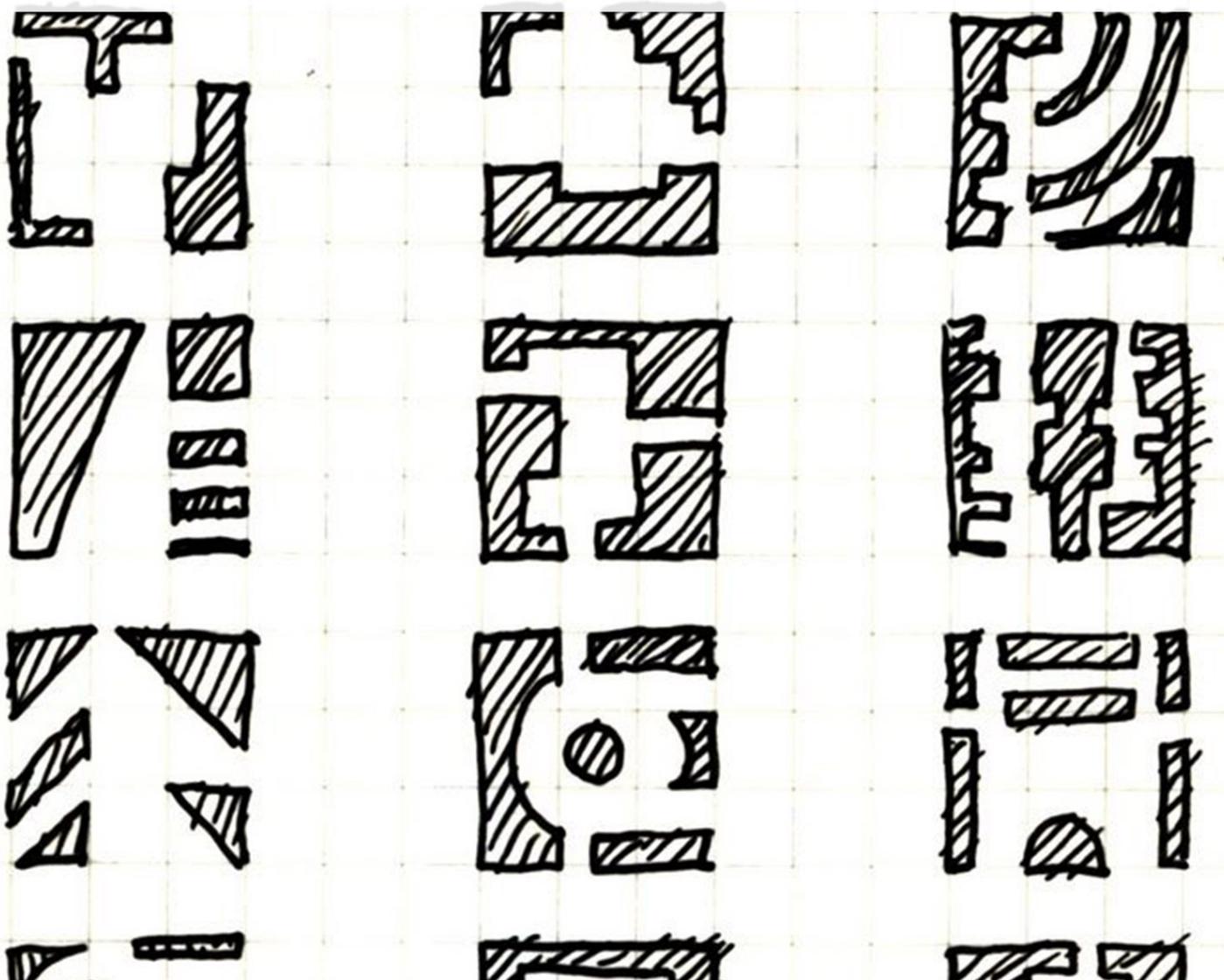


CONTEMPORARY ISSUES IN ARCHITECTURE AND URBAN PLANNING

Architectural & Urban Forms



EDITED BY
YILDIZ AKSOY
EFE DUYAN

DAKAM

**CONTEMPORARY ISSUES IN
ARCHITECTURE AND URBAN
PLANNING**

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AN ANALYSIS ON GREEN AREAS AND THE POTENTIAL OF IRRIGATION USING RAINWATER AND GREY WATER: A CASE STUDY FROM THE MEGACITY ISTANBUL

BILSEN BELER BAYKAL¹, ÖZGE GÜRSOY², YILDIZ AKSOY³, AHMET SAMSUNLU⁴

ABSTRACT

Increasing population and urban sprawl in the last 50 years has led to the reduction of urban green and increase in water demand in the Turkish megacity Istanbul. As water resources of the megacity are limited, finding alternatives to maintain continuity and sustainability is a main issue in the agenda and harvested rain water and reclaimed grey water are two options. Ataköy is one of the neighborhoods with the most green areas in Istanbul. Its green areas are irrigated by using municipal water supply between April and October. This paper aims to present an overview of the change in urban green in the Atakoy neighborhood of Istanbul, the potential and possibility of using rainwater and greywater for its irrigation, to provide an example to be extended to elsewhere experiencing similar problems. First, irrigational water demand of Atakoy and its zones was calculated, then rain water harvesting, and grey water collection potentials were estimated. A comparison of the demand and the potential has revealed that 20% of the demand for green areas could be provided from rain water, 79% from grey water on an annual basis. The combination of both rain water and grey water can cover almost the entire demand. Zone 2 of Atakoy was observed to be the most effective for collection of rainwater and second most effective for grey water. A preliminary analysis was performed for storage in the zone with the highest potential (Zone 2) to suggest possible storage areas mostly under parking lots. The results show that considerable water savings may be achieved through the use of that rain water and grey water. These alternative water resources are valuable options that can aid the sustainability of water resources and water services, and the potential for their use is motivating.

KEYWORDS: Rainwater, Grey Water, Irrigation, Urban Green, Alternative Water sources

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1. INTRODUCTION

Currently the world is experiencing a serious problem of water stress and water scarcity and trying to find ways of dealing with this global concern. More pronounced in megacities, population increase, urbanization, droughts and increasing temperatures due to climate change lead to risks of enhanced losses/reductions in reservoirs, surface and groundwater resources (Stavenhagen et al., 2018).

The world has been experiencing a rapid flow of population from rural to urban areas. Urban population is increasing on a global scale, and as of 2018, 55% of the world population lives in urban locations. It is estimated that this number will raise to 68% by 2050. As opposed to two megacities in the World in 1950, i.e. New York and Tokyo, the number of megacities with populations exceeding 10 million was 33 in 2017 and it is expected to go up to 43 in 2030 (UN, 2018).

An increase in urban population accompanied by urban sprawl leads to increasing water demand. Providing water for the growing population within the urban areas becomes a challenge under most circumstances, especially when the increase is rapid. Hydrologists classify areas across the world with 1000 to 1700 m³ water per capita on an annual basis as areas of “water stress”, those with 500 to 1000 m³ as areas of “water scarcity” and those with less than 500 m³ as areas of “absolute water scarcity”. Currently, 700 million people, over 9% of the world population, live in areas of water scarcity. It is estimated that 1.8 billion people will be living in areas of absolute water scarcity while two thirds of the world population will be under water stress by 2025 (UN Water, 2017; Beler-Baykal & Baykal, 2017). This dictates that finding new alternative sources of water is vital, as water resources are rather constant but the population is growing in time, meaning that water availability per capita will be reducing continually.

Rainwater and grey water are two alternative water resources commonly used around the globe to minimize water scarcity. Rainwater harvesting refers to collecting rainwater from rooftops, paved and unpaved areas to make use of it in the immediate surroundings for a number of beneficial uses. Besides being an old and common practice, there are numerous studies in variety of scopes that establish rainwater harvesting has great potential for sustainable urban environment. Studies show using harvested rainwater in residential areas for irrigation, toilets etc. to aid potable water savings is a viable option. (Nachson et al., 2016; Rostad et al., 2016; Devkato et al., 2015; Rahman et al., 2010; Anand & Apul, 2011).

Grey water is defined as domestic wastewater originating from kitchens, bathrooms and laundries, practically all wastewater from washing activities in the household, excluding the one from toilets which is commonly referred to as “black water”. It typically corresponds to three fourths of the conventional domestic wastewater by volume. As only about 40% of organic matter remains in grey water with low levels of nitrogen and phosphorus, and lower amounts of pathogens as compared to regular conventional domestic wastewater, recycling of this fraction can be done by using a much milder treatment (Beler-Baykal, 2015). Although grey water is expected to have a lower quality than rainwater, it is generated with greater regularity, making it superior to rainwater in terms of dependability, as availability of rainwater will be dependent on precipitation events which show a considerable variability. Grey water production varies in line with the habits of users, as well as the type of equipment/ appliances used. Especially the presence of water saving devices will have a major impact on grey water generation. Examples for the most common grey water reuse practices of irrigation include Pinto and Maheshwari (2010), Turner (2013) and for flush water Nolde (2000), Gual et al. (2008), Mourad et al. (2011).

Some studies have proved that the use of one alternative water source alone, i.e., grey water or rainwater, may not be sufficient to replace non-potable water demands. The use of rainwater and grey water could enable the full supply of non-potable water demand when building catchment areas are insufficient. Ghisi and Ferreira (2007), Ghisi and de Oliveira (2007), Muthukumaran et al. (2011), Schoen et al. (2017), Marinoski and Ghisi, (2019) are examples of studies which show potable water savings through the combined use of rainwater harvesting and grey water reclamation.

One of the major megacities of the world Istanbul has been experiencing a rapid population increase in the last 50 years with a population of 15,5 million in 2020 as opposed to 3 million in 1970 (TUIK, 2021). Paralleling this vast increase, there has been an increase in the total lot coverage and gross building area for settlements, which has in turn lead to apparent reduction in green areas. The population increase has also triggered an increase in water demand together with wastewater production. In Istanbul, all of those changes have resulted in a search to fulfill the responsibility concerning domestic water supply, irrigational water demand for green areas, wastewater management together with a need for rainwater management, and put those issues to the forefront of the agenda.

With about 1350 m³ per person per year water potential (MFA, 2021), Turkey is one of those countries experiencing water stress. Furthermore, Turkey is predicted to be one of the 30 countries which will have a high water stress by 2040 (UNESCO, 2016). In accordance with the population increase, water demand in Istanbul has been increasing in time as depicted in Figure 1 which was generated from data obtained from the Istanbul Water and Sewerage Administration. The figure shows the increase in the water supplied has been more pronounced in the recent years exceeding 1 billion m³ level in 2017. With about 80% of daily supply being used for domestic purposes, the total daily water supplied in the megacity has typically reached 2 100 000 m³, which is reported to increase in the summer months. However, as water resources in and around the megacity are insufficient to meet the demand, inter-basin water transfer is being done. The water resource which supplies the largest fraction of water to the megacity is Buyuk Melen Dam at a distance of about 200 km, pointing at the significance of identifying alternative water resources, especially those which are available on site like grey water and rainwater.

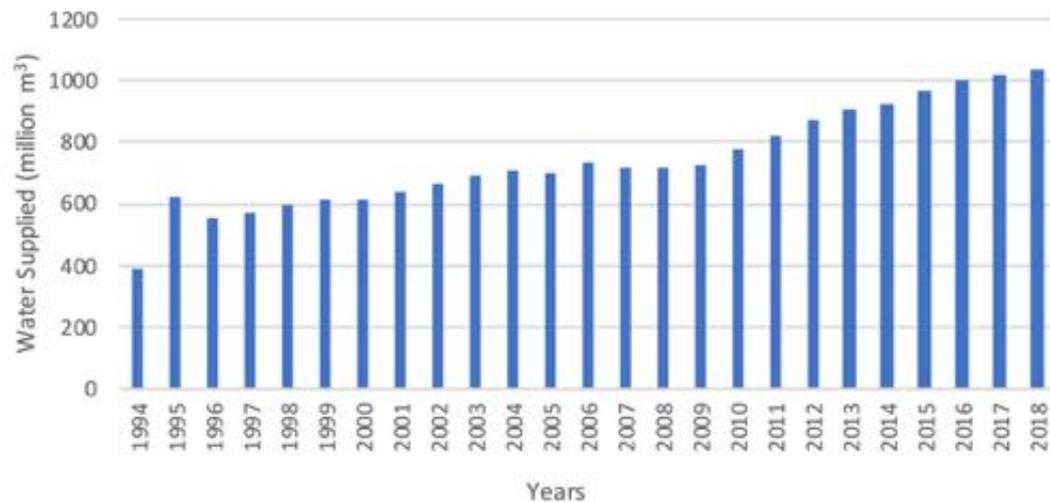


Figure 1. Change in the water supplied to Istanbul

Currently, the greatest majority of irrigational water by far is withdrawn from the municipal water supply, which has potable water quality, placing an additional demand upon the limited water resources of the megacity. The aim of this paper is to investigate the potential and the possible use of rainwater and grey water as alternative sources of irrigational water for green areas in private housing properties of a selected region in Istanbul. Atakoy neighborhood was selected as the pilot area to constitute a possible example for further applications of alternative water source use in the city and elsewhere to help maintain a sustainable city life with satisfactory water services to the society.

The paper also has the intention of providing an example for other locations facing similar issues and problems especially in urban areas in terms of identifying alternative sources of water. Although the emphasis of the paper rests with the irrigation of green areas, it is worthwhile to acknowledge reclaimed grey water and harvested rainwater as alternative sources of water for several other end uses led by toilet flushing and other functions like car washing, street cleaning, fire fighting and ornamental purposes which are common urban activities demanding water.

2. THE PROJECT SITE

Atakoy is a neighborhood within the boundaries of Bakirkoy Municipality of Istanbul, the most highly populated city of Turkey with a population exceeding 15,5 million (TUIK, 2021). The neighborhood had been designed as a satellite town in 1950's to serve the housing demand. Atakoy was built in 11 stages in 50 years and consists of 4 administrative zones. Location of the pilot area is shown in Figure 2. Located by the Marmara Sea, Atakoy neighbors Ataturk International Airport and the major European highway E-5.



Figure 2. Location of the project area (produced from Google Earth)

Atakoy settlement is one of the first mass housing projects of Turkey, with a new and well-planned approach including urban green space designs, transportation, low density housing and different building styles. Starting as a low density, middle income settlement, Atakoy evolved to be higher density and luxury area throughout the following 60 years.

Table 1, generated using the data obtained from Bakirkoy Municipality summarizes characteristics of Atakoy and its four zones in 2018. With the shopping mall, hotel and the marina within its boundaries, Zone 1 is marked by its commercial functions. It is the smallest zone with lowest land area, number of buildings and population. Majority of the buildings are low rise, low population and have high lot coverage per building. Originally the majority of the buildings consisted of 5-6 stories, again with low population and high lot coverage per building in Zone 2. However, there is on-going construction in the area with high rise mixed use buildings. Zone 3 has high rise buildings with high population, highest building density and low lot coverage per building. Zone 4 on the other hand has highest lot coverage and highest population. Most of the current buildings are eight stories high or higher, with areas which are newly opened for constructions also involving high rise buildings.

Table 1. Atakoy and its zones in 2018

	Area (ha)	Number of buildings	Number of households	Population
Zone 1	20	52	662	1 667
Zone 2	66	143	4 765	13 671
Zone 3	47	127	2 630	8 150
Zone 4	139	174	10 482	24 444
Total Atakoy	272	496	18 539	47 932

3. METHOD

Possible use of rainwater and grey water for irrigation in the Atakoy region has been investigated in this work. Analyses are based on rainwater harvested from building roofs and grey water collected from households, to irrigate green areas of the four zones of Atakoy each, as well as the entire neighborhood.

Green areas were calculated using maps supplied by Bakirkoy Municipality. Green areas are classified under three groups as active and passive areas which are owned municipality, and the privately-owned green areas which belong to housing settlements. Green areas in this work refer to the third group.

In an attempt to evaluate the option of using harvested rain and/or grey water for irrigation of green areas of the Atakoy district, the potential quantity of rainwater to be harvested from roof top areas and the amount of grey water that can be collected and reclaimed were calculated. Likewise, the amount of water demand for green areas were estimated. A comparison of the water demand and the potentially collectable rainwater and grey water was taken as the basis of decision upon the possibility of using these alternative water sources and their sufficiency for the intended purpose.

The rainwater potential was calculated based on data obtained from General Directorate of Meteorology (MGM) using the Ataturk Airport station. Average precipitation between 2009 - 2017 and in the year 2017 in the station is presented in Table 2 (MGM, 2018). Calculations were made using the values of 2017. Additionally, the current site plan supplied by Bakirkoy Municipality was used for calculating roof areas and it was assumed that %90 of precipitation could be harvested. Rainwater potential was calculated using $Q_r = A \times r \times \phi$, where A is the catchment are horizontal surface, r is precipitation intensity and ϕ is flow coefficient (0,90) (Sahin & Manioglu, 2018). Based on this formula, the potential in terms of collection of rainwater was evaluated, which is intended as irrigational water for green areas.

Table 2. Precipitation data in Ataturk Airport Meteorology station in 2017 (mm=kg/m²) (MGM, 2018)

	2009-2017 Average	2017
January	81.4	102.3
February	63.5	36.8
March	52.9	37.8
April	43.7	18.4
May	35.3	27.4
June	32.7	41.6
July	13.6	39.8
August	18.1	24.6
September	48.0	26.8
October	66.4	64.2
November	44.5	61.2
December	75.8	95.8

Average water consumption in Istanbul is given as 190 liters per capita per day (TUIK, 2018), and 90% of this, (171 liters per capita per day) corresponds to wastewater generation. Assuming that 70 % of domestic wastewater can be segregated as grey water, 120 liters per capita per day may be collected. Based on these values the quantity of grey water generated by inhabitants of Atakoy was calculated and potential of this to supply the irrigational water of green areas was investigated.

Green areas in Istanbul are typically irrigated between April and October, typically using 6 liters per m² per day, except in July and August where 12 liters per m² per day is used (Seckin & Celik 2003). Monthly irrigational water demand for green areas was calculated by multiplying the total irrigational area by the amount of irrigational water demand per square meter on a monthly basis. The demand for irrigational water was compared with the potential of harvested rainwater and grey water for sufficiency. Additionally, the storage requirement and possible areas for storage have been identified for Zone 2.

4. RESULTS AND DISCUSSION

Although the increasing population and built environment has led to a reduction in green areas there is still considerable need for irrigational water that is currently provided from the municipal water supply. This increases the load on the limited waterresource of the megacity further. In an attempt to alleviate the additional load, rainwater and grey water were investigated as two potential alternative sources of water.

4.1 Population And Green Areas In Atakoy

Population of Istanbul has increased rapidly after 1950's and reached 15 million in 2017. According to TUIK (2018), population of the city has increased 15 times in the last 70 years leading to urban sprawl, increase in the housing areas, decrease in green areas and increase in water demand. In line with this trend, population in Atakoy also increased together with its consequences since 1958, which marks the completion of the first stage of the housing project. From then on Atakoy gradually became one of the major centers of the megacity. Table 3 presents the change in population and gross density in Atakoy.

Table 3. The density changes of Atakoy between 1965-2017

	Population	Area (ha)	Gross Density (person/ha)	Area Information
1965*	4 360	38	114,7	Only Zone 1 and some parts of Zone 2 are in use.
1975*	18 343	118	157,9	Only Zone 1, some parts of Zone 2 and Zone 3 are in use.
1990*	39 307	47	92.9	Entire areas of Zone 1, Zone 3 and Zone 4 and some parts of Zone 2 are in use.
2001**	39 811	33	94.1	Entire area of Atakoy is in use.
2009**	43 040	76	101.7	Entire area of Atakoy is in use.
2017**	47 932	63	113.3	Entire area of Atakoy is in use.
*Calculations based on average household population				
** Population data from TUIK (2018)				

Atakoy is one of the neighborhoods in Istanbul which has highest densities of green areas. Urban green areas are divided into three groups as active, passive and privately-owned areas. Active and passive green areas which are the responsibility of the municipality refer to play grounds for children, park areas, sports areas, while passive green areas are wooded areas, grassy areas, traffic islands, squares and cemeteries. Privately-owned green areas refer to the green areas in and around buildings which are owned privately by housing buildings or complexes (Aksoy, 2001).

Based on 2017 data, the amount of active green areas per capita is 2 m² in Istanbul (Aksoy, 2017). According to the regulations of Turkey a total of 10 m² of active green area per capita should be provided (Official Gazette, 1999), as opposed to a minimum of 9 m² with the ideal between 10 to 15 m² as given by the World Health Organization (WHO, 2010). Table 4 presents active and privately-owned green areas in Atakoy. It may be observed that Atakoy and its zones has more the active green areas per capita than rest of the city. Moreover, in terms of privately-owned green areas per capita, Atakoy has more than WHO recommendations. The greatest portion of green areas of the neighborhood is privately owned. This is especially pronounced for Zone 1. But this abundance of green areas are not included active green area calculation because they are not for general public use.

Table 4. Privately-owned green areas per person and active green area per person in Atakoy and its zones in 2017

	Zone 1	Zone 2	Zone 3	Zone 4	Total
Population (TUIK, 2018)	1 667	13 671	8 150	24 444	47 932
Privately-owned green area (m²)	131 400	253 150	243 791	422 637	1 050 978
Privately-owned green area per capita (m²/ capita)	79	19	30	17	22
Active green area (m²)	6 700	92 100	22 347	199 190	320 337
Active green area per capita (m²/ capita)	4	7	3	8	7

Figure 3 and Table 5 show the variation of green areas, lot coverage and gross buildings areas in entire Atakoy in years. It may be observed that green areas predominate over others in 1982. This is due to the fact that not all zones had been completed and buildings were mostly low rise. As the number of high rise buildings

increased in Atakoy, gross building area started to predominate. However, land area occupied by green areas still exceeds lot coverage of buildings.

