people's motives and behaviors, as well as put other facts into context.

Interviews were conducted (ranging from 15-25 min) in this study to capture government officials' perceptions and perceived barriers to implementing green roofs in Izmir. The goal of these interviews was to obtain a better understanding of key actors' opinions before providing recommendations for the adoption of green roofs. Throughout the study, semi-structured interviews were employed to encourage respondents to speak freely and allow for the emergence of new points of view. Digital recordings of the interviews were made. The study was supervised by an Institutional Review Board (IRB). The interviews were recorded, transcribed, and coded so that important information could be retrieved from them.

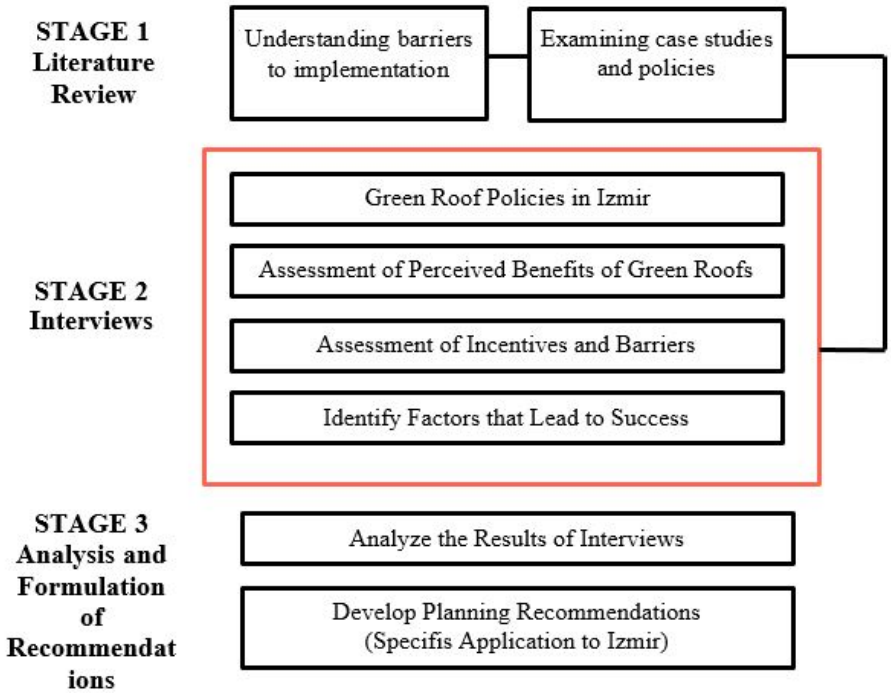

Figure 3. Research Design of the Study

Sample

The sample consisted of eleven individuals each with practical or theoretical experience or no experience of green roofs in Izmir. Through an examination of the literature, several relevant organizations with an interest in green exterior policy or design, including private companies, non-governmental organizations, and local governments, were identified as being involved in supporting or creating green roofs. This study focuses on barriers at the government level. Since then, municipals were contacted through phone numbers and/or email addresses to arrange a meeting for interviews. A subjective evaluation of people's opinions about green roofs was the goal of the interviews.

Each municipality has a different department related to green roof projects. The interviewees were chosen from a variety of backgrounds such as architecture (7), landscape architecture (1), urban planning (1), and engineering (3) with varying levels of experience or no experience with a green roof. There is no specific department related to green roofs. In each municipality, different units manage the work on green roofs such as the urban design department, zoning, and urban planning department. Interviews were conducted with four different municipalities: Izmir Metropolitan Municipality, Municipality of Karsiyaka, Çiğli, and Gaziemir. Among these municipalities, Gaziemir municipality has the only municipality building with a green roof application (Figure 4.)

Figure 4. The Building of Municipality of Gaziemir

By interviewing government officials, this research aims to learn more about their awareness toward green roofs, their knowledge about benefits of green roofs and more importantly, barriers to implementation in Izmir.

RESULTS

The results of the interview are depicted in Table 2. The cost of installing and maintaining green roofs, education/awareness among practitioners, and the role of government in its adoption, for example through the setting of national policies or the development of incentive schemes, are all mentioned as key factors that affect the commercial viability of green roofs. Detailed interview results are further explored in this part.

