INTERNATIONAL THEORY, RESEARCH AND REVIEWS IN

ARCHITECTURE, PLANNING AND DESIGN

October 2023

EDITORS

PROF. DR. SERTAÇ GÜNGÖR
ASSOC. PROF. DR. GÜLBİN ÇETİNKALE DEMİRKAN

SERÜVEN YAYINEVİ

Genel Yayın Yönetmeni / Editor in Chief • C. Cansın Selin Temana

Kapak & İç Tasarım / Cover & Interior Design • Serüven Yayınevi

Birinci Basım / First Edition • © Ekim 2023

ISBN • 978-625-6760-17-2

Serüven Yayınevi / Serüven Publishing
Türkiye Adres / Turkey Address: Kızılay Mah. Fevzi Çakmak 1. Sokak
Ümit Apt No: 22/A Çankaya/ANKARA
Telefon / Phone: 05437675765
web: www.seruvenyayinevi.com
e-mail: seruvenyayinevi@gmail.com

Baskı & Cilt / Printing & Volume
Sertifika / Certificate No: 47083

INTERNATIONAL THEORY, RESEARCH AND REVIEWS IN ARCHITECTURE, PLANNING AND DESIGN

October 2023

Editors
PROF. DR. SERTAÇ GÜNGÖR
ASSOC. PROF. DR. GÜLBİN ÇETİNKALE DEMİRKAN

CONTENTS

Chapter 1

URBAN PLACE PRODUCTIONS: PARTICIPANT APPROACHES

Elif Merve ALPAK[1]
Tuğba DÜZENLİ[2]

1 Assoc. Prof. Dr. Karadeniz Technical University, Faculty of Forestry, Landscape Architecture, Trabzon, Turkey, ORCID ID: https://orcid.org/0000-0002-2306-4299, E-mail: elifmervealpak@gmail.com
2 Assoc. Prof. Dr. Karadeniz Technical, Turkey, ORCID ID: https://orcid.org/0000-0001-6957-3921, e-mail: tugbaduzenli@gmail.com

1. Introduction

In its most general definition, place production is defined as the use of space, depending on needs, in a way that is different from its usual and institutionalized forms, that is, for purposes other than its original design. This sometimes occurs through a process that is compatible with the environment, and sometimes through a process in which the physical environment and locations are occupied. But what is important is to direct the built environment according to the needed meanings and practices (Alpak, 2017; de Certeau, 1980; Benner, 2013; Edinger, 2014; Lydon and Garcia, 2015; Öcal and Erkut, 2019). Placemaking represents an individual/community-focused development process through complex reflection on the construction, operation, and maintenance of public places. The community and the individual are key actors in the making process, rather than being consumers or participants of the process.

In general, in design approaches, the user is embodied as a component element of the environment but is not considered as a constituent element (Alpak and Yılmaz, 2022). This causes the space-city relationship to break down and the creation of unused, empty, or idle areas. The place production approach, on the other hand, considers the designer and the users, who have long become passive subjects, as another builder of the space (Henk de Haan, 2005; Pfeifer, 2013; Enigbokan, 2016), and the users create the locations themselves without being considered as a real designer. In other words, the user produces the urban area instead of using it (Lefebvre, 1991).

Thanks to new creative participation models at the micro level such as 'place production', the symbiotic relationship between the individual and the city, which is about to disappear, is being reconstructed. In this way, spaces that have the potential of a public open space are prevented from being reduced by privatization, and while empty-idle spaces in the city are transformed, the user has the right to have a say in changing these areas in line with their needs and usage practices (Alpak 2020).

Lefebvre (1991) says that the production of place gives the user the right to fully use and manage their daily lives in urban life. This right is not simply to visit or use the place. This right includes people's right to access and consume the resources of the cities they live in, as well as their right to change them. Lefebvre (1991) said, "To change life, we must first change the space" and explained the purpose of this as the recovery of the space for public use - its reintegration into daily life. Even though interventions vary depending on the context, the common denominator that unites them in the face of a need remains constant. Urban consciousness, which mobilizes individuals or communities who realize their needs, changes with the place itself when the process is completed.

When urbanites cannot participate in the production of urban spaces, it is inevitable that various problems will arise (Alpak and Yılmaz, 2021). In urban design processes where users are not included, it is seen that the decisions taken regarding the city are inadequate. It is very important to identify the practices that will enable citizens to have a greater say in the production of spaces related to the city they live in and to integrate them into design and planning decisions. In this direction, within the scope of this study, urban space productions were investigated, especially the production types in which the participants were involved were examined.

2. Urban Place Productions

Place production develops depending on a wide variety of actors, causes and processes.

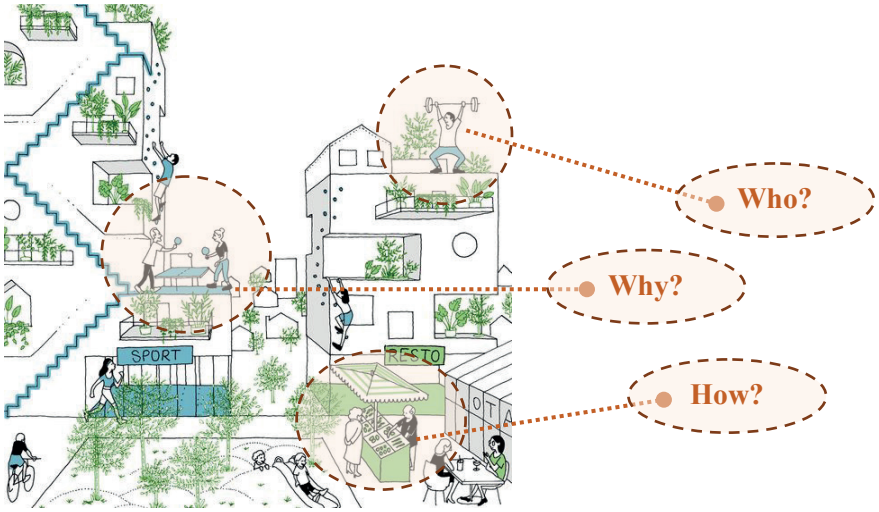


Figure 1. *How is place production and why is it done by whom?*

Although it develops depending on different reasons, people and processes, the starting point of place production is, these are the feelings of owning, protecting, making the place one's own, being safe and making the place a part of oneself (Madanipour; 2003; Brown et al., 2005). However, when it comes to the production of space in urban open spaces, the emotions mentioned here are not explained by owning and defending a space. The production of place in urban open spaces occurs through 'Symbolic Ownership', 'Perceived Ownership' or 'Psychological Security' (Aubert-Gamet, 1997; Kärrholm, 2007). The expression of these emotions can be done as a physical control indicator, such as changing, transforming, and arranging the place temporarily or permanently, by intervening in a place with or without permission, by the individual, society, businesses, authorities, or administrations, as well as at the emotional and mental level can be done (Fischer, 1992; Kärrholm, 2007)

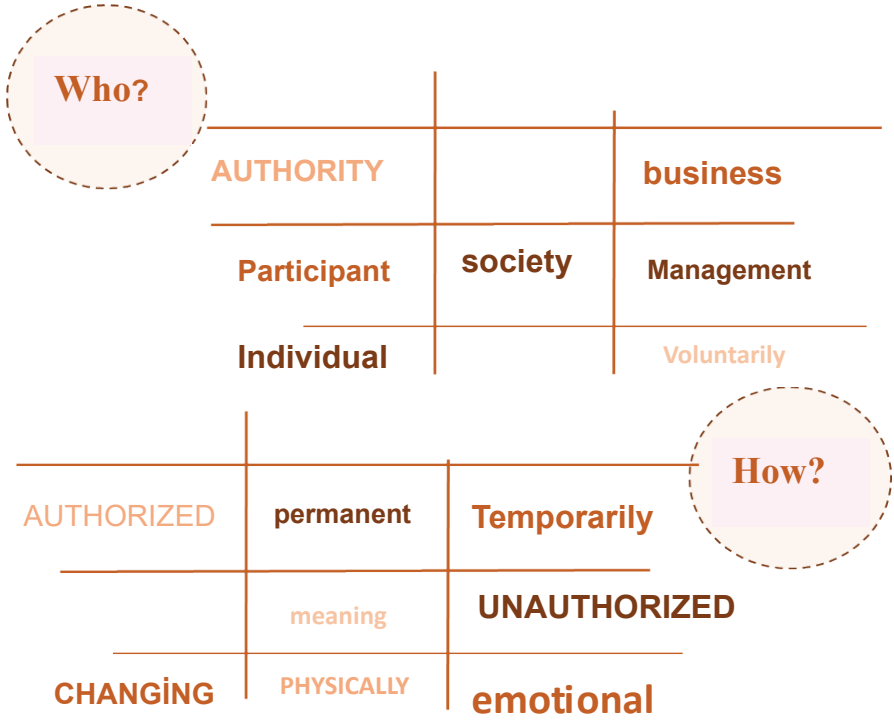


Figure 2. *Actors and Processes that Cause Place Production*

Although place production is generally small-scale practices implemented directly by urban actors with their own resources, emphasizing use-oriented practices and aiming to creatively own and change-transform the space, the reasons for its production differ according to the people who do it and the needs (Benner, 2013; Douglas, 2014; Pfeifer, 2013; Fabian & Samson, 2015; Lydon & Garcia, 2015; Sawhney et al., 2015; Talen, 2015). What these Place Productions have in common is to discover and reveal "cities within cities" and "equip them with new functions and meanings" (Hou, 2010).

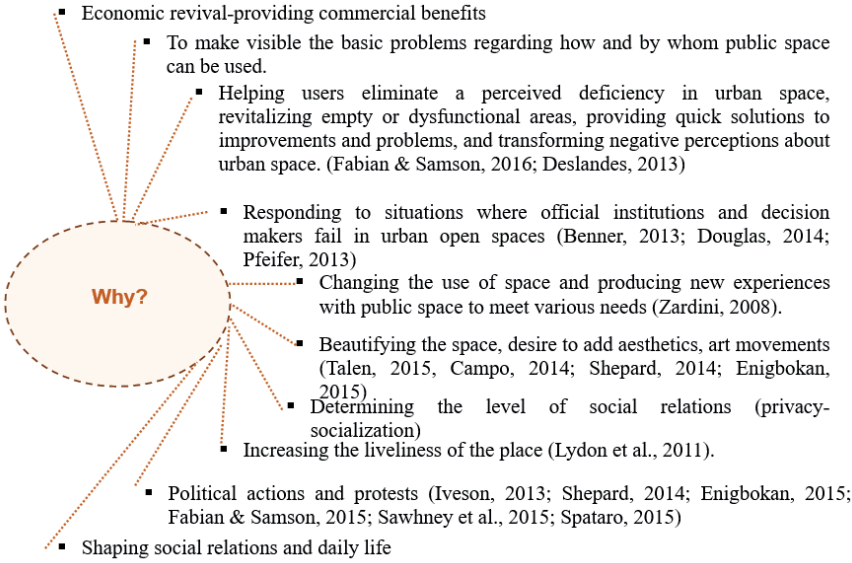


Figure 3. *Reasons for Place Production*

Some researchers have said that classifications should be made to create a more concrete understanding of place production, which is a multidimensional structure with its forms of construction, actors and reasons (Figure 4) (Bell et al. 1996; Fischer 1992; Kärrholm, 2005, 2007; de Certeau, 1980). These classifications have been used by many researchers and have led to the emergence of different concepts and production styles over time. First, the classifications put forward by these researchers are grouped and explained (Table 1). In the following sections of the study, these classifications are diversified and examined in detail through examples.

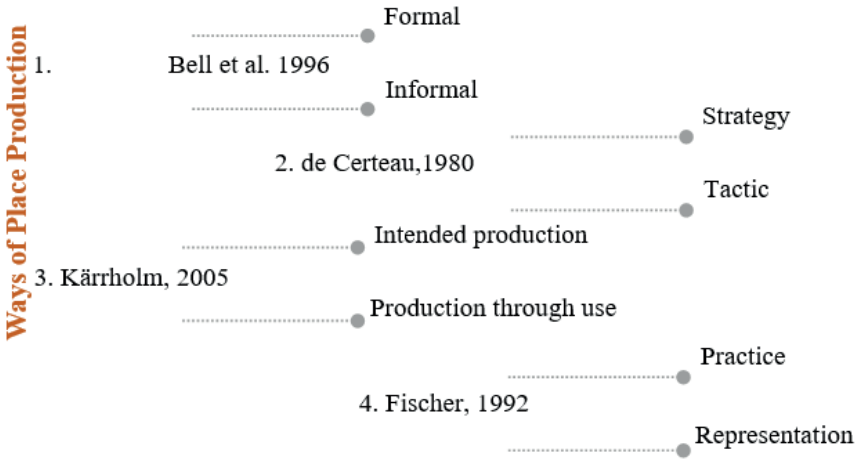


Figure 4. *Ways of Place Production of Different Researchers*

Table 1. *Place Production Classification*

	STRATEGY	TACTICS	MEANING
Way of production	• Authorized • Formal • Planned	• Unauthorized • Informal • Planned/Unplanned	• Mentally • Unplanned
Actors	• Authority • Management • Municipality • Business etc.	• Individual • Society • Participant • Neighborhood • Voluntarily • Street Vendor • Street Artist etc.	• Individual • Society
Scale	• Miro-scales such as parks, squares, streets,	• Miro-scales such as parks, squares, streets, neighborhoods	• Miro-scales such as parks, squares, street
Purpose	• Economic revival-providing commercial benefits • Increasing the liveliness of the space • Beautifying the space, adding aesthetics, art movements • Incorporating idle spaces into daily life • Shaping social relationships	• Political actions, protests, reaction • Eliminating deficiencies, revitalizing dysfunctional areas, improving, providing solutions to problems, • Changing its use according to need and producing new experiences about public space. • Determining the level of social relations	• Evaluating the place and comparing it with others • Emotional and functional attachment to the place • Adding meaning to space

Practice-use	• Moving Business Functions Outdoors • Temporary-Permanent Limitation-Interventions • Generally Regular and Traditional Use • Market Places-Local Organizations (open-air theatres, Pop-Up Urbanism festivals, etc.) Promotional Activities etc.	• Participatory approaches • Innovative and Attractive Usage in General • Temporary and Instant Interventions in general • Do It Yourself, Urban Hacking, Gerrilla Urbanism etc.	• Repeating Pattern of behavior (favorite location) • Mental coding • A place being the first place that comes to mind for the activity you want to do- association

In recent years, tactical movements have begun to be explained with different concepts, considering them as participatory approaches. In this study, the participatory approach dimension of place production was examined.

2.1. Participatory Approaches in Urban Space Production

Human relations and urban space cannot be considered separately from each other. Participatory approach in the production process of urban space establishes a strong bond with the individual. One of the main points of this study, which deals with participatory approaches in the production process of urban space, is that social relations and space production processes interact (Çağlar, 2017). Lefebvre defined abstract space as the space created by designers and authorities with design codes, and Concrete space with life codes. Concrete space is the space formed by the user's experiences. In fact, space is experienced not as imposed by the authorities, but as directed and organized by social relations. Therefore, it emerges as a participatory approach in place production of the collaboration area where abstract and concrete space intersect. Participatory approaches take place in different ways, differing in their purposes and forms. These;

- Do-It-Yourself Urbanism
- Urban Hacking
- Gerrilla Urbanism
- Urban Squatting

Within the scope of this study, the concepts of Do-İt-Yourself urbanization and Urban Hacking were examined. Differences regarding urban space production have been revealed.

2.1.1. Do-It-Yourself

Do-it-yourself urbanization practices are the challenges of the determined, regulated uses of urban spaces through unauthorized direct

interventions, regardless of the diversity, effects and consequences of the actors' actions (Douglas, 2014). Do-it-yourself urbanization is the provision of temporary solutions to urban problems through small-scale, low-cost, functional and often unauthorized interventions made by citizens or users of the space (Benner, 2013; Douglas, 2014; Pfeifer, 2013; Fabian & Samson, 2015; Lydon & Garcia , 2015; Sawhney et al., 2015; Talen, 2015). It is also defined as implementation efforts by non-professional urban actors to renew and revitalize empty or dysfunctional areas in the city (Deslandes, 2013; Kaya and Görgün, 2017). Even though these movements are small-scale, they help us experience the city in a different way. In fact, it is possible for people to produce alternative ways to live in the city in daily life while searching for the 'Right to the City' (Begg, 2011).

"Parking Day", initiated by the art and design collective Rebar in San Francisco in 2005, was one of the turning points of the do-it-yourself movement. The idea quickly went viral and for 2011's PARK(ing) Day activists created 975 temporary pop-up parks in 162 cities in 35 countries on six continents (Parking Day 2011). Against practices that do not give people the opportunity to experience the place they live in due to reasons such as vehicle occupation, it is realized by actions such as closing a street, neighborhood or park to vehicle access to do the activities they want at the same time of the year and limiting daily activities. When San Francisco passed the Sit-Lie Ordinance in 2011 banning sitting or lying on sidewalks, it crystallized a stance that many cities worldwide seem to have adopted over the years, to dissuade public sitting by removing benches or implementing other subtle anti-loitering urban design measures.

The "chair bomb" movement, initiated by a group of low-income West Oakland and Los Angeles urbanites led by Steve Rasmussen Cancien, involves placing illegal benches and street furniture on the streets. As a reaction to unusable, empty open spaces, users have sought a solution to this problem by bringing seating equipment to the space according to their needs. Chair-bombing is another tactic that creates and installs seating in a public space where places to sit are desirable but lacking. This rather simple gesture goes beyond offering a seat to others, it has been used to recycle disposed materials, generate social activity, as well as define key locations where additional public improvements should be made by municipal officials. Therefore, DIY Urbanization includes interventions made by individuals or a social segment, without involving a political protest, to make themselves visible by eliminating a deficiency, revitalizing dysfunctional areas, improving them, providing solutions to problems, or reacting to situations where official institutions and decision-makers fail. These interventions include temporary-instant interventions, as well as conscious, intentional-planned behaviors. When people do this behavior, they mark the place they are in.

Table 2. *Examples of Place Production with DIY Movements*

 URL 2	 URL 3
 URL 4	 URL 5
Way of Production Unauthorized Informal Planned	**Purpose** Eliminating deficiencies, revitalizing dysfunctional areas, improving, providing solutions to problems
Practice Temporarily Marking Stamping Behavior	**Actor** Individual Society Participant Voluntarily- Neighborhood
Chair Bombing	

<table>
<tr><td>  </td><td>  </td></tr>
<tr><td>URL 6</td><td>URL 7</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>URL 8</td><td>URL 9</td></tr>
<tr><td>Way of Production
Unauthorized
Informal
Planned</td><td>Purpose
Eliminating deficiencies, revitalizing dysfunctional areas, improving, providing solutions to problems</td></tr>
<tr><td>Practice
Temporarily
Marking
Stamping Behavior</td><td>Actor
Individual
Society
Participant
Voluntarily- Neighborhood</td></tr>
<tr><td colspan="2">Parking Day</td></tr>
</table>

2.1.2. Urban Hacking

'Hacking', which is based on using the city in extraordinary ways, is a movement that aims to create distance from the familiar by disrupting the familiar environment of the urban dweller. Finding a solution to any problem is not a behavior of fixing the missing parts. Short-term use based on need is a changing-transformation behavior (Gardinger, 2010)

"Urban hacking" contributes greatly to reintegrating an urban space or element into daily life with minor interventions. Today, the problem of idleness is being solved with much larger-scale projects by various government

institutions. This actually results in the privatization and reduction of places that have the potential for public open space. Repairing, renewing or providing a new function can play a big role in the revitalization of urban spaces. Utilizing, owning and putting into use empty spaces in the city is a field of study with great potential for those working in creative fields (Çağlar, 2017).

Creating solutions for the needs of that place through site-specific research, field trips and conversations, and being able to achieve this by taking the initiative as a citizen, underlines the concept we call "urban hacking". The importance of citizens being able to take the initiative, not shying away from intervention, and transforming places together, in order to socialize them without politicizing them, is felt more and more every day. Leaving seemingly unimportant small areas alone may lead to the loss of much larger areas in the future. For this reason, it is of great importance to bring to light practices that push citizens to make creative interventions, such as "urban hacking", and to create opportunities to experience them.

Participatory design or co-production practices aim to think together and produce solutions at different scales, from the transformation of the living space to the products used. This definition often ends in the design research process. Although conducting field research by asking citizens is called participatory design, situations where this process continues until the design and even production stages should be called participatory design. At this point, creators have the responsibility of educating as well as guiding. "Urban Hacking" refers to the least practiced parts of participation, namely design and deployment. Making an intervention, whether necessary or not, in the usual order and the ongoing course of events plays a role in thinking about the importance of what we call the right to the city, or at least the feeling of ownership. In this sense, producing unconventional interventions; It will create a guiding effect in adopting, using, and making people use the space. As urban spaces transform, "urban hacking" can be a good exercise to have a say in these spaces so that they can change in line with our needs and usage practices (Kuyumcuyan, 2021).

"Urban Hacking" can be handled in two different ways; (Table 3)

1. It includes unplanned and spontaneous interventions made by users. These interventions occur when users temporarily leave traces or mark the space with their behavior. Unlike the do-it-yourself movement, there is no planning involved. It takes place according to the need of the moment and is not intended to react to a negative situation, as in the do-it-yourself movement (Alpak, 2017).

2. Street vendors, street artists, etc. It takes place through the interaction scenes they create with their planned, sometimes temporary infiltration into

the place, and sometimes their permanent nesting-settlement (the same person selling in the same place every day) in order to gain financial gain. The main purpose here is to provide financial gain, as well as to entertain people and contribute to social unity by creating social interaction areas (Alpak, 2017).

Results

Until the 1990s, participatory approach practices were considered as 'Design for the User'. User expectations and needs were determined through methods such as public assemblies, surveys, appointments, establishing dialogue and offering alternatives. The user was in a passive state during the design and planning stages, that is, limited to the research part, and did not have any decision-making authority. The final say belongs to the designer and the authority. The designer is superior to the user and makes the decision. So, in fact, the classical participatory approach involves manipulation of a top-down decision-making process. It is based on a system of choice or imposition rather than the power to decide on the citizens**.**

After the 1990s, design for the user evolved into participatory design. An approach has been put forward that transforms the participant from passive to active, where the user reaches the highest degree of participation, and which brings the user, designer and researcher-authorities into a team. In the process of place production with the participatory approach, user participation continues until the design and production stages, and for these reasons, the designer and authority do not have any superiority, and the design is not based on hierarchy, but on design collaboration and network communication. The user ultimately becomes the decision maker rather than the one whose opinion is taken. In other words, it represents bottom-up participation.

The most common forms of place production with a participatory approach in urban spaces are do-it-yourself urbanization and urban appropriation dynamics. These forms of place production also have an important share in increasing the sense of commitment, maintaining, protecting and keeping the place safe, supporting sustainable approaches, and creating pro-environmental behavior tendencies. This individually occurring behavior can also turn into a collective structure over time. Research shows that people tend to act individually or with organizations to protect their environment and solve environmental problems, especially in place production that takes place on a neighborhood scale.

Table 3. *Examples of Place Production with Urban Hacking*

	
URL 10	URL 11
	
Author's	Author's
Way of Production Unauthorized Informal Unplanned	**Purpose** Changing the use of space and producing new experiences with public space in order to meet various needs, Determining the level of social relations
Practice Temporarily Marking Stamping Behavior	**Actor** Individual Society Participant
Hacking made by users	

<table>
<tr><td> 
URL 12</td><td> 
URL 13</td></tr>
<tr><td> 
URL 14</td><td> 
URL 15</td></tr>
<tr><td>Way of Production
Unauthorized
Informal
Planned</td><td>Purpose
Commercial benefit, Revitalizing art movements Shaping social relations and daily life, Increasing the liveliness of the space</td></tr>
<tr><td>Practice
Temporarily – Permanent
Nesting
Insinuate</td><td>Actor
Street artist
Street vendor etc.</td></tr>
<tr><td colspan="2">Hacking made by street artist, vendor etc.</td></tr>
</table>

The urban design process should aim to build public spaces that create a sense of experience and loyalty, are lively, have high levels of social relations, and have a strong sense of place, rather than creating standard areas that focus only on form. This is possible by establishing strong relationships between humans and the environment. Place production is also a phenomenon that expresses the dynamic interaction process and interventions between the

individual and his environment. These interventions, in which urban residents can reveal their own experiences and their own aesthetic perceptions, have the potential to influence urban policies (Enigbokan, 2016).