Table 5. Variations of green areas, lot coverage and gross building areas in Atakoy

Atakoy	1982	2001	2009	2017
Lot coverage (m ²)	413 700	670 360	749 585	1 048 945
Change (%)		62	12	40
Gross building area (m ²)	1 027 380	79 496 480	80 181 100	80 710 320
Change (%)		7 638	0,9	0,7
Total green area (m ²)	2 393 300	1 884 200	1 819 650	1 640 400
Change (%)		-21	-3	-10
Population	37 250	39 811	43 040	47 932
Total green area per capita (m ² / capita)	64	47	42	34

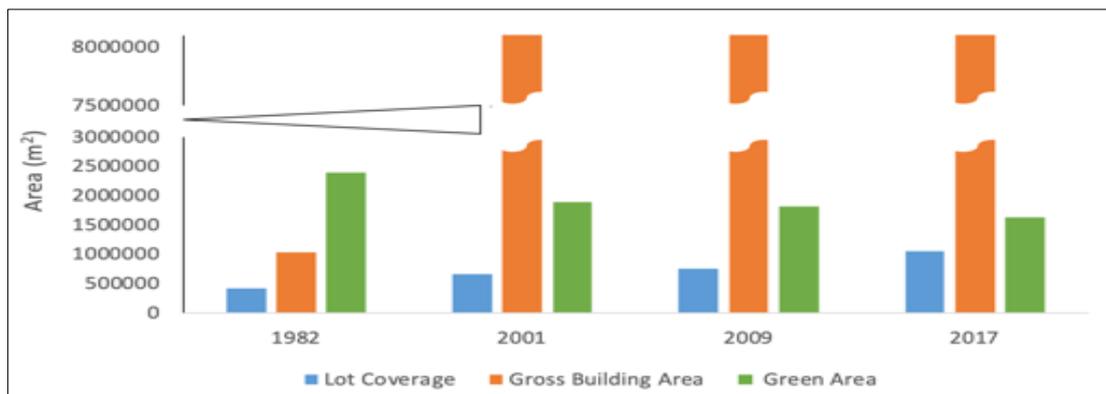


Figure 3. Variations of green areas, lot coverage and gross building areas in Atakoy

4.2 Irrigational Water Demand

Although its percentage is decreasing throughout years, Atakoy still has a large amount of green areas and uses a considerable amount of water for their irrigation. While it is the responsibility of the municipality to irrigate active and passive green areas, privately-owned green areas are to be irrigated by the land owners, and in both cases, currently municipal water supply is used for this purpose. Irrigation season for Istanbul is between April and October. Privately-owned green areas constitute the majority of green areas and use 65 % of the irrigational water demand of entire Atakoy which is given in Table 6. The annual consumption for Atakoy as irrigational water is 2 657 448 m³, of which 954 864 m³ is used by the municipality for active and passive green areas, and the remaining 1 702 584 m³ for private green areas, nearly twice as much as compared to municipal use. Furthermore, Table 7 lists the total irrigational demand of the four zones of Atakoy based on their monthly demand in the entire calendar year of 2017. The table shows that Zone 4 uses the highest amount of water with 1 223 586 m³, followed by Zone 2 with 722 034 m³. 46% of the irrigational water is used in Zone 4, 27% in Zone 2, 17% in Zone 3 and 10 % in Zone 1. As Istanbul is very much restricted by its water resources and the largest percentage of the water supply comes through inter-basin transport from about 200 km, using reclaimed gray water and/or harvested rainwater is very meaningful as alternative sources to

be considered. This is true not only for today, but also for aiding sustainability of water resources for the future.

Table 6. Irrigational Water Demand in Atakoy in 2017

	Area (m ²)	Daily Demand (m ³ /day)		Monthly Demand (m ³ /month)		Annual Demand (m ³)
		Regular	July-August	Regular	July-August	
Active and passive green areas	589 422	3 537	7 073	106 096	212 192	954 864
Privately-owned green areas	1 050 978	6 306	12 612	189 176	378 352	1 702 584
Total Atakoy	1 640 400	9 842	19 685	295 272	590 544	2 657 448

Table 7. Monthly and annual total irrigational water demand in Atakoy and its zones (2017) (m³)

w	Zone 1	Zone 2	Zone 3	Zone 4	Total Atakoy
January	0	0	0	0	0
February	0	0	0	0	0
March	0	0	0	0	0
April	28 512	80 226	50 580	135 954	295 272
May	28 512	80 226	50 580	135 954	295 272
June	28 512	80 226	50 580	135 954	295 272
July	57 024	160 452	101 160	271 908	590 544
August	57 024	160 452	101 160	271 908	590 544
September	28 512	80 226	50 580	135 954	295 272
October	28 512	80 226	50 580	135 954	295 272
November	0	0	0	0	0
December	0	0	0	0	0
Year Total	256 608	722 034	455 220	1 223 586	2 657 448

4.2.1 Rainwater

The possibility of harvesting rainwater from roof tops was investigated to be used further for irrigation in this work. Table 2 in Section 3 reports monthly precipitation in Atakoy in 2017 and the roof top areas are listed in Table 8 assuming that roof area is equal to lot coverage. Using these two groups of data, the potential amount of rainwater which can be collected from roof tops was calculated and the results are presented in Table 8. A total of nearly 550 000 m³ of rainwater may be collected from the entire Atakoy, providing %20 of the irrigational water demand. In terms of the four zones, rainwater will cover 40% of irrigational water demand in Zone 2, 23% in Zone 1, 12% in Zone and 11 % in Zone 3. It may be observed from the table that the greatest amount of rainwater can be collected in Zone 2 with 292 318 m³ which has the highest roof area and the least in Zone 3 with 48 900 m³ which has the lowest roof area. It may be observed further from the table that the largest amount of rainwater could be harvested between October and January, corresponding to a period

where irrigation is not practiced. Therefore, rainwater must be collected in the winter time and stored till April where irrigational water demand will start.

Table 8. Use of rainwater as irrigation water in Atakoy and its zones (2017)

	Irrigational demand (m ³ /year)	Roof top areas (m ²)	Rainwater (m ³ /year)	Sufficiency (%)
Zone 1	256 608	113 930	59 133	23
Zone 2	722 034	563 200	292 318	40
Zone 3	455 220	94 215	48 900	11
Zone 4	1 223 586	277 600	144 083	12
Total Atakoy	2 657 448	1 048 945	544 434	20

Among all zones of Atakoy, Zone 2 seems to be the most relevant zone for rainwater harvesting. This is due to the fact that Zone 2 contains low rise buildings with large roof areas, hence provides a higher potential for rainwater harvesting. Although the number of buildings in Zone 4 are more as compared to Zone 2, the design of the buildings in Zone 2 with larger roof areas make it more efficient for harvesting rainwater.

Irrigational period coincides with the period where there is no or negligible amount of rain. For rainwater there is a need for storage between November and March which coincides with the rainy period. Table 9 shows that about 170 000 m³ rainwater corresponding to 58 % of the annual rainwater could be collected in the rainy period which needs to be stored. Through storage, 40% of the annual irrigation demand in Zone 2 can be provided by rainwater.

Table 9. Monthly irrigational demand and rainwater potential in Zone 2 (2017)

	Irrigation demand	Rainwater (m ³ /Month)	Deficiency/Surplus
January	0	51 854	51 854
February	0	18 653	8 653
March	0	19 160	19 160
April	80 226	9 327	70 899
May	80 226	13 889	66 337
June	80 226	21 086	59 140
July	160 452	20 174	140 278
August	160 452	12 469	147 983
September	80 226	13 584	66 642
October	80 226	32 542	4 784
November	0	31 021	31 021
December	0	48 559	48 559
Total	722 034	292 318	429 716

4.2.2 Grey Water

Table 10 summarizes the water demand and the potential for supplying irrigational water from grey water in Atakoy and its four zones. The table shows the potential amount of grey water expected in Atakoy and its four zones assuming that 120 lt of grey water is produced per capita per day. It is predicted that 2 070 662 m³ of grey water may be collected in Atakoy on an annual basis. As the population is not expected to change in months, the same amount of grey water is expected to be produced every month. As the amount of grey water produced is directly proportional to population, the largest amount of production was in Zone 4 with 1 055 981 m³ followed by Zone 2 with 590 587 m³. Grey water can provide 86% of the irrigational water demand in Zone 4, 82% in Zone 2, 77% in Zone 3, 28 % in Zone 1. Among the four zones, in addition to having the highest quantity of green areas, Zone 4 has the highest population and therefore its potential for grey water collection is the highest.

It is obvious that irrigating with reclaimed grey water will provide a considerable portion of irrigational water demand in the region. Once again, the need for grey water storage in the period where irrigation is not practiced has to be taken in consideration and this requires further study for finding available space for doing this.

Table 10. Use of grey water as irrigation water in Atakoy and its zones (2017)

	Irrigation (m ³ /year)	Gray water (m ³ /year)	Sufficiency rate (%)
Zone 1	256 608	72 014	28
Zone 2	722 034	590 587	82
Zone 3	455 220	352 080	77
Zone 4	1 223 586	1 055 981	86
Total Atakoy	2 657 448	2 070 662	78

Table 11 shows irrigational water demand and the grey water potential for Zone 2. As can be observed from the table, approximately 50 000 m³ of grey water is produced in this area per month. Grey water is a continuous source and the same amount of grey water will be generated in all months, both in the months of irrigational water demand and in the period of no irrigation. In total, about 590 000 m³ of water may be provided using grey water which constitutes 82% of the irrigational water demand. Obviously, this is a significant contribution as an alternative water resource. However, benefits are contingent upon continuous storage of this source which needs further investigations, in terms of storage areas and costs.

Table 11. Monthly irrigational demand and grey water potential in Zone 2

	Irrigation demand	Grey water (m ³ /month)	Deficiency/Surplus
January	0	49 216	49 216
February	0	49 216	49 216
March	0	49 216	49 216
April	80 226	49 216	-31 010
May	80 226	49 216	-31 010
June	80 226	49 216	-31 010
July	160 452	49 216	-111 236
August	160 452	49 216	-111 236
September	80 226	49 216	-31 010
October	80 226	49 216	-31 010
November	0	49 216	49 216
December	0	49 216	49 216
Total	722 034	590 587	-131 442

4.2.3 Storage Proposal For Zone 2

Zone 2 ranks as the most effective in terms of rainwater harvesting and second effective in terms of grey water collection. Considering potential irrigational water which may be supplied from all four zones, it may be concluded that Zone 2 is the most meaningful area. Therefore, options for Zone 2 have been evaluated to suggest possible storage locations.

A proposal based on storage for rainwater in Zone 2 was prepared in this work using the areas below parking lots. Using a storage height of 3 meters under the parking lots shown in Figure 4, a storage volume of 170 000

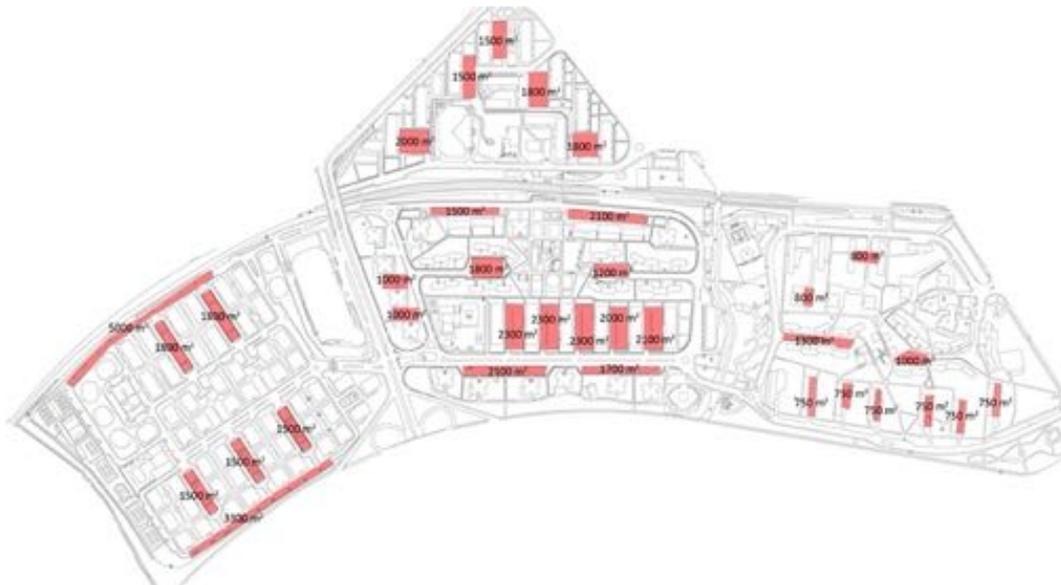


Figure 4. Recommended storage locations for Zone 2

m³ could be provided. This volume is enough to cover the entire rainwater estimated for this zone. This may also be used for grey water storage alternatively. This corresponds to about 70% of grey water which will be generated in the season where irrigation is not practiced. To be able to use the entire potential, further studies must be conducted to find storage locations to cover the entire storage volumes.

4.2.4 Combined Use Of Rainwater And Grey Water

It could be concluded from the discussion above that not all irrigational water demand could be covered by either rainwater or grey water alone. Table 12 lists monthly irrigational water demand and alternative water resources in Zone 2. The table shows that combined used of rainwater and grey water may potentially cover more than what is needed for irrigation. The challenge here is to be able to prescribe the best management plan to go with their storage focusing on the locations for storage and their costs which requires further investigations.

Table 12. Monthly irrigation demand and water sources for Zone 2 (2017)

	Irrigation demand	Rainwater (m³/month)	Gray water	Deficiency/Surplus
January	0	51 854	49 216	101 070
February	0	18 653	49 216	67 869
March	0	19 160	49 216	68 376
April	80 226	9 327	49 216	-21 683
May	80 226	13 889	49 216	-17 121
June	80 226	21 086	49 216	-9 924
July	160 452	20 174	49 216	-9 162
August	160 452	12 469	49 216	-98 767
September	80 226	13 584	49 216	-17 426
October	80 226	32 542	49 216	1 532
November	0	31 021	49 216	80 237
December	0	48 559	49 216	97 775
Total	722 034	292 318	590 587	160 871

5. CONCLUSION

The present work focuses on the use of rainwater and grey water for urban green irrigation using Istanbul Atakoy case on a neighborhood level. The results have revealed that of the nearly 2.6 million m³ per year irrigational water demand of green areas, 20% could be covered by rainwater and 78% by grey water. The combined use of rain and grey water may potentially cover almost the entire irrigational water demand. However, as the rainy season and irrigation season do not match with each other, rainwater has to be stored throughout the year. Likewise, storage will be needed for grey water.

One of the four zones of the Atakoy neighborhood, namely Zone 2 was observed to be the most effective for collection of rainwater and second most effective for grey water. Therefore, Zone 2 was selected as the area to set the example for evaluating storage capacity. With the suggested storage, 23% of irrigational water could be provided using rainwater, 82% using grey water. Although when combined, grey water and rainwater can cover the entire irrigational demand of Zone 2, the suggested storage area is enough to hold 88% of this quantity. Even when 88% irrigational demand is provided by combination of rainwater and grey water about 640 000 m³ water may be spared from Istanbul's central water supply. This shows that with well planned

infrastructure together with encouragement and incentives to be provided by the government, significant water savings can be achieved through irrigating green areas with alternative sources of water.

The results of the study have revealed that rainwater and grey water are two significant alternative sources of water within an urban context. Building type and density are two important determinants of the success of this practice. While wide lot coverage buildings have advantage for rainwater harvesting due their large roof areas, high rise buildings with high populations are better fit for grey water collection. Another important issue in the implementation of this practice is the promotion of buildings with harvesting and collection capacity through legislations. Policy making taking alternative water sources into consideration at earlier stages of planning and construction is critical in terms of implementation of this practice with the highest efficiency and will lead to selection of the best building types and layouts.

Based on the outcome of this investigation in the Atakoy neighborhood, it may be concluded that adapting alternative water sources will aid sustainability of water resources and continuity of water services especially in areas where water resources are limited. The Turkish megacity Istanbul and megacities/cities of similar nature may benefit from water sparing through the potential that may be provided from rainwater harvesting and grey water reclamation. Also, the implication of alternative water resource systems in a residential environment as in this study, may improve public awareness on how much water systems can aid sustainable future in cities.

Although this paper focuses on irrigation of green areas, it is important to acknowledge the possible use of reclaimed grey water and harvested rainwater as alternative sources for several other end uses within cities, especially for toilet flushing and other water demanding functions such as car washing, street cleaning, fire fighting and ornamental purposes which are common in urban life.

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FROM SCIENCE FICTION TO DESIGN FICTION: SPECULATIONS ON THE ADAPTATION OF XR TECHNOLOGIES INTO THE FUTURE SPACES

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ABSTRACT

Spatial computing technologies enable new interaction possibilities every day between virtual and physical spaces by bringing out new products that aim for a smarter lifestyle. The underlying technology of these new products is named XR (Extended Reality-Cross Reality) technologies, which include augmented, virtual, and mixed reality technologies and perhaps all future reality technologies waiting to be discovered. However, studies on the adaptation of XR technologies to daily life remain product-oriented, and solutions on how spaces will change with these technologies or how these technologies can be integrated into spaces remain deficient. The wide variety of science fiction artworks throughout history shows that people think about life in the future, and it is seen that these thoughts affect the use of technology in spaces over time. While these effects sometimes highlight the benefits of technology and encourage the use of technology in the future, sometimes people imagine a future without technology, emphasizing dystopias, which affect the adaptation of technology. This research aims to study the possible uses of existing XR technologies in the smart spaces of the future from a different perspective through the concept of design fiction. Here, design fiction will be used as a design technique for speculating future spaces within the scope of spatial computing technologies by analyzing the space, technology, and human relations in science fiction movies and series. In this study, we analyzed sci-fi movies and TV series to determine the ones containing XR elements, and then we discussed the use of XR in these media productions. In the end, we made speculations on future spaces with XR technology and propose a future space design method with the transition from science fiction to design fiction.

KEYWORDS: XR (Extended Reality/Cross Reality), Design Fiction, Science Fiction, Future Studies, Future Spaces, Spatial Computing, Spatial Interfaces.

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1. INTRODUCTION

In history, we continually try to predict the future to make life better for us and the next generations. The first example of it can be Plato's Republic in 380 B.C., which describes an alternative reality about the justice system concept. Much later in 1516, the book called "Utopia" by Thomas More was also presenting a fictional society focused on political matters (Dodds, 2019). Then with the industrial revolution around the 1700s and 1800s, people started to work with machines, and maybe because of that their perspective of the future has changed and more focused on technology.

Science fiction (sci-fi) works are one of the reflections of our desire to envision the future and promote our vision of future technologies. According to "The Science Fiction Reference Book" by Tymn (1981), sci-fi can be defined as a type of literature representing people's reactions towards the new developments in science and technology. The delineation in sci-fi books may not create the same images for everyone, and probably it is the beauty and freedom of literature. The words used to describe a futuristic space can inspire every person differently and trigger the imagination. Nevertheless, sci-fi movies are considered visual arts showing people directly how the artist thinks about the future. In a way, they force people to see the future from the artist's perspective. So, the impact of sci-fi movies can be higher than the sci-fi books on people's future vision and cause positive or negative biases on new technologies. That is why we chose to work on sci-fi movies and TV series in this study instead of sci-fi literature to analyze the use of XR technologies.

According to Sterling, design fiction differs from sci-fi with its more realistic mindset (Sterling, 2005). While science fiction focuses on the glory of technology, design fiction aims to find solutions for human needs with technological developments. Therefore, design fiction can provide a different way to look into the future by creating variations of solutions for technology use in the future. It can be said that design fiction provides people a foundation to think and discuss the future, unlike science fiction, which shows straight how the future will look like (Lindley & Coulton, 2015).

Design fiction contains various future possibilities for dealing with multiple problems and questions instead of a single design solution (Hales, 2013). Since the future is full of unknown possibilities, to discuss the current design solutions and how they will be carried out to the future, design fiction may be an efficient method to architectural design and future space design studies. Although sci-fi and design fiction can feed each other, design fiction can offer an academic environment to discuss possible scenarios. There are different approaches to the definition and use of design fiction in the academy. As Gonzatto et al. (2013) mention, some researchers suggest that design fiction is a philosophy, while others think it is a design method. In this study, we implement design fiction as a design methodology to provide a common ground between design, science, and science fiction (Bleecker, 2009).

Today in 2021, we have the technology that people from the 1800s might never have imagined to exist, like rollable TVs, foldable smartphones, smart glasses, and many more. Some might think that every screen in a room is an opening to another reality. So, the logic of X-reality may consist of all the technologies that provide an alternative reality to the physical world. Especially in sci-fi movies and TV series, there have been different XR concepts showing possible futures related to people and spaces. But these XR presentations are mostly focused on the product rather than integrating the technology into the spaces. Therefore, the motivation of this study is to get attention to the adaptation of XR technologies into future spaces and start a discussion on the content of design fiction. In the end, we intend to present that integrating XR technologies into future spaces is closer to architectural design solutions with the transition from science fiction to design fiction.

In the first part of the study, fifty-one science fiction movies and TV series are reviewed regarding the XR concepts and their integration into spaces. Following that, the use of these technologies in sci-fi movies and TV series is discussed compared to the available XR technologies in 2020-21. In the end, three different

scenarios are created by using the design fiction methodology with the help of a design typology to explore the possible futures and speculate on the adaptation of XR technologies into future spaces. The goal of the research is to contribute to the field of spatial interface design and guide the spatial interaction possibilities that spaces may offer in the future with spatial computing technologies.

2. SCI-FI MOVIES & TV SERIES WITH XR ADAPTATION

XR technologies represent all reality technologies that enhance the physical world or create illusions, alternative, and mirror worlds. They include AR, VR, and MR devices as we know of today in 2021, and there may be more devices out there that have not been recognized as XR yet. In the scope of this study, the spatial adaptation of XR technologies is the core point we are studying, which we assume is the missing part of XR implementations. Therefore, we mainly focus on the three-dimensional (3D) spatial interfaces and how we can use them in the future.

The idea of the 3D illusion via mechanical devices goes back to 1838 with the mirror stereoscope's invention by Charles Wheatstone (LaValle, 2017). With the stereoscope technology, a binocular vision is presented, which provides people a 3D experience with a sense of depth and immersion (Wade, 2018). Following the invention of stereoscopes, new devices focused on 3D view have started to appear in years, like the Kaiser-Panorama by August Fuhrmann in 1880 and later in the 1950s the Sensorama by Morton Heilig, both in similar movie cabinet concepts. There have been various devices with AR, VR, and MR technologies during the time. Starting from 2020, even some smartphones have LIDAR technology that enables 3D scanning of the space for high precision AR experiences (Apple, 2020).

Nevertheless, people have not started to use XR devices in daily life yet. There may be numerous reasons for that in terms of accessibility to the devices. Although the users of AR, VR, and MR devices have increased in years, it is still not comparable to the active number of television users (Statista, 2021). The reason for that can be the XR technologies are not integrated into people's daily spaces so far.