The majority of participants generally connected green roofs with some form of environmental benefits, largely because their ability to reducing air pollution and urban heat island effect. Additionally, most people agreed that green roofs were a good idea if properly implemented.

DOI: 10.15320/ICONARP.2023.259

Table 2. Results of Interviews

Perceived Benefits	Barriers	What should do
Ecosystem (4)	Cost (10)	Incentives (10)
Increase the amount of green space (4)	Lack of Awareness (5)	Policy (6)
Isolation (4)	Lack of technical staff (5)	Education (5)
Urban Heat island (3)	Lack of evidence related to its benefits (4)	Proven data (4)
Climate change reduction (2)	Standards (3)	Star system (1)
Decrease urban flooding (2)		
Aesthetics (2)		
Increase resilience (1)		
Recreational benefits (1)		

Perceived Benefits of Green Roofs

The literature has suggested that green roofs have lots of benefits to cities including mitigating climate change's negative effects, reducing urban heat islands, decreasing urban flooding, improving aesthetics, and increasing biodiversity (Oberndorfer et al., 2007). Results from interviews indicated that participants are mostly aware of the benefits of green roofs. They were mostly aware of their ecological benefits, contribution to green areas, and providing isolation to the building.

Interviewee 2: *Green roofs have many variety of benefits and the most significant one might be the provision of biodiversity. They provide habitat for urban wildlife.*

Interviewee 3*: Implementing green roofs will create greener cities which is environmentally healthy. I mean they can provide green space at dense urban areas by transforming unused roof spaces into a roof garden.*

Interviewee 7: *It (green roof) provides an additional layer of insulation to the building. It would, in my opinion, improve energy efficiency and reduce heating and cooling costs.*

Interviewee 6*: It (green roof) would help in lowering bills and energy efficient.*

The heat island effect in urban areas can be reduced by using green roofs in urban areas. Green roofs provide shade, absorb heat from the atmosphere and lower air and roof surface temperatures. Reduced urban heat island effect was second most mentioned benefit.

Interviewee 3*: Green spaces have replaced with buildings in cities. This raises the temperature, which is referred to as heat island effect. Green roofs can mitigate urban heat island effect in Izmir, which is a problem.*

Interviewee 1*: Urbanization and climate change are the main problems of cities which cause urban heat island effect. Green roofs might be effective in the reduction of the urban heat island.*

Interviewee 10*: Impervious surfaces in Izmir can have a negative effect on the urban climate, which in turn increases the severity of the urban heat island. Lowering the surface temperatures of the roofs may be crucial to*

deal with urban heat island effect. I think this can be achieved by replacing traditional roof surfaces with green roofs.

Following these benefits, mitigating climate change, decreasing urban flooding, and aesthetics benefits were the third discussed benefits by the interviewees. Green roofs can reduce the amount of stormwater runoff and improve the quality of water that returns to water bodies after storm events (Mentens et al., 2006). Less than half were aware of and valued the green roofs' capacity to reduce stormwater flows.

***Interviewee 8**: I think implementing green roofs can prevent flood events in cities by reducing the amount of stormwater runoff (decreasing urban flooding).*

***Interviewee 5**: Green roofs can improve the visual quality of cities (aesthetic benefits).*

***Interviewee 7:** Green roofs serves as a tool for coping with climate change by decreasing surface runoff amount and decreasing temperatures in cities (mitigating climate change).*

Finally, the least mentioned benefit was the recreational benefit of green roofs. Even if green roofs provide a space for recreation, this feature was not highlighted enough in the interviews, except for one interviewee.

***Interviewee 3:** Green roofs can increase green areas in cities and provide recreational areas for citizens. Roof tops are good options for urban areas since there is a lack of space to create green spaces on ground.*

Some benefits of green roofs were never mentioned by interviewers such as the reduction of air pollution benefits, increased rooftop lifespan, etc. Most respondents demonstrated a high level of awareness and understanding of the potential benefits of green roofs. However, a few felt unsure about their effectiveness.

***Interviewee 7:** We already have a green roof in this building but it looks messy now because of low maintenance. Although green roofs have lots of benefits, the key point is to maintain it. If we do not keep it well maintained, we cannot benefit from their advantages.*

Barriers

In this study, the word "barrier" is used to describe any current or anticipated difficulties experienced in achieving widespread installation of GRs. This section presents barriers to the implementation of green roofs from the perspective of local government. In this study, installation costs were determined as the most significant barrier. Ten out of the eleven interviewees named cost as the main obstacle to the installation of green roofs. On the other hand, the lack of application examples and required maintenance were considered to be the least critical barriers. The key factors that affect the implementation of green roofs include the cost of installation, practitioner education and awareness, and the role of governments, such as through the establishment of national policies or the development of incentive schemes.