These policies shorten the distance between the designer and the user. Instead of consuming spaces, place production focuses on society as the main creator of these spaces. Thus, loss is an important behavioral mechanism in preventing the formation of unused spaces and their gradual growth and mass losses. Preventing lost places has an important share in preventing people from becoming alienated from each other and losing the sense of togetherness and being a strong society. Lefebvre (1991); He said that if places are not produced in public spaces, there is no urban area. For this reason, ground production with a participatory approach has a very important place.

REFERENCES

Alpak, E.M. (2017). Transformatıon of shoppıng street ınto socıal behavıor spaces: Analysıs of appropriatıon behavıor wıth envıronmental charecterıstıcs [doctoral thesis]. Türkiye: Karadeniz Techinical University.

Alpak E.M. (2020). Occupants creating their own spaces without thinking as a real designer: A revolt and a routine. ITU A|Z, Vol 17 No 1, 85-94

Alpak, E.M., Yılmaz, S. (2021). Campus Open Spaces and "Triangulations": Effects on Socialization and Liveliness. Eds. B. RANGUELO, Z. G. BERDENOV, R. EFE, Developments In Engıneerıng And Archıtecture. Chapter 6, 62-75.

Alpak, E.M., Yılmaz, S. (2022). Place Productıon: Investıgatıon Of Envıronmental Desıgn-I Studıo Process. Ed. Felek S.Ö., International Research in Architecture, Planning and Design, Chapter V, 75-88, Publisher: Serüven Publishing.

Aubert-Gamet, V., 1997. Twisting servicescapes: diversion of the physical environment in a re-appropriation proces. International Journal of Service Industry Management, 8,1, 26-41.

Bell, P., Green, T., Fisher, J. ve Baum, A., 1996. Environmental Psychology , 4th edition, Harcourt Brace College Publishers, Fort Worth.

Begg, Z. (2011). Under the Beach Lies the City. The Right to the City (s. 61-65). Sydney: Tin Sheds Gallery, Faculty of Architecture, Design and Plannin

Benner, S. M. (2013). Tactical Urbanism: From Civil Disobedience to Civic Improvement. The University of Texas

Benner, S. M., 2013. Tactical Urbanism: From Civil Disobedience to Civic Improvement. The University of Texas.

Brown, G., Lawrence, T. ve Robinson, S., 2005. Territoriality in Organizations. Academy of Management Review, 30, 577-595

Çağlar, Ö. (2017). Kentsel Mekân Üretiminde Katılımcı Yaklaşımlar. İstanbul Teknik Üniversitesi, Fen Bilimleri Enstitüsü, Yüksek Lisans Tezi.

Campo, D. (2014). Iconic eyesores: exploring do-it-yourself preservation and civic improvement at abandoned train stations in Buffalo and Detroit. Journal of Urbanism: International Research on Placemaking and Urban Sustainability, 7(4), 351–380

de Certeau M., 1988. The Practice of Everyday Life. Berkeley: University of California Press.

Deslandes, A. (2013). Exemplary amateurism: thoughts on DIY urbanism. Cultural Studies Review, 19(1), 216-227

Douglas, G. C. C. (2014). Do-It-Yourself Urban Design: The Social Practice of Informal "Improvement" Through Unauthorized Alteration. City & Community, 13(1), 5–25.

Edinger E.C., 2014. Examining Space Perceptions. Combining Visual and Verbal Data with Reactive and Non- Reactive Methods in Studies of the Elderly and Library Users. Historical Social Research, 39, 2, 181-202

Enigbokan, A. (2015). Delai Sam: social activism as contemporary art in the emerging discourse of DIY urbanism in Russia. Journal of Urbanism:nInternational Research on Placemaking and Urban Sustainability, 1–16.

Fabian, L. & Samson, K. (2016). Claiming Participation – A Comparative Analysis of DIY Urbanism in Denmark. Journal of Urbanism: International Research on Placemaking and Urban Sustainability, 9(2), 166-184.

Fabian, L., & Samson, K. (2015). Claiming participation – a comparative analysis of DIY urbanism in Denmark. Journal of Urbanism: International Research on Placemaking and Urban Sustainability, 1–19

Finn, D. (2014). DIY Urbanism: Implications for Cities. Journal of Urbanism:International Research on Placemaking and Urban Sustainability 7(4), 381-398

Fischer, G.N.. 1992. Psychologie Sociale de L'espace, Privat, coll. Pratiques Sociales, Toulouse.

Gadringer, M. (2010). Urban Hacking as a Strategy for Urban (Re-)Planning/Designing. J. G. Günther Friesinger içinde, Urban Hacking CulturalnJamming Strategies in the Risky Spaces of Modernity (s. 35-44). New Brunswick, London: Transaction Publisher.

Henk de Haan, 2005. Social and Material Appropriation of Neighborhood Space: Collective Space and Resistance in a Dutch Urban Community

Hou, J. (2010). (Not) your everyday public space. J. Hou (Ed.), Insurgent Public Space Guerilla Urbanism and the Making of Contemporary Cities, London

Iveson, K. (2013). Cities within the city: Do-it-yourself Urbanism and the Right to the City. International Journal of Urban and Regional Research, 37(3), 941-956

Kärrholm M. 2005. Territorial Complexity in Public Places – a Study of Territorial Production at Three Squares in Lund. Nordisk Arkitekturforskning, 99-114

Kärrholm M. 2007. A Conceptual Discussion of Territoriality, Materiality, and the Everyday Life of Public Space, Space and Culture, 10, 4, 437-453

Kaya I. A. and Görgün E. K. (2017). Kentsel Mekân Üretiminde 'Kendin Yap' Hareketi. Planlama;27(1):57–74

Kuyumcuyan L. (2021). Urban Hacking ve Katılım. https://www.onaranlarkulubu.com/tr/urban-hacking-ve-katilim/

Lefebvre, H., 1991. The Production of Space. London, England: Blackwell.

Lydon, M., & Garcia, T. (2015). Chapter 1: Disturbing the Order of Things. In Tactical Urbanism: Short-term Action for Long-term Change (Lydon and Garcia eds.), 1-23.

Lydon, M., Bartman, D., Woudstra, R., Khawarzad, A. (2011). Tactical Urbanism: Short Terrm Action Long Term Change. Vol. 1. The Street Plans Collaborative

Madanipour, A., 2003. Public and Private Spaces of the City USA and Canada by Routledge 29 West 35th Street, New York

Öcal G. and Erkut G. (2019) Kent Hakkı ve Katılımcılık Bağlamında Kendin Yap Kentleşme: Roma Bostanı Örneği, Planlama, 29(2):115–128.

Parking Day. 2011. "PARK(ing) Day 2011 – Official PARK Count!." Parkingday.Org. Accessed June 7, 2012. http://parkingday.org/parking-day-2011-official-park-count/

Pfeifer, L. (2013). The Planner's Guide to Tactical Urbanis

Sawhney, N., De Klerk, C., & Malhotra, S. (2015). Civic Engagement through DIY Urbanism and Collective Networked Action. Planning Practice & Research, 30(3), 337–354

Sawhney, N., De Klerk, C., & Malhotra, S. (2015). Civic Engagement through DIY Urbanism and Collective Networked Action. Planning Practice & Research, 30(3), 337–354.

Shepard, B. (2014). DIY urbanism as an environmental justice strategy: The Case Study of Time's Up! 1987-2012. Theory in Action, 7(2), 42–73

Spataro, D. (2015). Against a de-politicized DIY urbanism: Food Not Bombs and the struggle over public space. Journal of Urbanism: International Research on Placemaking and Urban Sustainability, 1–17.

Talen, E. (2015). Do-it-Yourself Urbanism: A History. Journal of Planning History, 14(2), 135-148.

URL 1. https://gaelleanastasio.com/imgp-rueil-malmaison

URL 2. https://tr.pinterest.com/pin/184999497166774466/

URL 3. https://bustler.net/news/3091/gdyby-group-project-shows-potential-of-empty-historic-targ-weglowy-square-in-gdansk-poland

URL 4. https://tr.pinterest.com/pin/474144666998110788/

URL 5. https://tr.pinterest.com/pin/438960294948629854/

URL 6. https://aiaseattle.org/event/udf-feb-event/

URL 7. https://www.dezeen.com/2019/06/28/city-parklets-london-festival-architects-fatkin-mcevoy-patri/

URL 8. https://tr.pinterest.com/pin/377739487477465539/

URL 9. https://tr.pinterest.com/pin/534591418261553549/

URL 10. https://www.onaranlarkulubu.com/tr/urban-hacking-ve-katilim/

URL 11. https://www.nytimes.com/2021/11/12/learning/where-is-your-favorite-place-to-read.html

URL 12. https://tr.pinterest.com/pin/227783693627902917/

URL 13. https://www.pinterest.jp/pin/233835405629590038/

URL 14. https://tr.pinterest.com/pin/315392780129150937/

URL 15. https://www.dailynews.com/2015/08/19/street-vending-in-los-angeles-is-out-of-control-and-needs-regulating-guest-commentary/

Zardini, M. (2008). A new urban takeover. G. Borasi & M. Zardini (Ed.), Actions: What you can do with the City içinde (s. 12-17). Montreal: SUN Architecture ve CCA.

Chapter 2

PLACES REPRODUCED BY IMITATION; THE EXAMPLE OF THEMED HOTELS

Zeynep YILDIZ[1]

1 Dr. Zeynep Yıldız, Konya Technical University, Faculty of Architecture and Design, Department of Architecture, Orcid ID: 0000-0001-7724-5215.

1. INTRODUCTION

Before the Industrial Revolution, production is made individually. With the Industrial Revolution, standardization and serialization began in production. Thus, the goods, which were produced individually with the help of machines, started to be produced in a similar way as one another. As a result, when we come to the postmodern age, people have turned into consumers who wear the same clothes and use the same products. The society has become the same over the objects it produces and consumes, and people who have become consumers have abandoned their individual identities and become members of the society that are copies of each other. The similarity and sameness on products and individuals has also found a place in art. Reproduction of existing works of art has emerged with technological means. Artists preferred the way of 'reproducing' by copying instead of reproducing.

Building production was also affected by these developments. In fact, imitation in building production is not a new phenomenon. While creating spaces, people have always followed the traces of their predecessors. Sometimes this situation is encountered in the form of copying the same architectural element and sometimes in the form of interpreting a form. Especially in the 18th century, movements such as neo-classicism, which emerged as a reaction to different searches, are an imitation of the ancient architecture beyond its interpretation and even interpretation. However, in the 20th century, beyond the search for architectural aesthetics, social dynamics became a priority in the production of space. The changing understanding of urbanization and increasing housing demand after the Second World War, the mass production and prototyping motto of the Industrial Revolution, and economic expectations have been the determinants of space design. This period, supported by the discourses of modernity, led to the emergence of mass production spaces. These similar spaces have begun to evolve in a different direction with the changing user expectations and postmodernist movements over time. In the globalizing world, the concepts of time and space have undergone a change in meaning and have been played with perceptions of reality and truth. Users have begun to expect a space to satisfy their hedonic feelings beyond being functional, practical and aesthetic. The experiences of being different, living in a fantasy world by breaking away from their real time and place, being everywhere or anywhere while being somewhere, and being beyond time have given birth to the non-places of the postmodern age. Today's non-places (terminals, banks, hotels, shopping malls, etc.) are similar to each other all over the world and establish the same type of relations with the user with the same identities.

At this point, the act of imitation plays an important role in moving the non-places from one point to another. By imitating the ready-made images that have taken place in the user's memory, it brings a historical structure

and culture to this time, creates a new time and place for itself. It builds relationships with the user on ready-made images that it imitates. What is done here is actually the reproduction of an existing structure through formal and symbolic similarities.

The issue of imitation in design is a controversial and often accepted situation. However, while the production and acceptance of other products repeatedly shows the success of that product, this repetition in building production is perceived as a situation that reduces the value of the building (Güzer, 2007). Among contemporary structures, there is production by imitation. However, it is an architectural adaptation of a mass production model that is out there. Similar residences, shopping malls, hotels, architectural elements and equipment are the results of this model. However, the problem addressed in this study is the reproduction of an existing structure belonging to another time at this time. In both cases, an architectural space is produced by imitation. But in the first, function is important. There is also a similarity of function among similar forms. However, this is not possible due to the change in social life norms in imitation of historical structure. A connection cannot be established between the function and form of a space produced with this model, the space cannot find a place of its own in the place and time it is located, and rootless spaces with no context emerge.

Today, historical buildings are revived by being reproduced in many building types with different functions. This situation has been frequently encountered in consumption places such as theme and amusement parks, shopping centers and hotels in recent years. Shopping malls resembling a medieval forum, parks resembling Ottoman walls, hotels resembling palaces transform the concepts of historicity into consumption objects and acquire a theme for themselves. Examples of this are most common in hotels. Hotels, which are the most sought-after tourism venues with the changing understanding of travel in the postmodern era, apply to different themes in order to attract more tourists and to stand out in this competitive environment. Themed hotels take an object, idea or historical structure known to the general public as a concept, and apply this in a formal, functional or just business approach. The most common theme among themed hotels is the reproduction of a historical building. The delusion of being in the past and in a different culture is presented to the post-tourist through place.

2. THE CONCEPT OF IMITATION IN BUILDING PRODUCTION

As a word meaning imitation, trying to resemble a particular example means something made by analogy (TDK,2017). Imitation, which is seen in every field of production through repetition, standardization and serialization, is also encountered in building production.

With the imitation method, existing structures can be reproduced

completely, as well as partially the form and details of the original structure can be reproduced. The limit determined in the imitation method also determines the quality value of the reproduced structure.

Reproducing structures by imitation can be caused by different reasons. Producing tried and accepted structures that are appreciated by the society and presenting the identity values of these structures to the consumers are among the most important reasons. In addition to this, accelerating the design and production process, meeting the traditional expectations of the society and management organisms, searching for a market are other reasons for imitation (Güzer, 2007).

Today, structures reproduced by imitation mostly refer to historical structures. According to Harvey (2014), the reason for this situation is the effort to respond to the nostalgia motive of postmodernism. Individuals of the postmodern age yearn for the past and the traditional. Individuals who yearn for history are interested in recreated history and reenactments today. However, this form of imitation stemming from the longing for the historical is frequently criticized. Venturi (1966) reacted to the fact that today's functional aesthetic understanding of architecture is replaced by imitation architectural forms. According to him, modern architecture is trying to be symbolic by abandoning its function. Instead of gaining form and form according to their function, these produced spaces imitated the forms and forms of historical buildings and used the qualities of historical buildings as symbolic images.

In addition, there are opinions that imitation can be used in architecture. According to G. Lippold (1923), he is of the opinion that imitation can be based on form as a copy of the original structure as a whole or its details. Baudrillard (1982), on the other hand, approached imitation from a different perspective. According to him, in the postmodern era, the distinction between original and copy has disappeared and the effectiveness of imitations has begun. In this age, everything has lost its meaning, science and art are exhausted, everything has been tried and the end has been reached. Only pieces remained in the hands of art, and the postmodern era gave way to a period where production was replaced by playing with pieces. For this reason, imitation has been effective in every field as an obligatory and inevitable method.

Güzer (2007) also approached the issue of imitation with a critical eye. According to him, there is no pure originality in architecture. Each design connects with previous works. It is the concept of boundary that should be noted here. An important separator that distinguishes architectural works from other imitation works is the issues of place and context. The same work gains different meanings in different contexts. The quality of the relation of belonging established with the context reduces the imitation aspect of the structure.

There are different views on reproduction by imitation in architecture. In this sense, it would not be correct to characterize imitation as a completely negative concept. Imitation emerges as a method that needs to be considered within the context and place, has limits, and the rate of creativity and originality should be considered.

3. REALITY IN IMITATION: SIMULATION

While spaces are reproduced through imitation, they lose their authenticity, and this reality is repeated with different tools in the newly produced structure. In other words, the form and reality of the existing structure are simulated in this reproduced imitation structure.

Simulation is the creation of reality with models and indicators that have all the information of reality but are not real (Baudrillard, 1982). However, the aim of the simulation here is to hide the reality. Baudrillard said that simulation is not 'pretend', it is beyond that. E.g; Someone pretending to be sick goes to bed trying to convince people that they are sick. The person simulating the disease carries the symptoms of the disease. Thus, simulation emerges as a technique that destroys the distinction between real and fake, reduces the visibility of imitation, and allows the copy to go beyond the original.

Harvey (2014) stated that there is a time and place compression in simulated places. In these new consumption spaces shaped by global capital forces, the context and boundaries have disappeared, the sense of belonging has been destroyed, and global environments that construct a new world within themselves have emerged. Locality was created with simulations in these new consumption spaces. Locality has now turned into a concept that serves economic expectations as a consumption tool (Süer and Sayar, 2002).

Another quality lost in simulated spaces is the unity of form and content. While the forms are imitated in the simulated spaces, the content is trivialized. In these new formal pursuits without content, forms are reproduced by imitation, copied and repeated one by one (Dağ, 2011).

This change in spaces has also had an impact on society and culture. In the postmodern era, everyday culture has turned into a heterogeneous culture where the sense of reality has been lost and images and simulations have replaced it. Today, culture is created with signs and is shaped by an artificial, dull and depthless perception of reality. Everyday life and culture develop in a fictitious and fantastical confusion based on images (Featherstone, 1996). The resulting consumer society lives in the world of signs and images, and it becomes incapable of distinguishing between imitation and real, real and fake. Society tries to reach reality through these simulations, instead of reaching reality and perceiving it directly. In society, he is satisfied with the 'as

if' situation, such as culture and places, and he is satisfied with only as much reality as is presented to him.

Baudrillard criticized the loss of reality through simulation as the main disease of the postmodern age. According to him, in this age, people preferred to reproduce reality instead of producing. In fact, the situation of repeating this fact is due to the desire of society to reach the lost reality. For this reason, everything that society produces has hyper-real qualities. However, what he achieves cannot go beyond the gigantic reflection of reality (Baudrillard, 1982).

The first and most important example of simulated places is Disneyland. Disneyland was established in the USA in the 1950s and soon turned into the country's most important attraction. Disneyland is very important in that it reproduces images and signs by simulating and is a prototype of the space of the postmodern age (Gottdiener, 1997). In Disneyland, visitors experience rapid transitions between countries and worlds created by imitating important places that evoke countries, away from the reality of time and space. Here, real spaces are repeated over and over, resulting in a synthesis of virtual spaces where reality is simulated.

Baudrillard (1982) describes Disneyland as a miniature model of America in which simulacrum layouts are intertwined. The credibility of the reality produced here is so high that American cities are starting to lose their own reality. The real and fake relationships between Disneyland and its surroundings begin to blur.

After the example of Disneyland, architectural spaces that serve economic expectations and social tastes have gradually turned into image spaces and become Disney around themes. All the negativities of the real city and the place were destroyed, and isolated and artificial barriers and spaces were started to be produced. In our age, cities and structures are rapidly multiplying around their reproduction by imitating existing cities and structures that have received the appreciation of the society by purifying them from their negativities.

4. THE EXAMPLE OF SPACE MADE BY IMITATION: THEMED HOTEL

In the postmodern era, where signs, imitations and simulations precede reality, spaces have also lost meaning. Today, spaces have started to have the characteristics of a multi-consumption space. Many places such as shopping malls, closed housing estates, airports, recreation and parking areas are transformed into machines that serve consumption and are designed to attract more consumers. One of the places most affected by this situation is hotels.

Hotels are places where consumers can spend their free time and where the dominance of the entertainment industry is felt the most. Today, different spatial ways have been used in hotels to attract visitors. Looking at the examples in the world and in Turkey, similar trends are seen in hotel design. In these new hotel approaches, we come across simulated spaces that imitate real spaces.

Not only spaces, but also employees and employee-consumer interaction are simulated. In the postmodern society, tourists do not perceive the real thing as beautiful, and find hotel spaces that are reproduced artificially and hygienically attractive (Ritzer, 2011). In these hotels, the perception of locality that the tourist expects from the real place is presented with images. The architect is interested in producing decor, not building, that meets this expectation. Thus, in these new spaces produced, tourists experience the feeling of being nowhere but everywhere while they attain the locality they desire (Süer and Sayar, 2002).

These hotels, produced by imitation, are shaped around a certain theme. A historical building, events and forms in the memory of the society, interesting and fantastic fictions are among the main themes of the hotels.

The thematization approach not only affects the form of the building, but also shapes the hotel as a whole, from business and concept understanding, promotion and advertising, food menus to interior arrangements.

Themed hotels should create a fascinating and eye-catching theme in order to attract the attention of tourists. According to Pine and Gilmore (1999), themes should be created according to five basic principles.

- A new spatial reality that is far from the reality of daily life should be created.
- Intensive usage areas should provide users with different time, place and subject experiences.
- Time, space and subjects should be designed in a consistent integrity within the themes created.
- In order to increase the effectiveness of the theme, more than one place should be created in a place.
- The business approach should be in line with the theme.

These spaces, which are incompatible with their surroundings, also contain contradictions within themselves. Themed hotels are consumption places where concepts such as history, time and locality are quickly spent (Akkaya & Usman, 2011). While the spaces in themed hotels serve consumption, they are also consumed visually. In addition to being consumed visually, places are also consumed literally. What users initially find meaningful in the space

(history, environment, etc.) loses its meaning over time and is consumed (Urry, 1999).

The space, which is complex in themed hotels, lacks the concept of time. The place is hardly perceived by the users. The venues are not arranged according to the needs, but according to the visual games that will affect the users. This visual game state created in themed hotels is expressed and can be easily read when viewed from afar (Eco, 1991).

5. EXAMPLES OF HOTELS CREATED BY IMITATION OF HISTORIC BUILDINGS: TOPKAPI PALACE HOTEL

Within the scope of the study, Topkapı Palace Hotel, which is an imitation of Ottoman Architecture in Antalya, is discussed. As a result of the interest attracted by Topkapı Palace Hotel, which was opened for the first time in 1999, two hotels with a similar concept were built on the same coastline. (Figure 1). It has reproduced architectural spaces and forms as faithfully as possible and made them suitable for use by tourists. This building was chosen as an example in the study because of its obvious similarities to the typical themed hotel logic and historical buildings.

Figure 1: Location of Topkapi Palace Hotel and other themed hotels

Topkapi Palace Hotel was built by MNG Holding in 1999 in Antalya. It was designed by imitating the Topkapi Palace, which belongs to the Ottoman Empire period and is very important in terms of historical tourism today. It is also the first theme hotel in Turkey.

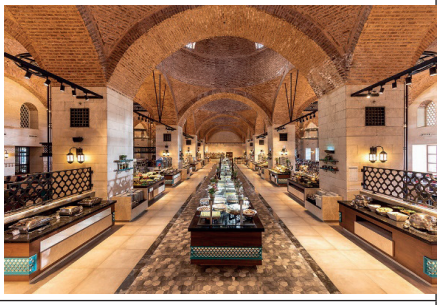
The general appearance of the hotel is an imitation of the palace. The façades, motifs, reinforcements, colors and shapes constantly refer to the Topkapı palace images. Although there are differences in the details, the general appearance gives the user the illusion of being in Topkapı Palace. Many of the hotel's venues are replicas of the palace's venues (Figure 2). In addition, business elements such as the clothes of the employees, the food menu, the names of the rooms also refer to Topkapı Palace.