Sci-fi movies and TV series are one of the mediums representing the possibilities of technologies to people. They can be seen as an opportunity to introduce and promote new devices to the public. On the other side, their effects can create a limited vision of future spaces and cause biases between people. Without imposing the ideas on the people, there should be a method to show different scenarios and implementations that can be examined further collaboratively. At this point, the transition from science fiction to design fiction can occur by putting design thinking and human needs forward. In this study, we reviewed sci-fi movies and TV series to examine the design elements related to XR technologies to produce alternative design fiction scenarios further.

We selected sci-fi works according to three criteria. The first criteria is the theme of the works should be a futuristic one, describing a future life or present life with futuristic technologies. The second one is that the work should be listed on IMDb (2021) in the science-fiction category. IMDb is an online database for movies, TV series, videos, and many more. And the last criteria is the setting of the work should be a physical world environment familiar to people, not an alternative reality or a space setting. Because if the design elements in the sci-fi works are reasonable and similar to the real world, people can relate to the fiction worlds and think about implementing them in their life (Căplescu, 2015).

In the beginning, there were 462 titles with the "future" keyword, five and above rating out of ten, and more than 100 votes in the sci-fi category on IMDb. But when we look for the third criteria on the real world and techno future with XR technologies, 51 sci-fi movies and TV series are left to be studied further (Table 1). The remaining 51 titles are also cross-checked with various studies on sci-fi works in case we may miss some critical

movies (Telotte, 2001; Cornea, 2007; Schmitz, Endres, and Butz, 2008; Booker, 2010; Kirby, 2010; Westfahl, Yuen, and Chan, 2011; Marcus, 2013; Figueiredo et al., 2015; Barbas, 2017).

Table 1. The list of sci-fi works with futuristic themes in real-world settings.

	NAME	TYPE	RELEASE DATE	YEAR SET	TECHNOLOGY
1	Forbidden Planet	Movie	1956	2220	MR
2	Logan's Run	Movie	1976	2274	MR
3	Brainstorm	Movie	1983	-	VR
4	Back to the Future Part II	Movie	1989	2015	MR
5	Total Recall	Movie	1990	2084	AR, MR, X-R
6	The Lawnmower Man	Movie	1992	-	VR
7	Wild Palms	TV Series	1993	-	MR, VR
8	Johnny Mnemonic	Movie	1995	2021	VR, X-R
9	Strange Days	Movie	1995	1999	VR
10	Virtuosity	Movie	1995	-	VR
11	Escape from L.A.	Movie	1996	2013	X-R
12	Nirvana	Movie	1997	-	VR
13	eXistenZ	Movie	1999	-	VR
14	The Matrix	Movie	1999	c. 2199	VR
15	The 6th Day	Movie	2000	-	AR, MR, X-R
16	Minority Report	Movie	2002	2054	AR, MR
17	Time Machine	Movie	2002	2030 and later	MR
18	Code 46	Movie	2003	-	VR, X-R
19	Paycheck	Movie	2003	-	MR
20	I, Robot	Movie	2004	2035	AR, MR
21	Sleep Dealer	Movie	2008	-	MR, X-R
22	Avatar	Movie	2009	2154	X-R
23	Surrogates	Movie	2009	-	VR
24	Iron Man 2	Movie	2010	-	MR
25	Prometheus	Movie	2012	2093	MR
26	The Hunger Games	Movie	2012	-	MR, X-R
27	Enders Game	Movie	2013	2083	X-R, MR
28	Her	Movie	2013	-	MR
29	Iron Man 3	Movie	2013	-	AR, MR, X-R
30	Oblivion	Movie	2013	2017, 2077-2080	X-R
31	The Machine	Movie	2013	-	MR, X-R
32	Almost Human	TV Series	2013-1014	2048	AR, MR, VR, X-R
33	Automata	Movie	2014	2044	MR
34	The Giver	Movie	2014	-	MR
35	Advantageous	Movie	2015	-	MR
36	Creative Control	Movie	2015	-	AR, MR, X-R
37	Equals	Movie	2015	-	MR, X-R
38	2047: Virtual Revolution	Movie	2016	2047	VR, X-R
39	Blade Runner 2049	Movie	2017	2049	MR, VR
40	Ghost in the Shell	Movie	2017	-	MR, X-R
41	Electric Dreams	TV Series	2018	-	AR, MR, VR
42	Hôus3	Movie	2018	-	AR
43	Mute	Movie	2018	c. 2048	AR, X-R
44	Ready Player One	Movie	2018	2040-2045	VR, X-R
45	Replicas	Movie	2018	-	MR
46	Reverie	TV Series	2018	-	VR, X-R
47	Auggie	Movie	2019	-	AR, MR
48	Black Mirror Season 1-5	TV Series	2011-2019	-	AR, VR, X-R
49	The Feed	TV Series	2019	-	AR, MR
50	Altered Carbon Season 1-2	TV Series	2018-2020	-	AR, MR, VR, X-R
51	Upload	TV Series	2020	-	VR, X-R



Figure 2. A scene with hologram dancers from Blade Runner 2049.



Figure 3. A scene with VR equipment from The Lawnmower Man.

The technologies in sci-fi works mostly emerge from the meetings between producers, directors, scenarists, scientists, and tech companies (Schmitz, Endres, and Butz, 2008; Marcus, 2012; Mubin et al., 2016). Whenever there is a new futuristic product available, sci-fi movie can be a place to introduce them. Our concern is since the movies and TV series present these technologies only in one scenario, the representation of devices can rapidly influence the future of technology without allowing any discussion. Thus, design fiction can be a method to create different solutions for the use of upcoming technologies in future spaces.

3. DISCUSSION ON THE USE OF XR TECHNOLOGY

The first XR devices are bulky and expensive gadgets, so they first started to be used for military and research purposes around the 1960s (Mazuryk & Gervautz, 1999; Rubin, 2018). Later, with the involvement of big companies in the XR industry, there have been more affordable devices available for everyone. Today, the use of XR technologies is limited by the capabilities of AR, VR, and MR devices. Thirty years ago, around the 1990s, Lanier (2017) and his team thought VR would be a part of people's communication routine and act as a new media language. Nevertheless, today VR is mostly used for entertainment purposes (Fortune Business

Insights, 2020; Stevanovic, 2019). Since there has been no attempt to integrate a gaming console to the places, VR devices like Oculus Quest is seen as a gaming device, and as far as we know, the adaptation of it to the places has not been brought up in academic studies. On the other side, AR and MR devices are more likely to integrate into the spaces with their see-through feature. Since they are like digital layers on the physical world, to implement them into places may need more attention to space and spatial interfaces.

According to our sci-fi movies and TV series review, the first appearance of XR is in 1956 on Forbidden Planet. It is a hologram created in a pyramid-shaped glass box with the power of the mind under the name of “3D mind simulator” (Figure 4). Today, we have a technology called 3D volumetric display which enables us to see and interact with holograms in the real world (Jo et al., 2019; Manuel, 2017) (Figure 5). However, people are not using it daily yet. It needs a light source to work and cannot appear anywhere without its source.

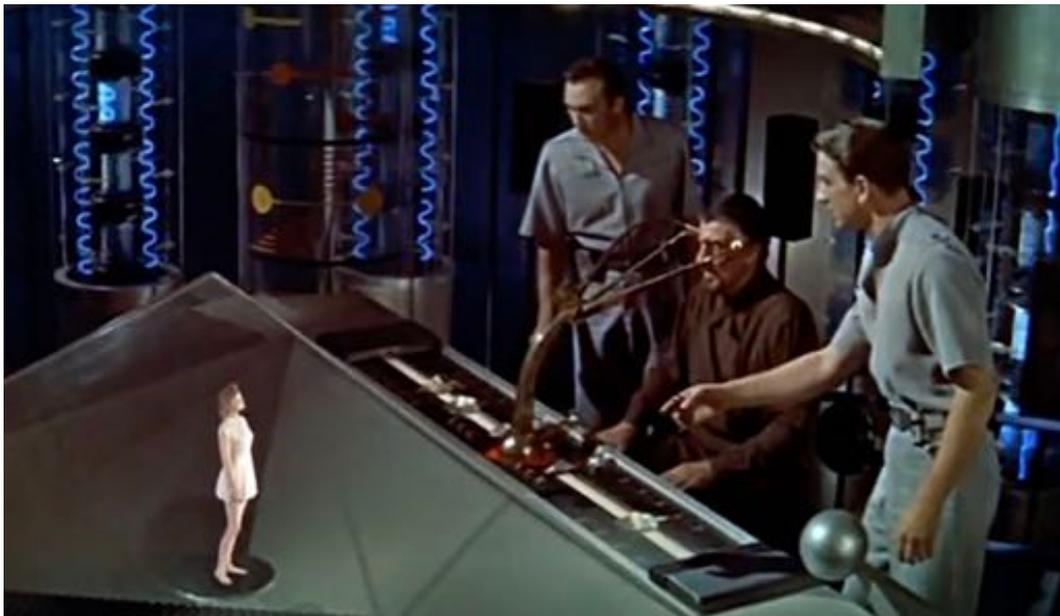


Figure 4. The mind simulator in the movie “Forbidden Planet”.



Figure 5. Voxon 3D Volumetric Display (Jo et al., 2019).

The use of holography can be also seen in the movie “Time Machine” from 2002. There are transparent screens in the library projecting a 3D hologram that looks like a human, but it is an artificial intelligence (AI) as the library assistant (Figure 6). We can assume that this may be one of the most potential uses of holograms in daily life since it has a specific place and function.



Figure 6. The holographic AI library assistant in “Time Machine”.

In the last years, we can say that AR technology has become more accessible other than VR and MR, considering it can be used via smartphones. In one episode of Black Mirror from 2016, an interactive AR system is presented, which works with the mental projection. The AR visuals are only seen by the user itself. In a way, it is a similar concept to the available AR technologies today. Because with available technologies right now, you can only use AR via smart glasses or screens. Thus, the amount of people that can experience it together is limited. So, we can assume AR focuses more on private shows.

During the study, we recognized that while there are many different uses of AR and MR technologies in sci-fi movies and TV series, there are little changes in the use and presentation of VR. There are many attempts to show VR with nice-looking VR goggles. However, in the real world, the devices are still bulky, making it hard to wear for long times. The latest wireless Oculus Quest 2 is still 503 grams, while the average weight of a pair of sunglasses is between 25 and 50 grams (Answers, 2021; Robertson, 2020).

In terms of integration of the XR technologies into the physical spaces, VR technologies can be the most problematic one since it transports the users into completely another space, which is a virtual one. However, a different attempt was made on the TV series “Upload” to connect the virtual world to the real one. They placed frames in various sizes both in the real world and the virtual world (Figure 7). When the connection between the worlds is established, the frames are activated. By doing so, each side can see the other one, and they can interact with each other through the frames.



Figure 7. The frame connecting the real and virtual world in TV series “Upload” (2020).

In the end of our review, we think that the design elements detected in sci-fi movies and TV series provide an opportunity to create various scenarios by the design fiction method. To discuss and evaluate each use of XR can develop solutions for possible problems that will be faced in the future. With this study we intend to provide a ground to start a discussion to encourage further development of a design fiction methodology for future space design.

4. SPECULATIONS ON FUTURE SPACES WITH XR TECHNOLOGY

In the study of Knutz, Markussen, and Christensen (2014), they offer a design typology for researchers to explain the design fiction method for design studies. According to the design typology they propose, there are five questions to create a future scenario (Table 2).

Five Criteria for Design Fiction Scenarios	
1	Basic Rule of Fiction (What if-scenario?)
2	The manifestation of critique (How is it critical?)
3	Design aims (What are the possible consequences?)
4	Materialization & form (How is it visualized?)
5	Aesthetic of design fiction

Table 2. The design typology proposed by Knutz, Markussen, and Christensen (2014).

Following the design typology with five criteria, we created three different scenarios with design fiction methodology. We propose that the transition from science fiction to design fiction occurs with three future scenarios: Utopian scenario, dystopian scenario, and realistic scenario (Table 3).

Utopic Scenario	Dystopian Scenario	Realistic Scenario
1 Basic Rule of Fiction (What if-scenario?)		
What if we embrace nature and build our places integrated into green spaces without disturbing natural habitats.	What if we got lost in globalization, and everywhere every place will look the same.	What if we accept technology as a part of our daily life and start integrating them into our everyday spaces.
2 The manifestation of critique (How is it critical?)		
It proposes a sustainable life but with the help of high-tech products.	It presents a techy world built by the same modules worldwide, focused only on people.	It offers a mixed lifestyle using technology in spaces and secluded areas with no internet connection.
3 Design aims (What are the possible consequences?)		
It aims at the connection between people and nature with a low budget, a recyclable tech circle.	It aims to provide the same quality of life everywhere on Earth with simple high-tech modules.	It aims to create modern and high-tech places not far away from what we have today, but with more options and more affordable prices.
4 Materialization & form (How is it visualized?)		
It blends in with green and earth tones.	It is built by the same cubic modules.	It is a traditional big city life look.
5 Aesthetic of design fiction		
Sustainability and modernism.	Chaotic.	Postmodernism.

Table 3. Three scenarios created with the design fiction method.

After reviewing the selected sci-fi works and how they tried to integrate the XR devices into spaces, we categorized the design elements to be used in utopian, dystopian, and realistic future design scenarios (Figure 8).

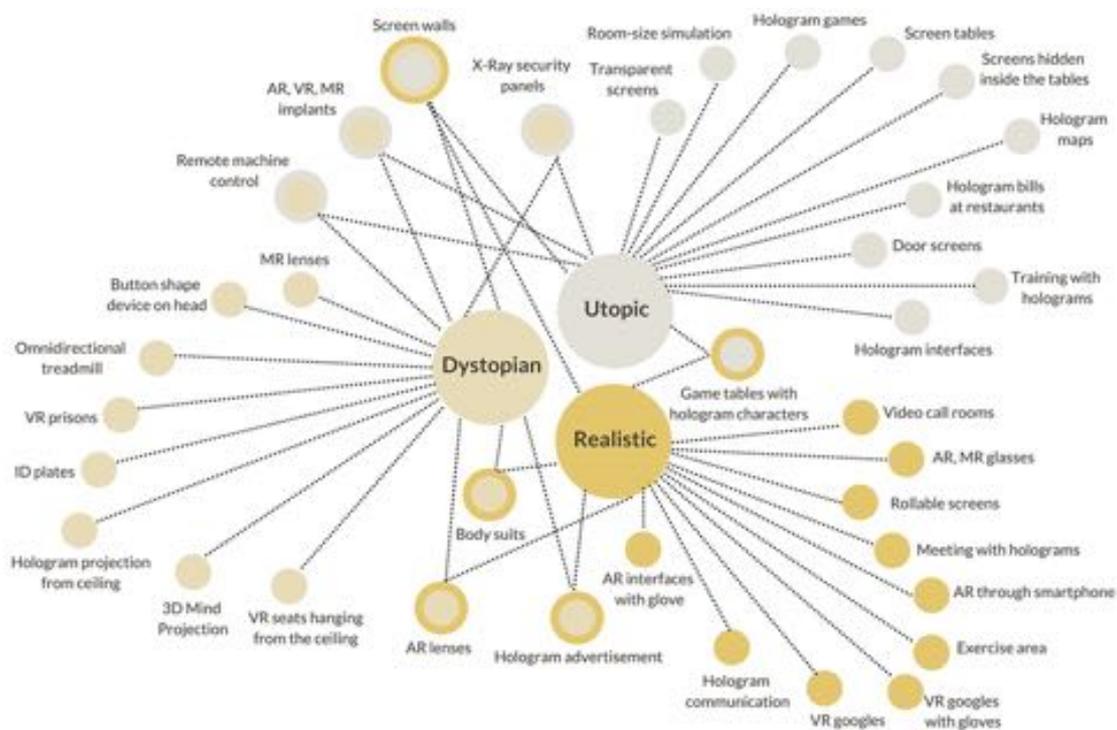


Figure 8. The categorization of XR design elements.

When we look into history, we do not see radical changes in spaces regarding main design elements. Wall is still a wall; the window is still a window. The functions are the same; only the materials and shapes change. But the technology evolves faster than the design of buildings. For instance, people started to use TVs in their living rooms, starting in the 1950s. Today, still, we do not design places with TVs in them. We intend to show how a living room can change through time using XR technology in the prototype visual series (Figure 9) (Johnson, 2011). As architects, engineers, and researchers from different industries, if we do not start thinking

about space and technology relations, these new technologies will come one after the other and can create chaos. It is also possible that people may like chaos. However, this is also a part of the design fiction, and all scenarios should be discussed and evaluated to design future spaces with the integration of XR technologies.

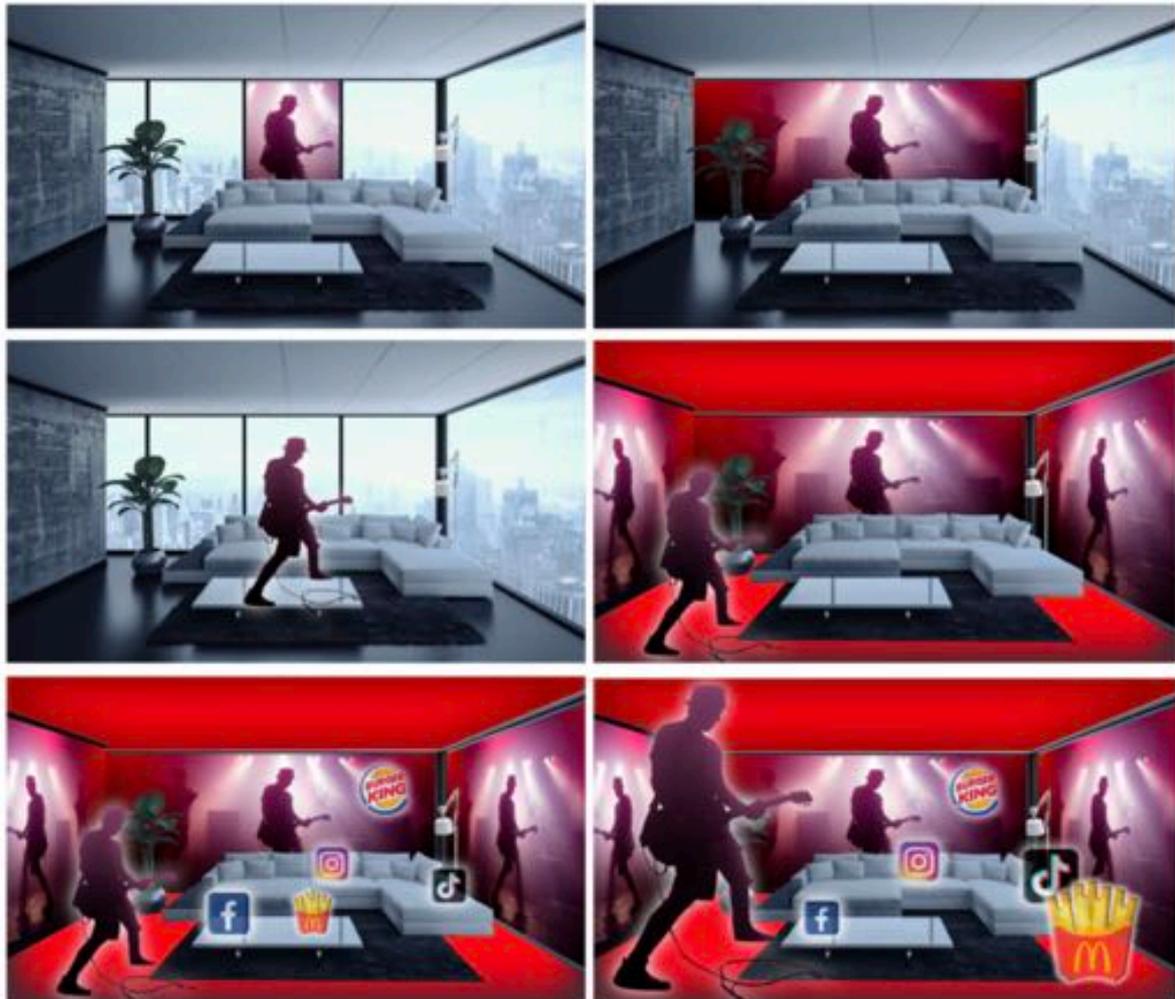


Figure 9. A prototype visual series on the adaptation of XR technologies into future spaces.

There are billions of people living in the world, in different countries with different habits and traditions. Imagining the same future spaces for everyone would sound illogical. However, the use of the same technological products may cause assimilation through time. According to the statistics in 2019, about half of the households in the world have at least a computer (Statista, 2019). And every screen they interact with opens up a new reality in the physical world. So, if we look into the Reality-Virtuality Continuum of the Milgram and Kishino (1994), it separates the real environment from the virtual one, which can be called VR, and all MR technologies, including AR, are in between the real world and the virtual world (Figure 10). Nevertheless, after studying sci-fi works and XR technologies, we recognize that everything starts in the real world. Thus, we offer a new perspective on the relationship between reality and virtuality, as parallel continuums (Figure 11).

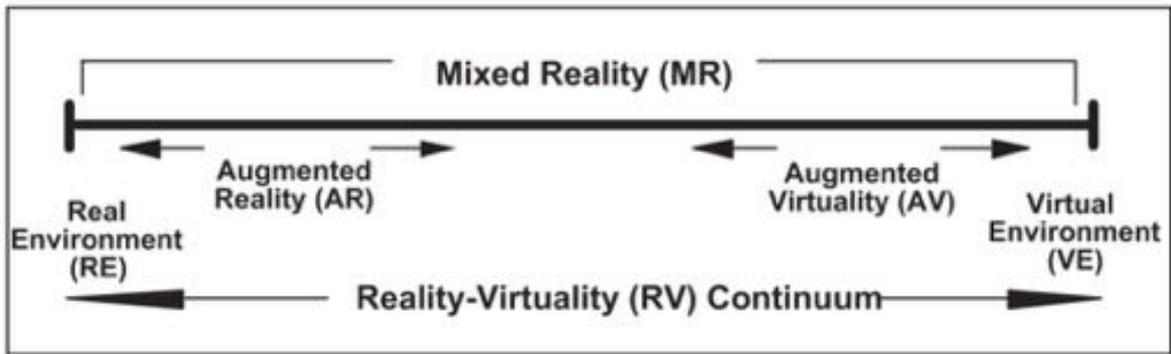


Figure 10. Reality-Virtuality Continuum by Milgram and Kishino (1994).