DOI: 10.15320/ICONARP.2023.259

Cost

In the literature, there are some persistent barriers to GR adoption, such as high installation costs, which have consistently been listed as one of the major obstacles to all types of green roofs for new buildings (Wilkinson and Feitosa, 2015). When asked what has been the most significant impediment to the adoption of local green roofs, ten of the eleven interviewees named installation cost as the most significant barrier.

Interviewee 3: *The cost of installing a green roof is more expensive than the cost of creating a regular roofing system. No one wants to pay more for green roofs. In my opinion, this (cost) is the most significant barrier to its installation.*

Interviewee 7: *Building contractors are very important stakeholders in green roof projects. They mostly may just be interested in how much they will pay more for green roofs, not benefits provided by them (green roofs). This way of thinking undervalues the long term economic advantages of environmental and individual benefits.*

Interviewee 4: *Obviously, I can say that the high initial cost of installing green roof acts as a barrier to its widespread adoption in Izmir. I think nobody shows willingness to pay for it.*

Interviewee 10*: Even if they provide numerous benefits, their installation is not very common in Izmir. Actually, I do not know any finished or ongoing green roof projects in Izmir. I just know that installing green roofs cost a lot. The high initial cost might prevent its adoption.*

These opinions related to cost barrier supports the existing literature which emphasized that cost is the most significant barrier.

Lack of awareness

Wider acceptance appears to be hindered by a lack of knowledge, awareness, and experience (Wilkinson et al., 2015). When asked what the barriers affecting the implementation of green roofs in Izmir, four of eleven interviewees emphasized that the perception towards green roofs was important. The interviewees' comments revealed that green roofs are, in some way or another, viewed negatively by the local building sector and the public.

Interviewee 1: *People are scared of something new. Change typically terrifies individuals away unless they are truly aware of its benefits and not enough knowledge. Public is very important in the implementation of new technologies such as green roof because they mostly generate demand. There is not enough demand.*

Interviewee 2: *From my experience, building contractors thought that green roofs were not effective enough… they were not convinced or not know about the benefits of green roofs.*

Interviewee 8. *Perception and awareness toward green roofs is the key element to its implementation. If we change the perception in a positive way, it might increase its wider acceptance.*

Interviewee 7: *Green roofs are not being promoted well. While there may be awareness, I do not believe it will be driven by planning.*
Interviewee 4: *Despite the fact that green roofs clearly benefit the environment, many building owners either did not know about or did not recognize these benefits.*

According to Rosasco and Perini (2019), the key stakeholders must support the inclusion of green roofs in building designs, especially landscape architects. The interviewees, however, emphasized the importance of a client's suggestion in green roof projects. The client was identified as public. Public perception is also a critical barrier. Many developers are hesitant to design and build roof gardens, partly because inhabitants might not like them, which would result in a waste of space (Zhang and He, 2019). This issue emphasized the need to chancing public awareness of and positive attitudes concerning roof gardens (Yuen and Hien, 2005).

Interviewee 5: *I think inclusion of public in green roofs is very important. If they really wants it, then it will happen.*
Interviewee 6: *Practice will be framed by perspectives, thus it is crucial that we should change people's perceptions toward green roofs in a positive way.*

Lack of technical knowledge and guide

The design, installation, operation, and maintenance phases of green roof strategies are crucial to its performance. Because of this, stakeholders should have an understanding of requirements. One of the requirements is to have a technical team that knows its operation and maintenance (Zhang and He, 2021). Five of eleven interviewees also agreed that the lack of technical support and knowledge to install and maintain green roofs is one of the significant factors in implementation.