Figure 2: Topkapi Palace Hotel General View

The entrance door of Topkapı Palace Hotel is the same as the 2nd entrance door (Babü's Selam) of Topkapı Palace. This door is currently the most used and known by tourists. It represents the first acceptance in both venues. The 3rd courtyard gate of the palace (Babü's Sade) is the same as the lobby entrance gate. This door provides the entrance to the submission room in the palace. In the hotel, this door provides access to the lobby. Both doors represent similar functions such as welcome, accept and meet. In this respect, the imitations made here are seen in functional similarity as well as form.

Architectural spaces have been imitated as well as architectural elements. For example; The main kitchen of the Topkapi palace was imitated. This place, which serves as the 'Hünkar Restaurant' in the hotel, has been compared to the architectural features and decoration of the original building. The 3rd Ahmet fountain, which belongs to Topkapı Palace, has been reproduced by imitating it as the "Lalezar Bar" in the hotel. In this fountain, sherbet was distributed to the soldiers after the war to celebrate the victory. A similar function, the act of drinking, has also been imitated. In both examples, functions as well as place are imitated.

The Hagia Irene Church, located in the 1st courtyard of the Topkapı Palace, was reproduced by imitating it exactly. Its function in the hotel is a bar and a disco. Similarly; The 'Justice Tower', built for the security of the palace, was imitated exactly in the hotel. The function of this place in the hotel is the observation tower and the wine house. The places of worship and security in the palace have been transformed into eating and drinking places in the hotel. As can be seen in the examples of these two spaces, the architectural spaces are imitated exactly, but the functions are completely different (Table 1).

ORIGINAL BUILDING	IMITATE BUILDING
	
Babü's Selam	Hotel entrance
	
Babü's Sade	Lobby Entrance
	
Palace Cuisine	Hunkar Restaurant
	
3. Ahmet Fountain	Lalezar Bar

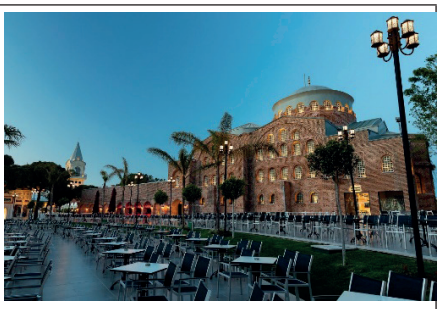
	
Hagia Irene Church	Dome Bar&Disco
	
The Justice Tower	Cruising Bar

Table 1: Topkapi Palace and Topkapi Palace Hotel- imitated and reproduced spaces

While imitating the places between the hotel and the palace, connections are established through function. However, spaces have been designed with functions that did not exist in the past and are needed today. While designing these spaces, it was seen that the imitation method was used with decoration and name similarity. For example, the equipment, colors and motifs used in meeting and ball rooms remind the general texture of the palace. Apart from this, an architectural style that serves the function, independent of the palace architecture, is seen in today's hotel services such as hotel rooms, entertainment venues, children's clubs (Figure 3,4).

Figure 3: Topkapi Palace Hotel rooms

Figure 4: Topkapi Palace Hotel children's activity areas

6. CONCLUSION AND EVALUATION

The effects of modernism and the mass production approach it brought with it also showed its effect in architecture. The fact that the spaces produced by mass production did not attract the attention of the users and the desire of the architects to produce a new space led to some searches. However, here, many architects preferred to interpret the old through imitation and simulation instead of producing something new. It has tried to attract the attention of the user in an easy way by using iconic designs and different themes. The

desire of postmodernism to reinterpret the old has also supported this mode of production. With globalization, such structures have begun to be seen all over the world. Spaces, where the place and function lose their importance, have become preferable. A hotel can offer its user the illusion of living in a palace in the 15th century. All this approach of timelessness and spacelessness has transformed today's spaces into places that are non-place. This new world created is real but far from the truth, it is a fictional world. The reason behind the user's preference for this placeless/fictional place is his curiosity and longing for the past. The user, who sees the familiar images (which are the most historical ones) in his memory, prefers such places with the instinct of nostalgia. These spaces are spaces that are reproduced by imitating historical structures.

This design method is encountered in many different building typologies. Public buildings, shopping malls, residences, parks can be reproduced based on a historical theme/structure. Tourism structures are also the most common typology. The post-tourist's desire to experience and escape from reality encourages the architect to produce themed hotels in hotel design. Historical buildings are transformed into tourism commodities and marketed.

Topkapı Palace Hotel, which was examined within the scope of the study, is a themed hotel produced with this understanding. It offers its users the illusion of living in a palace during the Ottoman period. While doing this, he copied the architectural space and elements. Some spaces and elements are imitated while functions are imitated. However, many imitations remained only formal and lost their functional meaning. The similarity between the functions remained superficial and the depth of meaning could not be established. The forms and functions of the past have been tried to be adapted to the needs of the present. However, this did not provide adaptation, and the relationship of the building with its location disappeared. It is not only related to the place but also to the period in which it is located. Themed hotels have thus turned into places that are out of place and timeless. This typology, which could not exist neither in the past nor today, cannot produce a context and does not contribute to the practice of architectural production, but on the contrary harms it.

REFERENCES

Akkaya, D. H., & Usman, E. E. (2012). Temalı otel: Yok-mekanla var edilmeye çalışılan 'kurgu mekan'. *Tasarım+ Kuram*, *7*(11), 67-80.

Baudrillard, J., & Adanır, O. (1998). *Simülakrlar ve simülasyon*. Ankara, Turkey: Dokuz Eylül Yayınları.

Dağ, A. (2011). Ölümcül şiddet: Baudrillard'ın düşüncesi. *İstanbul: Külliyat Yayınları*.

Eco, U., & Atakay, K. (2012). *Günlük yaşamdan sanata*. Can Yayınları.

Featherstone, M. (1996). Postmodernizm ve Tüketim Kültürü. İstanbul: Ayrıntı Yayınları.

Güzer, A. (2007). Mimarlıkta gerçekle taklidin sınırları. *DOSYA: Gerçek ile Taklit Arasında Mimarlık", Mimarlık Dergisi*, (333).

Gottdiener, M. (1997). Theming of America: dreams, visions, and commercial spaces, Boulder.

Harvey, D. (2017). Postmodernliğin Durumu. İstanbul: Metis Yayınları. 7.Basım,

Lippold, G. (1923). Kopien und Umbildungen griechischer Statuen. *Journal of Hellenic Studies*, *43*.

Pine, B. J., & Gilmore, J. H. (1999). İş Hayatı Bir Tiyatro ve de Her Şirket Bir Sahne. *Harvard Business School Press, Çeviren: Levent Cinemre, Boyner Holding Yayınları, İstanbul*.

Ritzer, G., & Kaya, Ş. S. (2011). *Büyüsü bozulmuş dünyayı büyülemek: tüketim araçlarının devrimcileştirilmesi*. Ayrıntı Yayınları.

Süer, D., & Sayar, Y. Y. (2002). Küresel sermayenin yeni tüketim mekânları lüks konut siteleri. *Mimarlık ve Tüketim, İstanbul: Boyut Yayın Grubu*.

TDK (2017,Haziran 20)

http://www.tdk.gov.tr/index.php?option=com_bts&arama=kelime&guid=TDK.GTS.5a704a7f5d3ec3.83832102

Urry, J. (1999). Mekânları tüketmek (RG Öğdül, çev.). *İstanbul: Ayrıntı Yayınları*.

Venturi, R. (1966). Complexity and contradiction in architecture. New York: Museum of Modern Art. *Garden City, NY*.

Chapter 3

EVOLVING SPACES: 18-YEAR POST-OCCUPANCY EVALUATION OF A KINDERGARTEN IN İZMİR

Erdem Yıldırım[1]

1 Dr. Öğr. Üyesi Erdem Yıldırım, Dokuz Eylül Üniversitesi, Mimarlık Fakültesi, Mimarlık Bölümü, ORCID: 0000-0002-8829-5274

INTRODUCTION

The architectural design of educational spaces is a complex activity that has attracted a growing amount of scholarly and professional interest. This complexity is a result of the need to integrate a variety of factors, including pedagogical theories, psychological considerations, and environmental sustainability. In recent years, the design of kindergartens has emerged as a focal point of this interdisciplinary dialogue, given the critical role these early educational environments play in shaping cognitive and behavioral patterns in children (Mei & Luen, 2023).

The "Gelişim Koleji Çocukevi", a kindergarten located within the industrial zone of İzmir, Turkey, exemplifies this integrated approach (Figure 1). Designed by Arno Mimarlk (an architecture office) in 2005, this facility has been serving as the kindergarten of the area's working population for over 18 years. This kindergarten's design is noteworthy for its integration of innovative architectural solutions, pedagogical principles, and client-specific needs. It is a compelling illustration of how thoughtful design can have a lasting impact on educational outcomes and well-being as a whole.

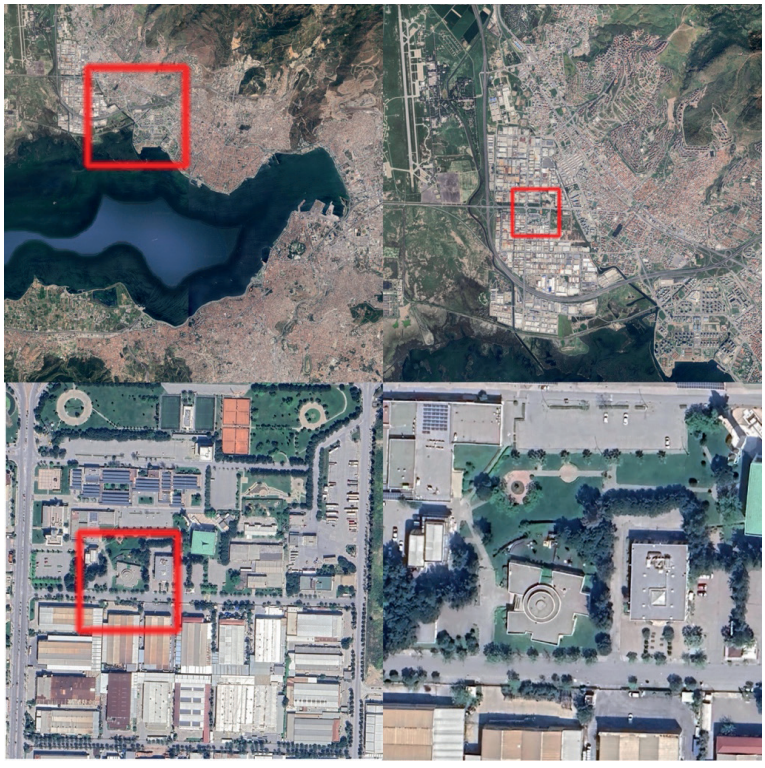


Figure 1. The site in İzmir Atatürk Organized Indusrial Zone (Yandex Maps)

Moreover, the kindergarten's design process involved not only aesthetic creativity but also the strategic application of modern technological tools. Archicad, a Building Information Management (BIM) program, was used to facilitate the project's planning, revision, and execution phases. This technological integration illustrates the changing nature of architectural practice, in which digital tools are becoming increasingly necessary to achieve design precision and operational efficiency (Hardin & McCool, 2015).

The purpose of this chapter is to provide a thorough analysis of the İzmir Atatürk Organized Industrial Zone Kindergarten. Through an in-depth review of its architectural strategies, design philosophies, and technological integrations, this chapter aims to contribute to the expanding body of literature on the architectural design of educational settings for young children.

In addition, this work examines the adaptations and modifications made over the years, supported by the facility's long-serving director's comments. The purpose of this study is to contribute to the expanding body of knowledge regarding the significance of post-occupancy evaluations in educational architecture, specifically in the context of kindergartens. In doing so, it hopes to provide valuable insights and lessons that could inform future projects in this domain, thereby enriching the ongoing discourse on architecture's role in educational environments.

CLIENT REQUIREMENTS AND DESIGN PROPOSALS

The site was formerly occupied by a government (SSK) dispensary, which was demolished to make room for the kindergarten (Figure 2). The management of the İzmir Atatürk Organized Industrial Zone made the decision to replace the dispensary with an educational facility. Both architecturally insignificant and abandoned, the dispensary was deemed unworthy of preservation. Its replacement with a kindergarten represents a strategic decision to better meet the needs of the community, especially the children of industrial zone employees.

Figure 2. The Previous Government Dispancer at he Site (Arno Mimarlık's archieve)

The kindergarten specifications for the İzmir Atatürk Organized Industrial Zone were desired an 800 m^2 single-story structure with a 650 m^2 private garden, enclosed gathering or activity space, and shared classroom service

areas. These requirements reflect a larger trend in educational architecture, where the emphasis is shifting toward the creation of multifunctional spaces that accommodate the diverse needs of young students (Baran, Yılmaz, & Yıldırım, 2007).

In the realm of architectural design for kindergartens, there are several critical considerations that must be taken into account to ensure an environment conducive to both learning and well-being.As fundamental components of early childhood development, the physical environment should be designed to encourage movement and exploration. Open floor plans with clearly delineated zones for various activities can encourage children to engage in a variety of activities while making supervision easier for educators.

Secondly, it is essential to incorporate natural elements. Exposure to nature has been shown to have a positive effect on the cognitive and emotional development of children. Therefore, the design should incorporate outdoor spaces, such as gardens or playgrounds, and incorporate natural light and materials into the interior spaces. Safety is also of paramount importance. All materials used must be non-toxic, and any potential hazards, such as sharp edges or tripping hazards, must be eliminated from the design. In order to ensure the safety and comfort of young children, the height and scale of all fixtures and furniture should also be suitable. Fourthly, the design should be adaptable to a variety of activities and requirements. The space can be easily reconfigured with the help of modular furniture and movable walls, allowing for a variety of teaching methods and learning experiences. Fifthly, consideration should be given to sensory stimulation. The use of color, texture, and acoustic elements can significantly influence the disposition and concentration of children. However, it is essential to strike a balance to avoid counterproductive overstimulation. Finally, cultural and community context must not be ignored. The design should reflect the cultural values and practices of the community it serves, and stakeholders, such as parents and educators, should ideally be involved in the decision-making process (Olds, 2001).

In the initial briefing provided to Arno Mimarlık, it was specified that each classroom should have a flexible layout, permitting the space to be reconfigured for dining, sleeping, and play. As we will see in the following sections of this study, this adaptive model was not fully implemented in practice. In contrast to the original vision of a flexible, multi-use environment, functional spatial separations were implemented.

First Proposal: Linear Arrangement

The initial proposal presented by Arno Mimarlık featured a linear spatial configuration (Figure 3). All functional units, such as classrooms and offices, were aligned along a single axis. This design aimed to provide children and staff with an intuitive navigational experience.

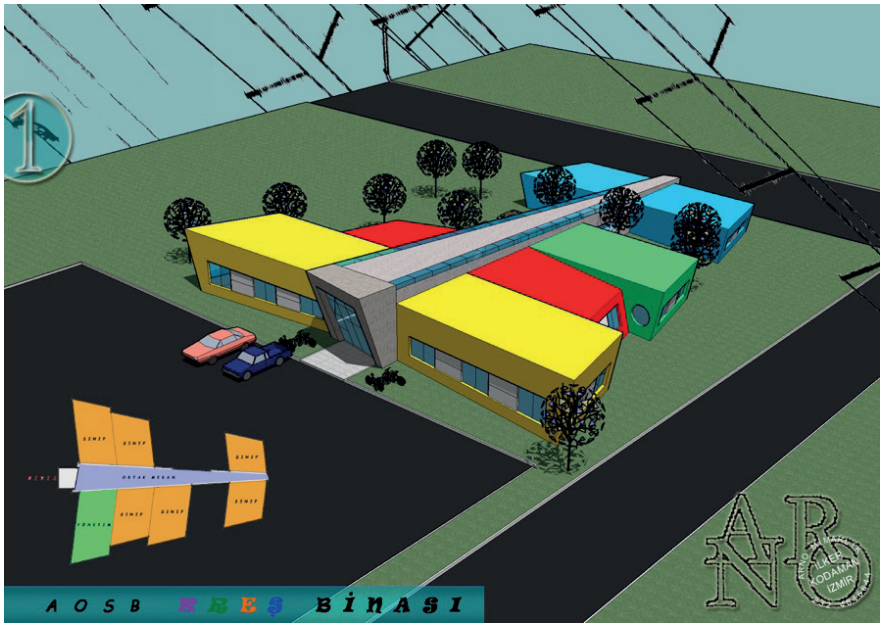


Figure 3. Proposal 1 - Linear Arrangement (Arno Mimarlık's archieve)

Second proposal: Curved layout.

The second proposal also took a linear approach, but curved on the central axis (Figure 4). The purpose of this curvature was to add dynamism to the spatial experience. The functional units were interspersed with service areas that provided easy access to shared facilities.

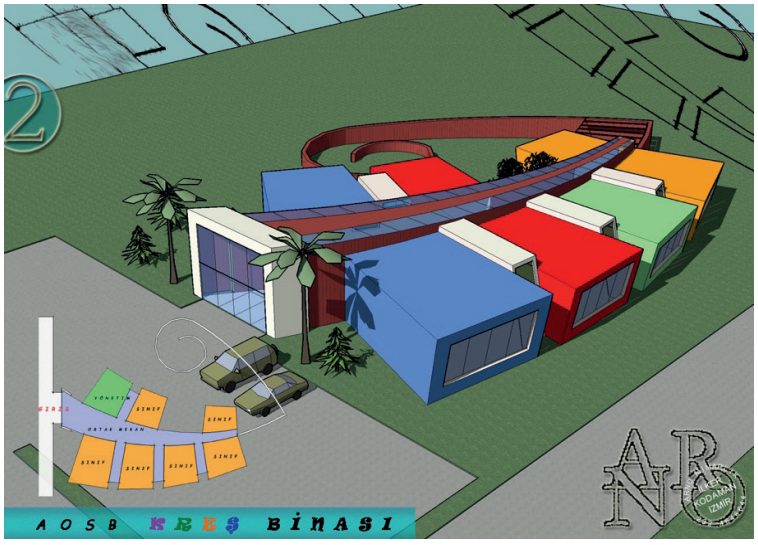


Figure 4. Proposal 2 - Curved layout (Arno Mimarlık's archieve)

Third Proposal: Orthogonal Grid with a Asymmetrical Central Unit

The third proposal departed from the linearity of the first two by employing an orthogonal grid layout (Figure 5). The design was anchored by a circular unit at its center, around which other spaces were organized. Some grid cells were left intentionally empty to accommodate green spaces, with the intention of integrating the structure with its natural surroundings.

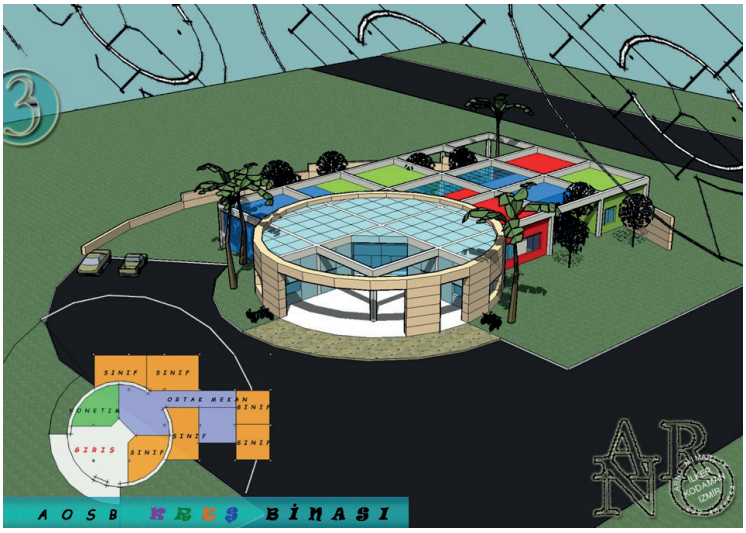


Figure 5. Proposal 3 - Orthogonal grid with a off center (Arno Mimarlık's archieve)

Fourth Proposal: Centralized Layout

The fourth proposal featured a centralized design with a central gathering area (Figure 6). This central area allowed for a more controlled and hierarchical arrangement of functions, as administrative and classroom spaces were organized around it.

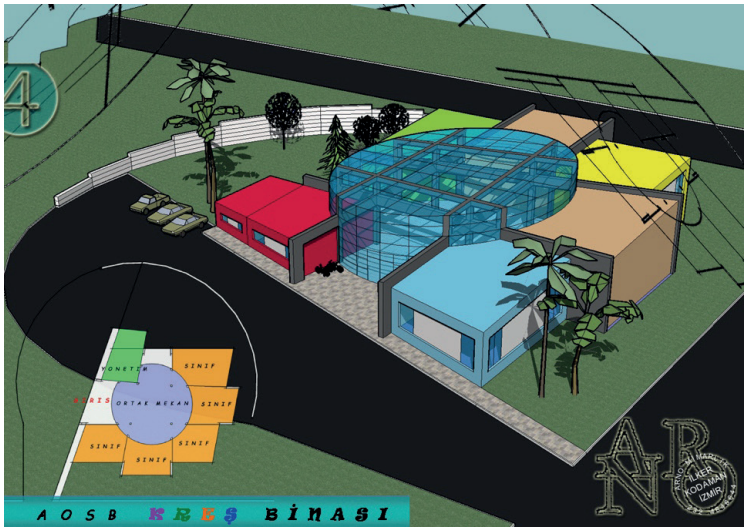


Figure 6. Proposal 4 - Centralized Layout (Arno Mimarlık's archieve)

Fifth Proposal: Segregated Axis Configuration

The fifth and final proposal returned to a linear concept but incorporated a dual-axis configuration (Figure 7). The administrative and common areas were arranged along one axis, while the classrooms were arranged along a parallel axis. This design sought to separate distinct functions while maintaining a straightforward, linear layout.

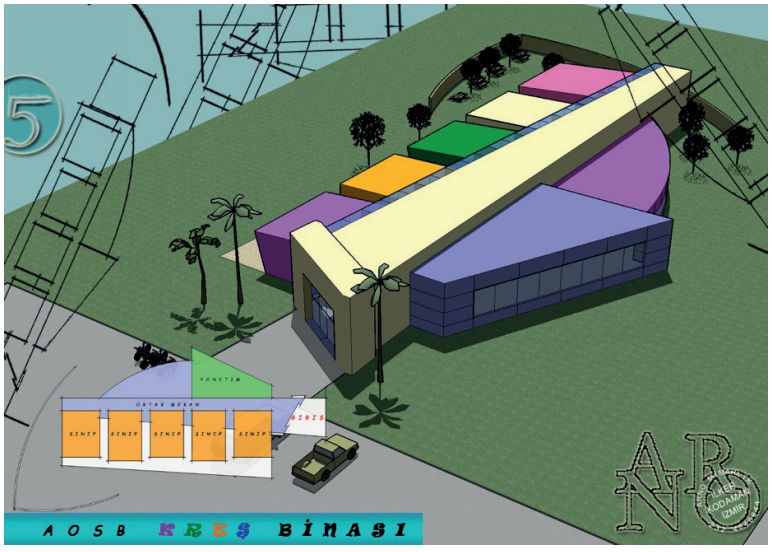


Figure 7. Proposal 5 - Segregated axis configuration (Arno Mimarlık's archieve)

Each of the five proposals presented a distinct spatial organization, functional efficiency strategy and aesthetic expression compared to its design date. The variety of these designs demonstrates the architectural firm's dedication to providing a customized solution that meets the client's specifications and provides a stimulating environment for the kindergarten's young occupants.

The selection of the final design was influenced by a number of factors, including, but not limited to, the need for dynamic spatial experiences, ease of navigation, and the incorporation of natural elements, which are increasingly recognized as essential components in the design of educational spaces for young children (Abusafieh, Muwahid, Muwahid, & Alhawatmah, 2022; Ebrahim, Eltantawy Elmadawy, & Elbadrawy, 2023).