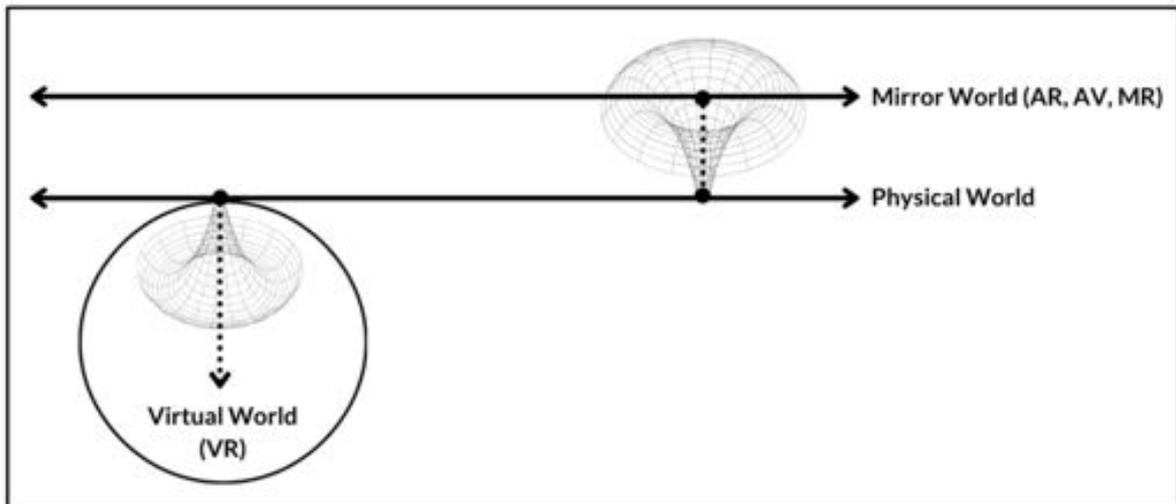


Figure 11. A new perspective to the relation between Reality and Virtuality.

Every screen or device that is used to connect with other worlds, mostly through the internet, provides a door to virtuality. They can be described as portals opening to alternative worlds. That's why we imagine each XR device as a wormhole to either a virtual world, which is entirely different from the physical world since it blocks all the senses of reality, or a mirror world, which is like a parallel world to the physical one with visual enhancement and illusions. These ideas are open to discussion. More scenarios and prototypes can be produced with design fiction's help to speculate on adapting XR technologies into future spaces.

5. CONCLUSION

Although the XR technologies, especially VR, have been around since the 60s, we still do not use them in our daily life. In architectural design, there has been no effort to integrate those technological devices as design elements into the spaces. However, all the sci-fi works we have reviewed show that people have imagined the future's techno spaces for years. The discussion we have started in this study indicates that the design fiction method can be an architectural design technique to think about adapting XR technologies into future spaces. While science fiction movies and TV series are a stage to perform the use of technology in the future, design fiction can be the backstage for the future of architectural design and the integration of XR technologies into the spaces.

Overall, the transition from science fiction to design fiction offers a creative discussion medium and can inspire subsequent studies on future spaces' design by integrating XR technologies. Thinking of every screen in a

room as a passage to other rooms and realities can bring a new perspective to future space design studies and help to consider possible changes in the architectural design of the future. Our work can contribute to designing future techno spaces with a design fiction method and provide a piece to work further on the adaptation of XR technologies into the spaces.

This study can be accepted as a first step to exploring future spaces' design with XR technologies from a creative and technological perspective. We assume that there can be many different future scenarios depending on all the development in time. However, the design fiction method can be a stage to compare and examine the possible future space designs to work on a better version for future humans' needs.

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AN ASSESSMENT OF THE REFLECTION OF TRADITIONAL AND COMPUTER ASSISTED ARCHITECTURAL DESIGNING PERIODS ON BUILDINGS THROUGH HYPERBOLIC PARABOLOID FORMS

İZZETTİN KUTLU¹, ZEYNEP YEŞİM İLERİSOY², ASENA SOYLUK³

ABSTRACT

This study examined the changes and developments in the designs and practices regarding the hyperbolic paraboloid surfaces, which have been more popular after the designs of Felix Candela during the architectural period of 20th century. Tracer method was utilized to compare the periods before and after the computer-assisted designing instruments were added to the architectural education curriculum. A comparison table was formed for the difference between the periods, and the variable traits that may change in years such as materials, method of practice or span were specified and presented in a chronological order. Assessments indicated that hyperbolic paraboloids used for different purposes could be used as designing elements as well as for passing wide spans, and that they were utilized in different continents during the same periods. It was understood that this form span could be used to reach and pass greater spans through the support provided by using computer-assisted architectural designing instruments. During 1950s, issues related to heating, illumination and ventilation emerged on the hyperbolic surfaces constructed with concrete materials. With the computer-assisted architectural designing instruments, solutions were found on these issues following the trials on the model. As people started to use computers as designing instruments, differences emerged in practices. Instead of buildings that were constructed through on-site concreting procedure with molds during the period of traditional drawing instruments, the panelization systems were able to be produced with the help of computer models and mounted accordingly. Furthermore, with the development of steel industry after 1990, steel was used more often in the construction of hyperbolic paraboloids. This study revealed the contribution of computer-assisted designing instruments which enable designing, analyzing and building complicated geometries to the constructability of hyperbolic paraboloid surfaces, and it demonstrated the current status of these instruments within designing-related processes following the technological advancements. The impact of computer-assisted designing instruments on the relationship between the architectural designing and load-bearing system designing was explained through the examples regarding integrated designing processes. Examining the architectural changes and developments in the hyperbolic paraboloid surfaces, this study indicated that using advanced computer technologies caused radical changes and that the designers were granted new horizons and became more liberal upon the searches for architectural form with the algorithms becoming producible in the digital environment.

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KEYWORDS: Form, Structure, Hyperbolic Surface, Computer-assisted Architectural Designing

1. INTRODUCTION

The statement by Albertus Magnus *“The universal essence of beauty consists of the resplendence of form on the material parts in proportion”* is considered as the synthesis of the aesthetic thoughts of the 13th century and the entire late medieval age more generally. The philosophy and science of the 13th and 14th century focus on the proportional relationships as the main expression of unity, consistency and comprehensibility of the universe. The ratio organizes the concept of reality and affects any subjects and objects ranging from human body to music harmony or from urban design to architecture. It may cover anything present in the nature (Spigaroli, 1999: 105). Presence of golden ratio and other similar ratios provide a rich field of study. However, a room or facade that is designed without adequate mathematical knowledge and that has arbitrary ratios cannot impress its users; it only serves as an aesthetic element. The reason for using ratios is to divide the forms into sub-divisions to define the accidental scales (Salingaros, 1999: 79).

The conception of form in architecture results in two questions according to Butelski (2000): *“How can architects nowadays create forms? How can forms be described and classified?”* Creating a form that has never been generated before indicates a significant criterion of innovation when approached from the perspective of form-related analyses. The latest works of Frank Gehry and Peter Eisemann are quite close to the criterion of certain forms that was unique for architecture at the end of the 20th century. Guggenheim Museum in Bilbao, which was designed by Gehry, and Disney Center Hall in Los Angeles resulted in an innovation as the curved line architecture of the 20th century (Figure 1a). The designing geometry of these two buildings is quite complicated and challenging to understand (Butelski, 2000: 19). However, designing principles of ancient Roman Temples can be easily defined through algebraic methods such as addition, subtraction and multiplication. Modern and traditional architecture provide us proper examples for such field definitions. Buildings designed by Frank Lloyd Wright, Louis Kahn and Richard Meier are among the typical examples of this convention (Figure 1b, Butelski, 2000: 21).



Figure 1. Architectural examples of the 20th century, a) Guggenheim Museum - Frank Gehry, b) Des Moines Art Center - Richard Meier (Butelski, 2000: 20-21).

Architecture was examined as a discipline of mathematics and these two disciplines were not separated in the past. Considering ancient buildings; pyramids, ziggurats or temples have an admirable mathematical form (Salingaros, 1999: 78). Important architects such as Louis Kahn, Zaha Hadid or Frank Gehry who examined architecture as a common discipline with mathematics utilized the information from other scientific disciplines and tried innovative practices to present creative suggestions in their designs. Designs formed in this manner become richer with the potentials of other disciplines. The architecture with curved surfaces that became more popular after the collective assessment of mathematics and geometry aims to design volumes and surfaces in an irregular and curved manner and to make them more definable. The designing language regarding the forms of buildings is based on geometry and geometrical rules, basics of architectural designing. However, this topic was not considered until the beginning of the architectural curvature forms, and this field

of study was not attributed an importance. The geometry of architectural designing became more complicated, and the relationship between architecture and geometry developed further after this complication was demanded (Ghadim, 2013: 63). Curvature surfaces can be rapidly distinguished from other surfaces with their unique amorphous traits, directly flowing lines and complicated geometries (Hambleton et al., 2009). Forms with curved surfaces play a more important role in contemporary architecture. The latest technological developments made the panelization of architectural surfaces with inter-panel continuity possible, compared to the plane panels. The large-scale production of single and double curvature panels has become more popular upon these developments.

The concept of curvature was introduced to architecture with the concrete shell structure at the beginning of the 20th century. Computers considered as a great innovation at the end the same century were used to define the buildings and form. This innovation enabled the increase in designing and production options (Pedreschi, 2008: 19). The visible development of computers in architectural education occurred between 1985 and 1995. In addition to the courses such as architectural designing criteria, building structure, materials or public buildings presented within the traditional architectural curricula, Computer-Assisted Designing (CAD) courses were also introduced to architectural curriculum. Schools that are leading in terms of architectural education already added the course of computer-assisted designing to their curricula, but the instruction of Computer Assisted Architectural Designing (CAAD) became common at the end of 1980s and beginning of 1990s (Penttilä, 1998: 348). The yearly distribution of Cumulative Index about publications in Computer Aided Architectural Design (CumInCAD) reflects the aforementioned change (Table 1).

Table 1. CAAD publications in CumInCAD by decade (developed from Koutamanis, 2005: 631.)

Decade	Number of publications in CumInCAD
1960s	16
1970s	185
1980s	984
1990s	3,226
2000s	2,723
2010s	5,267

The figures indicate that CAAD provided effective opportunities for the publications during 1990s, highlighting the increase in the number of scientific publications in the last decade. This result confirms the idea that 1990s were a critical period for CAAD (Koutamanis, 2005: 631). The concepts of parametric designing and artificial intelligence which were associated with the digital environment with CAAD became more popular during 2000s, which resulted in the increase in the number of relevant publications during 2010s.

The double curvature hyperbolic paraboloid surfaces within the curvature surface were not known in USA before 1950, but they became popular after that year and contributed to large stylistic and materialistic changes on the pre-war conditions of the built environment. In 1962, academics and experts considered hyperbolic paraboloid form as a significant contribution to the American construction industry and used hyperbolic paraboloids to construct anything ranging from churches to warehouses, houses to gas stations, or libraries to arenas with the architectural orientations and constructional skills of the post-war era (Sprague, 2013: 165). Accordingly, this study assessed the development and change of the paraboloid form, which rapidly became popular with the new constructional techniques found after 1950 and with the contribution of pioneering designers who were interested in the innovative form, along with the addition of computer-assisted designing courses to architectural education. This study aimed to evaluate the characteristics of the

architectural works formed with double curvature hyperbolic paraboloid surfaces that spread swiftly with Felix Candela during 1950s in relation to the years when traditional drawing instruments were used and the period (1985-1995) when computer-assisted designing instruments were added to the architectural curriculum, and to analyze the changes and developments of buildings. Another aim was to perform an efficient comparison to reveal how the new construction techniques (panelization, prefabricated etc.) emerged and to understand the relationship between architectural education and building construction.

2. MATERIALS AND METHODS

The reflection of the changes and development of hyperbolic paraboloid surfaces, which occur as a result of traditional drawing instruments and computers becoming a part of designing processes, on the architectural works was revealed in the study. Accordingly, hyperbolic paraboloids used more often with the influence of Candela as well as the designs formed using traditional methods until 1985, and the change and development of buildings constructed after 1985 were evaluated within this study.

Tracer method was utilized to compare the periods before and after the computer-assisted designing instruments of hyperbolic paraboloid forms were added to the curriculum. This method is a qualitative research method examining the causal mechanisms where a single or few cases are analyzed. It serves for the purpose of collecting data and ensuring the reliability of the sample. Hornby and Symon defined this method as follows: *“definition of organizational processes regarding certain groups, at a certain time and with the help of certain labels (documents)”* (Hornby & Symon, 1994: Özcan, 2018: 60).

A table was formed for the targeted comparison, and the variable traits that may change in years such as materials, method of practice or span were specified and presented in a chronological order. This table was divided into two sections: traditional drawing instruments and computer-assisted designing instruments.

The hyperbolic paraboloid forms, which are among the curvilinear building forms, constitute a sub-title of double curvature surfaces. No generalization was performed for the curvilinear building forms, and the study was conducted in particular relation to hyperbolic surfaces. Ten architectural works reflected in Table 2, which was formed by being divided into two significant periods, are among the remarkable designs with their innovative and different traits. These significant works were selected as they had the traits of other hyperbolic paraboloid works constructed in the same period, which enabled making more general comments on the hyperbolic paraboloid forms through the selected works.

The research question was about how the hyperbolic paraboloid forms, the double curvature forms, changed as the CAAD was added to the architectural curriculum, and about the sort of developments utilized while implementing these forms.

3. CURVILINEAR ARCHITECTURAL SURFACES

“I believe deeply in that geometry and a sense of mathematics relates to beauty because you see mathematics are a pure creation of the spirit. The geometry, which means the measurement of the earth. And the measurement of the earth will still be an important subject maybe even the measurement of the universe.” (Calatrava, 1999). The aforementioned statement by Santiago Calatrava, the most significant architect and engineer of the present day, indicates that mathematics (geometry) and architecture should be closely associated in making designing-related decisions and that understanding geometry is as important as understanding the building. Buildings formed by using geometrically curved surfaces are more durable than the buildings with straight surfaces and enable a better aesthetic configuration. The buildings with thin shells designed by Félix Candela constitute the most successful examples in this context (Susam, 2013: 63).

The reasons for using surfaces built from curves are that curved surfaces are more durable than plane buildings and configured better from an aesthetic perspective. The constructional attitude of the shells provides a better mechanical efficiency than the other building types. Concrete shells depend upon configurations, rather than their masses, for stability. Should proper designs be created, shells may support high loads and cover significant areas with limited materials and/or thickness being utilized (Tomás & Martí, 2010: 1650). Contrary to the traditional carcass systems, most curvature surfaces serve as the main constructional system. Maximum endurance can be ensured with minimum number of materials when suitable design is created for the integration of form and construction system.

There are many classifications for the geometry of curved surfaces, with the most general of them being as follows: (i) single curvature, (ii) double curvature, (iii) synclastic, (iv) anticlastic, (v) combination of synclastic and anticlastic, and (vi) Free (Pérez & Suárez, 2007: 853-854). This study focused on double curvature surfaces, and an assessment of the hyperbolic paraboloid forms was performed.

3.1. Double curvature surfaces; Hyperbolic Paraboloid Forms

Production of surfaces can be performed through geometric or non-geometric methods. Geometrical surfaces can be divided into surfaces including revolution, translational surfaces, ruled surfaces and freeform surfaces). Hyperbolic paraboloid surfaces can be produced from translational and ruled surfaces (Osmani et al., 2017: 92). Hyperbolic paraboloids are the surfaces with double curvature that can be generated through the simple rotation of lines. They are generally defined through two different methods: rotating or bending a two-dimensional plane (Figure 2a); rotating a parabolic arch throughout the second hyperbolic arch of an anticlastic (Figure 2b). In both cases, surfaces have a negative Gaussian curvature with the basic curves of the anticlastic form.

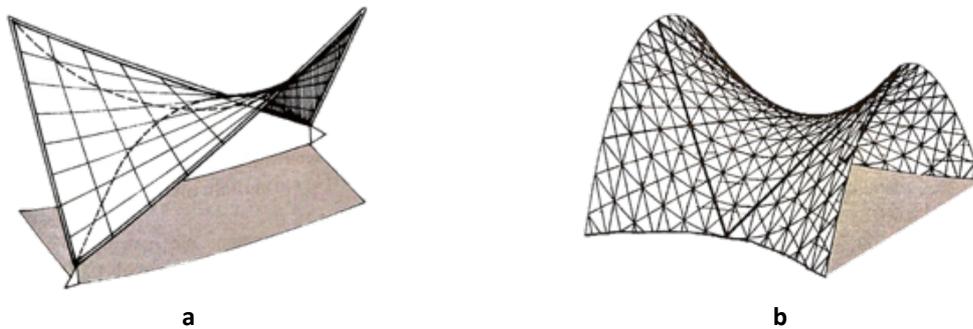


Figure 2. Hyperbolic paraboloid surfaces – a) Straight edged, b) Curved edged (Türkçü, 2017)

Anticlastic hyperbolic paraboloids over two axes have a remarkable rigidity, and the loads are carried to the shell plane as the stressing, compression or shearing forces. These forms provide a significant thinness over long spans and prevent out-of-plane bending (Sprague, 2013). Türkçü (2017) associated the important status of hyperbolic paraboloids in architecture with the following reasons:

- They have a great structural strength owing to having double curvature.
- Simultaneous emergence of compression and tensile stresses at every point due to the anticlastic trait decreases the orientation of bending within the compression elements.
- Mold-related expenses are lower than those of the other double curvature surfaces in the same direction.
- The appearance is pleasing, with satisfactory architectural and aesthetic effects. (Türkçü, 2017: 141)

The beginning of the World War II in 1939 reduced the rate of practices regarding hyperbolic paraboloid surfaces, but the interest toward this form returned as the war ended in 1945. Migration of many architects, engineers and constructors to the United States (US) (during and after the war) and new materials such as aluminum alloys and plywood developed during the war period resulted in innovative attempts for the field of construction. This innovation led to the hyperbolic paraboloid being re-explored as a settled form in US (Sprague, 2013). Eero Saarinen pioneered the modern shell designs in US with his various sphere and paraboloid practices, while Candela did the same in Mexico (Figure 3a). In terms of other continents, Bernard Laffaille developed studies (calculation methods through examining the static research on the inelastic thin hyperbolic paraboloids) on linear-surface shell constructions in the institute 'Memories de l'Association Internationale des Ponts et Charpanter' after 1926 and found the basic principles used in the modern day. He designed the French pavilion in Zagreb formed with hyperbolic paraboloid with four linear sides (Figure 3b). As a result of his studies on the hyperbolic paraboloid shells, Giorgio Baroni implemented this practice on a foundry in 1934. Konrad Hruban performed studies on hyperbolic paraboloid shells in Russia and developed a new type suitable for use in industrial buildings after 1940s. He utilized this type in the factory buildings constructed in Nove Mesto in 1945 and Prostejov in 1948 (Figure 3c). Eduardo Torroja captured attention with different shell roofs in Spain and implemented the hyperbolic paraboloid shell principles on the hippodrome tribunes in Zarzuela in 1935 (Figure 3d, Güler, 2011: 51-52).



Figure 3. Use of hyperbolic paraboloid surfaces in architecture - a) Kennedy Airport, New York, Eero Saarinen, b) Zagreb Pavilion, Zagreb, Bernard Laffaille, c) Prostejov Factory, Prostejov, Konrad Hruban, d) Zarzuela Hippodrome, Madrid, Eduardo Torroja

New concepts and procedures were sought in time in the light of the experiences obtained from the surfaces with thin shell produced by using concrete materials. Further progress from this point reached through traditional design instruments became a possibility with technology. The desire of fulfilling and implementing different designs gained a momentum as architecture met with computer technology, and a new period of transformation occurred in architectural practices and education with computer-assisted designing.

3.2. Computer-Assisted Architectural Designing (CAAD)

Computer-assisted designing (CAD) and computer-assisted architectural designing (CAAD) have different meanings despite being closely associated. The concept of CAD is related to vector-based graphics software for creating a draft as defined by the industry, while CAAD is used to reflect a broader field of research from abstract architectural calculation to concrete computer-related practices and automatic manufacturing technology. The roots of CAAD are closely associated with Design Methods Movement of 1960s initiated with the first Conference of Designing Methods held in London in 1962 (Celani & Veloso, 2015: 48). Design Methods Movement consisted of a series of conferences and publications, and its main purposes included creating a better design by understanding the designing process, externalizing the designing process, and utilizing the computer technology in the meantime. With the statement “Computer-aided design technology has passed through many metamorphoses in the three decades since it was first imagined, and it will pass through more

before the century is out.” in the article dated 1989, Mitchell foresaw that CAD system would continue improving before the end of the 20th century, indicating further progress in the following years (Mitchell, 1989: 493). Penttilä (1996) examined the impact of CAD on architectural education and divided this education into two as *“traditional architectural curriculum”* and *“CAD-courses to traditional curriculum”* (Penttilä, 1996: 347-348). Stating that all architectural schools cannot suit these two divisions and that a precise historical distinction cannot be made, Penttilä explains the reason for this simplification as defining a clear evolutionary path. Adopting different approaches, methods and designs became a possibility as the popularity and usability of CAAD increased with computational design during and after 1980s (Figure 4).

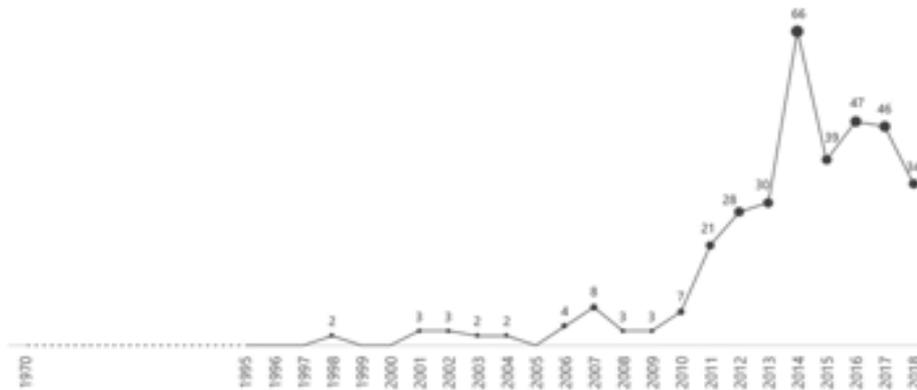


Figure 4. Use of the concept of computational design in time: A time chart indicating how many times the concept of computational design appeared as a key word or study topic in the literature (Caetano, Santos & Leitão, 2020: 4).

CAAD has become a significant instrument used to construct a high-quality building with all steps and expertness regarding architectural designing and building construction (Koutamanis, 2005). Development of technology obligated going beyond the traditional forms and undergoing technological designing for the modern architectural designing processes. Accordingly, creating designs by using computer technologies became a significant factor in reaching results and practices that cannot be experienced with the traditional methods (Topçu, 2012).