Interviewee 5: *There is no technical guide related to its implementation. We mostly follow the installation examples in Europe but not consider different weather condition, or kmlkşkki*
Interviewee 1: *Since there are not enough green roof applications, there are no specific standards*
Interviewee 3*: Even if we have an understanding of green roofs, how about technical staff?*
Interviewee 7: *Green roof systems require expertise for the installation. However, there is a lack of expertise in government.*

Lack of evidence related to its benefits

There are not enough examples of green roof installation and since then, no data have been provided on how efficient green roofs are. According to Meulen (2019), if there is reliable evidence analyzing the costs and advantages of green roofs, policymakers are likely to show more willingness to integrate them into building rules and planning guides. Studies on how well this technology performs over the long term

DOI: 10.15320/ICONARP.2023.259

are developing as green roof becomes increasingly common. Although there is plenty of information showing that a green roof has a favorable short-term influence on the amount and quality of urban stormwater, there is still not enough longitudinal research and evidence related to its multifunctional benefits. Four of eleven interviewees agreed that since there is a lack of sufficient application examples, its acceptance is not very common.

Interviewee 5: *I suppose if people see great examples of green roofs in our country, the demand will increase. The government may install green roofs to their own buildings, then the market might start to want it.*

Interwiewee 4: *The government can play a crucial role in the business, particularly when it came to carrying out demonstration projects in public spaces to relieve the current worries surrounding green roofs.*

Interviewee 1*: There is a number of examles around the world but not in Turkey. Since there are not enough examples in our country, we cannot be sure of their benefits.*

Interviewee 3: *Governments and people are hesitant to adopt green roofs because of uncertainty about its efficacy.*

Lack of technical guide

According to Mahdiyar et al. (2020), stakeholders in the green roof industry are cautious of potential failures due to a fear of the unknown and a lack of direction from building practice about green roofs. Only a few nations now have standards and regulations governing green roofs. For example, Germany, which is a leader in green roof technology, created one of the first regulations in 1990. The German standard '*Planning, execution and maintenance of green areas on the roof*" was developed by the Research Society for Landscaping and Landscape Development. This guideline played an important role in the success of green roofs in Germany (Walker, 2014). Five of eleven interviewees agreed that lack of technical guidance is a barrier to green roof installation.

Interviewee 5: *Since it (green roof) is a new technology in Turkey, there is no guide related to how to install, operate and maintain it. This is a bit discouraging.*

Interviewee 1: *Although there are examples (green roof application) or guide related to its installation in Europe or other countries, we cannot directly take this guide and apply in Turkey. We need our own standardization.*

What Needs to Change

When asked how to overcome the challenges to wider acceptance of green roof technologies, ten of the eleven interviewees cited the role of incentives by government as a possible approach, while six interviewees mentioned the importance of government policy in supporting the sector.

Government policy

In literature, government policy is always the most effective method for putting urban sustainability ideas into action (Zhang and He, 2021). The role and influence of governments in encouraging the local green roof sector are not thoroughly discussed in the current literature. Unlike many other advanced nations, Turkey has few national-level legislation or regulations governing the installation of green roofs. Based on the results, although the development of new legislative frameworks does have value in advancing the installation of green roofs, typically seems to have less impact than the type of government-driven change: incentives. Six of eleven participants agreed that the government role in installation is very important.

Interviewee 10: *The issue is that there is no policy and legislative in Turkey for green roof implementation. The lack of policy is a barrier to the broad use of green roofs. We must first overcome this barrier.*

Interviewee 11: *Government policies would encourage more individuals to install green roofs which would increase market competition and drive down prices.*

Interviwee 5: *I keep thinking how to promote green roofs… One is to build more of them. This is possible thorough adjusting policy setting.*

Interviewee 1: *There is a policy regulation in İzmir related to green roofs. Green roofs on buildings over 60 thousand square meters has been made mandatory. However, it is a huge area so the government should require it for new small developments as well.*

Interviewee 7: *Installing green roofs on new structures should be mandatory through legislation, planning guidelines or making changes to the building zone.*

Interviewee 2: *To enable that [implementation of green roofs], the local government must put the required regulations into place.*

The idea that the implementation of policy change would increase the acceptance of green roofs is also supported in this study. According to most interviewees, the policy change would pay the way for its wide installation. Four of the interviews also make a connection between the change in policy and installation cost.