SELECTED DESIGN AND ARCHITECTURAL FEATURES

Due to its effective zoning and functional layout, the fourth proposal was selected following a thorough evaluation. Other functional units were organized around a central gathering space that served as the kindergarten's nucleus in this design. Contemporary architectural theories emphasize the importance of creating focal points in educational settings to facilitate community building and social interaction (Dudek, 2007). This centralization of main activity space is consistent with recent researches (Astaresh, FakhİmzadeFakhİmzade, & Rezaee, 2015; Dudek, 2005; Yanılmaz, Sönmez, & Ertaş Belir, 2019).

The administrative section was separated from the classrooms and activity areas, in accordance with the growing awareness of the need for hierarchical and controlled spatial arrangements in educational facilities (Chen, 2020). This separation makes administrative operations more efficient while minimizing disruptions to the educational environment (Figure 8).

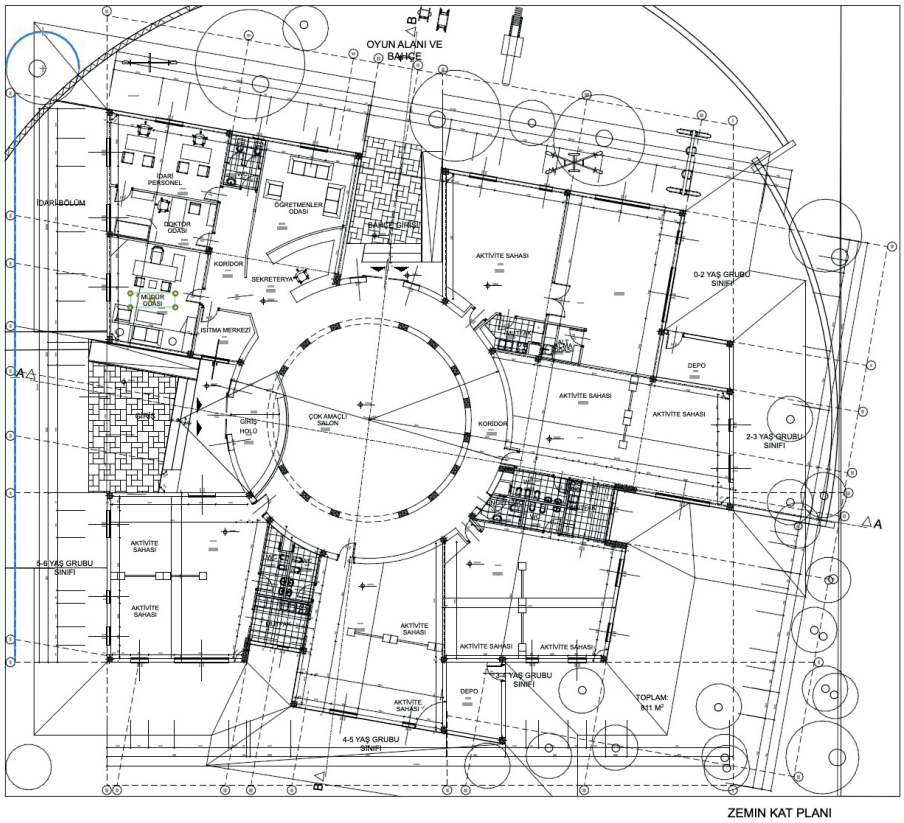


Figure 8. Selected design's floor plan (Arno Mimarlık's archieve)

This design's reconsideration of the use of the windows in the spaces is one of its distinctive features. This aspect was modified due to the climate of İzmir, highlighting the significance of adapting architectural designs to local environmental conditions. Structures that take into account climatic conditions and implement climate-appropriate solutions use energy efficiently and effectively. By making informed design decisions, it is possible to reduce the overall energy consumption of buildings and ensure their efficient energy use.

The kindergarten's considerate approach to natural lighting is one of its distinguishing features. In addition to strategically placed circular windows along the perimeter of the central gathering area, a skylight is positioned directly above it. The skylight faces south at an optimal angle for sunlight capture. Furthermore, the size of the skylight was delicately calibrated to prevent excessive heat accumulation during the scorching Izmir summers (Figure 9). This design decision is consistent with current research on energy-efficient buildings in Mediterranean climates, which frequently incorporates

smaller skylights to strike a balance between natural light and thermal comfort (Küçük & Sümengen, 2022; Aşıkoğlu, 2023).

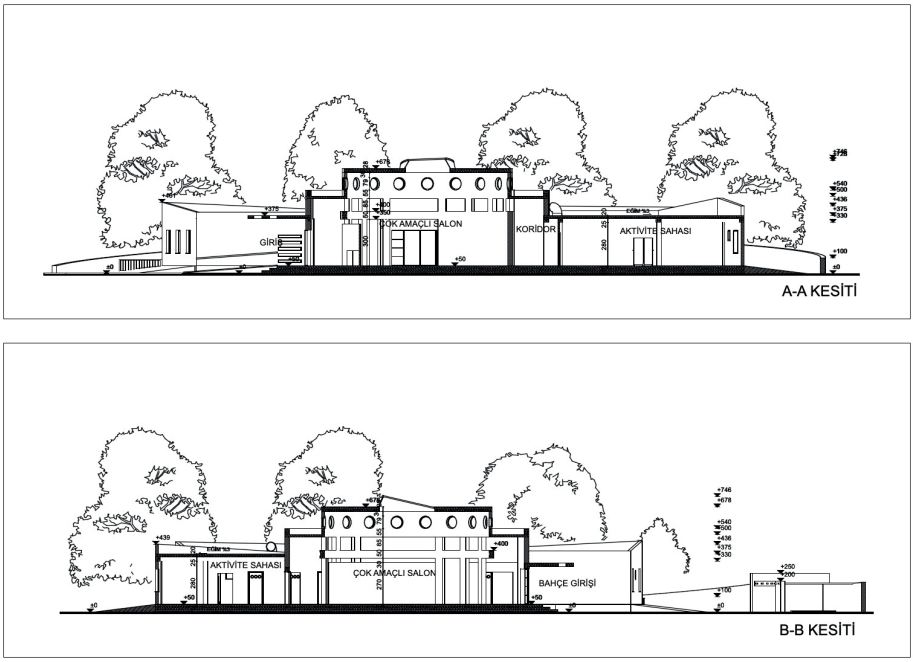


Figure 9. Sections (Arno Mimarlık's archieve)

The design also incorporated sloping ceilings in the classrooms with the intention of enhancing the spatial dynamism and thereby enhancing the children's perceptual experience (Figure 10, 11). This architectural element can be viewed as an innovative strategy to combat monotonous conditions commonly associated with educational spaces, thus contributing to a more stimulating learning environment (Cao, Mária Tamás, & Sztranyák, 2021).

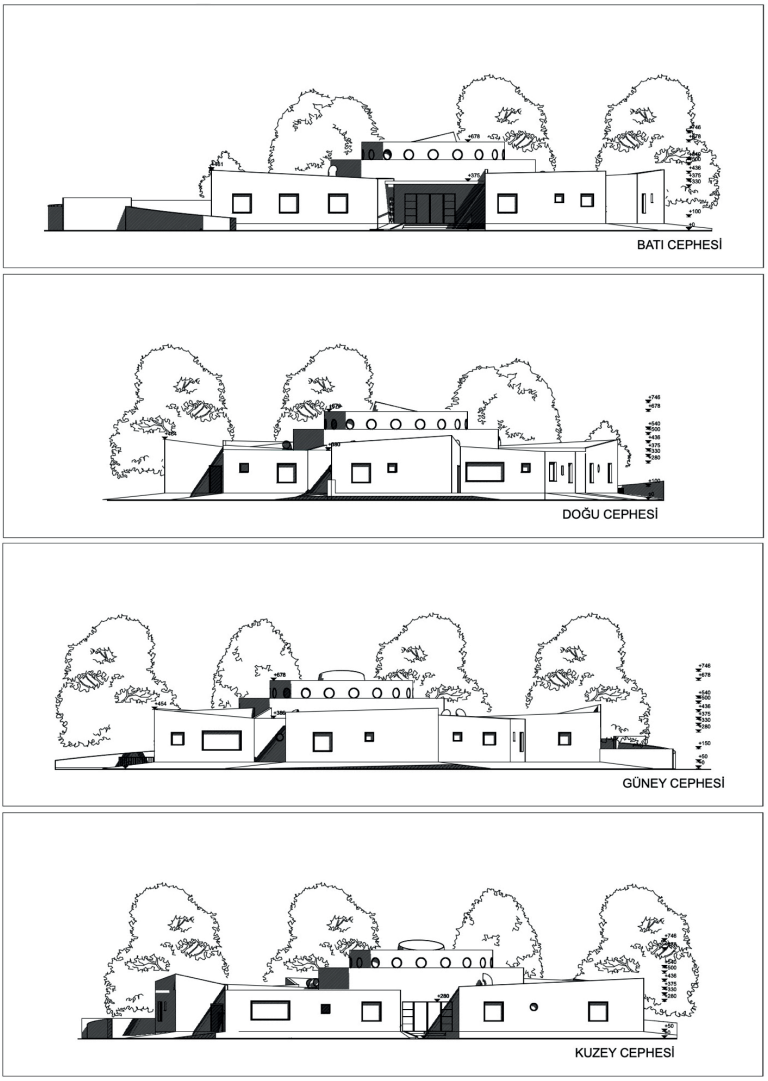


Figure 10. Elevetions (Arno Mimarlık's archieve)

Figure 11. General view of the masses (author's archieve)

In order to restrict unsupervised access to the children's areas, controlled entry points were also a noteworthy feature. This security measure reflects a broader trend in educational architecture that prioritizes the safety of the occupants.

While the central gathering space and the skylight serve as the architectural highlights of the kindergarten, they also posed the most significant challenges during the construction phase. A review of the construction photographs reveals that the craftsmanship and materials used were not of the highest quality (Figure 12). This observation raises questions about the trade-offs between design ambition and construction feasibility, a tension that is often present in architectural projects (Gallanti, 2006). Despite these challenges, the completed structure has stood the test of time, serving as an educational facility for 18 years, which speaks to the resilience of the design.

Figure 12. Construction phase (Arno Mimarlık's archieve)

Accessibility was also a major design consideration. Both the main entrance and the garden exit are equipped with ramps to ensure that the facility is accessible to people with disabilities (Figure 13). This is in accordance with global architectural standards that advocate for universal design principles in public buildings, including educational facilities (Zhang & Lu, 2016).

Figure 13. Main entrance (author's archieve)

In conclusion, the selected design successfully integrates a variety of architectural strategies and features that not only meet the client's explicit requirements, but also conform to contemporary theories and practices in educational architecture (Vahideh, Akram, & Tahereh, 2021).

TECHNOLOGICAL INTEGRATION

The incorporation of technology into the design of the İzmir Atatürk Organized Industrial Zone Kindergarten was crucial, particularly during the phases of design and construction. The use of Building Information Management (BIM) software, specifically Archicad, was instrumental in streamlining the design process, facilitating revisions, and enhancing the evolutionary stages of the design. Alfieri's team cite a growing body of research that highlights the importance of BIM in improving the efficiency and effectiveness of architectural design processes, particularly in educational settings (Alfieri, Seghezzi, Sauchelli, Di Giuda, & Masera, 2020).

In addition, the kindergarten is equipped with advanced security systems, such as biometric access controls and CCTV surveillance, to ensure the safety and wellbeing of the children. This technological integration is consistent with current trends in educational architecture that prioritize occupant safety (Zeki, Elnour, Ibrahim, Haruna, & Abdulkareem, 2013).

In conclusion, the technological integration in the design and operation of the İzmir Atatürk Organized Industrial Zone Kindergarten is not a supplementary feature, but a fundamental aspect that aligns with contemporary educational architecture and technology practices and research.

LONG-TERM FEEDBACK AND USER EXPERIENCE

The İzmir Atatürk Organized Industrial Zone Kindergarten, managed by Gelişim Koleji Çocukevi, has been in operation for 18 years, providing a valuable longitudinal perspective on the design and functionality of the building (Figure 14). An extensive interview with the kindergarten's director, Nilüfer Eren Demir revealed several key insights that contribute to our understanding of the relationship between architectural design, educational pedagogy, and children's well-being (personal communication, September, 2023).

Figure 14. Main Facade of the building (author's archieve)

The building's purpose-built nature as a kindergarten is one of its most significant advantages. This is a significant benefit, especially in a context where many educational facilities for young children are retrofitted spaces in apartment buildings or detached houses in Türkiye. The safety implications of the single-story design are particularly noteworthy, as they effectively eliminate the risk of falls from heights, a concern that is frequently overlooked in the design of educational spaces for children. However, the building also features a three-step staircase at the entrance to the garden, providing a balanced approach to the motor development of children. This feature aligns well with the larger discourse on the significance of physical spaces in children's educational experiences, where the design of the environment can have a significant impact on various aspects of child development, such as motor skills (Yüksel, 2012).

The central common area has proven to be an adaptable space, particularly during the winter months. This is consistent with the general consensus

that flexible, multipurpose spaces can enhance the educational experience. Additionally, the sound insulation provided by the walls around this common area has become increasingly valuable, this way, doors could be remain opened all the time, and this feature is so important, particularly in a country prone to seismic activity. This characteristic emphasizes the significance of considering long-term functionality and adaptability in design, particularly in regions with unique environmental challenges.

Figure 15. Main enclosed activity space (author's archieve)

However, there have been some difficulties, the majority of which are due to implementation rather than design. These include the skylight leaking during heavy rains and the initial inadequacy of the heating system, both of which have since been resolved (Figure 15). These obstacles made by contractor highlight the significance of post-occupancy evaluations to identify and address issues that may not have been apparent during the design phase but arise during the lifecycle of the building.

The building has successfully served its intended purpose for nearly two decades, a testament to the efficacy of its design principles. Although there have been a few operational difficulties, they have been largely resolvable and do not compromise the building's overall functionality and contribution to educational pedagogy (Figure 16).

Figure 16. A classroom view (author's archieve)

In a conversation with the kindergarten director, who has worked at the facility since the very beginning of the facility, the availability of restrooms was also discussed. The director emphasized the significance of having adequate restrooms in the kindergarten environment. Despite the apparent simplicity of this requirement, it is frequently overlooked in the design of educational spaces for young children. The director's observation is consistent with general pedagogical principles that emphasize the importance of creating environments that meet children's basic needs, allowing them to concentrate on learning and development.

ADAPTATIONS AND MODIFICATIONS: LEARNING FROM LONG-TERM USE

The iterative process of architectural design frequently necessitates post-implementation modifications, especially in educational settings where user needs can change over time. In its 18-year history, the kindergarten building under discussion has undergone several modifications intended to better align the facility with pedagogical requirements and user feedback.

Initially, each classroom had its own dining area, with a shared kitchen serving every two classrooms. This arrangement was based on the notion that localized dining would provide the children with a more intimate and manageable environment. However, in practice, centralizing this function

into a single dining hall has proven to be more efficient and practical (Figure 17). According to Mei and Luen's (2023) research, centralized facilities can promote social interaction and facilitate management in educational settings.

Figure 17. Dining space (author's archieve)

Diverse types of temporary and permanent separators have been installed within classrooms to create more regulated and flexible spaces. Different textures and materials are used to create these separators, which serve both practical and aesthetic purposes (Figure 18). Studies emphasize the importance of flexible spaces in children's learning environments, allowing for a variety of activities and pedagogical approaches (Omopariola, Abdullahi, Enihe, & Ogbonna, 2023).

Figure 18. Separators (author's archieve)

The installation of a child-sized bathtub in the kindergarten's medical care area is a noteworthy post-occupancy modification (Figure 19). This modification has proven especially useful for providing immediate care for children who may become ill during the day. Although this element was not part of the original design, its inclusion highlights the significance of adaptability and flexibility in educational architecture. The ability to make such adjustments based on actual needs and experiences demonstrates the importance of post-occupancy evaluations and user feedback in refining and optimizing the design of educational spaces.

Figure 19. Bathtub for infants (author's archieve)

These modifications highlight the significance of post-occupancy assessments in educational architecture. They provide valuable insights into how well the initial design met its objectives and where improvements can be made, either to the same structure or to future projects.

CONCLUSION

The kindergarten's post-occupancy evaluation reveals a nuanced understanding of how architectural design decisions manifest in the daily lives of the building's occupants. The one-story design, which was initially intended to reduce the risk of falls, has been praised for its safety features. However, the presence of a few steps at the entrance to the garden (Figure 20) provides a controlled environment for children to develop stair-climbing skills, in accordance with research that highlights the importance of motor function development in children through interaction with architectural elements (Campbell & Evergreen, 2013). The sound isolation provided by the walls surrounding the central common area has proven to be particularly advantageous, especially in the context of keeping classroom doors open during seismic activities as a safety precaution. This is consistent with the larger discussion regarding the significance of acoustic design in educational settings.

Figure 20. A view from garden (author's archieve)

Nonetheless, the post-occupancy evaluation revealed a number of improvement opportunities, the majority of which were attributed to implementation errors rather than design flaws. There were issues such as water leakage from the skylight during heavy rains and inadequate heating elements initially. These findings highlight the significance of post-occupancy evaluations in architectural programming, particularly for contractor choosing (Dundar, 2016).

The 18 years of successful operation confirm to the kindergarten's success in meeting its goals. The post-occupancy feedback provides valuable insights into the building's performance, validating the necessity of user-centric design and iterative evaluation to ensure the building continues to meet its functional and safety objectives (Erten Bilgic & Surur, 2016). The integration of technology, such as BIM software, has proven to be invaluable during the design and revision phases, reflecting broader industry trends (Tripathi, Froese, & Mallory-Hill, 2023). While the building has some areas for improvement, these are primarily the result of implementation problems, highlighting the need for rigorous post-occupancy evaluations to guide future educational architecture projects.

REFERENCES

Abusafieh, S., Muwahid, N., Muwahid, R., & Alhawatmah, L. (2022). The Effectiveness of Kindergarten Buildings in Jordan: Shaping the Future toward Child-Friendly Architecture. *Eurasia Proceedings of Science, Technology, Engineering and Mathematics*, *17*, 161–174. https://doi.org/10.55549/epstem.1176080

Alfieri, E., Seghezzi, E., Sauchelli, M., Di Giuda, G. M., & Masera, G. (2020). A BIM-based approach for DfMA in building construction: framework and first results on an Italian case study. *Architectural Engineering and Design Management*, *16*(4), 247–269. https://doi.org/10.1080/17452007.2020.1726725

Aşıkoğlu, A. (2023). Akdeniz İklim Bölgesinde Yer Alan Ülkelerin NZEB Süreci ve Uygulamalar. In G. Çetinkale Demirkan & S. Güngör (Eds.), *Mimarlık & Planlama & Tasarımda Güncel Araştırmalar* (1–19). Ankara: Gece Kitaplığı.

Astaresh, M., FakhİmzadeH., & Rezaee, E. D. (2015). The Analysis of Kindergarten Architectural Ideas with a Focus on Play Element. *Cumhuriyet University Faculty of Science*, *36*(4), 23–33.

Baran, M., Yılmaz, A., & Yıldırım, M. (2007). Okul Öncesi Eğitimin Önemi ve Okul Öncesi Eğitim Yaplarındaki Kullanıcı Gereksinimleri: Diyarbakır Huzurevleri Anaokulu Örneği. *D.Ü.Ziya Gökalp Eğitim Fakültesi Dergisi*, *8*, 27–44.

Campbell, H., & Evergreen. (2013). *Landscape and Child Development* (2nd Editio; C. Collyer, Ed.). Toronto: Evergreen.

Cao, H., Mária Tamás, A., & Sztranyák, G. (2021). Application of environmental psychology in kindergarten architectural design. *Pollack Periodica*, *16*(3), 169–174. https://doi.org/10.1556/606.2021.00334

Chen, X. (2020). Practice and Thinking on the Architectural Design of Kindergartens in Jingkai District of Nanchang. *IOP Conference Series: Earth and Environmental Science*, *560*(1). https://doi.org/10.1088/1755-1315/560/1/012009

Dudek, M. (2005). *Children's Spaces*. Oxford: Architectural Press.

Dudek, M. (2007). *Schools and Kindergartens - A Design Manual* (R. Stein, Ed.). Berlin: Birkhauser.

Dundar, M. (2016). Post-Occupancy Evaluations in Architectural Programming Process : a Case Study of. *Archi-Cultural Interactions through the Silk Road 4th International Conference, Mukogawa Women's University*, 138–141. Nishinomiya.

Ebrahim, E. A., Eltantawy Elmadawy, A., & Elbadrawy, A. N. E. (2023). The Impact of the Architectural Design of Kindergarten Buildings on the Formation of the Identity of the Child. *Mansoura Engineering Journal*, *48*(1). https://doi.org/10.58491/2735-4202.3034

Erten Bilgic, D., & Surur, A. S. (2016). Okul Öncesi Eğitim Kurumlarında Uygulanan Eğitim Sistemlerinin Mekân Biçimlenişine Etkisi ve Reggio Emilia Eğitim Sisteminin Mekân Tasarımı Üzerine Denemeler. *Megaron*, *11*(1), 162–176. https://doi.org/10.5505/megaron.2016.03016

Gallanti, F. (2006). Architectural product. *Arq*, *20*(62), 20–22.

Hardin, B., & McCool, D. (2015). *BIM and Construction Management* (2nd ed.). Indiana: Sybex.

Küçük, A. A., & Sümengen, Ö. (2022). Evaluation of the Lighting Energy Performance of Educational Buildings with BEP-TR Methodology: The Case of ERU Faculty of Architecture. *Iconarp International J. of Architecture and Planning*, *10*(2), 482–502. https://doi.org/10.15320/iconarp.2022.212

Mei, S. D., & Luen, L. C. (2023). Effect of Kindergarten Environment Creation Quality on Children Health, Language, Social, Science and Art. *International Journal of Academic Research in Progressive Education and Development*, *12*(2), 187–219. https://doi.org/10.6007/ijarped/v12-i2/16714

Olds, A. R. (2001). *Child Care Design Guide*. Blacklick: McGraw-Hill.

Omopariola, V. A., Abdullahi, M. J., Enihe, R. O., & Ogbonna, C. N. (2023). Design and Implementation of an Edutainment Games Application for Kindergarten Kids. *Open Journal for Information Technology*, *6*(1), 7–32. https://doi.org/10.32591/coas.ojit.0601.02007o

Tripathi, I., Froese, T. M., & Mallory-Hill, S. (2023). Applicability of BIM-IoT-GIS integrated digital twins for post occupancy evaluations. *Frontiers in Built Environment*, *9*(June), 1–20. https://doi.org/10.3389/fbuil.2023.1103743

Vahideh, S., Akram, H., & Tahereh, J. K. J. A. (2021). Child-friendly kindergarten architecture: Perspectives of children in Iran. *Asia-Pacific Journal of Research in Early Childhood Education*, *15*(3), 85–112. https://doi.org/10.17206/apjrece.2021.15.3.85

Yanılmaz, Z., Sönmez, E., & Ertaş Belir, Ş. (2019). Okul Öncesi Eğitim Yapılarında 'Aktivite Alanlarının' Ergonomik Düzenlemeler Doğrultusunda Tasarlanması. *Uluslararası Sosyal Araştırmalar Dergisi*, *12*(65), 522–530.

Yüksel, B. (2012). *Analysis of the Effects of Sustainable Design in Kindergartens* (Master). Yasar University.