4. EVALUATION OF SAMPLE GROUP AND RESULTS

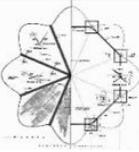
The attractive trait of hyperbolic paraboloid form gained a greater place in the minds of architects and engineers thanks to Candela effect. The construction industry discovered the marketable potential of this form, and many manufacturers and product industry union searched for a local usage with the new materials developed for the military practices during 1950s, the beginning of the hyperbolic paraboloid form. Hyperbolic paraboloid became an ideal form for making experiments with the new materials. Hyperbolic paraboloids, which cannot be constructed solely from the rotation of linear pieces or mildly bending a linear layer, capture attention with their remarkable physical form emphasizing the improved characteristics of new materials (Sprague, 2013: 179).

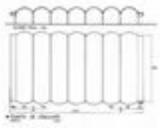
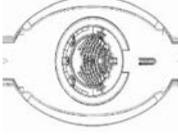
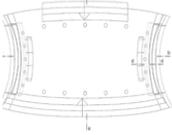
The buildings examined to determine the differences between the designs created during the period of CAD instruments with the traditional drawing techniques were chronologically assessed through the Tracer method. While examining the differences; the criteria of location, function, construction material, span passed, plan and indoor criteria were considered (Table 2).

Location assessment was performed to determine the development of curvilinear surfaces in different continents. Although communication instruments were not used commonly during the period when hyperbolic surfaces were used, there were developments showing similarity in different continents. Function assessment was performed to determine the changes in the relationship between curvilinear surfaces and function at different periods. Curvilinear surfaces initially seen in small-scale buildings were implemented in more complicated surfaces with the period of CAD instruments.

These surfaces constructed with concrete material in the initial periods were mostly produced with steel as concrete caused insulation and illumination problems due to thinness. The span passed and frequent use of CAD instruments were determined as the reflection on the building. The construction methods that could not be used in the past are comfortably utilized now with the increasing possibilities of the modern technology. Assessment of the plans indicates that hyperbolic paraboloids were used for the buildings with single function along with the small-scale and restrictive mathematical rules during the period of traditional drawing methods, that the spaces with different functions were covered with the same curvilinear surface as the CAD instruments became more popular, that the plan scales grew, and that the spatial flow increased. This also reflected on the indoor designs.

Table 2. Chronological presentation regarding the reflection of the development and changes in the periods of traditional drawing methods for hyperbolic paraboloid forms and CAAD

Building Name / Architect	Year	Location	Function	Materials	Building Span	Plan	Interiors	Images	Reference
THE PERIOD OF TRADITIONAL DRAWING TOOLS (1950 – 1985...)									
Cosmic Rays Pavilion/ Felix Candela	1951	Mexico	Pavilion	Reinforced concrete	10,90 x 11,80 m				(Susam, 2013)
Los Manantiales/ Felix Candela	1958	Mexico	Restaurant	Reinforced concrete	30,0 x 30,0 m				(Susam et al.)
St. Mary Cathedral/ Kenzo Tange	1964	Japan	Cathedral	Reinforced concrete	40,0 x 55,0 m				(Güler, 2011)
Cathedral of Brasilia/ Oscar Niemeyer	1970	Brasilia	Cathedral	Reinforced concrete	60,0 m				(Yazar, 2018)

Salto Bus Terminal/ Eladio Dieste	1973	Uruguay	Terminal	Reinforced concrete	25 x 35 m				(McKay, 2014)
THE PERIOD OF COMPUTER AIDED DESIGN INTEGRATED IN ARCHITECTURE EDUCATION (1985 -)									
The Hemisferic / Santiago Calatrava	1997	Spain	Museum	Steel	230 x 70 m				(Tola & Vokshi,
Schubert Club Band Shell/ Peter Kramer	2002	ABD	Pavilion	Glass + Steel	7.6 x 15.2 m				(Weller et al. 2012)
Soumaya Museum/ Fernando Romero	2011	Mexico	Museum	Steel	70 m				(Romero &
Heydar Aliyev Center/ Zaha Hadid	2013	Azerbaijan	Cultural Center	Steel	-				(Güler, 2011)
Bosjes Chapel/ Steyn Studio	2016	South Africa	Chapel	Reinforced concrete	36 x 7 m				(Günel, 2017)

According to Table 2 formed by being divided into two parts:

- Hyperbolic paraboloid building shells were not constructed to pass through broad spans (Cosmic Ray Pavilion), that they emerged after Candela created an experimental form, and that they were used to reach beyond the broad spans later (Heydar Aliyev Culture Center).
- Results indicated that this building form was used for multiple functions appealing to different users such as pavilion, restaurant, cathedral, terminal, museum, culture center, chapel, rather than a single function.
- Even in the periods when communication methods were not advanced, this form was used in different geographies (Mexico, Japan, Brazil, Uruguay).
- Although broader spans were passed compared to the carcass-system buildings in the period when traditional drawing instruments were used, broader spans were accessed with the CAAD.
- Hyperbolic paraboloid forms utilized as structural elements during the period of traditional drawing instruments were also used as the designing elements after the popularization of computers.
- Concrete shell system caused insulation problem during the period of traditional drawing instruments owing to being thin, and problems of natural illumination emerged due to the obligation

of passing the broad spans with single-piece shell. Therefore, people started to focus on CAD instruments and steel following the development of steel industry, and concrete material was only used after getting tested through computer software.

- Molds were formed through the computers first and on-site concreting was performed. In the meantime, the relevant building was divided into panels on the model and brought to the site after prefabricated production, which is the most important factor facilitating the construction of large-scale buildings.
- Results also indicated that in the beginning hyperbolic paraboloid form was used in a geometrically simple form, and that the hyperbolic paraboloid form was included in more complicated forms along with digital instruments.
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5. DISCUSSION AND CONCLUSION

Geometry has a significant place in the basis of the computational technologies and CADs regarding the discipline of architecture. Geometrical developments paved the way for authenticity and freedom in architectural designs. Ability to use and generate different geometries in designs facilitated the representation of architects' designs. With the technological advancements, computers have become a key instrument in terms of the representation of designs within the current architectural environment. Visualization methods can be prepared in the digital environment to support the traditional designing process such as technical drawing, three-dimensional modeling and animation. CAD technology was first used in the sectors of industrial designing, plane and vessel designing, and cinema and music sectors. Use of these technologies in the architectural designing dates to 1990s. With the impact of developments in the informational technology, technology transfers become popular and designing-related fields support one another. Computers should be considered as a digital designing environment, rather than a visualization instrument. Information-based designing systems have a significant place in CAD thanks to their capacity of representing, collecting and calling the designing information. Furthermore, computers should be supported with a certain implication and commenting mechanism in the designing process. Felix Candela sought for an innovative form without the computers and paved the way for the introduction of the concept of hyperbolic paraboloid form in 1950s. This form did not show a significant change until 1980s and 1990s, and generally concrete material were used for construction. In thin-shell reinforced concrete structures, natural light and ventilation problems were observed due to insulation problems and monolithic pouring. Frequent use of CAD instruments in architecture (with the development of the steel industry) resulted in the emergence of large-scale building design where hyperbolic paraboloid forms were among the free-form curvature surfaces. Consequently, people focused on steel as the construction material in curvilinear forms, and when concrete material was used, computer programs were utilized.

Mathematical analysis of calculations for complicated buildings with multiple functions and of practices is generally complicated. CAAD reduces the number of intense mathematical calculations and enables designers to spend more time to designing and construction. Analytical methods are supported by the tests performed with the models at different dimensions simplifying important assumptions of certain mathematical methods. Concrete buildings were constructed at the beginning of the 20th century, and use of computers resulted in another great innovation to define the building and form at the end of the same century, which helped increase the designing and production options and enrich architectural production. Invention of computers is regarded as a revolution like the industrial revolution, and the global rate of using computers in every field has been increasing. Having started with drawing, this process continued with CAD and developed to achieve production with computers. CAAD provides a new visualization instrument as well as designing and

production space to architects. The hyperbolic paraboloid form Candela found after structurally trying different forms during 1950s indicated that innovative designs could be created when architecture was considered with geometry. Table 2, which was formed by being divided into two as traditional drawing instruments and CAD instruments, shows that the use of steel increased because the industry of steel as the material of the hyperbolic paraboloid forms developed. The span distance also increased in the buildings designed by using steel. With the CAD, the reliability of broad spans was also tested during the process of designing within the project. The building modeled with the computer software during the implementation phase was divided into the pieces that could be produced through the panelization method on the model and constructed as prefabricated. This terminated the obligation of creating a monolithic mold for the buildings with fluid surface, such as the hyperbolic paraboloid form, and it facilitated the process of transferring and mounting the prefabricated material on the implementation site. As Table 2 indicates, mixed-function buildings with larger scale started to be popular particularly after 1990. As can be understood from the present study, architects began to create the forms and structures they imagined despite all restrictions they faced in years with the assistance of three-dimensional software. During the construction of these complicated forms, computers provide possibilities for controlled manufacturing methods. In conclusion, it is clear that the system setup that deeply affected the construction technology like hyperbolic paraboloid which was initiated by Candela by utilizing traditional drawing instruments and mathematical and material knowledge during 1950s will turn into different variations through the developed software, material and construction methods of the modern architects. Technological possibilities enabled the realization of complicated architectural designs that were solely digital plans in the earlier periods, and the place of load-bearing system design resulted in a particular field of research. The increased calculation capacity of the instruments used and variety of the CAAD methods made the designing process more efficient and helped improve the conceptual limits. Accordingly, more authentic designs with different forms will be created as contemporary architecture progresses within a dynamic process supported by the technological advancement.

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THE BENEFITS OF MODERN WRITTEN WORKS AND URBAN MORPHOLOGY TO ARCHITECTURAL DESIGN EDUCATION

KEZBAN AYÇA ALANGOYA ¹

ABSTRACT

As of the 18th century, the works of artists, literati, sociologists, philosophers have become the sources for examining the modern urban life and the big cities, which are the living space of the modern individual and include cultural, social, political, economic, temporal, spatial, functional and formal dimensions. These works touch on the contents and concepts reflecting the multi-layered structure of urbanism. However, especially in the first quarter of the 20th century, urban planners, architects, theorists, who focused on the functional and formal features of the city, namely on the urban body, neglected to examine the phenomenon of urbanity and to draw inspiration from its multi-layered structure in the design of modern urban spaces. Artistic and theoretical works produced outside the discipline of architecture, in which the modern city is handled as the stage of urban life, touch the essence of modern life, namely the urban soul. In these works, which examine the individual, society and the relationship between them, modern urban life is reflected through the descriptions of the private and public morphological elements of the city. The science of urban morphology, in which the hereditary traces and transformations of urban textures are investigated, the private and public main elements that make up the physical structure of cities are examined, and the urban scale intersects with the architectural scale, contains important basic information in the context of architectural education. The intersection of individual and social events contributes to the enrichment of urban life, and collective spaces where the private and public intersect contribute to the typological and morphological richness of the cities. Therefore examining artistic and theoretical works outside the discipline of architecture focusing on the individual, society, modern life, and its scenes and gaining knowledge about the basics of urban morphological content will help students to comprehend the multi-layered structure of urbanism, increase the curiosity and encourage students to explore the spatial characteristics of different urban environments, user profiles with different lifestyles and needs. Questioning the relations between the individual, group, community, and space will enable students to gain service awareness and expand the service boundaries of their professions. The blending of the knowledge of urban morphology, the sensitivities to be gained from works dealing with urban life, and the experiences to be gained from phenomenological studies will inspire the architecture students to design collective spaces at the intersection of the private and the public, and will lead the designs include diversity, meaning, and creativity.

KEYWORDS: Collective spaces at the intersection of private and public, Urban morphological data in modern literature, The multi-layered structure of urbanity, The urban soul and the urban body, Modern literature and urban morphology as inspirational sources for spatial design.

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1. THE DISCIPLINE OF ARCHITECTURE AND THE EXPERIENCE OF URBANITY

1.1 The Building Scale and Beyond

Architectural design is associated with urban planning, interior design, and object design. Considering the interactions of these disciplines with social sciences, it becomes difficult to draw sharp boundaries on the definition of the discipline of architecture. If issues such as class, race, and gender are brought to the fore regarding the definition and boundaries of the discipline of architecture, and if their participation in the production of the built environment is questioned, the views of academics dealing with the built environment differ (FAAC, 2017). The tendencies can be classified into two groups. Academics in the first group interrogate the possibility to practice or teach in a way that doesn't rely on the architectural canon which often includes only classical modern buildings. They believe over-reliance on the canon, can redouble the negative cultural symptoms of the capitalist societal structure as individualism, self-exploitation, competition, sexism, racism, ableism. Academics in the second group seem to locate themselves outside of the discipline of architecture. They aspire to transcend the discipline and move away from architecture, instead to revive it within the boundaries of the discipline. Talking about philosophy, a painting, a living room, an object and especially about the city seems more interesting than buildings.

The building scale. To revive the discipline of architecture within its borders, architects should try to find solutions to current problems such as the needs of visitors with disabilities and the housing crisis (D'Aprile, 2018). In architectural education nor practice, the architectural canon should not be abandoned since architects can look at canonical buildings from non-canonical perspectives. Going in-depth at the building scale is possible without placing the architectural canon at the centre. Indeed design issues such as focusing on local architectural examples, developing the art of tectonics, emphasizing the importance of context, proposing appropriate programs, using the expressive power of materials still lead to witness the inexhaustible mysteries of architecture at the building scale. Beyond the building. The suggestion to revive the discipline of architecture from within its boundaries and focusing on the building scale is legitimate. Yet, when studying theoretical sources or considering the everyday issues of urban history and urbanism, it is difficult to deny the magic of cities, city life, and maps that make you think about the relationships between urban textures and natural elements, the processes that settlements go through, the life stories they contain. Cities mean a concentration of life. The phenomenon of urbanity sheds light on the relationship between the individual and society. Through studies in urban environments in architectural education, the students develop curiosity and awareness about life. Studying the city increases the artistic sensitivity, social and service awareness and may distract students of architecture from the building scale. The process of understanding places and discovering their qualities can go deep enough to include literary works, works of other arts, historical, philosophical, sociological, political, geological studies.

1.2 Deepen at Building Scale

Throughout history, there have been architects who have explored the profound expressive power inherent in architecture from within the boundaries of this discipline. The German architect Gottfried Semper, as one of the major theoreticians of the 19th century, separated the building into four components which are the vertical surfaces that envelope and enclose the volume and thus form the space, the load-bearing structure, the ground, and the hearth that is the spiritual centre of the building. As the four main elements of architecture, These four elements of architecture correspond to the four crafts, which are carpentry, textile, masonry, and ceramics, and to the four basic materials, which are wood, fabric, stone, and ceramic (Quitzsch, 1981, 176-222). In his theory of metabolism (Stoffwechsel Theory), which still has enormous scientific value and creativity, Semper has investigated the four spatial elements of architecture, their actions, their materials,

and how and what these elements have borrowed from each other (Semper, 1878, 12-50). Thus, he has illuminated the process of transforming a simple act of building into a creative design act. French philosopher Gaston Bachelard would also write about the psychological basics and effects of space. Through the relationship humans intimately establish with the house, he has examined the transformation of the building into a home. Archetypal spaces are created when archetypal emotions, actions, and memories specific to humans match the physical features of the house, such as an attic and the cellar. Actually, through the example of a house, Bachelard has treated the transcendence of the physical boundaries of space (Bachelard, 1971, 30-60). The Finnish architect and author Juhani Pallasmaa examines the phenomenological experience of space. Humans interact with space both objectively through their senses and subjectively through their perceptions and memories. Rather than pure form, Pallasmaa directs the designer towards the performative essence, namely to the functions of archetypal architectural elements, towards the choice of materials, the effects of temporal change, and actions in everyday life. Thus, space acquires a poetical dimension that only artists could express so far instead of architects (Pallasmaa, 2009, 16-41; 2011, 50-60; 2012, 118-144).

1.3 Beyond the Building Scale: The Urban Field

Space is a phenomenon that transcends the building scale, molded by the actions of living beings (animals, plants, humans, etc.) and by natural forces (wind, sea, light, sun, etc.), and by materials. Whatever the scale, space has been a subject treated by artists, both in material and non-material terms (Pallasmaa, 2009; 2011). Artists are particularly drawn to urban spaces, which are the scenes of the dynamics that shed light on the friction between the individual and society (Mersmann, 2015). Among the first big city novels are *Ulysses* (Joyce, 1922); *Manhattan Transfer* (Dos Passos, 1925); and *Berlin Alexanderplatz: The story of Franz Biberkopf* (Döblin, 1929). In his novel about 1920s Berlin during the Weimar Republic, Döblin develops a brand new literary language inspired by the tempo of city life. The focus is on one typical neighborhood at a specific historical moment: Alexanderplatz. It is a large open square and public transportation hub in central Berlin. Originally a cattle market, it became a major commercial district in the late nineteenth century. In the 1920s, it was the center of the city's nightlife, bustling with bars and clubs, not to mention the attendant crime. The author holds up a mirror to the poignant life of the modern city. The portrayal of the tempo of modern city life, the physical features of the square, the interiors of public buildings, the inner thoughts of the city-dwellers standing in, crossing, waiting in, bustling about the square, and the mundane and compelling fates that await them, as inseparable parts of a whole, stimulates the reader's emotions. Impressed by Döblin's novel, director Rainer Maria Fassbinder filmed a fifteen-and-a-half-hour epic drama of the same title (Fassbinder, 1980). Also, Fassbinder interpreted with remarkable sensitivity the city life, period, characters, and relationships depicted by Döblin. As readers and viewers alike, we admire the unique performance of a literary writer and a director who was influenced by him and are rewarded for witnessing the diversity and depth of life experiences in urban space and the integration of the urban soul and urban body. As an urban morphological element, Alexanderplatz also was the subject of an architectural competition in the years when Döblin wrote his novel (Oliveira, 2016, 7-30; 106-107). But the competition guidelines and the projects proposed are disappointing when compared with the sensitivity in how Döblin and Fassbinder look at urban space and life. In project proposals that efface the dynamics of the living city and see the city-dweller merely as a consumer, Alexanderplatz, a public square, is transformed into a sterile traffic circle. Indeed the modern architects of the 20th century would remain sterile, distant, and reticent about reckoning with urban reality within the city (Sonne, W., 2014, 10-40). Their works bear witness to how they immediately focused their attention mostly on functional and physical contexts of urbanity, which attract the attention to the urban body. Yet, from their emergence to our day, cities have been stages for intense phenomenological experiences

reflecting the rich content of urbanity and the urban field as the space of encounters. For at least three hundred years, the modern city has been the space of challenging living conditions. These features of the modern cities coincide with the purpose of modern artworks that aim to reflect the contradictions and conflicts of human life. While portraying modern life in modern urban spaces surrounding the individual and society, the modern artist is not concerned with portraying peace, balance, or a measured beauty. Art treats adventure of the soul, which obstinately defying the challenging conditions of modern life and becoming much stronger. Art and literature intensify the realities of modern life and fiction life scenes that shake readers and mature them.

2. THE PHENOMENON OF URBANITY IN LITERARY, SOCIOLOGICAL, PHILOSOPHICAL WORKS

2.1 The Urban Soul. The Urban Body. The Urban Morphological Elements.

Between the eighteenth and the twentieth-century big cities, which are the living spaces of the modern individual, have transcended being mere metaphorical tools in the works of literary authors, sociologists, and philosophers, and have become sources for phenomena and concepts related to urbanity, which is a multi-layered phenomenon with cultural, social, political, economic, temporal, spatial, functional, and formal dimensions (Sonne, 2014, 10-40). Many seemingly opposite facts, such as individuality-society, freedom-loneliness-socialization, anonymity-strangeness-identity-belonging, diversity-chaos-segregation, indifferent city-dweller-initiative citizenship, have been revealed especially through written works. Litterateurs, sociologists, and philosophers in their works have treated as much of the private living spaces of individuals as of cities. By making use of the phenomena and concepts specific to the multi-layered structure of urbanity, they have reflected modern life, namely the urban soul and the urban body. For a more impressive representation of the interaction between the individuals and the society and for a more illustrative depiction of the moments and scenes of modern urban life, they have imagined the urban morphological elements in a wide variety of forms. The scenes created by using urban morphological elements and the meaning of the story are an inseparable whole. Thus, these works are sources in which the various semantic layers of urban morphological elements are displayed. In these, the referrals to the urban soul and urban body by making use of urban morphological elements can be examined under 5 headings.

a. Social conditions reflected in imaginary urban spaces: Especially in the novels, modern life is reflected with the depiction of social and physical conditions. The city forms the background to modern life. Philosophy of the modern city is constructed through a critique of the bourgeois lifestyle, and the consumption, by the wheels of the modern city, of skills coming from the provinces. Cramped urban courtyards, impoverished outskirts, working-class neighborhoods on the city's peripheries, single-room housing units for crowded families are urban morphological elements reflecting the cruel faces of modern cities that store the wealth of the world (Lichtenberg., 1775; Dostoevsky, 1866; Balzac, 1829-1850; Hugo, 1832; Dickens, 1854). Spiritual values shattered in the wealth and power game played in cities dominated by the industry continue to be told today (Hauser, 2011, 70-72). In the novels, as well as the excitement and amazement awakened by the goods of unprecedented abundance, diversity, and quality but also social classes differences are depicted.