Interviewee 1: *Government policy setting would encourage more people to put green roofs up and therefore more people enter the market and they (green roofs installation cost) become cheaper.*

Interviewee 7: *The market will start to want it if people get more aware of it or, I suppose, if they see amazing instances of what that space (roof space) can be. I think that's crucial to realize because without policy, you really rely on the market to drive it.*

Government intencives

Financial incentives were discussed in literature as a way to overvome financial barriers to the implementation of green roofs. In developed countries, government mostly provide incentives to new developments if they install green roofs. For example, in Stuttgart, since 2008, there has

DOI: 10.15320/ICONARP.2023.259

been an incentive scheme with a sizable budget in place; enterprises and residents are given a subsidy of €30 per square metre, which should cover around half of the installation expenses. Six of eleven participants agreed that incentives would play an impportant role in the installation of green roofs in the context of Izmir.

Interviewee 1: *If the government offered incentives, green roofs would become increasingly common.*

Interviewee 4: *Government incentives, in my opinion, would be useful.*

Interviewee 11: *To increase the installation of green roofs, you should provide a number of incentives.*

Interviewee 6: *Incentives that can cover installation cost may increase people's interest in green roof projects.*

Prooven data

The lack of knowledge and information on return on investments may decrease the adoption of green roofs (Nurmi et al., 2006). Rayner et al. (2010) stated that until reliable data is analyzing the costs and advantages of green roofs, policymakers are likely to be hesitant to integrate them into building rules and planning guidelines.

Interviewee 1: *In order to convince owners and contractors to really spend, it is important to use benefit-cost analysis technique to balance its high initial cost. In other words, economic research should be used to estimate all potential environmental, economical and social advantages.*

Interviewee 10: *Cost evaluations are necessary to demonstrate the sustainability and benefits of this strategy (green roof).*

This highlighted the importance of proven data in the adoption of green roofs. If government officials, the public, or building contractors can be informed about the long-term benefits of green roofs through scientific research, the success of green roof implementation might increase (Zhang et al., 2019).

Education

Education was discovered to be another significant factor affecting the application of green roofs in the Izmir building sector. Five out of the nine respondents stated that education has a large scope and power for enhancing the existing situation of the regional green roof business when asked whether there was a workable strategy to offset the issues posed by green roof technology in Izmir. Through the course of conducting interviews, it was revealed that the word "education'' mostly used for increasing awareness of public and government officials.

Interviewee 3: *People may have different attitudes and perceptions toward green roof systems. It is crucial to convince people to accept and use the green roofs, and change their negative attitudes into positive through education.*

Interviewee 4: *Public' interest might motivate building contractors to design and construct green roofs, which might have a domino effect on contractors, then designers and engineers.*

Interviewee 7: *Local governments and communities might organize educational seminars and workshops to present green roofs' benefits to increase public's awareness.*

Star system

One participant commented on the effectiveness of the star rating system in encouraging the use of green roofs in Izmir. For instance, to receive a high BREEAM (Building Research Establishment Environmental Assessment Method) grade in the UK, such as BREEAM "Excellent", developers were found to be explicitly incentivized to spend extra money designing a green roof into a structure.

Interviewee 1: *A star system unique to Turkey can be developed. Buildings with higher scores are sold at higher prices. In this way, building owners may rise the price of structures with GR layers to make up for the higher initial cost. Since the contractors will receive a financial return, they try to fulfill the criteria (designing a green roof into the building) for getting a star.*

CONCLUSIONS AND RECOMMENDATIONS

During the past few years, municipal administrations in Turkey have begun to take notice of green roofs. The development laws of metropolitan municipalities, particularly Izmir, include green roof initiatives. It is reasonable to assume that the implementation of green roofs will be increased on Turkey's agenda shortly given the growing national and international practices and research on urban green infrastructure in general, and green roofs in particular. The green roof technology has the potential to, when applied appropriately, be a sustainable method of development in Izmir. This was demonstrated by instances of working green roof systems and established literature. Despite the advantages, green roofs in the Izmir building sector have not yet reached their full potential. To better understand the barriers to adoption and the growth opportunities, this article examined and compared the views of government officials.

The cost was determined to be the biggest obstacle to the broad adoption of green roof technologies in the Izmir building sector. Across the local construction sector, the cost is also commonly seen as a major barrier to the implementation of green roofs. To promote the building of green roofs, government action is necessary. Governmental agents could offer financial incentives in addition to pressuring owners and building contractors to adopt green roof systems. Incentives and support from the government are listed as important for its widespread adoption. Overall, these strategies can lessen the financial obligations of government, business owners, and contractors to maximize the benefits of green roof systems, and spread their use across society. Moreover, the initial cost of green roof might decrease as the number of green roofs increases.