Zeki, A. M., Elnour, E. E., Ibrahim, A. A., Haruna, C., & Abdulkareem, S. (2013). Automatic interactive security monitoring system. *International Conference on Research and Innovation in Information Systems, ICRIIS*, *2013*, 215–220. https://doi.org/10.1109/ICRIIS.2013.6716711

Zhang, J., & Lu, S. (2016). *The study on outdoor space type of kindergarten based on the architectural typology with BUA kindergarten as an example*. *63*(Icseee), 614–620. https://doi.org/10.2991/icseee-16.2016.112

Chapter 4

THERMAL INSULATION TECHNOLOGIES IN TERRACE ROOFS: CURRENT RESEARCH

Burcu Buram ÇOLAK [1]

İdil AYÇAM [2]

1 Res. Assist. Burcu Buram ÇOLAK, Zonguldak Bülent Ecevit University, Faculty of Architecture and Design, Department of Architecture, 0000-0001-7932-6422

2 Prof. Dr. İdil AYÇAM, Gazi University, Faculty of Architecture, Department of Architecture, 0000-0001-7170-5436

1. INTRODUCTION

The roof, constituting the topmost layer of structures, provides versatile protection against external factors such as precipitation, wind, temperature variations, solar radiation, frost, snow, hail, and more. Simultaneously, it allows transitions through openings. Therefore, the roof stands as a structurally crucial element that is not only exposed to but also needs protection against damages caused by external elements. Especially in modern architectural perspectives, roofs with minimal slopes and functionality-focused open designs are preferred. Terrace roofs, in this context, are among the favored architectural solutions, particularly in climates with mild temperatures and infrequent precipitation. However, inadequate insulation of heat and moisture in these roofing systems can lead to serious issues if not done accurately (Ekinci & Yıldırım, 2004).

Thermal insulation plays a critical role in enhancing energy efficiency, improving comfort within indoor spaces, and reducing energy costs. Modern building standards, emphasizing high thermal resistance requirements in buildings, highlight the significance of insulation materials in terms of both thermal properties and durability, including mechanical characteristics. These materials, when integrated into building structural elements, should be capable of carrying mechanical loads and exhibit resilience.

The correct selection of insulation materials allows for the establishment of successful roof systems in the long run. Intelligent choices in insulation enhance energy efficiency, reduce environmental impact, and offer building occupants a more comfortable living environment. Conversely, incorrect insulation selections can adversely affect roof performance, leading to energy losses and high energy costs. Proper implementation of thermal insulation and the appropriate material selection are of critical importance in terms of energy efficiency, environmental conservation, and sustainability. Therefore, in the construction sector, the selection and correct application of suitable insulation materials play a vital role in achieving energy savings and environmental sustainability goals.

2. THERMAL INSULATION MATERIALS AND THEIR CHANGE DURING THE HISTORICAL PROCESS

Isolation, or thermal insulation, refers to building materials used to prevent temperature differences between different environments. Standards and regulations have been established for such materials. According to the European Technical Approval Guideline (ETAG) 004, thermal insulation materials are prefabricated products that provide high thermal resistance to the structure they are applied to and transmit insulation properties (ETAG 004, 2013). As per the definition in DIN 4108 standard, for a material to be classified as insulation, its thermal conductivity coefficient (λ) must be less than 0.1 W/mK (Hegger et al., 2006).

The history of insulation materials is not as ancient as some other materials, but the understanding of the necessity for insulation dates back as far as human construction activities. In the past, people built shelters using natural materials to protect themselves and later turned to more durable alternatives. However, people have discovered not only natural materials but also other suitable materials for insulation. During the 19th century, the inception of insulating panels was propelled by the processing of organic substances. This era saw the emergence of diverse alternatives within the realm of synthetic materials, such as rockwool, fiberglass, foam glass, hollow bricks, and expanded perlite. Plastic foams marked a monumental breakthrough, despite plastic production being unveiled in the same century. The advent of plastic foam fabrication transpired in 1941, ushering in a transformative era. In modern times, plastic foams and mineral wools reign as the prevalent choices for insulation materials, with natural materials being manufactured in restricted quantities. Notably, the demand for these products has experienced a substantial surge, attributed to a multitude of factors (Bozsaky, 2010).

The primary goal of advancing technologies and innovations has been to enhance human comfort within buildings. Clearly, a pivotal concern emerged – how to effectively retain heat, leading to the growing importance of thermal insulation in residential constructions (Déry, 2000). Remarkable progress in heating and ventilation systems was observed during the 1880s, necessitating precise calibration. Mechanical engineers grappling with building-related challenges faced a crucial task: calculating heat loss and gain, prompting the inception of initial theories in thermal insulation and building physics (Tomlow, 2007).

Increasing energy demand and the comparatively expensive nature of fossil fuels such as coal and crude oil during the global economic downturn (Long Depression, 1873-1896) compelled thermal power plants to minimize heat losses from steam engines, heating apparatus, chimneys, and the adjacent building structures (Tomlow, 2007).This necessity, along with the rise of light frame construction, catalyzed the integration of thermal insulation materials into industrial architecture.

Towards the conclusion of the 19th century, there was a dramatic and rapid transformation in the methodologies of planning and construction. A range of novel building materials surfaced, including cast-iron, glass structures, concrete, and steel. Structural systems began to be designed based on calculative approaches rather than relying solely on empirical methods (Déry, 2000).

Following the 1950s, a plethora of additional thermal insulation materials made their debut, notably plastic foams. Innovations in this era included the creation of polyester foam (PES) and polyethylene foam (PE) during the 1950s.

Subsequently, phenolic foam (PF) and formaldehyde foam (UF) emerged during the 1970s, while melamine foam (MF) made its entrance in the 1990s (Novák, 2008).

In summarizing the evolution of thermal insulation materials, we can delineate five distinct periods, each marked by a significant milestone in human history, science, or industry. These milestones triggered shifts in the thermal insulation materials market, leading to the introduction of new materials or the obsolescence of older ones (Table 1) (Bozsaky, 2010).

Table 1. The historical progression of thermal insulation materials (Bozsaky, 2010)

Period	**Reasons**	**Changes**	**Insulation materials**
2.5 mill - 7000BC	nomadic lifestyle	materials for clothing	fur, animal skins, wool.
7000BC - 1870AD	settled lifestyle	vegetable fibres and durable materials	earth, reed, bricks, wood, eelgrass, straw.
1870-1950	industrial revolution & heat loss	first natural products	reed, cellulose insulation cork, wood wool and flax plates.
		development of bricklaying elements	hollow bricks, ash-filled bricks, AAC.
		first artificial insulation materials	rock wool, foam glass, fiberglass, dross, asbestos, expanded clay, perlite.
1950 -2000	increase of plastic	spread of artificial materials apperance of plastis foams disappearance of natural materials	polyurethane, polystyrene, , phenolic, polyester, polyethyleneformaldehyde, melamin foam.
2000 -	CO2 emission & fossil fuels & global warming	revival of the natural materials	cellulose insulation, straw bale, cork, sheep wool, wood wool.
		experiments with new materials	swichable thermal insulation, nanocellular insulation, transparent thermal insulation, vacuum insulation panels.

3. THE IMPORTANCE OF DEVELOPING NEW THERMAL INSULATION MATERIALS FOR TERRACE ROOFS

Entering the third decade of the 21st century, confronting the ever-increasing global energy demand within both industrial and residential construction becomes a focal point.The entire spectrum of activities involved in construction, from building erection to raw material processing and product fabrication, is pinpointed as a critical contributor to greenhouse gas emissions. The primary culprits are carbon dioxide compounds stemming from the utilization of fossil fuels.Given that buildings rank among the

foremost energy consumers, their substantial role in exacerbating global warming is undeniable, consequently accelerating climate change and posing a severe threat to the survival of numerous individuals, plant species, and wildlife. Directive 2010/31/EU of the European Parliament and of the Council dated 19 May 2010 underscores the imperative of significantly reducing energy consumption in new constructions, aiming for zero energy utilization. Furthermore, this energy should stem from renewable resources. These imperatives are underscored by the construction sector's profound ecological impact, responsible for up to one-third of the world's annual greenhouse gas emissions (GHG), contributing a significant 40% to global energy consumption, and consuming approximately 25% of the world's water resources (Lemmet, 2009).

According to the Energy Information Administration's 2018 report (Capuano,2018), a substantial surge in global energy consumption, projected to reach a 64% increase by the year 2040, is anticipated. This surge is predominantly attributed to the burgeoning demands of residential, industrial, commercial, and urban construction, spurred by industrial expansion and population growth. Consequently, these trends have escalated environmental concerns, notably evident in the rise of environmental disasters and the pressing issue of climate change. The significant contribution of the buildings and construction industry, accounting for 45% of carbon dioxide emissions, compounds the greenhouse effect, amplifying global warming (Olivier et al., 2017). Projections indicate that this escalating global warming trend could elevate the Earth's average surface temperature from 1.1◦ to 6.4 ◦C by the close of the 21st century (Solomon et al., 2007).

Projections indicate a notable surge of 64% in global energy consumption by the year 2040, primarily attributed to a substantial increase in residential, industrial, commercial, and urban construction. This escalation is a consequence of both industrial advancements and the expanding population. These forecasts, emphasized in 2018 by the Energy Information Administration, underscore the impending challenge (Capuano, 2018). Consequently, the escalating trajectory of energy consumption has exacerbated environmental apprehensions, prominently manifesting in environmental calamities and the pervasive specter of climate change. Specifically, the greenhouse effect, significantly propelled by the substantial carbon dioxide emissions of the buildings and construction industry, which account for a substantial 45%, serves as a key catalyst for global warming (Olivier et al., 2017). Future estimations suggest a potentially alarming elevation in the Earth's average surface temperature, ranging from 1.1◦ to 6.4 ◦C by the denouement of the 21st century (Pachauri & Reisinger, 2007).

The escalating demand for natural resources in commercial buildings, driven by the rapid pace of urbanization, encompasses critical areas such

as lighting, refrigeration, ventilation, recycling, and heating or cooling systems. This surge necessitates a significant energy investment. Hence, the implementation of insulation materials becomes imperative to optimize energy conservation, thereby augmenting sustainable energy strategies within the building sector (Pásztory, 2021).

Terrace roofs are a type of roof structure that can withstand external weather conditions for an extended period, possess calculated insulation properties, and allow for adaptability and ease of maintenance. Consequently, their preference rates are exceedingly high, not only due to aesthetic considerations but also owing to these factors. In terrace roofs, when the designed and calculated insulation layers are correctly applied during the project phase, both the initial cost is lower compared to other roofing solutions and there is a return on investment through energy savings throughout the usage period. The significance of energy savings in mitigating environmental pollution is unquestionable. A designed terrace roof can be tailored to different purposes, such as being pedestrian-accessible, open to vehicular traffic, traffic-free, or garden roofs. In all these alternatives, a crucial aspect is the proper detailing and application of water and heat insulation using products with adequate technical specifications (Çırpanlı, 1996).

Efficiency and savings in energy consumption have become prominent across all sectors, significantly influencing decisions in the design and production processes of contemporary buildings. The concepts of efficiency and savings are determinants in choices made throughout the design and production of today's structures. Buildings that consume less energy not only contribute to a sustainable environment but also propose more enduring solutions. This necessitates a comprehensive perspective encompassing material production, transportation, design, implementation, maintenance/repair throughout the service life, and recycling processes. Such an approach becomes imperative to ensure lasting and sustainable solutions for a sustainable environment (Türkmen, 2016).

The increase in energy consumption brings about a host of environmental problems. The harmful gases released in excessive amounts into the atmosphere result in a myriad of environmental issues, including climate change. These emerging challenges make it imperative for governments to take measures in this regard. Alongside sanctions focusing on reducing energy consumption and thereby minimizing the environmental impact of production and consumption, policies are being developed to promote the development and widespread adoption of renewable energy sources. When examining the areas of energy consumption, it is observed that approximately 41% of the total energy consumption occurs in buildings (Sezer, 2005).

With the aid of advancing and evolving technology in today's world, the

production of new materials and their integration into structural elements has become more feasible through easier means. Utilizing these new materials, it is possible for the insulation materials used in terrace roofs to provide energy efficiency that affects the entire structure. Energy efficiency and conservation can be achieved by designing and implementing insulation applications in new or existing structures in a way that meets all performance requirements during the project and implementation phases. The development of new materials and systems, as well as the widespread adoption of these developed systems and materials, are crucial in providing solutions to the energy issue, one of the major consequences of climate change. This approach aids in addressing the energy challenge, which is among the most significant consequences of climate change.

3.1. Benefits of Developing New Thermal Insulation Materials for Terrace Roofs

Insulation of terrace roofs is an indispensable factor for the energy efficiency of buildings. The effectiveness of insulation not only reduces energy consumption and lowers energy costs but also minimizes environmental impacts. The development of next-generation materials can enhance efficiency in this area and significantly contribute to sustainability goals. Key factors in this regard are outlined below.

- **Energy Savings and Efficiency:** Effective insulation in terrace roofs reduces energy consumption by maintaining stable indoor temperatures, thus minimizing heating and cooling requirements, and ultimately reducing energy costs.
- **Sustainability:** Next-generation insulation materials tend to be recyclable and environmentally friendly. Their use can contribute to the preservation of natural resources and the reduction of waste.
- **Reduction of Carbon Dioxide Emissions:** A significant portion of the energy used for heating and cooling is derived from fossil fuels. Improved insulation can help reduce energy consumption, subsequently lowering carbon dioxide emissions.
- **Comfort and Human Health:** Adequate insulation provides stable indoor temperature conditions, enhancing comfort. Additionally, it is crucial for creating a healthy indoor living environment.
- **Long-Term Investment:** Quality insulation is considered a long-term investment, continually saving on energy costs throughout the building's lifespan.
- **Regulations and Standards:** Energy efficiency standards are increasing in many countries and regions, promoting energy-efficient

buildings. Therefore, new and improved insulation materials are crucial to comply with these standards.

In conclusion, the use of innovative materials for insulation in terrace roofs enhances energy efficiency, resulting in economic, environmental, and societal benefits. Therefore, supporting and promoting research and development in this field holds great significance.

3.2. An Example of the Benefits of Developing New Thermal Insulation Materials for Terrace Roofs

3.2.1. The Ethelred Estate, Central London

Ethelred Estate, located in the heart of London, underwent a renewal program in 2005 with the aim of creating an inspiring environment for the community. The roof renovation of the residential buildings was part of a phased program, involving 10 mid-rise residential buildings comprising a total of 253 units.

During the roof renovation phase, the use of green roofs was proposed as a way to achieve value in terms of cost-effectiveness and environmental improvements. Perhaps the most noteworthy aspect of this project is that it represents the largest green roof renovation in the United Kingdom. Ethelred Estate has become a sustainable model for other projects. The roof also provides benefits by reducing UV damage to the buildings and helping to minimize maintenance costs (url 1).

The integration of internal thermal management systems at Ethelred Estate yielded substantial cost efficiencies. Simultaneously, this implementation markedly elevated the quality of the residential environment. Consequently, the apartments within Ethelred Estate attained heightened thermal comfort, improved dryness, and enhanced operational affordability. Notably, these improvements played a pivotal role in ameliorating challenges pertinent to winter fuel poverty.

Figure 1. The initial flat roofs at Ethelred Estate were transformed into green sedum roofs as part of the refurbishment process (Castleton et al., 2010).

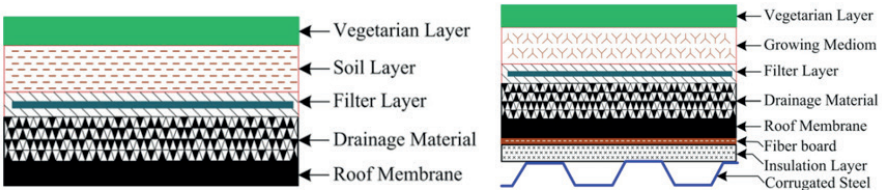


Figure 2.Components of a typical green roof and green roof on a corrugated steel roof (Saadatian et al., 2013).

4. CURRENT LITERATURE RESEARCH ON THERMAL INSULATION TECHNOLOGIES IN TERRACE ROOFS

Chandra et al. (2019) investigated the creation of a long-lasting, thermally insulated roof system through the application of bamboo insulation panels. Their research unveiled an innovative approach for crafting roof panels that incorporated horizontally cut bamboo layers as the primary thermal insulation material. The main goals of their research encompassed the development of a roof panel insulation system utilizing this natural thermal insulation material and assessing its efficacy within the context of tropical climate conditions.

Within any thermal insulation system, the selection of the insulation material stands as the pivotal factor. Hence, the objective was to carefully choose a suitable thermal insulation material that would enable the attainment of the targeted comfort levels. Comprehensive data concerning locally accessible natural materials suitable for thermal insulation were gathered from existing literature to inform the design of the module.

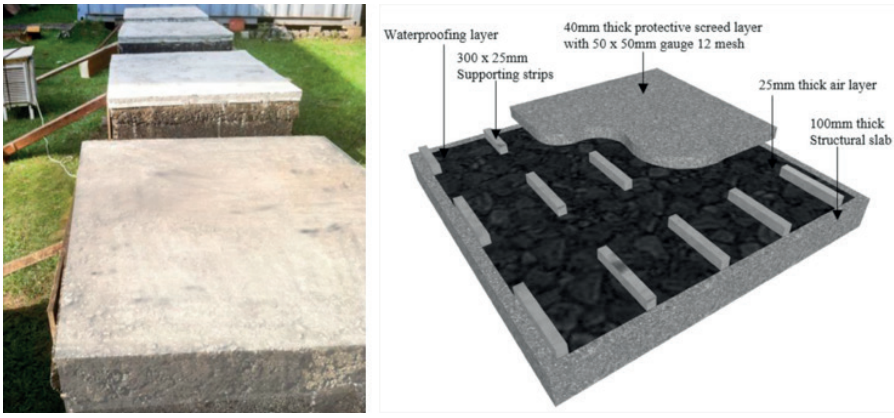


Figure 3. Small-scale physical models and details of the insulation system used to evaluate thermal performance (Chandra et al., 2019).

The suitability was tested through experiments conducted on small-scale physical models constructed using a bamboo insulation system. Optimization was performed, considering the thickness of the insulation layer and the

number of layers, to achieve enhanced thermal performance. It was found that better thermal performance could be obtained through the optimization of the thickness and the number of layers in the insulation system.

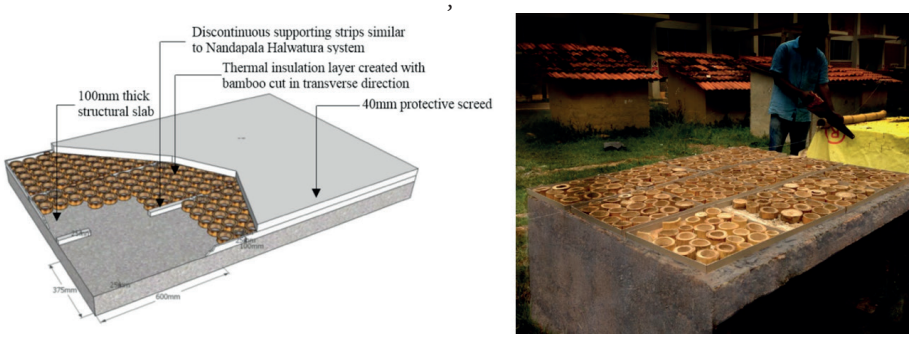


Figure 4. Detail of the bamboo insulation layer and construction of the system (Chandra et al., 2019).

In their 2022 study, Danacı and Akın carried out a comparative test study on thermal insulation materials in architecture, with a specific focus on aerogel and stone wool. The research aimed to investigate and compare the insulation values of prevalent thermal insulation products. The properties and insulation values of these materials were analyzed in accordance with national standards. The materials were classified into three categories: commonly used thermal insulation materials, nanotechnology-based thermal insulation materials, and alternative thermal insulation materials. Furthermore, the study involved energy loss and gain analysis using a Revit model to discern the disparities between the frequently utilized stone wool and the aerogel-enhanced thermal insulation material—a product of nanotechnology.

In the study conducted by Danacı and Akın in 2022, a thorough literature review was performed regarding the utilization of natural materials like goat hair, wool, flax, straw, and hemp as alternative thermal insulation materials. The research involved a comparative analysis of the insulation values of these thermal insulation materials, drawing on data obtained from the comprehensive literature review.

Table 2. Summary Table of Thermal Insulation Material Properties (TS 825) (Ozer 2017) (Arslan and Aktas 2018) (Ahmed et. al. 2019)

Thermal Insulation Material	**Thermal Conductivity (W/m·K)**	**Density (kg/m³)**	**Specific Heat Capacity (J/kg·K)**
Rock Wool	*Varies*	*60-200*	0.84 - 1.05
Glass Wool	*Varies*	12 - 96	0.84 - 1.18
Expanded Polystyrene (EPS)	0.030 - 0.040	15 - 40	1400 - 1500
Extruded Polystyrene (XPS)	0.028 - 0.040	28 - 45	1400 - 1500
Aerogel	0.012 - 0.020	180 - 220	900 - 1100
Vacuum Insulation Panel	0.002 - 0.007	200 - 300	800 - 1000

While aerogel-based insulation is not extensively utilized, its potential for widespread adoption is underscored by its inherent advantages. Within this study, calculations were conducted under the presumption of employing thermal insulation materials on the exterior walls, terraces, and roof bases of the analyzed edifice. The comparison table below presents terrace roof insulation materials fabricated using stone wool and aerogel. It's worth noting that all other materials were held constant throughout this investigation (Danacı & Akın, 2022).

Table 3. The U value of the roof slab for rock wool and aerogel (Danacı & Akın, 2022)

Place	**Thermal Insulation**	**Thickness d (m)**	**Heat conduction coefficient (W/mK)**	**Thermal Conductivity Resistance R (m²K/W)**	**Thermal Permeability Coefficient U (W/m²K)**
Terrace	Rock Wool	0.1	0.04	2.500	0.359
	Aerogel	0.1	0.015	6.667	0.144

Bozsaky (2019) conducted a state-of-the-art review focusing on nature-based thermal insulation materials derived from renewable sources. The primary objectives of this study were to establish a novel systemization of nature-based thermal insulation materials, summarize fundamental information regarding these materials, and delineate the direction for future research and development in this domain.

The category of "rediscovered materials" includes thermal insulation materials derived from nature that were once used as building insulation products. These materials had diminished in use with the advent of synthetic alternatives. However, a renewed interest in environmentally conscious architecture at the beginning of the 21st century led to their rediscovery (Bozsaky, 2019).

Table 4. Thermal conductivity of nature-based thermal insulation materials among recently introduced materials and materials in the experimental phase (Bozsaky, 2019).

Category	Materials	Thermal conductivity(W/mK)
Recently introduced materials	Sheep wool	0.035-0.040
	Cotton	0.040-0.050
	Cellulose insulation	0.045-0.055
	Seagrass	0.040-0.045
	Coconut fiber	0.040-0.050
Materials in experimental stage	Palm fibers	0.041
	Cornstalk block	0.045-0.055
	Sunflower stalks	0.064-0.085
	Bamboo fibers	0.080-0.340
	Corncob board	0.096
	Kenaf fibers	0.039

Agarwal and Kamal (2023) conducted an in-depth examination into the thermal performance and energy efficiency attributed to insulated roofing materials, considered as prospective components for building envelopes. Their research offers a qualitative analysis of insulation materials commonly employed in building structures. Furthermore, the study evaluates the application of Expanded Polystyrene (EPS) as an insulation material for both walls and roofs within architectural contexts.

The section and material of the examined terrace roof, encapsulated with interlocking insulated EPS flooring for air-tight insulation, are depicted below (Agarwal & Kamal, 2023).

Figure 5. Insulated EPS deck and section with interlocking arrangement for airtight insulation (Agarwal & Kamal, 2023).

The application of the material on a terrace roof is illustrated below (Agarwal & Kamal, 2023).

Figure 6. Application images of insulated EPS sheets (Agarwal & Kamal, 2023).