The 250-year-old literary tradition proves that the individual and society and their relationships constantly transformed in modern life can be explored only by penetrating city centers (Hauser, 2011, 66). The city centers, including various urban morphological elements such as the squares, parks, lively crowded roads, and public buildings, are fascinating yet irritating. They expose their citizens to unpleasant encounters, a blurring of perceptions, and distraction of consciousness. From the perspective of a child, the center of the modern city is an environment of glitter and adventure which abounding in all sorts of goods (Dickens, 1860).

b. Scenes and themes of modern life reflected on imaginary urban excursions: The protagonists walking from the impoverished outskirts to the major urban edifices stride through the city, which is never quiet from dawn to midnight (Camus, 1951). Bridges, prisons, marketplaces, train stations, cafes, and passageways where the protagonists pass are urban morphological elements of special importance on city routes. Examined with their physical structures and social meanings, these urban elements in the route of an urban explorer document the modern life and shed light on the urban soul and urban body (Dickens, 1860; Baudelaire, 2007; Camus, 1951; Benjamin, 1927-1940).

c. The liberating effect of the modern city: The superficial social life of the city has created an irresponsible city-dweller who is physically, psychically, morally decadent, and lives in a state of indifference, and lacks any binding role. The city created individuals whose nerves are on edge, whose senses are overstimulated, who are arrogant (Simmel, 1903). But also environment the modern city is liberating for the provincials; in which aliens quickly feel at home (Bahrdt, 1961, 40-43). In urban districts where everyday activity is most concentrated, the relationship between the society and the individual is not always tense. Like a drop in the ocean (Rousseau, 1761), the individuals can feel calm and integrated and can find peace in the modern city where nobody about anybody cares (Goethe, 1786; Humboldt, 1789). The city liberating people from the oppressive commune mentality of the rural order and created free individuals; free urban souls sharing the consciousness of society (Tönnies, 1887).

d. Suggestions for improving the social urban life through imaginary urban designs: Modern cities and modern urban life have led authors to conceive urban spaces that deepen the scope of the phenomenon of urbanity both in terms of the urban soul and urban body (Richardson, 1875; Verne, 1888; Zola, 1901; France, 1905; Bellamy, 1888; Morris, 1890). The main subject of both utopian and dystopian novels is the design of new urban environments where the problems of the modern city and urban life have been solved. Hygienic and humane ideal city designs based on social justice and recognizing technological and scientific development were informed by the social theories of their time. Although some were formed with urban morphological elements of the spatial language of Ancient Greek and Roman architecture, the ultramodern city designs combining technological conceptions that were ahead of their time laid the pioneering foundations of futuristic visions (Lampugnani, 2011).

e. Transferring the rhythm of modern urban life to structural conception: Authors, who through a literary language, strove to encompass the irregular structure of the modern city and its life and the phenomenon of urbanity, which from the 18th century to the present, became increasingly complex, likened cities to environments such as thickets and forest, oceans, and the wild (Hauser, 2011, 66-78). By developing montage techniques in their fiction, some authors tried to reflect the heterogeneous, complex, and fast rhythm of urban life. Inspired by these features, some authors have constructed parallel and sub-universes that began to fail at the slightest technological glitch or slightest mistake of their protagonists (Joyce, 1914; Dos Passos, 1925; Döblin, 1929).

2.2 Archetypal Meanings of Urban Morphological Elements

The urban spaces of the modern city depicted in the novels highlight the dramatic impact of modern urban life. The impressions of protagonists reflect the mental, emotional and physical conditions of modern individuals and the often contradictory relationship of the individual to modern society. The inner world of the modern individual is nourished by the dynamics of modern social life. However, the individual is aware of the permanence of being separated from society and feels alone. For the modern individual, solitude is the price of freedom. Urban spaces depicted in the novels also gain their poetry from the conflicting dynamics

between the individual and the society. Readers share the protagonists' impressions. The imagination and personal associations of the reader awakening by the written word deepen the narrative and the spatial scenes within. In the imagination, soul and body unite. This topic recalls the thoughts of the French philosopher Bachelard. In the imagination, soul and body unite. This topic recalls the thoughts of the French philosopher Bachelard. According to him, the spatial elements of the house and the personal associations and memories triggered by the spatial elements of the house cannot be separated and belong to a source that transcends personality and contains archetypal meanings unique to humanity (Bachelard, 1971, 30-60). In novels that focus on modern life in modern cities, the spatial elements of Bachelard's 'home' are transferred into the urban scale. How urban morphological elements in literary works gain archetypal meanings similar to spatial elements of the 'home' can be examined under 3 headings.

a. The use of associations: The authors, blending the physical characteristics of the city with social life, are intermediaries for revealing the archetypal meanings of urban morphological elements. This becomes especially apparent when the protagonists are portrayed as excluded individuals. The 'others' are unable or prefer not to hold on to modern urban life. Their observations shed light on the bourgeois and proletarian lifestyle and loneliness of the modern individual. The 'others' sometimes mingle into the crowds. They take the readers to taverns, which are the people's parliament (Balzac in Hauser, 2011, 66-78), and to train stations which are places of departure and reunion. Sometimes they go to less frequented spaces such as abandoned plots and parks, back streets. Following the protagonist, the author takes the readers out on the terrace (Camus, 1951). He makes them watch the sea, which freely stretches out from the city, and the harbour, which forms a separate life and a separate 'inside' inside the city. One night on a terrace located on the line separating the city and the sea, the protagonist and the reader watch the harbour whose function is associated with distant horizons, turn their backs on the city, and dream of salvation. In spaces where they can hold onto, they witness the reader in their thoughts, actions, and perceptions of the city and society. Escaping to a high hill, an urban morphological element and part of the natural context from where they can watch the city and the urban life, they dream of a natural force that would destroy all this middle-class life (Sartre, 1938). These 'others' as outcasts represent the friction between the individual and the society in the modern city, namely the conflicted relationship between the urban soul and the urban body. The mental and emotional responses of the excluded to modern life reveal the archetypal meanings of urban morphological elements and urban scenes constructed with them.

b. Exchanging-blending-transforming the attributes of urban morphological elements: Public and private urban morphological elements in the novels acquire a poetic dimension recall Semper's (1878) theory of metabolism (Stoffwechsel theory). According to Semper, the first people developed techniques suitable for the materials they found and produced the 4 basic elements of architecture: the floor, the wall, the roof, and the stove that symbolizes social unity. Early humans later have exchanged and blended the original materials, forms, and production processes of these 4 main architectural elements, and thus they transformed and added poetic dimensions to them. Likewise, the protagonists in the novels have transformed the public and private features of urban morphological elements according to their inner world and their impressions of modern life and have added them poetic dimensions. The protagonist of *Nausea* takes refuge in cafés that sparkle like stars at night and gain a functionality between a private and public space. During the day, he finds the dosage of socialisation he can tolerate in libraries that substitute for a public square (Sartre, 1938). By filling the football field with the beds of people suffering from the plague Camus (1951) transforms it into an open hospital space and points to the shock of modern life. The demonstration of this unexpected blow caused by the epidemic by subverting the original functions of urban morphological elements deepens the scale of the disaster in the reader's mind.

c. The use of natural phenomena: The modern city as it is can only be depicted from certain places, or at certain times of the day; from high and/or distant points, or in the early morning and/or late at night. The authors complement the poetic atmosphere of depicted urban morphological elements by using natural phenomena and contrasting elements resulting from daily and seasonal changes (such as light, dark, foggy, cloudy, bloomed areas, etc.) and so they enhance the dramatic impact of both modern urban life and its scenes. Even animal sounds such as dog barkings echoing from afar at night and the chirping of birds in the trees are elements contributing to the atmosphere of the described scenes.

3. THE PHENOMENON OF URBANITY AND THE EDUCATION OF ARCHITECTURE

3.1 The Urban Body and the Urban Morphological Elements in the Works of Planners, Architects, and Theorists

The sensory and emotional experience-triggering qualities of cities only came into the focus of urban theorists and planning by the mid-20th century in their criticism of monotonous urban spaces designed without taking into account individual perception and experience (Mumford, 1960, 1-6; 2000, 215; Jacobs, 1992; Hauser, 2011, 66-78). As in the example of Alexanderplatz (1.3), the surviving work of planners, and architects, and theorists before the mid-20th century proves that they usually focused their attention on the functional and physical contexts of urbanity, namely on the urban body (Gold, 1997, 35-45). Although they usually do not provide sensitive spatial answers to the multi-layered structure of urbanity, architects fall under the spell of the city and the life in it. Probably because they also are city dwellers who are shaped within the frictional dynamics of the individual and the society inherent in urban life, they believe designing urban spaces is encompassed by their discipline. Yet, the discipline of urban design as 'the largest art' has other principles than those of the discipline of architecture (Ryan, 2017). As an urban designer and an academic, Ryan criticizes the way architects approach the design of urban areas as if they were large buildings, describing it as a unitary attitude. Unitary designs have created urban spaces that do not address urban dynamics and are monotonous and closed to change. Emphasizing the pluralist qualities of cities in terms of scale, time, property ownership, agent, and form, Ryan gives examples of pluralist urban designers, theorists, and architects (Ryan, 2017). The Slovenian architect Jože Plečnik is one of these architects who took a pluralist approach to the city. Through his designs at the architectural and urban scale, including diverse urban morphological elements, Ljubljana, the capital of Slovenia has become a city having urban spaces where lonely individuals and urban explorers, and groups, enjoy nature and urban life scenes. (Ryan, 2017). Plečnik's pluralist urban designs incorporate various urban morphological elements such as roads, squares, natural areas, and public buildings. By interpreting each urban morphological element differently in terms of scale, time, property ownership, agent, and form, Plečnik lends them an individuality. Acquiring unique identities, these urban morphological elements are functioning as spatial memories in the subconscious of the inhabitants of Ljubljana and the visitors. Indeed the citizens of the world compare cities and their urban morphological elements through sensory and emotional experiences and enrich their store of morphological memories as long as life lasts.

3.2 The Urban Morphology and the Collective Spaces

Urban morphology is a science in which the elements of the physical structure of cities are analyzed, the transformation of cities over time is traced, the dynamics that lead to physical changes are explored, and propositions for future planning are prepared. Natural elements, streets, street blocks, plots, buildings together constitute various urban tissues (Oliveira, 2016). When the main elements of urban morphology interfere with the natural terrain at different degrees, this causes different 'inside's and tissues to form. Cities are enriched by the juxtaposition of morphological regions of different textures (Kropf, 2018). Through the

various formations of its elements for private and public use and their interplay, the urban morphology has provided an infinite source for creating diverse cityscapes throughout history and the world over. The urban spaces or maps conceived, inhabited, and dreamed up by societies, immerse in thought those who wander and look around, impressing them like works of art. Also, the literary, sociological, and philosophical works prove urban morphological elements being not only a tool for analyzing the body shape of urban environments but offers tools for the reflection of urban life. Morphological features describe the life within a settlement like a written letter (İnceoğlu, 2016-2020). The civic, architectural, urban, and morphological richness of contemporary cities resides in the collective spaces that are not strictly public or private, but both simultaneously (de Solà Morales, 1992). Created through urban morphological elements, collective spaces are public spaces that can be used for private activities or private spaces that allow for collective use, and they include the whole spectrum in-between. The definition, character, and role of collective spaces in the urban fabric raise important questions concerning the incorporation, expression, and relation of public and collective domains within that sort of space (Avermaete, Hooimeijer, Schrijver, 2006). From an architectural point of view specifically, the multifunctional hybrid buildings being a type of collective space, are often assigned an iconic value. From the view of urban design, collective spaces are seen as microcosms that replicate the complexity of urban space. But since the collective spaces and especially the multifunctional hybrid buildings as architectural elements add value to the combination of signs defining the city and enrich urban life, they are important urban elements for cities and citizens. Therefore, if both in architectural and urban design education the investigation of the influential role of collective spaces in cities, their sizes, and the possible combinations of diverse urban functions should be considered, the way for creative spatial design topics and solutions will be opened.

3.3 Exploring the Urbanity and Collective Spaces at the Intersection of Private and Public in Architectural Education

For students of architecture, there are four inspiring sources to explore the multi-layered structure of urbanity and the collective spaces at the intersection of private and public:

a. Written works: In addition to the works of architectural historians and theorists, readers interested in spatial design can benefit from literary, sociological, and philosophical works. Architecture students especially can benefit from literary works that are intertwined with various layers of urbanity (please see 2.1.; a., b., c., d., e.). The written word in general but specifically written works from the past allow the reader to imagine her or himself as a foreign individual in urban scenes from other times. Following the protagonists, these literary works function as sources, containing urban spaces staged with different urban morphological elements at the intersection of private and public (please see 2.2; a., b., c.).

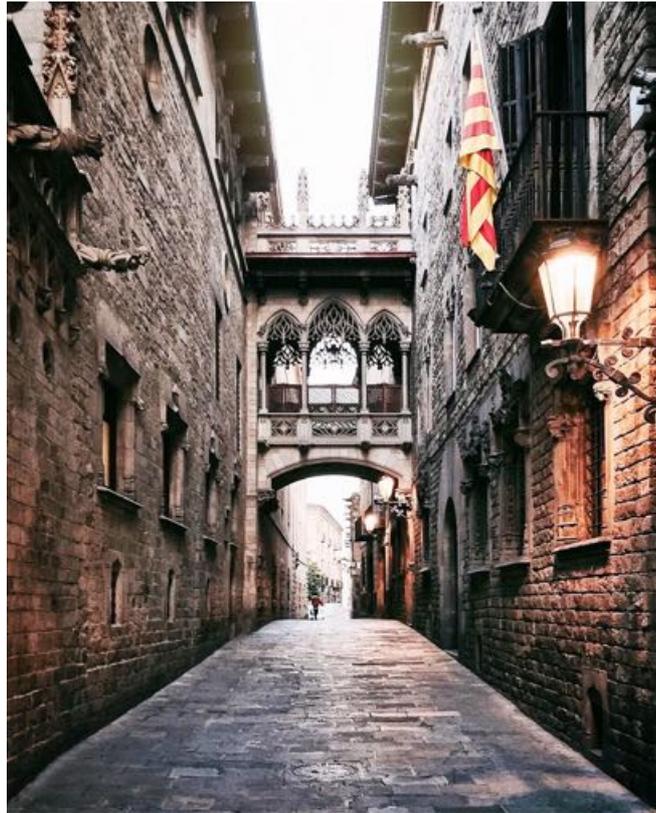


Figure 1.

b. Traditional cities: On excursions to traditional cities, students of architecture could find the opportunity to experience various urban morphological elements phenomenologically. About what a good human scale is, the architects still learn from traditional cities (Gehl; 2017). In the well-balanced compositions of the urban morphological elements of the picturesque traditional cities and townscapes, the modern citizen still senses the human scale (Alonso, 2017). But containing various private and public spaces, they also don't let explorers miss surprises. An unexpected connection between separated buildings in form of a small private bridge or city roads that are filled with water suddenly may appear in front of the explorer (Figure 1.). Not for experiencing the phenomenon of urbanity, but the relations between the individuum and community, and the human scale, the rural settlements, where local materials dominate the built environments are, also sources of inspiration.

c. Modern and contemporary cities: In addition to the connotations of the protagonists in the novels, the students of architecture can organize excursions to specific areas of modern and contemporary cities as adventurous urban explorers. Contemporary urban spaces have been created with urban morphological elements that differ from those in traditional cities.

Other than the pure forms of basic urban morphological elements in traditional cities, the urban morphological elements in the modern and contemporary urban environments are deformed, out-of-standard scales and relations. The deserted streets, the lifeless and silent modern areas, cloverleaves full of noise and exhaust fumes in which are entangled dozens of highways that have trampled over and crushed the urban tissues; the dark areas under bridges; or suburbs formed of identical houses or towers spread over an endless expanse, affect the body and soul of urban explorers. All these, including structures that are no longer in use, the in-between and the left-over urban spaces, constitute poetical urban spaces of modern and

contemporary urban environments (Hajer, Reijndorp 2001). The morphological elements of these urban spaces disrupt the morphological balances of traditional cities. It seems that life gains depth in spaces that transcend the balanced relations of the language of urban morphology. The contemporary cities challenge the standard norms of beauty, compatibility, and harmony. The contradiction embedded deep at the core of the contemporary human being also becomes embedded at the core of spaces that she/he experiences and conceives. Do not also the poems and works of modern art acquire their intensity from the unbalanced? Do they not reflect conflicts, discrepancies, contradictions inherent to the inner world of artists? Do they not constantly move beyond the standard, the norm-al, the balanced, and the aestheticized?



Figure 2.

d. Spaces where urban morphological elements are about to disappear: Where the features of morphological elements in terms of their types, shapes, materials, colors intermingle and begin to disappear under certain environmental, natural, and climatic influences, there the explorer may experience the effects of the disappearance of public and private (please see 2.2.c.), (Figure 2.). Also, ruins of settlements where nature has taken over the buildings with green plants growing out of the floors between the bare walls are poetical collective spaces, where the explorer contemplates the temporariness of individual and society.

Complementary exercises for architecture students. In addition to the study of these theoretical (3.2.a.) and phenomenological (please see 3.2.; b., c., d.,) resources, some educational exercises can be applied. These exercises will help students to combine their theoretical knowledge and phenomenological understanding about the multi-layered structure of urbanism and wake their interest in urban life that is staged in various urban morphological elements.

a. The students can be encouraged to depict urban life scenes in their surroundings and compose stories staged on real or imaginary urban morphological elements about contradictory urban areas such as crowded-empty city parts or city parts where user profiles and their actions differentiate from each other.

b. The students can be encouraged to organize excursions to certain urban morphological elements and urban areas at different times of the day and under different natural conditions. By taking account of opposite facts or concepts, they can create their own city routes and document their experiments in creative tools (please see 2.1).

4. URBAN MORPHOLOGY AS A TOOL TO EXPLORE AND DESIGN COLLECTIVE SPACES

4.1 The Four Principles of Collective Spaces at the Intersection of Private and Public

Urban spaces depicted in novels and other works of modern art gain their poetry from the conflicting dynamics between the individual and society (please see 2.2). Scary or fascinating, the scenes of urban life refer to the tense or liberating relationship between the individual and society. The long unfrequented roads,

describing loneliness, or surprises that await in the dark corners of the modern city are just two of the infinite examples that hint at both the social and the individual. According to the use of urban morphological elements, social and individual are classified as public and private. Roughly roads are public, and some buildings such as residences are private. Whether public, semi-public, or private, the roads, buildings, squares are the main urban morphological elements. The individual and society meet in collective spaces formed through public and private urban morphological elements in combination. Examples of collective spaces that hint at the individual and society can be traced (on journeys, through research on the internet, or works of art) for advanced analysis. Encountered besides in modern and contemporary cities also in traditional cities, the collective spaces can be examined under 4 headings.



Figure 3.

a. The 'private insides' inside the 'public inside':

A 'home' or an inner courtyard where the individual lives to a certain degree detached from social life offers two basic examples of this category. Just as the individual is surrounded by society, the spaces of specific groups as private interiors are also surrounded by bigger morphological regions with their own spatial features. Living beings with unique lifestyles and environments different than ordinary citizens and actions different than the routine make urban spaces collective. Compared to surrounding spaces, in these private insides, the relationships between urban morphological elements are utterly different in terms of functions, forms, users, materials. Temporary spaces such as amusement parks, circuses, etc., but also stations, ports, airports, harbours, production facilities, market places, ghettos, natural elements, historical cities surrounded by contemporary urban environments, etc., can be considered to be private or semi-private insides (Figure 3.). Also, urban spaces and structures in contemporary urban environments that have lost their original functions may be considered as potential collective spaces (please see 4.2), (Fauquet, 2019).

b. The combination of urban morphological elements: Blending the private and the public qualities of morphological elements and changing their standard dimensions add collectivity to urban spaces. There, without losing the connection to the inner world, the individual finds an opportunity to perceive society and observe the diversity of urban life. The number of that sort of collective space, which will be explained with

representative examples under 8 headings, can be increased. In the mind of an imaginative reader and designer, these spaces will be transformed into new poetic spaces where the relationship between 'private' and 'public' may become deeper.

Building + Road. By being special roads, bridges are public morphological elements. However, some bridges, such as Ponte Vecchio, acquire public and individual dimensions beyond their role of connecting the two sides. With semi-public spaces allowing to spend more time on it, Ponte Vecchio lets the mind imagine a floating home near a crowded city road, where the noises of ships and citizens and merchants intermingle (Figure 4.). Modern and contemporary cities also contain spaces such as residential complexes integrated with highways, or small residential units built by a contemporary urbanite by himself can be included in this category (Figure 5.).



Figure 4.



Figure 5.

Building + Square. The change of standard dimensions of urban morphological elements may cause the change of their attributes in terms of their functions or their private or public characteristics. One of the

examples of such spaces is pocket parks. By transforming empty spaces between the cramped buildings, becoming almost private spaces, they can be transformed into homes for citizens.

Road + Square. For the result of the change of standard dimensions of an urban morphological element such as a road, The Triple Bridge in Ljubljana gives an impressive example. Designed by Plecnik once only for the use of pedestrians, the bridge has become a lively public square on the river rather than a road (Figure 6.).



Figure 6.

City Block + Road. Walking in the covered passages means walking moving through the city's veins. By transforming empty spaces between the cramped buildings, becoming almost private spaces, they can be transformed into homes for citizens. Roads are symbols of the public, whereas a city block generally consists of private and semi-private units. In terms of the integration of the private and the public, in such spaces as in passages, a spatial poem arises, which is also experienced by Benjamin (1927-1940) in passages of Paris. In these passages, where new products near used items of unknown people are exhibited, the individual witnesses the social life through materiality.

Building + City. The inspiration Le Corbusier drew from ships emphasizes self-sufficiency beyond physical, technological, aesthetic features. Unraveling the fabric of cities by eliminating the streets out of them, Le Corbusier built private buildings floating in the greenery. Connecting some public facilities via a public internal road rather than a usual corridor, and placing other public facilities on the roof terrace, interpreted as a public square, he has fitted the city life into these residential buildings. By making these facilities available to dwellers of all ages, Corbusier designed multifunctional hybrid buildings and has transformed standard residential

blocks into self-sufficient organisms where both individuality and sociality can be lived. Also, the 'Brutalist' architectural structures offer spaces where various urban morphological elements such as bridges, ramps-open corridors-staircases as roads, private gardens-terraces, and public squares are in multiple ways integrated. As spatial representations of the individual and the social, the private and the public morphological elements take wide varieties of forms. The brutalist housing complexes usually containing large numbers of housing units are collective spaces where just like in urban environments, individuality and sociability can be lived together (Figure 7.).



Figure 7.

Building + Nature. Nature is count as one of the main elements of urban morphology. The landform urbanism movement emphasizes the requirement that the design of cities and the buildings in them should start from nature (Allen, 2011). To design spaces that eliminate the hegemony of the city and the opposition to urban life and nature is to design collective spaces (Figure 8.).



Figure 8.

City + Nature. Spaces of urban farming create oases within the city. Adding nature to the city and offering a reminder of rural life is an alternative to the everyday hustle and bustle imposed by capitalism and an opportunity to rest. The private or semi-private urban farming areas as collective spaces let individuals get away from the city in the city.

City + Street. City streets are not only for vehicles. Visible on the city surfaces or hidden underground such as roots, the roads if for some time could be opened to different uses of citizens of all ages or enriched by private, semi-private, and public uses collective places will arise (please see 3.2.c. and 4.2), (Fauquet, 2019; Hajer, Reindorp, 2001).

c. The Metamorphosis of urban morphological elements: Just as the individuals undergo personal changes, urban morphological elements having acquired certain proportions and formal features as the result of standard uses may undergo metamorphosis. Terraces as small squares and balconies as open interiors provide basic examples of metamorphosed and in-between spaces where the private and the public are interconnected. Qualitative metamorphosis occurs when standard attributes of urban morphological elements are altered through additions. For example, roads, covered with tree branches, turn into tunnels. Buildings turn into towers with roads winding around them (Figure 9.). Qualitative metamorphosis of morphological elements occurs when some characteristic features are taken of them or when characteristics of other morphological elements are added to them. For example, long buildings with fewer openings on their facades turn into walls. Recalling Semper's theories and Bachelard's work, all these and other transformations affect perception and create emotional collective spaces containing new archetypal meanings for individuals and society.