DOI: 10.15320/ICONARP.2023.259

The importance of policy setting was also supported in this study. During the investigation, it became clear that there is a noticeable absence of policy at all levels of government in Izmir. Even if the policy-barrier overcame, implementing green roofs in a consistent manner is restricted to the knowledge of individual site consultants and developers. Once people start to demand them for whatever reasons, it becomes the responsibility of the decision-makers to promote the usage of green roofs. The government can emphasize the significance of green roofs through legal means. Even if people are aware of the advantages of green roof benefits, it is difficult to integrate newly offered technology for sustainable projects. At that point, policy regulations are the key factor for their installation.

It was conclusively determined through the study process that the Izmir construction sector (in its whole) sees green roof technology with skepticism and anxiety. The interviewee's comments revealed that green roofs are, in some way or another, viewed negatively by the local building sector. Since then, the importance of education related to green roofs were highlighted by interviewees. It was discovered that for the local sector in green roofing technology to advance in the future, every stakeholder group—from project managers to subcontractors to clients—generally needs some kind of further education regarding green roofs. Another concern is that many urban land use planners lack experience and may be unable to evaluate such a project. An option for hiring a green roof specialist is to have a team of urban professionals such as planners, landscape architects, ecologists, engineers, and urban designers.

Overall, various stages of action may be needed if authorities want to enhance the adoption of green roofs. Firstly, a series of policy decisions regarding the distribution of benefits and, consequently, a just distribution of costs and subsidies. The second and third points refer to significant preliminary work regarding awareness and understanding concerning building-level costs, risks, and benefits and, finally, several exemplar projects to illustrate their viability and effectiveness. There is still a lot of work to practically understand green roofs, especially targeting various stakeholder groups. Barriers should be removed for green roofs to succeed and for wider acceptance. The existing corpus of research and interviews, taken together, clearly shows the necessity for government help in the form of policy settings. As green roof technology becomes more common practice, regulatory settings can cut the cost of green roof technology indirectly. There might be a need for additional research into the effects of policy changes on the cost of green roofs in Izmir, an analysis of the role of industry bodies in the promotion of green roofs, and a lifecycle cost-benefit analysis of green roofs in the Izmir context. These studies would all be of significant value to the local green roof industry.

ICONARP – Volume 11, Issue 2 / Published: 28.12.2023

REFERENCES

Berardi, U., GhaffarianHoseini, AmirHosein &GhaffarianHoseini, Ali. (2014). State-of-the-art analysis of the environmental benefits of green roofs. *Applied Energy, 115*, 411–428. https://doi.org/10.1016/j.apenergy.2013.10.047

Bernard, H. R. (2011). *Research Methods in Anthropology Qualitative and Quantitative Approache*s (5th ed.). Blue Ridge Summit: AltaMira Press.

Brudermann, T., & Sangkakool, T. (2017). Green roofs in temperate climate cities in Europe - an analysis of key decision factors. *Urban Forest Urban Green, 21*, 224–234. https:// doi.org/10.1016/j.ufug.2016.12.008.

Chen, X., Shuai, C., Chen, Z., & Zhang, Y. (2019). What are the root causes hindering the implementation of green roofs in urban China? *Science Total Environment, 654,* 742–750. https://doi.org/10.1016/j.scitotenv.2018.11.051.

Dogmusoz, B.B. (2023). Benefit-Cost Analysis of an Extensive Green Roof Project in Izmir Kâtip Celebi University Cigli Campus. *Online Journal of Art and Design, 11(3)*, 219-232.

Gargari, C., Bibbiani, C., Fantozzi, F., &Campiotti, C.A. (2016). Environmental Impact of Green Roofing: The Contribute of a Green Roof to the Sustainable use of Natural Resources in a Life Cycle Approach. *Agricultural Science Procedia, 8*, 646 656. https://doi.org/http://dx.doi.org/10.1016/j.aaspro.2016.02.087

Goudarzi, H., Mostafaeipour, A.(2017). Energy saving evaluation of passive systems for residential buildings in hot and dry regions. *Renewable Sustainable Energy Review, 68,* 432–446. https://doi.org/10.1016/j.rser.2016.10.002