Agarwal and Kamal (2023) listed the advantages of using the researched material, EPS, in terrace roofs as follows:

- Each roof insulation tile is uniquely molded, ensuring consistent insulation coverage across the entire roof.
- Unlike cutting from an EPS block, these tiles are molded, eliminating water absorption through cut surfaces, which is common in sheet cuts. Each tile features a molded water-repellent finish on both surfaces.
- A dual-layer approach offers enhanced insulation, leveraging interlocking joints of concrete tiles to ensure watertight seams and an effective sealing effect.
- Significant cost savings are realized with this method. Comparable options such as XPS or PUF, which possess similar essential characteristics, cost three to five times more.
- Insulating the roof against intense summer heat significantly elevates the comfort level of the upper floor.
- Utilizing air conditioning sees a substantial 40–50% reduction in electricity consumption. The insulation investment pays off within a year, leading to a 40% cost reduction.
- The waterproofing of the roof, including bitumen-based solutions, remains free from aging cracks, preventing seepage or dampness even during heavy rainfall.
- Applying roof insulation using insulated EPS tiles guarantees a lifetime of durability and reliability, effectively protecting the structure (Agarwal & Kamal, 2023).

5. CONCLUSION AND EVALUATION

The advancement of novel materials for thermal insulation in terrace roofs is of significant importance within the contemporary realm of the

construction industry. Propelled by technological progress and sustainability-centric paradigms, relentless advancements are witnessed in the domain of thermal insulation. These pioneering materials proffer substantial merits across pivotal domains encompassing energy efficacy, environmental sustainability, structural resilience, and inhabitable comfort. From the standpoint of energy efficiency, efficacious thermal insulation substantially contributes to sustainable energy utilization through pronounced curtailment of energy expenditure. Furthermore, diminished energy usage serves to mitigate environmental footprints, diminish greenhouse gas emissions, and substantiates preservation endeavors concerning natural reservoirs. Adequate thermal insulation stands as a critical determinant for the robustness and longevity of edifices, whereby materials of the new age confer diverse advantages. Additionally, they serve to elevate comfort levels by ensuring consistent indoor temperatures, thereby engendering a more gratifying milieu within habitation spaces.

To conclude, the development of contemporary thermal insulation materials tailored for terrace roofs assumes paramount significance within the construction sector, duly considering imperative constituents such as energy preservation, ecological sustainability, and structural endurance. The incessant revitalization and enhancement of these materials augur the prospect of erecting edifices that are both more sustainable and operationally efficient in the times ahead.

REFERANCES

Agarwal, R., & Kamal, M. A. (2023). Role of Insulated Tiles as a Prospective Material for Building Envelope: Thermal Performance and Energy Efficiency. Architecture Engineering and Science, 4(2), 51-61. DOI: 10.32629/aes.v4i2.1182

Ahmed A, Qayoum A, Mir FQ (2019) Investigation of the thermal behaviour of the natural insulation materials for low temperature regions. J Build Eng 26. https://doi.org/10.1016/j.jobe.2019.100849

Arslan MA, Aktas M (2018)). "İnşaat sektöründe kullanılan yalıtım malzemelerinin ısı ve ses yalıtımı açısından değerlendirilmesi. ", Journal of Polytechnic 21(2):299–320. https://doi.org/10.2339/politeknik.407257

Bozsaky, D., (2010). The historical development of thermal insulation materials. Periodica Polytechnica Architecture, 41(2), 49-56.

Bozsaky, D. (2019). Nature-based thermal insulation materials from renewable resources–A state-of-the-art review. Slovak Journal of Civil Engineering, 27(1), 52-59.

Capuano, L. (2018). International energy outlook 2018 (IEO2018). US Energy Information Administration (EIA): Washington, DC, USA, 2018, 21.

Castleton, H. F., Stovin, V., Beck, S. B., & Davison, J. B. (2010). Green roofs; building energy savings and the potential for retrofit. Energy and buildings, 42(10), 1582-1591.

Chandra, M. S., Nandapala, K., Priyadarshana, G., & Halwatura, R. U. (2019). Developing a durable thermally insulated roof slab system using bamboo insulation panels. International Journal of Energy and Environmental Engineering, 10(4), 511-522.

Çırpanlı, E. (1996) Çatılarda İzolasyon Proje Aşamasında Başlamalıdır. İzolasyon Dünyası Dergisi, Sayı 2, 3-4.

Danacı, H. M., & Akın, N. (2022). Thermal insulation materials in architecture: a comparative test study with aerogel and rock wool. Environmental Science and Pollution Research, 29(48), 72979-72990.

Déry, A., (2000). Történeti anyagtan, Terc Kft, Budapest.

Ekinci, C. E., & Yıldırım, S. T., (2004). Teras Çatılarda Su ve Isı Yalıtımının Önemi. Fırat Üniversitesi Doğu Araştırmaları Dergisi, 2(3), 39-43. Retrieved from https://dergipark.org.tr/en/pub/fudad/issue/47007/590582

ETAG 004., (2013). Guideline for European Technical Approval of External Thermal Insulatıon Composite Systems (ETICS) with Rendering. European Organisation for Technical Approvals (EOTA), Brussels.

Hegger, M., Auch-Schwelk, V., Fuchs, M. ve Rosenkranz, T., (2006). Construction Materials Manual, Munchen : Birkhauser Edition Detail.

Lemmet, S., (2009). Buildings and Climate Change. Summary for Decision-Makers,

UNEP SBCI.

Novák, Á., (2008). Természetes anyagú környezetbarát h ″oszigetelések – egészséges épületek, Építész Spektrum 7, no. 1, 41-46.

Olivier, J. G., Schure, K. M., & Peters, J. A. H. W. (2017). Trends in global CO2 and total greenhouse gas emissions. PBL Netherlands Environmental Assessment Agency, 5, 1-11.

Ozer N (2017) "Atıklardan Üretilen Isı Yalıtım Malzemelerinin Yaygın Kullanılan Isı Yalıtım Malzemeleri ile Karşılaştırılması", Master's Thesis, ITU, Institute of Science and Technology, Istanbul

Pachauri, R. K., & Reisinger, A. (2007). Climate change 2007: Synthesis report. Contribution of working groups I, II and III to the fourth assessment report of the Intergovernmental Panel on Climate Change. Climate Change 2007. Working Groups I, II and III to the Fourth Assessment.

Pásztory, Z. (2021). An overview of factors influencing thermal conductivity of building insulation materials. Journal of Building Engineering, 44, 102604.

Saadatian, O., Sopian, K., Salleh, E., Lim, C. H., Riffat, S., Saadatian, E., ... & Sulaiman, M. Y. (2013). A review of energy aspects of green roofs. Renewable and sustainable energy reviews, 23, 155-168.

Sezer, F. Ş. (2005). Türkiye'de ısı yalıtımının gelişimi ve konutlarda uygulanan dış duvar ısı yalıtım sistemleri. Uludağ Üniversitesi Mühendislik-Mimarlık Fakültesi Dergisi, Cilt 10, Sayı 2, 2005.

Solomon, S. (Ed.). (2007). Climate change 2007-the physical science basis: Working group I contribution to the fourth assessment report of the IPCC (Vol. 4). Cambridge university press.

Tomlow, J., (2007). Bauphysik und die technische Literatur des Neuen Bauens. Bauphysik, 29(2), 146-158.

Türkmen, M. (2016). Bina Kabuğunda Isı Yalıtımı Uygulamalarının Yapısal Performansı Ve Etkinliğinin İstanbul'da Bir Alan Çalışması İle İncelenmesi (Doctoral dissertation, Fen Bilimleri Enstitüsü).

TSE (2013) Rules for Heat Isolation in buildings (TS 825).

İNTERNET KAYNAKLARI

url 1: https://www.greenroofs.com/projects/the-ethelred-estate-kennington-london/

Chapter 5

INVESTIGATION OF THE POTENTIAL OF GRAY WATER REUSE AND RAINWATER HARVESTING SYSTEMS

Cansu BEKLER[1]

İdil AYÇAM[2]

Asena SOYLUK[3]

1 Cansu BEKLER, Gazi Üniversitesi, Mimarlık Fakültesi, Mimarlık Bölümü, https://orcid.org/0000-0001-7861-7404
2 İdil AYÇAM, Gazi Üniversitesi, Mimarlık Fakültesi, Mimarlık Bölümü, https://orcid.org/0000-0001-7170-5436
3 Asena SOYLUK, Gazi Üniversitesi, Mimarlık Fakültesi, Mimarlık Bölümü, https://orcid.org/0000-0002-6905-4774

1. INTRODUCTION

The current situation of water resources emphasizes the need for sustainable management of water resources. Knowing the value of water and incorporating it into decision-making is essential to achieving sustainable water resources management and the Sustainable Development Goals (SDGs) of the United Nations' 2030 Agenda for Sustainable Development.

The total volume of water on Earth is approximately 1.4 billion cubic kilometers, with 97.5% being saltwater and 2.5% being freshwater (UN World Water Development Report-WWDR, 2003; Shiklomanov and Rodda, 2003; Alparslan et al., 2008). When countries are classified based on their water availability, countries with an annual per capita availability of less than 1,000 m^3 of water are categorized as water-stressed nations, those with 1,000-3,000 m^3 are considered water-scarce, countries with 3,000-10,000 m^3 are considered to have sufficient water, and those with more than 10,000 m^3 are considered water-rich nations (Alparslan et al., 2008; Sahin and Manioglu, 2011). According to the United Nations World Water Development Report (2023), on average, approximately 10% of the world's population lives in water-stressed and water-scarce countries. Global water usage has been increasing at an approximate rate of 1% over the past 40 years, and it is expected to continue growing at a similar rate until 2050, driven by a combination of population growth, socio-economic development, and changing consumption patterns. The majority of this increase is concentrated in low and middle-income countries, particularly in emerging economies (UN-WWDR, 2023).

Turkey is considered a "water-scarce" country, with an annual per capita water availability of 1,519 m^3. It is predicted that the population of Turkey will reach 100 million by the year 2030 and the amount of water per capita will decrease to 1,120 m^3. Turkey is on its way to becoming 'water poor' with its increasing population (WWF-TR, 2014). Climate change is one of the most significant factors in the management of water resources. Climate change-induced adverse effects on water resources, coupled with the increasing water demand from a growing population, have made alternative water sources, water reuse and recycling, and strategies to enhance water use efficiency and security increasingly important (Wanjiru et al., 2017). In the 2023 assessment report by the Intergovernmental Panel on Climate Change (IPCC, 2023), it is forecasted that along with the increase in temperature, there will be a decrease in precipitation in the Mediterranean Basin, which includes Turkey. Therefore, the Mediterranean Basin has been identified as one of the vulnerable regions to global climate change (IPSS, 2007; IPCC, 2023). Hence, Turkey is among the regions that will be significantly affected by climate change. Our country exhibits a propensity for reduced precipitation, particularly during the winter season, in regions such as the Mediterranean, Aegean, and Southeastern Turkey. Turkey is one of the countries in the Mediterranean Basin, and changing

precipitation patterns, less frequent but more intense snowfall and rainfall, as well as the unsustainable and excessive use of water resources, including the depletion of groundwater, as highlighted in IPCC reports, contribute to Turkey's increased susceptibility to the impacts of climate change (Ministry of Environment and Urbanization, 2012). In Turkey, when we examine the distribution of water usage by sectors, the residential sector accounts for a relatively high percentage, approximately 10.3%. Taking measures within the construction sector in terms of water management can be highly effective in mitigating water crises and, consequently, addressing climate disruptions.

In the construction sector, environmental impact is reduced by using systems integrated into building design to ensure water management. These systems, which are used integrated into the building design; purification and reuse of gray water and rainwater collection systems. In this study; It is aimed to examine the potential of greywater and rainwater collection systems integrated into single-house buildings in the Adana province of the Mediterranean region of Turkey, which is a sensitive region where precipitation will decrease with the increase in temperature, through calculations. The reason why Adana was chosen is that it is the province with the highest temperature values in the Mediterranean Region. In this sense, first of all, a literary evaluation will be made on gray water treatment systems, gray water reuse and rain water systems. Afterward, the water recovery calculation of the use of gray water system, rainwater harvesting system, and hybrid system in which these two systems are used together in a single house with a household size of 4 in Adana will be made based on the meteorological data of the region. As a result of the calculations made, the water gains of these three models will be evaluated.

2. LITERATURE REVIEW

Various recent environmental challenges have been instrumental in raising global environmental awareness and promoting its steady growth. In many countries, issues related to urban water, including climate change, rapid urbanization, and inappropriate urban planning policies, have led to problems such as flooding disasters, water pollution, and water scarcity (Nguyen et al., 2019). Increasing the quantity of clean water resources through replenishment is technically and economically unfeasible in the face of water scarcity. In this case, the search for alternative water sources for the sustainable management of natural resources is a subject that has been widely practiced and emphasized in many countries in recent years (Asano and Levine, 1996; Sturm et al., 2009; Zhang et al., 2010).

Rainwater harvesting systems and graywater reuse systems are leading alternatives that contribute to improving water use efficiency and urban water management. Rainwater harvesting involves the collection and storage of rainwater and runoff to supply the water needed for agricultural,

livestock, and domestic consumption (Oweis et al., 2001; Kantaroglu, 2009). The practice of collecting rainwater has been employed for several thousand years as a means of harnessing seasonal rainfall that might otherwise be lost to runoff or evaporation. In India, simple stone and rubble structures for capturing rainwater date back as far as 3000 BCE (Gould and Nissen-Petersen, 1999). As early as 2000 BCE, a civilization in what is now Israel survived in the Negev Desert by storing hillside runoff in cisterns (Pacey and Cullis, 1986). In ancient Rome, rainwater was collected from covered walkways and directed into small garden pools for both aesthetic purposes and future use in irrigation (Winterbottom, 2000). The Romans designed rainwater collection systems for both individual residences and urban areas, using the collected rainwater as a primary source for drinking and other domestic uses (Gould and Nissen-Petersen, 1999). In central Mexico, underground cisterns stored rainwater collected from city squares and rooftops for human consumption and irrigation (Winterbottom, 2000). In the United States and Canada, rainwater harvesting systems have historically been used by local residents and settlers in isolated areas where municipal water sources were not available (Wilson, 1997). In Istanbul, there are many examples of traditional cisterns that were fed by various aqueducts to meet the needs of the increasing population. The most famous cisterns in Istanbul include the 336-column Basilica Cistern (Yerebatan Palace), the 224-column Philoxenos Cistern (Binbirdirek), and the Acimusluk Cistern. Moreover, in ancient times, due to the inadequacy of available water sources for the existing population, especially in the historic peninsula, the basements of houses or palaces were used as cisterns (Tema, 2017). While rainwater can provide water for a variety of uses, the most common applications include agricultural irrigation and domestic consumption in households.

Rainwater harvesting is a technique in which rainwater is captured, stored, and reused for various purposes (Stec and Kordana, 2015). Regarding the research conducted on the use of rainwater in residential settings, Kumar (2004) analyzed the scope, physical feasibility, and economic viability of roof water harvesting systems under various physical and socio-economic conditions in India. Various studies have recommended the use of harvested rainwater for domestic and landscaping purposes (Abdulla and Al-Shareef, 2009). Research conducted by Sturm et al. in 2009 demonstrated the economic and technical feasibility of rainwater harvesting systems (Sturm et al., 2009). Advanced decentralized water management techniques that combine greywater recycling and rainwater management for densely populated cities were studied by Zhang et al. in 2009 (Zhang et al., 2009). Marlow et al. (2013) conducted a critical review, taking into consideration the benefits and limitations of sustainable urban water resource management (Marlow et al., 2013). This study reported a favorable outcome with improved water

resource management. Similarly, many other studies have emphasized the significance of adopting rainwater harvesting techniques, either on a small scale (individual households) or a large scale (urban areas).

Another alternative system that contributes to improved water management is greywater reuse. According to the TS EN 1085 standard, domestic wastewater refers to the wastewater generated from the kitchen, washing machine, bathroom, toilet, and similar purpose areas that is discharged into the sewage system. Domestic wastewater is typically categorized into two types: greywater and blackwater. Greywater is typically defined as wastewater from showers, baths, sinks, washing machines, and dishwashers, while the remaining wastewater from toilets is classified as blackwater. Greywater can be further classified into two categories: slightly contaminated and highly contaminated. Slightly contaminated greywater includes wastewater from showers, baths, and sinks, while highly contaminated greywater consists of wastewater from the kitchen and washing machine. Greywater constitutes the largest volume percentage of domestic wastewater, accounting for 75% (Karahan, 2011) (Figure 2).

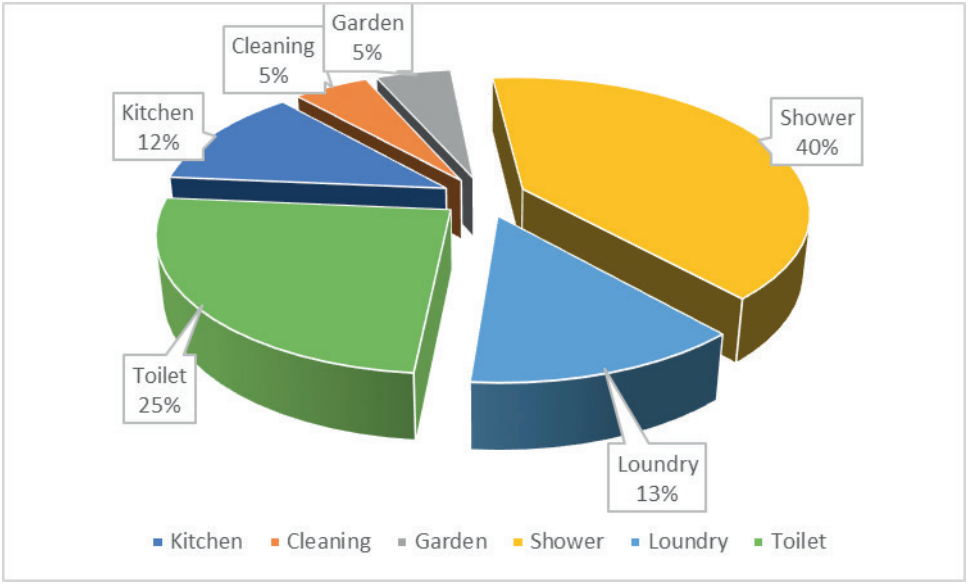


Figure 1. Daily Domestic Water Consumption Rates (Karahan, 2011)

Greywater recycling involves treating and reusing the least contaminated portion of domestic wastewater, which typically comes from sources such as showers, sinks, and bathtubs. In certain exceptional cases, wastewater from washing machines and the kitchen can also be included in greywater recycling for recovery and reuse. Greywater recycling and reuse involve the filtration and recycling of various wastewater sources from daily use, which can then

be applied in secondary water applications (Jefferson et al., 2000; Ottoson and Stenström, 2003; Wilderer, 2004). Treated greywater can be used for flushing toilets, irrigation, and car washing (Do Couto et al., 2013). Many countries facing water scarcity issues have actively developed greywater technologies and policies, with these policies being implemented in agricultural and residential uses. For example, in a home in Brazil, treated greywater was used for toilet flushing, leading to a reduction in water consumption by approximately 29-35% (Ghisi and Ferreira, 2007). Los Angeles used 13-65% of recycled greywater from households for agricultural irrigation (Sheikh, 1993). In Malaysia, 67% of water consumption is for domestic use, and reusing grey water for toilet flushing has the potential to reduce water demand by around 30%. The operational rate of greywater facilities in South Korea, with the supply of two hundred million tons of greywater, is 26.5% (UNESCAP, 2012). In Japan, despite the government not actively promoting the implementation of greywater systems in households, around 70% of the population supports rainwater or greywater reuse due to their high awareness of water conservation and relatively high water costs in urban areas (UNESCAP, 2012). As evident from various studies, greywater, an increasingly valuable resource, needs to be treated in the field to eliminate organic matter, surfactants, micropollutants, and microbial activity to make it suitable for various purposes. Biological treatment of greywater can be achieved using technologies such as artificial wetlands, rotating biological reactors, sequential batch reactors, and membrane bioreactors (MBR) (Li et al., 2009; Abdel-Kader, 2013; Elmitwalli and Otterpohl, 2007; Arunbabu et al., 2015; Wurochekke et al., 2014; Bani-Melhem et al., 2015; Merz et al., 2007; Can et al., 2020) (Figure 3).

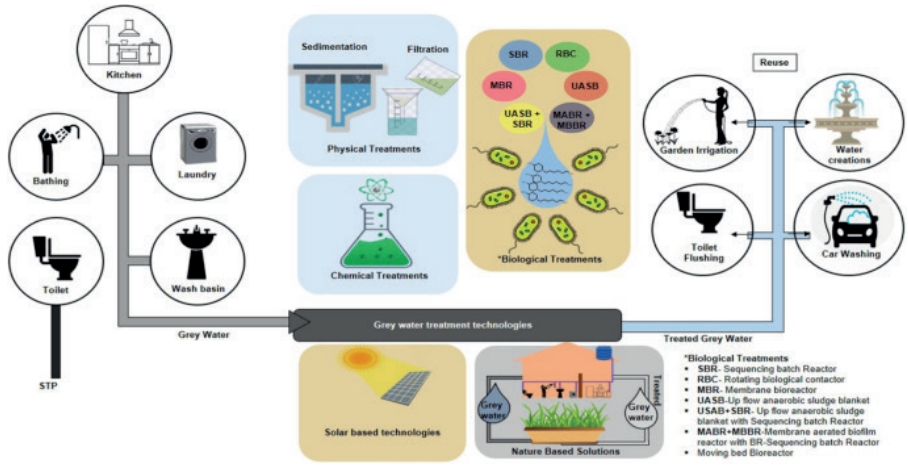


Figure 2. Gray water treatment technologies (Awasthi et. al., 2023)

Membrane bioreactors (MBRs) are biological treatment systems that combine biological processes with membrane technology (Judd, 2008). In these systems, there is no need for final settling tanks, sand filtration (Melin et al., 2006), and simultaneous disinfection applications (Lv et al., 2006) as a result of membrane filtration. MBR systems can be used for the treatment of effluents from domestic and industrial wastewater. Water reclamation and reuse can also be successfully achieved through membrane technology (Innocenti et al., 2002).

Studies have shown that rainwater harvesting systems and greywater systems have been analyzed in detail for their environmental performance, and the results indicate that their environmental impact is lower compared to traditional centralized water distribution systems. In this study, the performance of greywater reuse and rainwater harvesting systems will be evaluated for three different model scenarios in a single-story detached house with a garden for four people in the city of Adana, located in the Mediterranean Region of Turkey. In the first model, the performance of greywater reuse treated with membrane filtration and biological treatment will be analyzed. In the second model, the performance of an integrated system that includes both greywater reuse and the collection of rainwater from the roof of the house with a water tank will be analyzed. In the third model, the integrated reuse of rainwater systems and greywater treated with MBR technology will be analyzed. The purpose of these three models is to demonstrate that greywater reuse and rainwater harvesting systems are effective water-saving strategies that reduce drinking water consumption through the use of treated water for non-potable uses such as irrigation and toilet flushing.

3. MATERIALS AND METHODS

The case analysis of the study will be conducted for a sample single house used by a household size of 4 in Adana, Turkey. The sample house has a roof area of 200 m^2 (20 m x 10 m) and a garden of 400 m^2. The region where the sample house is located is the region covering the borders of Adana province, with its center at latitude and longitude of 37°0′ N 35° 19′E (Figure 3).

Figure 3. The region where the case analysis was conducted is Adana province.

Adana is located in the Mediterranean region, one of the regions with the highest average temperatures in Turkey. Adana's annual average temperature is 19.2°C and its annual average rainfall is 668.8 mm. On average, 74 days of the year are rainy. 51% of the precipitation falls in winter, 26% in spring, 18% in autumn and 5% in summer (Figure 3). Although the air is loaded with moisture in summer, it is seen that there is no precipitation at all in some years. The climate classification according to Köppen-Geiger is Csa.