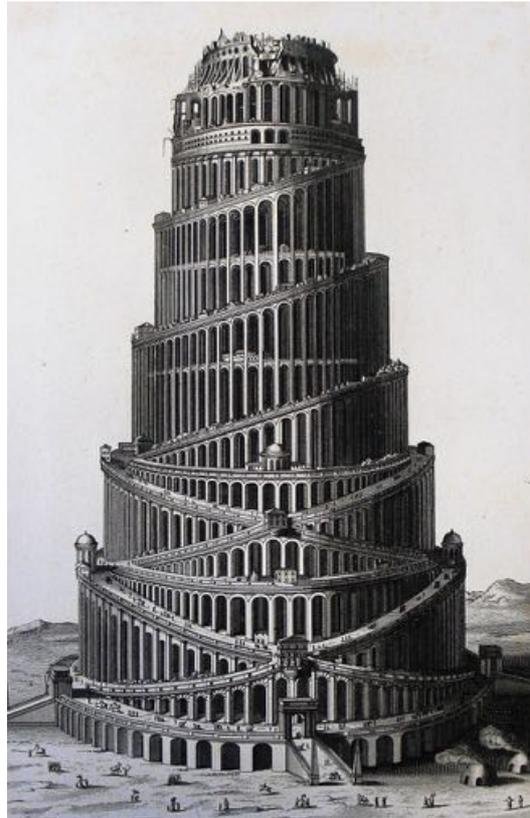


Figure 9.

d. The intertwining of the 'individual' and 'society' or intertwined urban morphological elements: It was mentioned that environmental, natural, climatic, and temporal effects may cause the visual integration of some features of urban morphological elements such as their form, material, and color with each other, and transform them into poetic collective spaces that lead the explorer to contemplate life, individual, social, and nature (please see 2.2.c and 3.3.d).

By integrating the urban morphological elements for private and public use, the brutalist architects have contributed to the integration of individuals and society and to the creation of collective spaces (please see 4.1.e.). Brutalist architects using the same material throughout the entire space provide in terms of designing collective spaces

another tip for contemporary architects. As a result of using bare concrete at the entire space and its elements, the contrasts between internal-external, private-public, building-city has been eliminated. The implementation of different materials than the bare concrete will contribute to other regulations of the relations of the individual and community and lead to the design of collective spaces containing different atmospheres.

4.2 The Urban Life and Morphological Elements of the Contemporary City

By being at the intersection of architectural and urban scales the collective spaces interconnect the privacy and publicity and thus contribute to the civic, typological, and morphological richness of any city (Avermaete, Hooimeijer, Schrijver, 2006). Combining the private and public elements of urban morphology can serve as a conduit for the design of collective spaces, just as raw materials such as flour and butter blended with complementary materials create thousands of different flavors. When dealing with the design principles of collective spaces, the designer can draw upon Semper's 'Four elements of architecture' (Quitzsch, 1981) and

'The Theory of Metabolism' (Semper, 1860). They can adapt Semper's principles to the composition of urban morphological elements (see 2.2.b). Also, archetypal human emotions and memories embodied in the spatial parts of a home in Bachelard's 'The Poetics of Space' (1992) can be transformed into an urban scale and explored in the context of elements of collective spaces (please see 2.2.a).

The architectural space, which humans perceive through their senses, and experience phenomenologically encompass also the city (Pallasmaa, 2012). Specifically, in the past decades, the design of collective spaces seems to have become an important modus operandi to intervene in the contemporary city (Avermaete, [Hooimeijer](#), [Schrijver](#), 2006). Also, today's young architects are focusing more on urban encounters (Liggett, H., 2003) and the dynamics between the private and public by their designs. It is witnessed that some of today's young architects are making use of the principle using private and public urban morphological elements in combination and design collective spaces (Figure 10.). Events such as the competition Reinventing Paris 2 also call attention to the main urban morphological elements which have fallen into disuse but can be transformed in poetic collective spaces (Fauquet, 2019; O'Sullivan, 2019), (Figure 11.). And today, spaces of brutalist architecture that contain clues about the comfortable coexistence of the individual in society are admired, defended, renovated, and added to contemporary urban life (Sosbrutalism). Public buildings, such as metro stations integrated with underground museums and libraries that are no longer used exclusively by readers and offer a wide range of uses, thereby accommodating 'other' citizens such as children and the homeless, are examples of the contemporary city's just and inclusive transformation (Hajer, Reijndorp, 2001). Or highways and airports, which were once defined only for transportation functions, containing only gas stations and stopovers, become more lively and more appealing places with more social opportunities (Hajer and Reijndorp, 2001). These developments encourage us to look artistically and without prejudice at the contemporary city, which has deformed the proportional relations of the basic elements of the traditional urban environments. Artists depict cities as scenes of stories that deeply move us. They depict the urban life on the intersection between poetics and reality, between the soul and the body, between the individual and society. The contemporary city can also be a source of inspiration for architects and architecture students.

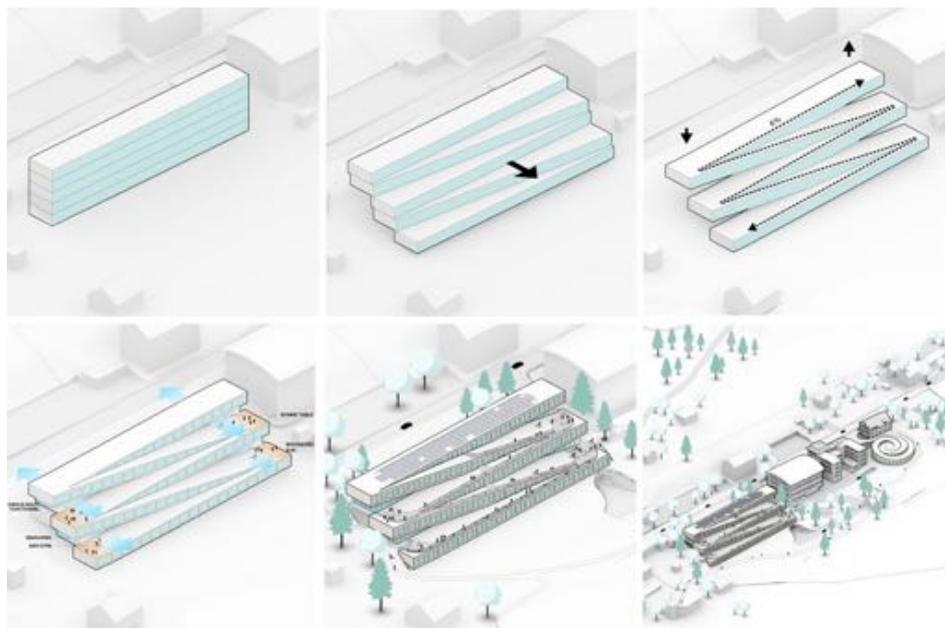


Figure 10.



Figure 11.

5.CONCLUSION

Adventure, curiosity, and service awareness in architectural education. In the contemporary city, a curious and adventurous urban explorer can find many collective spaces. Although an innocent quest may lie at its core, adventure can be far from the sense of responsibility; and without service awareness, curiosity can be egoistic. When students of architecture as adventurous urban explorers visit places they are curious and which they find interesting but where they would actually never want to live permanently, they must remember their commitment to serve. The commitment to serve the user and the community is made during education. Especially in the contemporary city, service should be inclusive; it should be accessible to all. The main elements of urban morphology and the standard measurements of the spaces built by these elements are determined by following the public needs. Public space and public life are more important than ever for cities in the 21st century. The abundance of public spaces is a testament to a city's justice. The principles of the Soft City movement for building cities and urban spaces that prioritize fundamental human needs such as light, air, and connection to place and community should not be recognized only in times of crisis (Søholt, 2020). Service awareness imparts a feeling of responsibility, but it shouldn't eliminate the spirit of adventurous curiosity but should help mature the poet within us. Used without forgetting the commitment to service, the modern written works and the science of urban morphology can inspire and provide ideas and tools for designing collective spaces where urban encounters enrich everyday urban life. And indeed, transcending the building scale is inherent in the discipline of architecture, just like going deep into the building scale (please see 1.1).

Being a part of a more vibrant and resilient urban life. Although living in big cities, most of the citizens do not encounter different social, ethnic, and religious classes than their own, and therefore, can not experience heterogeneity as one of the most characteristic aspects inherent urban life in big cities. In the route of their daily life mainly organized around work, they follow the orders of the capitalist system and are drawn into the same urban districts on the same urban roads. But even if their perception of urban environments may get monotonous and shallow, the irritating yet fascinating features of the first modern cities still exist and may still be grasped and brought into consciousness. Architecture students, especially in design studios, can be encouraged to explore the urban field as an intellectual and sensual program. Thus, the phenomenon of

urbanism should be grasped not only in a formal dimension. On the theoretical level, the multidimensional content of urbanity can be acquired through various literary works, works of art, and social studies on urban planning and its history. Students can be encouraged to write short stories about actors and places in their immediate urban environment, taking into account natural and temporal conditions. By organizing daily excursions to specific urban areas and urban morphological elements according to specific levels of urbanity, students of architecture would examine the urban soul and urban body; namely the rhythm of daily life, the diversity of actions and user profiles, and the physical conditions of urban environments on a phenomenological level. In this study, it has been emphasized that through the examination of the phenomenon of urbanity, and the urban life that is staged on various urban morphological elements, architecture students could gain interest to investigate the relations between the individual, the society, and the spatial conditions in the urban environments.

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ENHANCING SOCIO-SPATIAL ACTIVITIES IN URBAN AREAS THROUGH URBAN FURNITURE: CASE OF BAĞDAT AVENUE - ISTANBUL

EBRU HACIOĞLU ¹, İBRAHİM EREN ², ÇİĞDEM POLATOĞLU ³

ABSTRACT

This study is based on an analysis of how urban furniture affect user perception and the sustainability of everyday life in urban areas. The research question of the study is how the different nature of the street affects user performance in the use and design of urban furniture. It is hypothesized that furniture in urban space has a stimulating effect on people, and street furniture influences user perception and behaviour positively. Within the scope of the study, space perception and behavior were investigated through urban furniture, survey and observation were made in the context of the case study carried out on Bağdat Street. As the study method, the “Semantic Differentiation Scale” with open-ended questions was used in the prepared survey which aims to measure the effect of furniture on user perception in the urban space, Bağdat Avunue in Istanbul. In addition, facades or the furniture limiting the street are considered as streetscapes, as the street space is considered within the scope of the study. In the method of the research, the continuity of daily life is researched through surveys conducted by urban design professionals who have experienced the street, since public space and everyday life are up-to-date and changing subjects. As a result of the study, it was found that the street was evaluated holistically; It has been seen that streetscape elements are also important as well as urban furniture.

KEYWORDS: Urban Furniture, Spatial Perception, Public Space, Bağdat Avenue.

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1. INTRODUCTION

In the mutual and strong relationship between humans and the environment in urban space, the individual perceives and evaluates his environment with external stimuli. While many factors such as the experience and needs of the individual are effective in the process of defining the environment in a holistic way with the help of multiple senses, the physical environment as an external element also constitutes one of its basic elements.

There are many factors affecting the perception of the users in the streets that have many usages in the urban space and that people use to meet their daily needs. The question arises from whether urban furniture such as seating elements, bins, lighting, border elements, landscape design elements affect user perception and experience. In this context, the research questions that the study seeks to answer are as follows: What are the effects of urban furniture on the user in spatial perception? How are the different nature of the street and user performance affected in the use and design of urban furniture? It is assumed that these design elements have a stimulating effect on people and cities. In order to prove the hypothesis that "Urban furniture positively affects the user's perception and experience of space", the study begins with conceptual and theoretical studies that will feed the research question and hypothesis. The sustainability of public space and daily life, which has a fundamental place in urban design, and the effect of urban furniture on users are discussed.

Public spaces include many urban components such as streets, avenues, boulevards and squares. This study focuses on the streets where people interact intensively. In cities like Istanbul, there are many urban streets that are the backbone of the city, such as Vatan Street, Ordu Street in the Historic Peninsula; Istiklal Street, Çırağan Street, Büyükdere Street on the European Side; Bağdat Street from the Anatolian side (Asian). Of course, the identity and typology of each street will also differ. As a result of the descriptive research, Bağdat Street was preferred for it has both pedestrian and vehicle use, large pedestrian spaces with good scale and ratio.

Within the scope of the research, user experience was examined in terms of perception and behavior. Afterward, the street furniture used in the urban space was researched. With the determinations, the effect of urban furniture on user experience and space atmosphere has been examined. The findings were arranged for examination on Bağdat Street. (Fig 1).

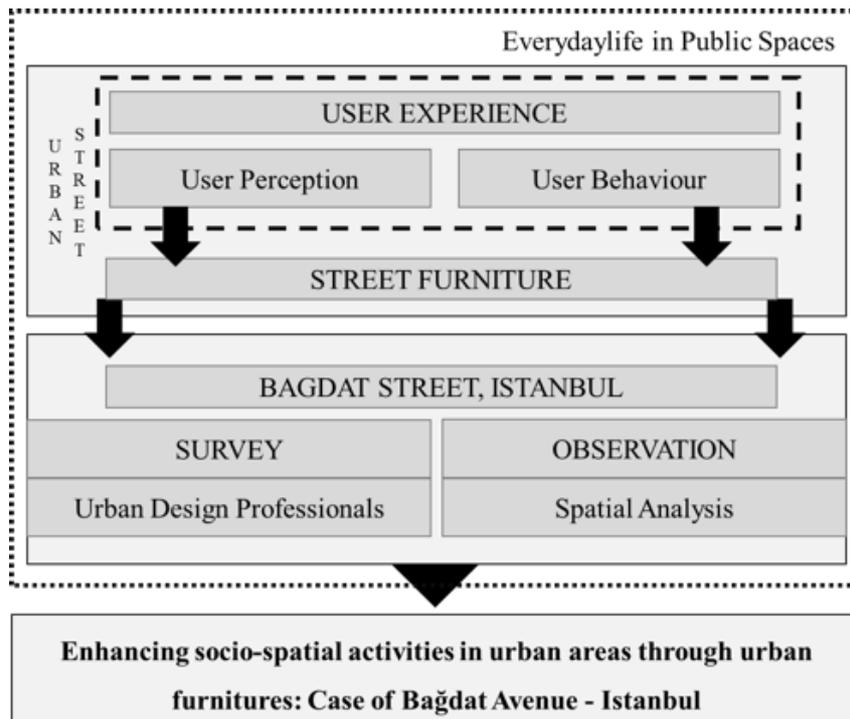


Figure 1. Scope of the Study

This study is an environmental perception research that involves revealing the relationship between the individual and urban furniture, how the individual perceives the elements. It aims to investigate the effective factors in the perception of urban space, the effects of urban furniture in urban space on the perception of users, the effects of urban furniture in pedestrian spaces on pedestrian movements in the sustainability of daily life, and to reveal effective criteria in the perception of streets. Since the research area is an urban space, research has been done *on the site*. In this study, a complementary literature review was conducted first, and then a case study was conducted to prove the hypotheses put forward.

The case study method was selected from 'Research Methods in Architecture' (2002, p: 88-95), which is the sum of the previous methods of Groat and Wang. As the research technique, "inquiry (questionnaire)", which is one of the techniques frequently used in environmental-behavior inquiries, is preferred, while the "Semantic Differentiation Scale" with open-ended questions was used in the prepared survey questions. In the study, which purposes to measure the effect of urban furniture on user perception in urban space, Bağdat Street in Istanbul. Since the street space is considered within the scope of the study, facades or the elements limiting the street are considered as street views. Conducted in the case study, questions regarding furniture and perception of the user were asked, and the findings were evaluated. (Fig 2).

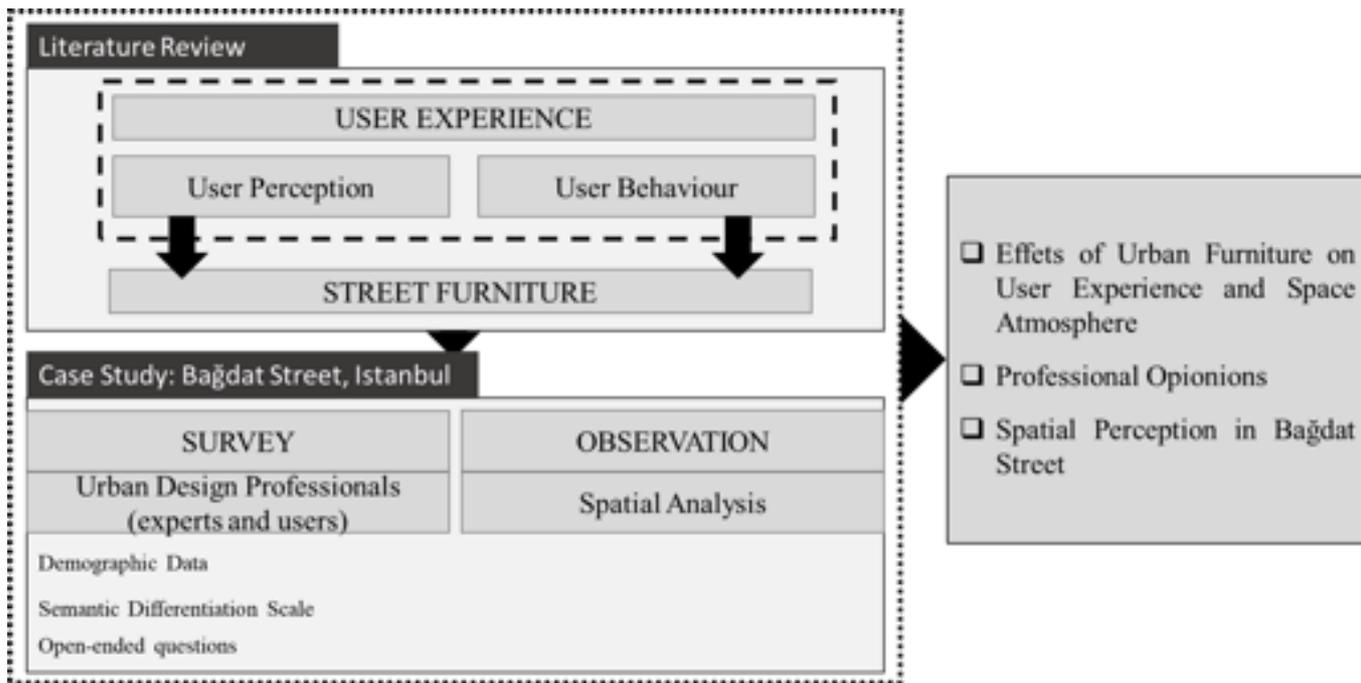


Figure 2. Method of the Study

2. THEORETICAL FRAMEWORK

In this section, conceptual and theoretical studies that will support the user experience in the public place are included. These reviews were created under the headings of public places in daily life, user perception and behavior, urban furniture and user experience. In other word, it is based on supporting concepts to measure the effect of urban furniture on users, which is the main purpose of this study.

2.1. Public Places in Everyday Life

Public spaces are areas accessible to all city users, offered to users and providing a common social space (Erdönmez & Çelik; 2016); any perceived residential center and focal point for public life, activities and events (Carmona, 2018); communication channels that connect many different urban uses and meet the needs of the society in daily life (Moughtin, 1999 as cited in Akkar Ercan 2012).

According to Rapoport (1990), the starting point in the organization of urban space is *the pedestrian and the concept of movement* is the first requirement for the pedestrian to use urban spaces. After all, the main movement seen in urban areas is walking. Potential movement possibilities within the space cause us to distinguish and perceive that urban space. Çubuk et al. (1978) emphasize that pedestrians in urban space move from urban living areas to spaces or to another settlement within the framework of daily movement. In addition to the preferences and goals of pedestrians, how the movement will take place develops depending on the characteristics of the urban space, depending on the shape, function and other physical characteristics of the occupancy in the urban space.

Space, where pedestrian movements are completed with solids and voids and the quality of the movement, differ according to these solid-void characteristics. On the other hand, *daily life focuses on* an approach that focuses not on the actions of users; furthermore, on the way they do things such as *speaking, reading, moving, shopping* (Tekeli as cited from Certau, 1988). According to Lefebvre, the street is the place where words are spoken, words and things are exchanged. The metaworld takes place on the street. People do not meet on the street, they approach (Lefebvre, 2015). When the street loses its interestingness, daily life will lose its

importance. The *lively street*, which has nothing to do with nature except the sky, clouds, a few trees and flowers, is a lively street that represents daily life for the community. (Lefebvre, 2013). Lefebvre emphasizes the relationship of today's society with *the street as a summary of daily life*.

All areas other than buildings have positive and negative effects on the urban ecological and social system. Urban furniture includes objects such as bus stops, benches, street lighting, power lines, trees and bushes. In addition to these urban furniture functions, they often have a strong social significance (Kohler, 2007)

Activities in public spaces can be simplified into three categories: essential, optional and social. *Social activities* occur spontaneously as a direct result of users moving and being in the same places. Social activities in urban streets and centers are usually more superficial, mostly passive contacts, such as seeing and hearing people you do not know. However, even this type of activity can become alluring. *Meeting, seeing and hearing* someone is a form of contact and a social activity in itself. Although the physical environment may not directly affect the intensity, quality, content of social interactions, architects and planners can affect the way people meet, see and hear. (Gehl, 2011). The activities used in the public space, whether basic or social, create an interaction between people and the environment. According to Gehl (2010) although *walking is a linear form of movement* that takes the individual from one place to another, it means much more. In addition, the author mentions that walkers can effortlessly accelerate, slow down, change direction and maneuver. Additionally, he emphasizes that a walking user can switch *to another activity*, such as sitting, running, standing, climbing, dancing or lying down.

In the streets as a public space, users can fulfill their different needs and engage in different forms of activity at the same time. As a street element, urban furniture also forms a part of this process and is shaped according to human needs and the possibilities of the space. Various activity forms of users are schematized in Figure 3.