Gwak, J.H., Lee, B.K., Lee, W.K., & Sohn, S.Y. (2017). Optimal location selection for the installation of urban green roofs considering honeybee habitats along with socio-economicand environmental effects. *Journal of En vironmental Management, 189*, 125–133. https://doi.org/10.1016/j.jenvman.2016.12.022

Jim, C.Y., &Tsang, S.W. (2011). Modeling the heat diffusion process in the abiotic layers of green roofs. *Energy Buildings, 43*, 1341–1350. https://doi.org/10.1016/j.enbuild.2011.01.012

Kazmierczak, A. and Carter, J. (2010). *Adaptation to climate change using green and blue infrastructure: A database of case studies,* The University of Manchester.

Keeley, M., Koburger, A., Dolowitz, D. P., Medearis, D., Nickel, D., & Shuster, W. (2013). Perspectives on the use of green infrastructure for stormwater management in Cleveland and Milwaukee. *Environmental management*, *51*(6), 1093–1108. https://doi.org/10.1007/s00267-013-0032-x

Kohler, M. (2006), Long-term Vegetation Research on Two Extensive Green Roofs in Berlin, *Journal of Urban Habitats, 4(1),* 3-26.

Kutluca, A.K. (2006) : The Izmir City and Natural Hazard Risks, 46th Congress of the European Regional Science Association: "Enlargement, Southern Europe and the Mediterranean", August 30th - September 3rd, 2006, Volos, Greece, European Regional Science Association (ERSA), Louvain-la-Neuve

Li, W. C. & Yeung, K. K. A. (2014), A Comprehensive Study of Green Roof Performance from Environmental Perspective. *International Journal of Sustainable Built Environment, 3(1),* 127 – 134.

Mahdiyar, A., Tabatabaee, S., Sadeghifam, A.N., Mohandes, S.R., Abdullah, A., & Meynagh, M.M. (2016). Probabilistic private cost-benefit analysis for green roof installation: A Monte Carlo simulation approach. *Urban Forest Urban Green. 20*, 317–327. https://doi.org/10.1016/j.ufug.2016.10.001

Mahdiyar, A., Tabatabaee, S., Abdullah, A., & Marto, A. (2018). Identifying and Assessing the Critical Criteria Affecting Decision-Making for Green Roof Type Selection. *Sustainable Cities Society, 39*, 772–783. https://doi.org/10.1016/j.scs.2018.03.007

DOI: 10.15320/ICONARP.2023.259

Mahdiyar A, Mohandes SR, Durdyev S, Tabatabaee S,& Ismail S. (2020). Barriers to green roof installation: An integrated fuzzy-based MCDM approach. *Journal of Cleaner Production 269:122365*. https://doi.org/10.1016/j.jclepro.2020.122365

Mees, H.L.P., & Driessen, P.P.J.(2011). Adaptation to climate change in urban areas: London, Rotterdam, and Toronto. *Climate law, 2 (2),* 251–280.

Mentens, J., Reas, M., & Hermy, M., 2006. Green roofs as a tool for solving the rainwater runoff problem in the urbanized 21st century?. *Landscape and Urban planning, 77 (3),* 217–226.

Meulen, S. (2019). Costs and Benefits of Green Roof Types for Cities and Building Owners. *Journal of Sustainable Development of Energy, Water and Environment Systems, 7(1),* 55 – 71. https://doi.org/10.13044/j.sdewes.d6.0225

Nurmi, V., Votsis, A., Perrels, A.,& Lehvavirta, S. (2016). Green roof cost-benefit analysis: special emphasis on scenic benefits. Journal of Benefit Cost Analysis. 7, 488–522. https://doi.org/ 10.1017/bca.2016.18

Oberndorfer, E., Lundholm, J., Bass, B., Coffman, R.R., Doshi, H., Dunnett, N., Gaffin, S., Kohler, M., Liu, K.K.Y.,& Rowe, B.(2007). Green roofs as urban ecosystems: ecological structures, functions, and services. *Bioscience 57*, 823–833. https://doi.org/ 10.1641/B571005.

Oğuztürk, T., Çorbacı Ö. L., & Aktaş E., (2018), Çatı Bahçeleri Tasarım Projelendirme ve Uygulama Süreçleri, Mimarlık Bilimlerinde Güncel Akademik Çalışmalar, Current Academic Studies in Architectural Sciences-2018, Gece Kitaplığı, Ankara, 225-236.