3.1.Reuse of Gray Water with MBR Technology

In order to calculate gray water reuse in the sample house, it is first necessary to calculate the total amount of water consumed daily by the household. According to official data from TÜİK, the average daily used water volume per person was calculated as 224 liters. In this case, to calculate the total household water consumption, multiply the household size by the average amount of water a person uses daily;

Household size (4) x Average used water volume per capita per day (224 L) = Daily water consumption of the household (896 L)

In the calculation made, it was determined that the household in the sample house consumed 896 L of water daily. Annual water consumption;

Total household water consumption (896 L) x 365 = Total domestic water use (327.040 L)

When we divide the annual water consumption rate by the domestic water consumption rates given in the study of Karahan (2011) to find the domestic water consumption rates, the amount of gray water generated for the house is given in Table 1.

Table 1. Allocation of domestic water use according to percentages Karahan (2011)

Grey Water					Black Water
Shower (%40)	Loundry (%13)	Kitchen (%12)	Cleaning (%5)	Garden (%5)	Toilet (%25)
130.816 L	42.515,2 L	39.244,8 L	16.352 L	16.352 L	81.760 L

These calculated flow rates will be used for garden irrigation and toilet flushing by recycling the water from the shower and washing machine with the gray water reuse system. Water from the toilet and kitchen sink will be directed to the sewer. In this case, the total amount of water recycled from laundry and shower;

Loundry (39.244,8 L) + Shower (130.816 L) = Total amount of water (170.060,8 L)

It is calculated as. Water recycled from domestic water uses will be used for toilet flushing and garden irrigation. The amount of water to be used for the green area has been taken as 6 Lm^{-2} per square meter (Durmuş Çalışkan, E.). In this study, the sample house has a garden of 400 m^2 and the annual water requirement if the garden is irrigated every day, once a week and twice a week is;

For irrigation of a 400 m2 garden;

400 m^2 x 6 Lm^{-2} = 2400 L

If watering is done every day; 2400 L x 365 day= 876000 L

If watering is done twice a week; 2400 L x (365x2/7) day = 250,3 L

If watering is done once a week; 2400 x 365/7 day = 125,1 L

The gray water recovery amount of the sample house and the amount of water needed for toilet flushing and irrigation were calculated. As a result of the calculation, approximately 17.8% of the water needed when garden irrigation is done every day is met by reusing gray water. If garden irrigation is done twice a week, approximately 51.2% of the water needed is met. If garden irrigation is done once a week, approximately 82.2% of the water needed is met.

3.2. Use of Rainwater Harvesting System

In the second model created for water recovery of the sample house, the water to be collected from the roof is collected in an over-ground water tank system and its usability in daily needs is examined. Calculations for rainwater harvesting from the roof surface are as follows (Tema 2017).

Rainwater Efficiency = Rain collecting area x Precipitation amount x Roof coefficient (0.8) x Filter efficiency coefficient (0.9)

The area where rainfall collects is the total roof area. The amount of rainfall is the total annual rainfall amount determined by the General Directorate of Meteorology. Roof coefficient; It is the coefficient specified by German standards as 0.8 in DIN (1989). The roof coefficient indicates that not all rainfall on the roof can be recycled. The filter efficiency coefficient is the coefficient specified by German standards in DIN1989 (0.9). It is the efficiency coefficient of the first filter passed to separate the rainwater obtained from the roof from visible solids. It is a coefficient calculated by calculating that some amount of water cannot pass through here. In this study, the roof surface area of the sample house is 200 m^2. The average precipitation amount per square meter in Adana province between 1929 and 2022 was measured as 668.8 mm (668 L m^{-2}) (Table 2) (Meteoroloji Genel Müdürlüğü)

Table 2. Average precipitation amount (mm) in Adana over the years (1929-2022).

Months	January	February	March	April	May	June	July	August	September	October	November	December	Annually
Precipitation (mm)	113.6	89.0	65.5	51.0	48.1	22.1	10.2	9.3	19.3	42.8	71.5	126.4	668.8

In line with these data, the amount of precipitation falling on the area covered by the roof;

Rainwater Efficiency = Rain collecting area x Precipitation amount x 0.8 x 0.9

Rainwater Efficiency = 200 m^2 x 668,8 mm x 0.8 x 0.9 = 96.307,2 L

The amount of water needed for rainwater harvesting, toilet flushing and irrigation of the sample house was calculated. As a result of the calculation, if rainwater harvesting and garden irrigation are done every day, approximately 10% of the water needed is met. If garden watering is done twice a week, approximately 29% of the water needed is met. If garden watering is done once a week, approximately 36.9% of the water needed is met.

3.3. Integrated Use of Gray Water and Rainwater Harvesting Systems

In this model, an integrated gray water system and rainwater harvesting system were used in the sample house with a garden area of 400 m^2. The amount of water gained by the separate and integrated use of these two systems, the amount of water required separately for the 3 states of garden irrigation and the percentage of water need met are given in Table 3.

Table 3. Usage data of integrated water reuse systems in the sample house

		Total Saved Water	Required water for Irrigation		Required water for toilet flushing	Total Required Amount of Water	Percentage of Water Needs Met
Model 1	Grey water re-use	170.060,8 L	1 per week	125.142,8 L		206.902,8 L	%82,2
			2 per week	250.285,7 L		332.045,7 L	%51,2
			Every day	876.000 L		957.760 L	%17,8
Model 2	Rainwater Harvesting System	96.307,2 L	1 per week	125.142,8 L	81.760 L	206.902,8 L	%36,9
			2 per week	250.285,7 L		332.045,7 L	%29
			Evey day	876.000 L		957.760 L	%10
Model 3	Hybrid System	266.368 L	1 per week	125.142,8 L	81.760 L	206.902,8 L	%128,7
			2 per week	250.285,7 L		332.045,7 L	%80,2
			Every day	876.000 L		957.760 L	%27,8

Table 3 presents the calculated data for different water management models. The first model evaluates the use of greywater reuse systems for a sample house. In this case, the annual domestic water use in Adana, which is 896 L, is distributed according to the percentages given in Table 1 and the final domestic water usage is calculated. In the greywater reuse system, water from the shower and laundry is used for the reuse system, while the water coming from kitchen basin and toilets is directed immediately to sewer. The saved 170,060.8 L of water was reused for toilet flushing and garden irrigation. The second model uses a rainwater harvesting system by collecting rainwater from the roof of the building. The amount of water that can be collected from a 200 m2 roof area with an average annual rainfall of 668.8 mm was found to be 96,307.2 L. In the third model, the total potential water amount was found to be 266,368 L. Using the hybrid system, the water coverage percentage for garden irrigation and toilet flushing once a week is 128.7%. This means that the entire amount of water required for garden irrigation and toilet flushing is met, and the excess water is directed to sewer. The water needed for irrigation and toilet flushing twice a week is met at a rate of 80.2%. If the garden is watered every day, 27.8% of the amount of water required for toilet flushing is met.

4. CONCLUSION

In this study, it was aimed to investigate the potential of gray water, rainwater harvesting and a hybrid system in which these two systems are integrated for a single sample house with a 400 m^2 garden in Adana, located in the Mediterranean Region of Turkey. Calculations were made for three models created for this purpose.

In Model 1, the gray water flow rate in the sample house was calculated and it was investigated whether it was suitable for use every day of the week, twice a week and once a week for garden irrigation and toilet cistern. The resulting gray water flow rate will be purified and reused with appropriate technology, providing economic and environmental benefits in houses. The resulting gray water flow rate will be purified and reused with appropriate technology, providing economic and environmental benefits in houses. In gray water treatment, MBR systems, which generally do not require the addition of chemicals and require less energy and maintenance, are also preferred in small-scale houses because they carry out the treatment process in a shorter time than traditional treatment systems and require less space. In the study, 170,060.8 L of water was saved annually with the gray water system treated with the MBR system, and the water need was met at a maximum rate of 82.2% and minimum 17.8% depending on the frequency of garden irrigation.

In Model 2, the water to be collected from the roof of the sample house was collected in an over-ground water tank system and its usability for daily needs was investigated. With this system, 96,307.2 L of water was saved annually, and a maximum of 36.9% and a minimum of 10% of the water needs were met, depending on the garden irrigation situation.

In Model 3, the water recovery potential of the hybrid system, which integrates the gray water system purified with MBR technology and the rainwater harvesting system, was investigated. With the hybrid system, 266,368 L of water was saved annually, and the water need was met at a maximum of 128% and a minimum of 27.8%, depending on the frequency of garden irrigation. It has been concluded that by using this hybrid system, if the garden is watered once a week, all the required water needs are met, and the 28.7% increased water is directed to the sewer.

According to the results obtained, promoting the use of greywater reuse systems and rainwater harvesting systems as tools for sustainable water resource management is important to reduce drinking water consumption in Adana. While water is one of the renewable resources in a perpetual cycle in nature, due to climate change, many countries around the world are facing water scarcity, leading to the transformation of several nations into water-stressed countries. It can be said that regulations and examples related to water-saving strategies such as greywater reuse, rainwater harvesting, and water consumption reduction in Turkey are insufficient. In conclusion, this study shows that the sustainable management of water resources is an important issue that should be considered in the light of sustainable ethics and strategies. For sustainable development, it is necessary to aim to transfer our water resources to future generations and to implement legal regulations that will require the use of systems developed for this purpose, especially in

places where water consumption is high (All housing projects of 200 flats and above, hotels, shopping malls, student dormitories, offices, business centers, schools, gyms, social facilities, public buildings, mass villa projects, mosques, etc.).

REFERENCES

Abdulla, F. A. and Al-Shareef, A. W. (2009). *Roof rainwater harvesting systems for household water supply in Jordan*.Desalination, 243(1-3), 195-207.

Abdel-Kader, A. M. (2013). *Studying the efficiency of grey water treatment by using rotating biological contactors system*, Journal of King Saud University - Engineering Sciences, Cilt 25, ss. 89–95.

Alparslan N., Tanık A. and Dölgen D., (2008). *Türkiye'de Su Yönetimi Sorunlar ve Öneriler*. Türk Sanayicileri ve İşadamları Derneği (TÜSİAD) Yayın No: T/2008-09/469.

Anchan, S. S. and Prasad, H. S. (2021). *Feasibility of roof top rainwater harvesting potential-A case study of South Indian University*. Cleaner Engineering and Technology, 4, 100206.

Arunbabu, V., Sruthy, S., Antony, I. and Ramasamy, E.V. (2015). *Sustainable greywater management with axonopus compressus (broadleaf carpet grass) planted in sub surface flow constructed wetlands*, Journal of Water Process Engineering, Cilt 7, ss. 153–160.

Asano T. and Levine A.D. (1996). *Wastewater reclamation, recycling and reuse: past, present, and future*, Water Science and Technology, 33(10-11): 1-14

Awasthi, A., Gandhi, K. and Rayalu, S. (2023*). Greywater treatment technologies: a comprehensive review*. Int. J. Environ. Sci. Technol,. https://doi.org/10.1007/s13762-023-04940-7

Bani-Melhem, K., Al-Qodah, Z., Al-Shannag, M., Qasaimeh, A., Rasool Qtaishat M. and Alkasrawi, M. (2015). *On the performance of real grey water treatment using a submerged membrane bioreactor system*, Journal of Membrane Science, Cilt 476, ss. 40–49.

Can, A. S. A. N., GÜREL, L., and BÜYÜKGÜNGÖR, H. (2020). *Batik Ultrafiltrasyon Membran Biyoreaktörü İle Gerçek Gri Su Aritimi*. Konya Journal of Engineering Sciences, 8(1), 103-112.

Do Couto, E. D. A., Calijuri, M. L., Assemany, P. P., da Fonseca Santiago, A., and de Castro Carvalho, I. (2013). *Greywater production in airports: Qualitative and quantitative assessment*. Resources, conservation and recycling, 77, 44-51.

Durmuş Çalışkan, E., *Çimlendirme Ve Bakım Teknikleri*, https://avys.omu.edu.tr/storage/app/public/elif.kinik/135586/%C3%87%C4%B0MLEND%C4%B0RME%20VE%20BAKIM%20TEKN%C4%B0KLER%C4%B0%20ders%20sunum.pdf, (Accessed on: 13.10.2023).

Elmitwalli, T.A. and Otterpohl, R., (2007). *Anaerobic biodegradability and treatment of grey water in upflow anaerobic sludge blanket (UASB) reactor*, Water Research, Cilt 41, ss. 1379–1387.

Ghisi, E. and Ferreira, D.F. (2007). *Potential for potable water savings by using rainwa-*

ter and greywater in a multi-storey residential building in southern Brazil. Build. Environ. 42, 2512–2522.

Gould, J. and Nissen-Petersen, E. (1999). *Rainwater catchment systems for domestic supply*. Intermediate Technology.

IPCC, (2007). *Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, 104 pp.

IPCC, (2023). *Sections. In: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, pp. 35-115, doi: 10.59327/IPCC/AR6-9789291691647

Innocenti, L., Bolzonella, D., Pavan, P. and Cecchi, F. (2002), *Effect of sludge age on the performance of a membrane bioreactor : Influence on nutrient and metals removal*, Desalination, Cilt 146, ss. 467–474.

Intergovernmental Panel on Climate Change,(2007. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge, UK, 976pp.

Jefferson, B., Laine, A., Parsons, S., Stephenson, T. and Judd, S. (2000). *Technologies for domestic wastewater recycling*. Urban water, 1(4), 285-292.

Karahan, A., 2011. *Gri Suyun Değerlendirilmesi*, IX.Ulusal Tesisat Mühendsiliği Kongresi, 1155–1164

Kumar, M. D., 2004. *Roof water harvesting for domestic water security: who gains and who loses?*. Water international, 29(1), 43-53.

Li, F., Wichmann, K. and Otterpohl, R. (2009*). Review of the technological approaches for grey water treatment and reuses*, Science of the Total Environment, Cilt 407, ss. 3439–3449.

Lv, W., Zheng, X., Yang, M., Zhang, Y., Liu, Y. and Liu, J. (2006). *Virus removal performance and mechanism of a submerged membrane bioreactor*, Process Biochemistry, Cilt 41, ss. 299–304.

Melin, T., Jefferson, B., Bixio, D., Thoeye, C., De Wilde, W., De Koning, J., van der Graaf, J. and Wintgens, T. (2006). *Membrane bioreactor technology for wastewater treatment and reuse*", Desalination, Cilt 187, ss. 271–282.

Merz, C., Scheumann, R., El Hamouri, B. an Kraume, M. (2007). *Membrane bioreactor technology for the treatment of greywater from a sports and leisure club*, Desalination, Cilt 215, ss. 37–43.

Meteoroloji Genel Müdürlüğü, *Resmi İstatistikler*, https://www.mgm.gov.tr/verideger-lendirme/il-ve-ilceler-istatistik.aspx?m=ADANA, (Accessed on: 13.10.2023).

Pacey, A. and Cullis, A. (1986). *Rainwater harvesting. The Collection of Rainfall and Runoff in Rural Areas*. Intermediate Technology Publ., London.

Ottoson, J. and Stenström, T. A. (2003). *Faecal contamination of greywater and associated microbial risks*. Water research, *37*(3), 645-655.

Oweis T., Prinz D. and Hachum A. (2001). *Water Harvesting: Indigenous Knowledge for The Future of The Drier Environments. International Center for Agricultural Research in the Dry Areas (ICARDA)*, Aleppo, Syria.

Sheikh, B. (1993). *The city of Los Angeles grey water pilot project shows safe use of grey water is possible*. In Water Management in the 90s: A Time for Innovation; American Society of Civil Engineers: New York, NY, USA, p. 681

Shiklomanov, I. A. and Rodda, J. C. (2003). *World Water Resources at the Beginning of the 21st Century*. Cambridge, UK, Cambridge University Press.

Stec, A. and Kordana, S. (2015). *Analysis of profitability of rainwater harvesting, gray water recycling and drain water heat recovery systems*. Resources, conservation and recycling, 105, 84-94.

Sturm, M., Zimmermann, M., Schütz, K., Urban, W., and Hartung, H. (2009). *Rainwater harvesting as an alternative water resource in rural sites in central northern Namibia*. Physics and Chemistry of the Earth, Parts A/B/C, 34(13-16), 776-785.

Tema (2017). *TEMA - Geleceğin suyu*. Available online: https://silo.tips/queue/gelecen-suyu-sutemaorgtr?&queue_id=-1&v=1697150010&u=MTc2LjQyLjI2LjY2 (Accessed on 13.10.2023).

UN World Water Development Report (2023). *Partnerships and Cooperation for Water*. UNESCO Publishing, ISBN 978-92-3-100576-3, Available online: https://unesdoc.unesco.org/ark:/48223/pf0000384655 (Accessed on: 13.10.2023).

UN World Water Development Report (2003). *Water For People, Water For Life Executive Summary*, United Nations Educational, Scientific and Culturel Organization (UNESCO), UN Water, World Water Assesment Programme, UNESCO Publishing, ISBN: 92-3- 103881-8.

UNESCAP (United Nations Economic and Social Commission for Asia and the Pacific) (2012). *Water Resource Management: Policy Recommendations for the Development of Eco-Efficient Infrastructure*, Available online: http://www.unescap.org/sites/default/files/8.%20Water-Resource-Management.pdf (Accessed on 13.10.2023).

Wilderer, P. A. (2004). *Applying sustainable water management concepts in rural and urban areas: some thoughts about reasons, means and needs*. Water Science and Technology, 49(7), 7-16.

Wilson, A. (1997). *Rainwater Harvesting*. Environmental Building News, 6(5), 9-13.

Winterbottom, D. (2000). *Rainwater harvesting*. Landscape Architecture, 90(4), 40-46.

Wurochekke, A.A., Harun, N.A., Mohamed, R.M.S.R. and Kassim, A.H.B.M. (2014). *Constructed wetland of lepironia articulata for household greywater treatment*, APCBEE Procedia, Cilt 10, ss. 103– 109.

WWF-TR (2014). *Türkiye'nin Su Riskleri Raporu*, Ofset Yapımevi: İstanbul. Erişim Adresi: http://awsassets.wwftr.panda.org/downloads/turkiyenin_su_riskleri__raporu_web.pdf (Erişim Tarihi: 12.10.2022)

Zhang Y., Grant A., Sharma A., Chen D and Chen L. (2010). *Alternative water resources for rural residential development in Western Australia*. Water Resource Management, 24: 25-36.

Chapter 6

DEVELOPING PROPOSALS THROUGH THE INTEGRATION OF SPACE SYNTAX, TRAVELING SALESMAN PROBLEM AND PARTICLE SWARM OPTIMIZATION IN THE ARCHITECTURAL CONTEXT

Gencay ÇUBUK[1]

Sennur AKANSEL[2]

1 Res. Assist. Dr. Gencay ÇUBUK, Trakya University, Faculty of Architecture, Department of Architecture, ORCID: 0000-0002-7908-976X

2 Prof. Dr. Sennur AKANSEL, Trakya University, Faculty of Architecture, Department of Architecture, ORCID: 0000-0002-2052-8289

1. Introduction

There are many studies showing that the space syntax process, traveling salesman problem and particle swarm optimization have interrelated important points in terms of architectural design. These studies contain important data, both in terms of their relationships with each other and their approaches to identifying axial areas and nodal points in problem solving. It is understood that all methods and approaches that address these three processes offer solutions to make public preferences better detectable if configuration and sustainability are matched with the security theme. In this context, the preferences of both individuals and masses in the city and wedding points and the linear axes they prioritize make important contributions to urban continuity and the efficiency of the axes. From an architectural design perspective, the space syntax process, particle swarm optimization and traveling salesman problem have both important advantages and some restrictive disadvantages. Each way of working contains potentials for increasing the efficiency of areas that can be developed in terms of architectural design and includes appropriate methodologies to use these potentials. Developing spatial proposals through the integration of space syntax, TSP and PSO in the architectural design process is only possible by examining architectural advantages, constraints and potentials.

2. Overview of Space Syntax, TSP and PSO

Examining the relationship between spatial configurations and user behavior is among the main purposes of the space syntax process. Considerations on how to describe and predict socio-spatial experience provide important criteria for determining processes of understanding movement and user behavior within urban spaces. The studies, which provide a theoretical basis to understand and facilitate the application of the space syntax process in urban space, aim at the visibility of the relationship between human behavior and spatiality by examining public spaces and interior spaces as working spaces. Analyzing some basic squares provides effective solutions as these squares work as turning points and mediates the determination of the basic preferences in the organic movement of individuals and masses (Abdelalim et al, 2023).

It is known that the traveling salesman problem is a classic algorithmic problem in computer science operations research. The fact that topics that will arise as sub-problems in many fields, such as DNA sequencing, can be solved with the traveling salesman problem provides important clues that the basic solution style has very strong references and possibilities in distance calculations and optimization problems between places. The fact that very complex problems related to planning and logistics can be solved even in the purest form of the traveling salesman formulation through various paradigms

indicates that this problem can yield very important results for distance and stop optimization not only between certain years but also in the coming years. (Gohil et al, 2022). Particle swarm optimization is used not only for the traditional optimization of incoming systems, but also to reduce the error rate in the entire search space. The optimization means that the update works with a guide, refreshing each time to explore the area more intensively. By using multi-swarm particle swarm optimization for clock detection with the proposal of an incremental fashion control approach, the components that are a major obstacle in pattern control and disrupt the process reveal that the gradual incremental approach shows a greater success rate in terms of diversity and density (Kumazawa et al, 2023). Architectural design outputs related with space syntax, traveling salesman problem and particle swarm optimization also include these components (Image 1).

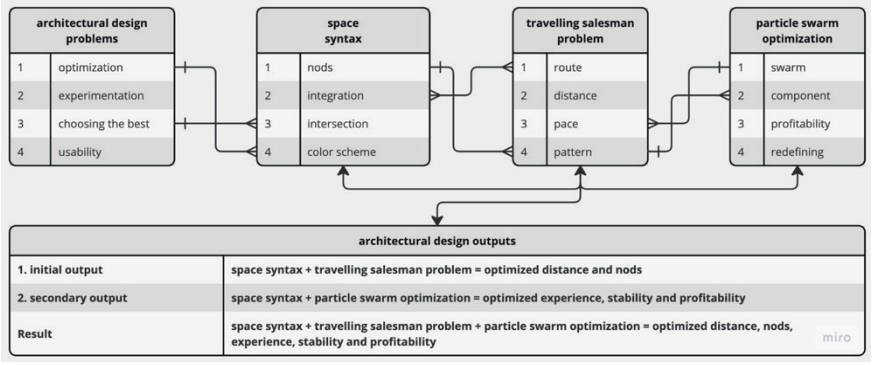


Image 1. *Architectural design outputs related with space syntax, traveling salesman problem and particle swarm optimization. Created specifically for this chapter.*

3. Integration of Space Syntax, Travelling Salesman Problem and Particle Swarm Optimization for Architectural Design

Promoting the creation of an inclusive public life, public spaces fundamentally aim to stimulate not only visibility but also social interactions. Among these places, which take as a criterion that interaction opportunities offer few opportunities for encounters and socialization, dual settlements and large urban expansions are decisive. Contrary to the solutions in European cities, which are mainly associated with space syntax, it is an important example in this context to see that there are extremely limited opportunities in the city center of Luanda in Angola, as an African example, and that there is not enough data on how to evaluate wedding points on a micro scale. In fact, although this example points to the importance of the space syntax process, it also contains data that the space syntax process will provide an inadequate solution without public participation. In this regard, the protection of city centers that have the potential to encourage public life and the private sector's

provision of special contributions to the development of communities and public spaces for the revitalization of urban life are among the most important topics that should be targeted as basic inputs (Inglês et al, 2023).