Rosasco, P. & Perini, K.(2019). "Selection of (Green) Roof Systems: A Sustainability-Based Multi-Criteria Analysis" *Buildings, 9 (5),* 134. https://doi.org/10.3390/buildings9050134

Shafique, M., Kim, R., & Rafiq, M.(2018). Green roof benefits, opportunities and challenges – A Review. *Renewable Sustainable Energy Review, 90*, 757–773. https://doi.org/10.1016/j.rser.2018.04.006.

Shin,E.&Kim,S.(2019). Analysing Green Roof Effects in an Urban Environment: A Case of Bangbae-dong, Seoul. *Journal of Asian Architecture and Building Engineering, (14),2*,315-322.

State Institute of Statistics (2001). Census of Populalation In Years Since 1950-2000, Ankara, State Institute Of Statistics.

Susca, T., Gaffin, S.R., & Dell'osso, G.R. (2011). Positive effects of vegetation: urban heat island and green roofs. *Environmental Pollution, 159,* 2119–26. https://doi.org/10.1016/j.envpol.2011.03.007

Tassicker, N., Rahnamayiezekavat, P. & Sutrisna, M. (2016). An insight into the commercial viability of green roofs in Australia, *Sustainability, 8 (7),* 603-625.

Urwin, K. & Jordan, A. (2008). Does public policy support or undermine climate change adaptation? Exploring policy interplay across different scales of governance. *Global Environmental Change, 18 (1),* 180–191.

Vijayaraghavan, K. (2016). Green roofs: A critical review on the role of components, benefits, limitations and trends. *Renewable Sustainable Energy Review, 57*, 740–752. https://doi.org/10.1016/j.rser.2015.12.119.

Williams, N.S.G., Rayner, J.P., & Raynor, K.J. (2010). Green roofs for a wide brown land: Opportunities and barriers for rooftop greening in Australia. *Urban Forestry Urban Green, 9*, 245–251. https://doi.org/10.1016/j.ufug.2010.01.005.

Wilkinson, S., &Feitosa, R.C. (2015). Retrofitting housing with lightweight green roof technology in Sydney, Australia, and Rio de Janeiro, Brazil. *Sustainability, 7,* 1081–1098.https://doi.org/10.3390/su7011081.

Wilkinson, S.J., Lamond, J.E., Proverbs, D.G., Sharman, L., Heller, A. and Manion, J. (2015), "Technical considerations in green roof retrofit for stormwater attenuation in the central business district", *Structural Survey, 33 (1),*36-51.

Wong, N.H., Wong, S.J., Lim, G.T., Ong, C.L., & Sia, A. (2005), "Perception study of building professionals on the issues of green roof development in Singapore", Architectural Science Review, Welsh, Elaine (2002). "Dealing with data: using

NVivo in the qualitative data analysis process", *Forum: Qualitative Social Research, 48 (3),* 205–214.

Yuen, B., & Nyuk Hien, W. (2005), "Resident perceptions and expectations of rooftop gardens in Singapore", *Landscape and Urban Planning, 73 (4),* 263-276.

Zhang, X., Shen, L., Tam, V.W.Y., & Lee, W.W.Y. (2012). Barriers to implement extensive green roof systems: A Hong Kong study. *Renewable Sustainable Energy Review, 16,* 314–319. https://doi.org/10.1016/j.rser.2011.07.157

Zhang, Q., Oo, B.L., & Lim, B.T.H. (2019). Drivers, motivations, and barriers to the implementation of corporate social responsibility practices by construction enterprises: a review. *Journal of Cleaner Production, 210*, 563–584. https://doi.org/10.1016/j. jclepro.2018.11.050

Resume

Dr. Burcin Burcu Dogmusoz received her bachelor's degree in Landscape Architecture from Ankara University. After graduation, she earned a full scholarship from the Republic of Turkish Ministry of National Education, which funded both her master's and Ph.D. degrees in United States. She completed her master's degree in Landscape Architecture and Ph.D. at North Carolina State University. Currently, she is a lecturer in the department of City ad Regional Planning at Izmir Katip Celebi University. Her research focuses on green inftastructure strategies. So far, she has participated in research projects and studies, as well as well-known international conferences.

DOI: 10.15320/ICONARP.2023.259