Identifying primary spatial values in the built environment in order to detect implicit relationships in space and developing a new representation tool to express their outputs in a rational manner are among the most important goals of the space syntax process. In the 1970s, the most important goal of Bill Hillier and related studies at The Bartlett School was to create an approach that showed an effective organic spread regarding space and could offer solutions and values that were both flexible and rational enough. In this context, the importance of the space syntax process, both in interior architecture and in defining the relationship between the axes in the city and in determining the busy wedding points, has been better understood and related approaches have accelerated (Hillier and Hanson, 1984). If configuration and sustainability are matched with the security theme, public preferences become better detectable. In this context, the preferences of both individuals and masses in the city and wedding points and the linear axes they prioritize make important contributions to urban continuity and the efficiency of the axes. This situation is valuable in determining the future of cities and their public developability potential (Nes and Yamu, 2021). It is possible to evaluate anthropological studies and the differences between learning styles in this context. This situation provides important data in that the space syntax process highlights how fundamental differences are observed between individuals and local governments in preferences and public priorities (Hillier and Iida, 2005). In this context, it should be understood that the concepts of space and space syntax are actually concepts of space analysis, and basic strategies should be developed to ensure that this analysis process is about the preferences of the users and the improvement of the processes that play a role in giving these preferences (Li, 2023).

Space syntax data obtained by examining open and closed spaces gives insight not only about those spaces, but also about urban and global preferences and determinants that are indirectly related to the data related to those spaces. In relation to sustainable development goals, it is known that the space syntax process is related to the flow in urban environments and the connectivity values in closed structured systems. Analyzing pedestrian flow is necessary for the production of a sustainable architecture and mediates the response of pedestrian movements defined in the literature on the plan plane. Open urban systems and closed structures, which are among the most important systems where the mass is observed, offer some flexibility in the architect's authority to determine the user's preferences regarding functionality (Leite et al, 2023). One of the most useful features of the traveling salesman problem for cities divided into clusters is that it contains the potential to trigger new studies in

which the necessity of visiting cities consecutively can be eliminated. When the process of finding the shortest tour among all cities is shaped by a meta-heuristic solution proposal consisting of an artificial bee colony and the Tabu search algorithm, it shows how flexible the traveling salesman problem is and how potential it contains to offer solutions for new distance calculations for cities. (Nourmohammadzadeh and Voss, 2023). Spatial intersections of space syntax, traveling salesman problem and particle swarm optimization widen this approach by reevaluation of integration and optimization (Image 2).

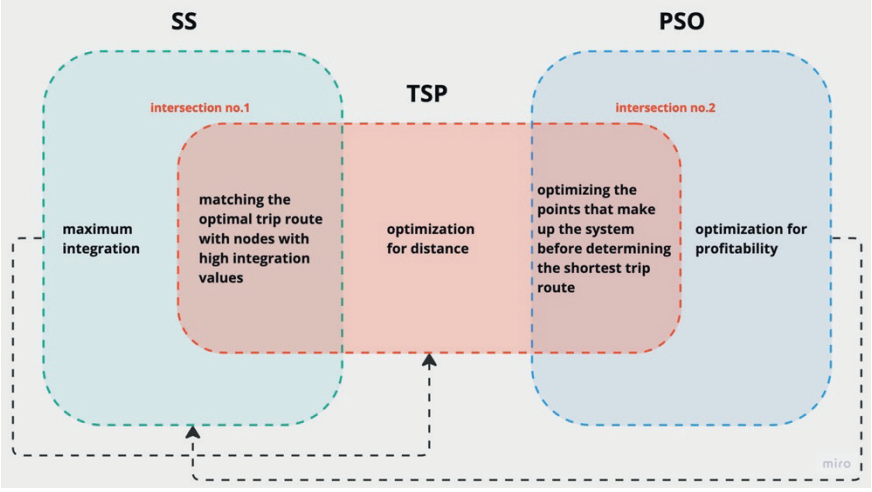


Image 2. *Spatial intersections of space syntax, traveling salesman problem and particle swarm optimization. Created specifically for this chapter.*

In an example involving the neighborhood of a series of polygons that takes into account polygonal obstacles, a meta-heuristic method called generalizing the large neighborhood search can be used for the traveling salesman problem. It is seen that the proposed approach in an environment blocked by certain criteria and limits is developed with a state-of-the-art algorithm modified for the disabled environment, and many contemporary technologies, including robotics, can provide reference in studies on solutions between distances and minimizing distances between neighborhoods (Kulich et al, 2023). Applegate et al. (2011) emphasizes that relevant studies have been developed not only by mathematicians, but also by computer scientists, chemists, physicists, psychologists and a number of non-professional researchers, and they actually want to emphasize that this topic is the most important variable of a process that can be addressed by many different disciplines. The fields of logistics, genetics, production, telecommunication and neuroscience are among the areas where the traveling salesman problem is most frequently used. The fact that it provides data to popular culture and can easily find a place in contemporary mathematical activities makes it easier for the traveling salesman problem to remain up-to-date. Applegate (2011) emphasizes

that local search methods, the namesake of the traveling salesman problem, are among the main tools for calculating tours that can visit the maximum number of vertices in the shortest distance in TSP examples. Another important information is that the neighborhoods used in local search algorithms are equal to the number corresponding to the identical polynomial sets and indicating the number of elements in these sets. In addition to the development of computational testing of code with relational theory and algorithms, combinatorial optimization is known as a popular topic of TSP. After the problems are classified according to their difficulty level, especially time complexity, the solution steps are listed. The aim of combinatorial optimization is to choose the one that minimizes an objective function from a finite set of configurations of the system, and the most famous combinatorial problem is the traveling salesman problem (Parpas and Rüstem, 2008). The ant system, considered as an example of this issue, offers a very original solution. By varying a set of densities to reduce the convergence rate, an updated system relies on re-optimizing paths based on a new routing to prevent participants from getting stuck in a local optimum. The results of the algorithm attract attention because the proposed method offers better solution suggestions than previous methods. Noteworthy points include local search improving thresholds, with swap insertion and inversion being the most commonly used methods, and performing a series of sequential operations to refine the usage preferences of a bounded population, taking into account the criterion of reducing the convergence rate. (Rungwachira and Thammano, 2023). Related with the convergence rate, spatial intersections of space syntax, traveling salesman problem and particle swarm optimization also supports the need for creating the most durable composition (Image 3).

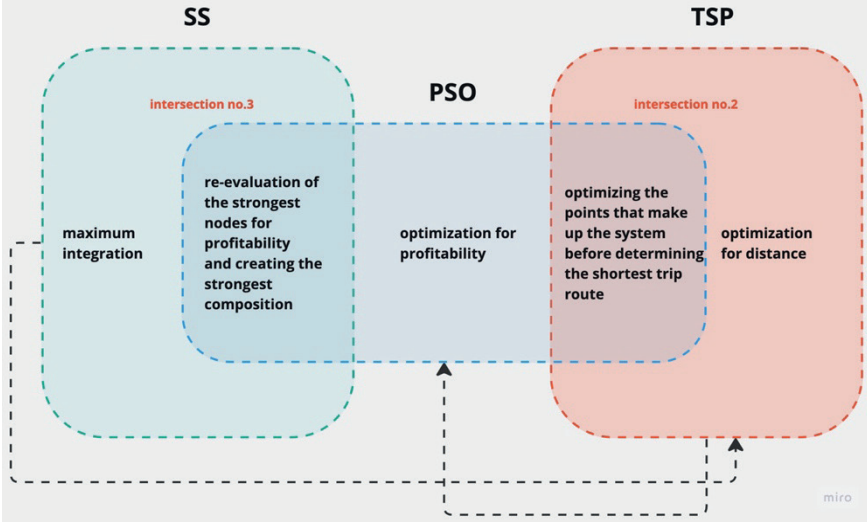


Image 3. *Spatial intersections of space syntax, traveling salesman problem and particle swarm optimization. Created specifically for this chapter.*

Particle swarm optimization, which is a computational method used to find the most suitable solutions at a random search time, offers many useful fields of study for researchers due to its simplicity and effective performance, and the high potential of the mathematical model of the algorithm in terms of detecting and correlating basic variables such as speed, location and suitability. . Optimization of the strategies that flying swarms or organized groups are about to develop to benefit from in search of food sources in order to increase performance by adjusting the position and speed parameters can also be achieved with the help of particle swarm optimization. Thanks to its basic features such as time-varying acceleration and systematic operation, particle drive optimization provides solution suggestions that aim to identify and use the most beneficial and advantageous solution for the system by providing a correlation between the most advantageous values for the system. These solution suggestions can be in the form of tabular data or directly in the three-dimensional modeling of the system. They offer effective solutions on basic topics such as obtaining the most efficient section, creating the fastest solution, and optimum load distribution (Khandelwal and Sharma, 2023). Kennedy and Eberhart (1995) introduce particle swarm optimization as a method for optimizing nonlinear functions. He points out that the method was discovered through simulation of a simplified social model. The best ones are appointed as a result of the comparison and highlighted as the best of the system. Thus, speed and position values are renewed. Once the stopping criterion is included in the system, the result is displayed. In their next, more comprehensive and deepened study on swarm intelligence, Kennedy and Eberhart (2001) emphasize that optimization is a term with different connotations and repeat with examples that the goal is to find the best, and that in some cases, a "good" result can also be the best. At this point, it is pointed out that the complex attitudes and behavior patterns of social interactions between "particles" are the main factors that determine the efficiency of the optimization. Cichocka et al. (2017) also points out that PSO offers more successful results in terms of efficiency compared to Galapagos, Goat and Octopus. Related to this topic is Silvereye, which is a plugin that works as a particle swarm optimization provider on Grasshopper (Cichocka et al., 2017). When we look at the theoretical foundations of particle swarm optimization, it can be seen that some important variations of the algorithm make more significant contributions to the optimization process. In this context, the use of stopping criteria and mutation operators together with swarm initialization techniques and swarm topologies provides valuable data in many basic areas such as boundary approaches and complete presentation of variations (Kouziokas, 2023).

One of the most basic criticisms regarding this issue is that social and psychological criteria are ignored due to the prioritization of economic criteria.

There are some basic advantages that will enable the development of the particle swarm optimization algorithm for the basic problems of systems that show the phenomenon of fragmentation and do not fully constitute a disciplinary theory system. The failure to evaluate these advantages adequately is also due to the limitations of particle swarm optimization in the literature. Better success of the improved particle swarm optimization algorithm compared to previous versions can only be possible by developing strategies that prioritize not only economic problems but also social and ecological benefits. However, if such a situation is realized and only if it is applied in multi-perspective studies, particle swarm optimization will not only enable the systems to create outputs to provide them in the most economically efficient way, but also to create additional value to improve the social operability and ecological added value of these systems. can be provided with an identity that will provide To solve an optimization problem, the Silvereye component needs to be operated in the Grasshopper interface and the number sliders need to be connected to the gene pool components. These parameters form the N-dimensional search space of the optimization problem. The best result is shown at the top of the list. The best result obtained in any iteration is restored by selecting a row in the table and clicking the Restart button (Cichocka et al., 2017). The default swarm size is set to 20 particles. A higher particle count means more dense sampling of the fitness environment, thus reducing the chance of missing good solutions or getting stuck in the local optimum. If Silvereye cannot find a better solution, it tends to find a solution close to the one suggested by the user. Matching the optimal trip route with nodes with high integration values and re-evaluation of the strongest nodes for profitability and creating the strongest composition can be seen as the intersection of the related themes (Image 4).

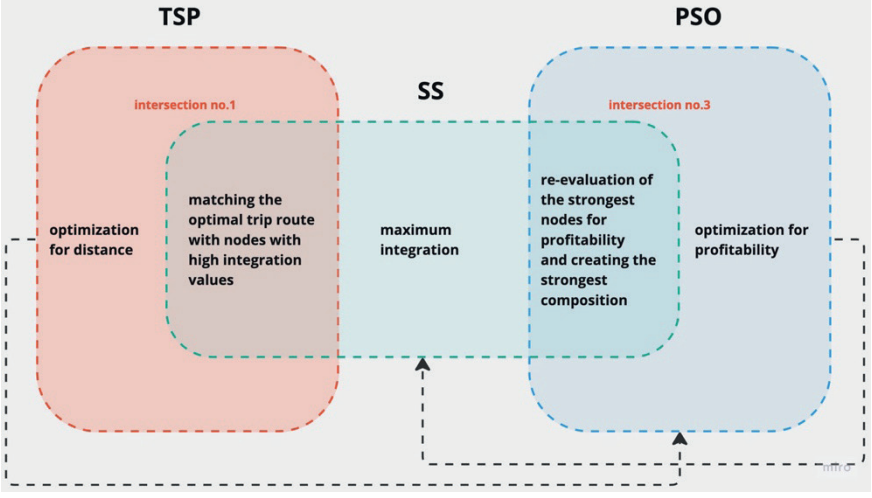


Image 4. *Spatial intersections of space syntax, traveling salesman problem and particle swarm optimization. Created specifically for this chapter.*

Although PSO is not the first swarm intelligence-based meta-heuristic algorithm, it offers efficient results in terms of collaboration with Python. In this context, it is very important to test the processes of how this algorithm can be implemented in the Python programming language. In this efficiency, it is important that PSO internalizes parallelized calculation in addition to its abstract and simple calculation structure and offers the optimization of the whole system in the most appropriate and short time (Zolghadr-Asli, 2023). Similarly, the Reconstruction Particle Swarm Optimization (RPSO) algorithm, developed as an intelligent approach based on the linear system theory of particle swarm optimization (PSO), provides qualified suggestions to successfully solve discrete optimization problems (Zhu et al, 2023).

4. Advantages and Limitations

From an architectural design perspective, the space syntax process, particle swarm optimization and traveling salesman problem have both important advantages and some restrictive disadvantages. If we need to list the advantages in terms of architectural design, these advantages can be listed as follows. Space syntax is valuable in terms of determining the node points and providing insight into how the preference of the most used axes by pedestrians may change. The space syntax method used in a public space can also be used indoors without the need to change too many parameters. In this way, it is determined how user preferences can change through connected roads and how popular stops can be matched with popular nodes (Image 5).

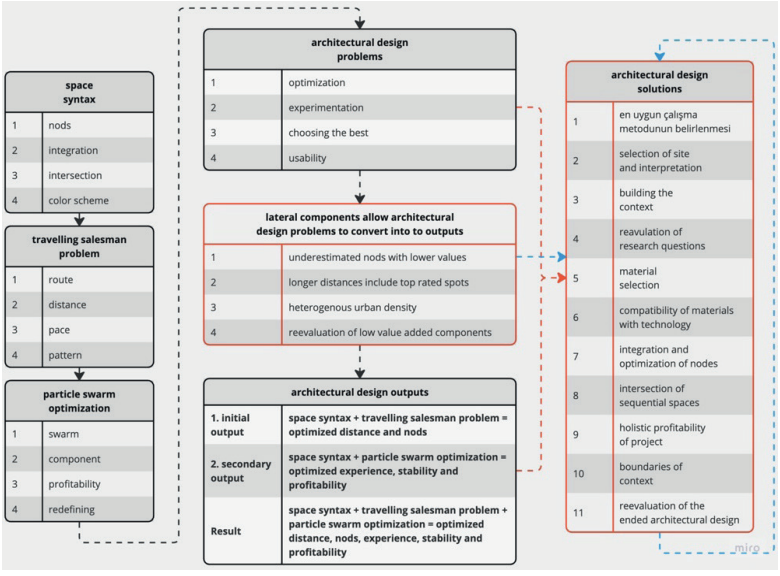


Image 5. *Spatial intersections of space syntax, traveling salesman problem and particle swarm optimization. Created specifically for this chapter.*

The color scale offered by the space syntax process creates not only a numerical hierarchy between connection paths and nodes, but also an organic distribution whose gradations are distinguished with the help of color differences. The traveling salesman problem, related to space syntax, also offers significant advantages that can be used in all disciplines to reach the most productive points in the shortest time. Identifying the most important spatial points for users allows users to spend less time creating important navigation routes. In examples where the hierarchy between these visited points is determined with the help of space syntax and distance optimization is solved with the traveling salesman problem, the most desired points are visited and the route is optimized by using the shortest time during this visit. The main reason why the traveling salesman problem works as a solution partner compatible with space syntax is that the high inter-space connectivity and interaction values are as important in architectural design as the spaces themselves. In this context, distance values optimized through the traveling salesman problem ensure that points selected with high preference values in indoor and public spaces are included in the route and create a richer route. This provides significant contributions to institutions and art works produced with many different spatial registers, such as businesses, museums, galleries, experience installations that stand out with their navigation routes and want to show different spatial features to their users at a unit time. Finally, it offers a general comprehensive optimization proposal that will solve the two-dimensionality problem in routes optimized with the help of particle swarm optimization, space syntax and traveling salesman problem. At this point, the particle swarm optimization process, based on speed and diversity, allows not only the priority use of the best parts, but also the production of the main product or the main space or the main structural component with the highest efficiency, with the help of the unity of the parts. It is known that the most successful examples of this are seen in the optimization of elements such as roofs, insulation layers or structural components.

On the other hand, when looking at the disadvantages, it is known that the space syntax process will cause the connection roads and important city values that contribute to the social and urban image to not be detected, as it focuses on the color scale at the wedding points. It is known that this situation may cause many important city components such as connection roads and wedding points to be ignored if the venues are evaluated individually and their name is used alone. Therefore, carrying out supporting studies in addition to the space syntax ensures that urban components that are important to city users are not ignored and a more homogeneous route is created in terms of spatial experience. Similarly, although the traveling salesman problem is a solution that focuses on optimizing the distance between places and aims to shorten the distance and provide the most efficient service, sometimes

users choosing the long route may be a necessity in terms of urban flow and continuity. Successful examples can be seen in museums and open exhibition areas, or in consciously slowed walking paths in landscape design. In these roads, a road is either lengthened or made more curvy so that pedestrians are deliberately slowed down, creating a special experience. Observable constraints related to architectural design in particle swarm optimization are also related to this. The goal of particle swarm optimization is to optimize a system to achieve maximum economic efficiency. However, this method may cause some experience focuses to be ignored and the user's psychological and social priorities to be ignored. Although particle swarm optimization provides successful results in terms of economic efficiency, it must be supported by lateral components in order to be successful in basic issues such as spatial operability, spatial continuity and spatial flow.

5. Discussion and Conclusion

When looking at the spatial proposal development processes by examining the advantages and constraints of the integration of space syntax, TSP and PSO in the architectural design process, it is seen that the following inferences can be made. Publicity is one of the easiest areas to study in the process of associating the space syntax process with the traveling salesman problem. Because generally public preferences work more efficiently in areas where the integration values of sensation points are highest. In addition, if the efficiency opportunities provided by particle swarm optimization are added to the partnership of the traveling salesman problem and the space syntax process, a space image that is both efficient and offers high values in terms of the integration value of the sensory points, and in addition provides the highest experience opportunity in the shortest distance, is created. Regarding this issue, when we look at the use of the space syntax process in interior spaces, we can talk about a scaled-down version of a similar process. In order to obtain maximum experience between spaces with different functions, basic concepts such as duration and depth of experience can be improved through particle swarm optimization. For this purpose, after the surveys regarding spatial efficiency obtained from users are assigned as coefficients to spatial components, these coefficients can be optimized, just like in the process of developing a structural component with particle swarm optimization, and can mediate the creation of an experience route for users that spreads homogeneously within the space. When the optimization of the traveling salesman problem for covering all stops in the shortest time is combined with the diversity and efficiency of the wedding points in the space syntax, all that remains is to improve the original efficiency values of all these components with particle swarm optimization. For this reason, it is understood that particle swarm optimization can contribute to the areas where space syntax and traveling salesman problem provide common solutions. As a result, while

the risk that social, psychological and experience-oriented special urban points in the space syntax may be ignored can be sidelined with user surveys, the data obtained from here can be decisive in the preference processes of businesses and architects with the speed and time-oriented approach of the traveling salesman problem. The most successful results in terms of spatial pattern and inter-spatial user experience will be achieved if particle swarm optimization is used so that economy-oriented solutions can support social and psychological data and experience data obtained from surveys.

This research is composed of part of the doctoral dissertation originally named "Açık Alanlarda Kamusallığın Geliştirilmesine Yönelik Çözümlerde Parçacık Sürü Optimizasyonunun Kullanımı: Bir Model Önerisi".

REFERENCES:

Abdelalim, A., Khalil, H., Sobhy, T., Farouk, H. (2023). Space Syntax as a Vital Tool to Enhance Urban Spaces. ERU Research Journal. 1. 399-414.

Applegate, D. L., Bixby, R. E., Chvátal, V., & Cook, W. J. (2011). The Traveling Salesman Problem. Amsterdam: Amsterdam University Press.

Cichocka, J.M., Migalska, A., Browne, W.N. & Rodriguez, E. (2017). SILVEREYE– the implementation of particle swarm optimization algorithm in a design optimization tool. Computer-aided architectural design: future trajectories : 17th International Conference.

Gohil, A., Tayal, M., Sahu, T., Sawalpurkar, Vy. (2022). Travelling Salesman Problem: Parallel Implementations & Analysis. 10.48550/arXiv.2205.14352.

Hillier, B. & Hanson, J. (1984). The Social Logic of Space. Cambridge: Cambridge University Press.

Hillier, B., Yang, T. & Turner, A. (2012). Normalising least angle choice in Depthmap and how it opens new perspectives on the global and local analysis of city space. Journal of Space Syntax 3 (2).

Inglês, A., Cannas, L., Heitor, T. (2023). Urban Design, Architecture and Space Syntax in the Conception of Public Spaces—A Look at Luanda's Revitalization. 10.1007/978-981-99-2217-8_8.

Khandelwal, Mukesh & Sharma, Neetu. (2023). A Survey on Particle Swarm Optimization Algorithm. 10.1007/978-981-99-3485-0_47.

Kouziokas, Georgios. (2023). Swarm Intelligence and Particle Swarm Optimization. 10.1201/9781003247746-3.

Kulich, M., Vidašič, J., Mikula, J. (2023). On the Travelling Salesman Problem with Neighborhoods in a Polygonal World. 10.1007/978-3-031-15226-9_32.

Kumazawa, T., Takimoto, M., Kodama, Y., Kambayashi, Y. (2023). Enhancing Safety Checking Coverage with Multi-swarm Particle Swarm Optimization. 10.1007/978-3-031-37616-0_12.

Leite, P., Oliveira, C., Moro, L., Bodah, B., Mores, G., Junior, D., Engel, A., Santosh, M., Neckel, A. (2023). Space Syntax: Expression of Science on User Flows in Open and Closed Spaces Aimed at Achieving SDGs. 10.20944/preprints202307.0655.v1.

Li, H. (2023). Spatial Hierarchies: Enlightenment to Space Syntax Theory. Advances in Economics and Management Research. 6. 438. 10.56028/aemr.6.1.438.2023.

Nes, V. A., & Yamu, C. (2021). Introduction to Space Syntax in Urban Studies. NY: Springer.

Nourmohammadzadeh, A., Voss, S. (2023). A Hybrid Metaheuristic for the Clustered Travelling Salesman Problem. 10.1007/978-3-031-24907-5_46.

Parpas P., Rustem B. (2008). Laplace Method and Applications to Optimization Problems. Encyclopedia of Optimization. Boston: Springer https://doi.org/10.1007/978-0-387-74759-0_322.

Rungwachira, P., Thammano, A. (2023). Hybrid Sweep Algorithm and Modified Ant System with Threshold for Travelling Salesman Problem. 10.1007/978-3-031-20738-9_36.

Zhang, D., Li, B. (2023). Application Progress of Particle Swarm Optimization in Modern Literature. 10.1007/978-3-031-23947-2_65.

Zhu, J., Liu, J., Chen, Y., Xue, X., Sun, S. (2023). Binary Restructuring Particle Swarm Optimization and Its Application. Biomimetics. 8. 266. 10.3390/biomimetics8020266.

Zolghadr-Asli, B. (2023). Particle Swarm Optimization Algorithm. 10.1201/9781003424765-7.