Figure 3. *Different activities on streets*

2.2. User Perception and Behaviour

In this study, external factors aiming to measure the effect of the environment on user perception are emphasized. These factors are the stimuli around the individual that are part of the perception process. There are many theories about spatial perception; for instance, Kevin Lynch's (1960) Image Theory, Gibson's Ecology Theory in Perception, and Gestalt Theory (Lang, 1987). According to Garling and Golledge (1989), these theories are like guides on how to make a city legible. In addition, they state that in perception and cognition studies, motives, goals and ideas are accepted to exist according to behavioural alternatives.

The psychological reaction or formations that establish *the connection between the environment and behaviours* constitute the main subject in the studies. These formations provide information to be learned from the environment and its surroundings; internal, perceptual, and cognitive depiction of information; provisions, decisions, and choices form the basis of knowledge. According to Zeissel (1995) *observing behaviours* in physical fiction gives information about the activities of these people and their relationships to

sustain them. The order of movements because of predicted, new or misuse of space, and the behavioural opportunities and constraints of the environment.

With the different meanings and functions of urban open spaces, users often connect with their physical and social environments. Moreover, users are attracted to public open spaces when the environment can be an important part of their daily life and meets their needs and expectations. The *human environment has two components: the physical environment of everyday life and the social environment of interrelationships*. User experience, use and behavior are influenced by psychological, social, cultural and demographic factors. (Jurkovic, 2014)

The relationships between urban structures and user experiences also need to be investigated. It is emphasized that such studies should be specific to the region as well as the general level. In addition, while it is emphasized that the research of environmental psychology is rarely used in the discipline of urban planning, it is stated that urban designers should be more sensitive to such research. (cited from Kyttä, 2011; Jurkovic, 2014)

2.3. Urban Furniture and User Experience

Complementary units such as digital information, information points, dustbin, infrastructure covers, telephone booths, seating, and lighting elements, bus stops, taxi stand, public lavatories are urban furniture. Urban furniture should be high quality, robust, safe, and economical, as well as bring innovative solutions that remind the architectural features of the surrounding cultural and natural heritage. Urban furniture is fixed or mobile units that can provide temporary or permanent service to user needs. Correctly designed *urban furniture increases the use of public space*. "The main task of urban furniture is that a service provides integrity by coming together following the development, needs, and structural features of the city" (Dogan, 2017; 156-166).

In addition, surfaces affect the perception of space, the correct definition of space elements, the direction of the users, and the feeling of security. It is a substantial indicator for keeping the quality and public benefit at the highest level. Surface materials used in horizontal and vertical planes in urban space are preferred from natural, artificial, and new generation materials (Akay et al, 2017). Sidewalk and road widths, the length of the line, and vehicle-pedestrian traffic density are fundamental criteria in choosing the type of plants to be used in landscape design on the streets.

Street furniture can make conversations difficult or even impossible, but on the contrary, it can offer rich conversation opportunities as desired and needed. Urban furniture can provide "talkscapes". Moreover, they can make a valuable contribution to meetings in urban spaces. It is suitable for maintaining a form of keeping "arm-length" with other people, where people sit shoulder to shoulder. Furniture, set up and fixed space can offer a well-functioning environment to daily life in the city. (Gehl, 2010).

3. THE CASE STUDY: USER PERCEPTION AND URBAN FURNITURE IN BAĞDAT STREET, İSTANBUL

The streets are the dynamic spaces of the cities as places where the movement takes place. Depending on the object that makes up the movement, pedestrian priority, and vehicle priority can be considered. To prioritize the comfort and safety of pedestrians in pedestrian priority streets, all kinds of urban furniture, landscape arrangements, lighting, colour, technical infrastructure, and floor coverings that will be on the street should be handled in a harmonious and coordinated manner. On the other hand, an approach that will make the vehicle and pedestrian relationship positive should be followed in the streets with priority. The location of the parking areas of the vehicles, whether the qualitative features of the border elements between the pedestrian-vehicle are hard/soft, the border, material, colour selection, and dimensions should be taken

into consideration. Design solutions, in which the bicycle is also considered a vehicle, should be produced (Akin and Erkan, 2017).

Within the scope of the study, it is aimed to measure the holistic furniture perception in the daily life practice of those who use the selected street in Istanbul. In this context, Bağdat Street is chosen from the Anatolian Side of Istanbul as field study (Figure 4). The selection criteria of the street are one of the main important direction of Istanbul, the frequency of usage. Moreover, as an urban street – Bağdat Street- is pedestrian-vehicle axle but also used extensively by pedestrians. The fact that the route is a long and linear space, pedestrian area and public use facilities were also fundamental factors in the selection criteria. It is usually more crowded on weekends and the street is generally preferred for walking, shopping, and eating-drinking (Figure 5). Bağdat Street, located on the Anatolian Side (Asia) in Istanbul and extending parallel to the Marmara, is one of the important pedestrians and vehicle arteries. The street, which is a fundamental transportation axis in the city, includes mainly trade, housing, workplace, service, shopping malls and large public spaces. Especially in recent years, many changes have been experienced on the street, where pedestrian use is eminent and intensive.



Figure 4. Location of Bağdat Street



Figure 5. View from the street

3.1. Localities on Bağdat Street

Bağdat Street, which runs parallel to the Sea of Marmara, is an intensely used axis that continues from Kadıköy to the district of Maltepe. Although there are different typologies and uses on the street that stretches along many localities, it can be said that both districts are located in decent localities. In the Kadıköy part of Bağdat Street, which is the subject of this study, the street is a central axis that connects large public spaces and hosts mostly commercial, office, culture and entertainment venues. In addition, the Marmaray line, which continues parallel to Bağdat Avenue, makes the place more accessible. Although the density of eating and shopping on the street decreases towards Kızıltoprak, the density of polyclinics and offices shows itself.

Feneryolu, located between Kızıltoprak and Selamiçeşme, is one of the pleasant localities of Kadıköy. Monument trees and one-way traffic begin to change the structure of the street in Feneryolu. Dwelling is also observed in the locality, which mostly houses commercial and office functions. In Selamiçeşme, which takes its name from the existing historical fountain, Liberty Park constitutes an important green area. The Park, where festivals were held in the past, is still used extensively today. The presence of green areas along the street is meaningful. In addition, Göztepe Park is an important green public space in Göztepe, where residential use is more intense, and stretches from Bağdat Street towards the coast. Wide sidewalks, street furniture and large trees draw attention in this part of the street. Sitting areas are used extensively on wide sidewalks. Although Caddesbostan has the same physical typology as Göztepe, it is used much more intensively by people. It has been observed that it is used more because of the people going to the green areas along the coast and the entertainment and eating-drinking areas around. In short, it can be mentioned that there is a general usage similarity in Caddesbostan, Erenköy and Suadiye localities. In addition, Erenköy and Suadiye are used more intensively in terms of shopping venues. It is seen that the intense influence in Caddesbostan permeates these two neighborhoods.

Bostancı, which is the closest locality of Kadıköy to Princes' Islands, is heavily used both by the continuation of the street culture and by the Ferry Port. In addition, Bostancı Performance Center and Amusement Park areas in the locality are also important functions (Figure 6).

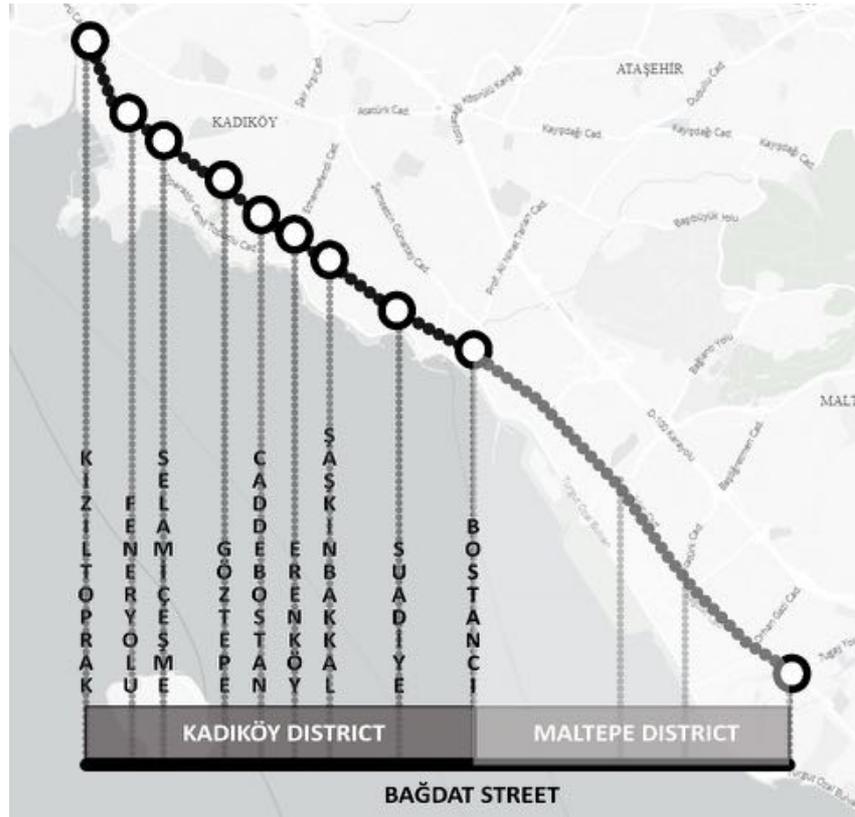


Figure 6. Localities on Bağdat Street

A questionnaire form with 20 questions was prepared, in which the influence of urban furniture on the perception of users in Bağdat Street can be measured. "Semantic Differentiation Scale" was used in the online survey with open-ended questions. Architects and urban planners were preferred for this case study, as they were urban design professionals. These chosen people are not only experts but also residents of this place. In this context, 40 architects and 40 urban planners answered the questionnaire for the street. In the research, the perceptions of the professionals who know and use the place about the street were questioned through urban furniture. Participants were asked to evaluate the urban furniture in Baghdad Street. The participants were expected to answer the questions (numbered 1-5), with pre-determined appropriate adjectives. Open-ended and multiple-choice questions were measured in detail by the participants' opinions about the street. In the sustainability of everyday life, urban furniture affects the urban / users. According to the evaluation of the survey conducted with 80 urban design professionals for the street. The respondents answered the survey of the street they had experienced before.

Table1: Urban Design Elements

URBAN DESIGN ELEMENTS	Space Perception and Atmosphere	
	Benches	

	Lighting Elements		
	Bins		
	Surface Materials		
	Tree and Planting Design		
	Signage and Billboards		
	Sheets		

	<p>Bus stops</p>	
	<p>Other Urban Furniture</p>	
	<p>Facades</p>	



3.2. Data Analysis

Bağdat Street, one of the fundamental transportation arteries of Istanbul, is also an important residential area on the Anatolian side. Although Kadıköy is a street that extends from Kızıltoprak to Maltepe Cevizli, when it is called Bağdat Street, the place up to Bostancı comes to mind first. Public use and pedestrian continuity transform the street into avenue (Figure 7). In this context, analyzes of the street were gathered under the headings of demographic data, answers given according to the semantic differentiation scale, and answers to open-ended questions.



Figure 7.,Figure 8. Pedestrian and vehicle traffic belonging to Bağdat Street

3.2.1. Demographic data

In a survey with an equal number of architects and urban planners, it is seen that the number of female experts is higher in the area. More than half of the respondents have the title of master's degree and doctorate (Table 2). The age range of the respondents and the information about which part of the city they live in are shown in Table 3.

Table 2. Gender of status, Educational status, Profession of participants

Street	Gender Status of The Participant (number of people)			Professional Distribution of participants (number of people)		Education Status (number of people)		
	Total	women	Man	Architect	Urban Planner	License	Master Degree	Doctorate
Bağdat Street	80	62	18	40	40	27	33	20

Table 3. Table showing the age ranges of the participants and which side of the city they live in

QUALIFICATIONS	Age ranges of the participants (number of people)			On which side of the city the participants lives (number of people)		
	Total	23-35	36-45	46-65	Anatolian Side	European Side
Bağdat Street	80	59	17	4	22	58

The street is preferred once a week and every day in Bağdat. While the question of access to the streets is questioned, it is seen that transportation by private vehicle is higher in Bağdat Street (Table 4).

Table 4: How often the street is used and the transportation preferences

Street	How often the area is used (number of people)				How access to the street (number of people)				
	once a month or less	every three weeks	fortnightly	once a week	almost everyday	special vehicle	public transport	on foot	those who prefer more than one option
Bağdat Street	44	6	7	13	10	24	31	12	13

3.2.2. Responses according to the Semantic Differentiation Scale

In this section, questions were answered according to the semantic differentiation scale. When asked 'Do you feel safe while spending time on this street?', it was seen that the vast majority felt safe using this street (Table 5).

Table 5. Feeling safe while spending time on the street and sound level on the street

Street	Do you feel safe while spending time on this street? (number of people)					What are your thoughts on the sound level in this street? (number of people)						
Qualifications	I don't feel safe at all	I don't feel safe	I feel safe nor insecure	I feel safe	I feel very safe	pretty noiseless	noiseless	neither noisy nor noisy	noisy	very noisy	more than one option	those who prefer more than one option
Bağdat Street	0	0	12	48	20	0	6	21	46	5	2	

Half of the participants think that there is air pollution on the street. In addition, most of the participants stated that the street was crowded (Table 6, 7).

Table 6. Air pollution and environmental pollution on the street and the crowd in the street

Do you think there is air pollution and environmental pollution on this street?		I don't think it is any	I don't think it is	I do not think nor do I think	I think it is	I think it's too much
air pollution	Bağdat Street	3	13	16	46	2
environmental pollution	Bağdat Street	5	26	23	26	0

Table 7. The crowd in the street

Street Name	not crowded at all	Not crowded	neither crowded nor crowded	Crowded	too crowded
Bağdat Street	0	0	12	56	12

The purpose of use of the street is given in Table 8 in detail. Users expressed their intention to go out. And these answers have often been found to be walking, shopping, leisure, or home-work route.

Table 8. The purpose of coming to the street.

Purposes	Bağdat Street
Walk	9
Entertainment	8
eating-drinking	4
Shopping	5

home-work route	4
entertainment and walk	0
eating-drinking, entertainment	4
eating-drinking, walk	8
shopping, eating-drinking,	4
shopping, eating-drinking, entertainment	4
shopping, eating-drinking, walk	11
eating-drinking, entertainment, walk	8
shopping, eating-drinking, walk, entertainment	11

On Street, the participants were asked about their thoughts on the features of the place. In the survey phase, 3 positive and 3 negative features were asked from them, moreover in the analysis phase, the three most frequently given words were determined in each answer. The most shared positive words on Street are wide pedestrian paths, safe and diverse. When the negative features were examined, it was seen that the first negative response was often traffic. The ranking continued with the ongoing urban transformation constructions on Street and the changing urban texture. In addition, noise, parking problems and crowds are also included in the ranking (Table 9).

Table 9. *The positive features of the street*

Bağdat Street			
Positive I	Wide sidewalks	Negative I	Traffic
	Good		Noise
	Trees		Crowded
Positive II	Safe	Negative II	Deterioration of pattern due to urban transformation
	Diversity		Noise
	Wide sidewalks		Parking problems
Positive III	Diversity	Negative III	Traffic
	Relations with the seaside		Parking problems
	Green		Crowded

Q. What do you think about existing lighting elements (street lamps)?

Q. What do you think about bins on the street?

Adjectives about lightning elements were given to participators. These are sufficient, pleasant, original, and well-maintained. They were asked to evaluate using the Likert scale. As a result of, about the street, the average of the assessments remained between 2 and 4 (Figure 9a). Users evaluated the bins on the street in

terms of size, compatibility with the environment, and originality. Although the answers were close to negative, they were between 2 and 3 (Figure 9b).

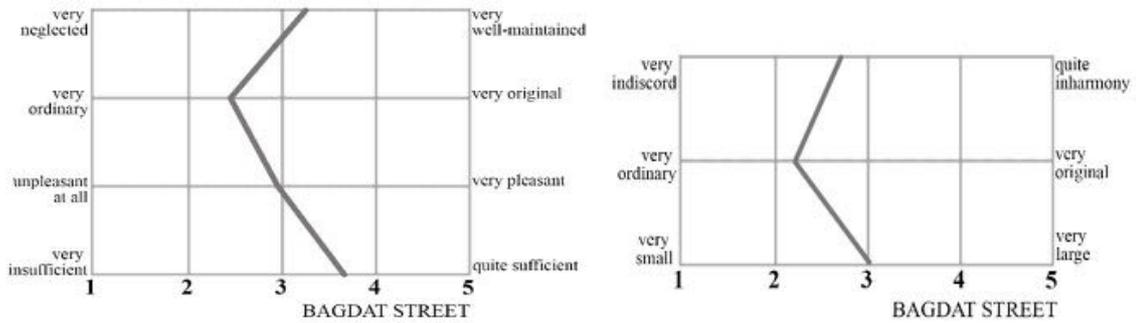


Figure 9. a) Existing lighting elements b) Dustbins on the street

Q. What do you think about the existing seating elements (benches) on the street?

Q. What do you think about signs and billboards on the street?

The answers for this street are below 3 (Figure 10a). Furthermore, users were asked for ideas about the size, complexity, distraction, compatibility and colour of the signs and billboards (Figure 10b).

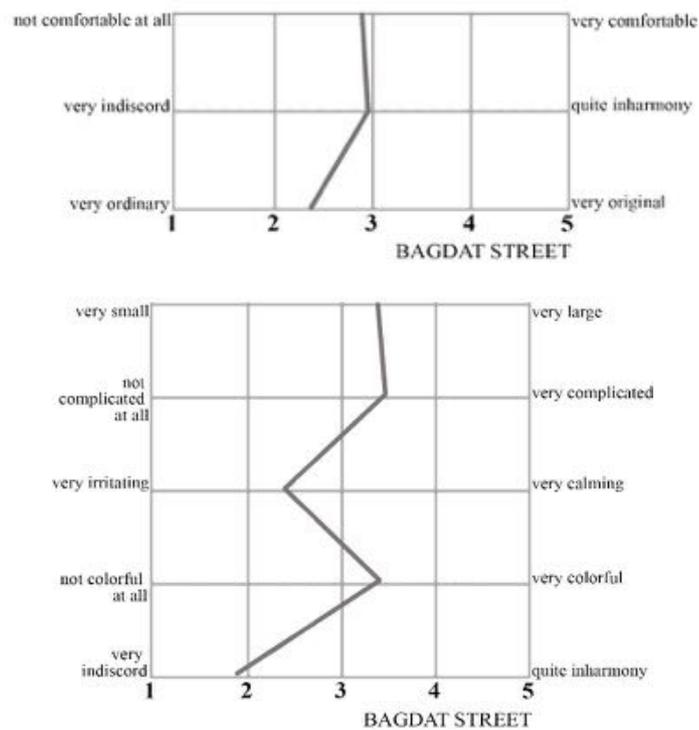


Figure 10. a) Seating elements on the street b) Signs and billboards on street

Q. What do you think about the surface material on the street?

Q. What do you think about planting on the street?

Participants were asked the situation of the surface material. The answers were closer to negative but were between 2 and 3. Bağdat Street, only the comfort choice was higher than 3 points and was closer to the positive (Figure 11a).

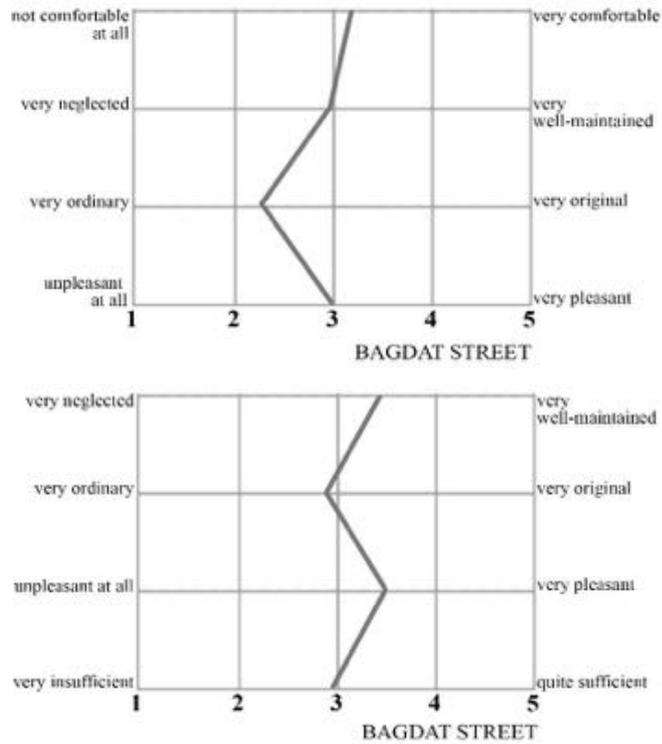


Figure 11. a) The surface material on the street b) Planting on the street

Q. What do you think about on building facades?

Q. How does the presence of urban furniture, trees and plants affect you?

When users are asked about their thoughts on building facades, it is seen that the participants give more positive answers. Once the users were asked how the presence of street furniture affected them, it was determined that their answers were above 3, that's to say, close to positive. As this case demonstrates, the users of this street have a more positive approach to the holistic evaluation of the space. (Figure 12b).

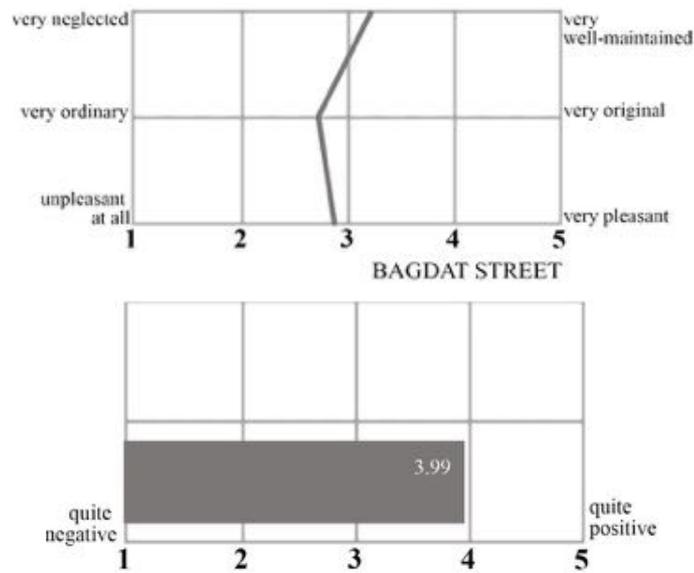


Figure 12. a) Building facades b) Urban furniture, trees, and plants

Q. How does this street make you feel?

Participants are asked to consider the street holistically. The answers are more accessible, cheerful, and understandable for the street. Besides, the answers were closer to the positive (Figure 13).

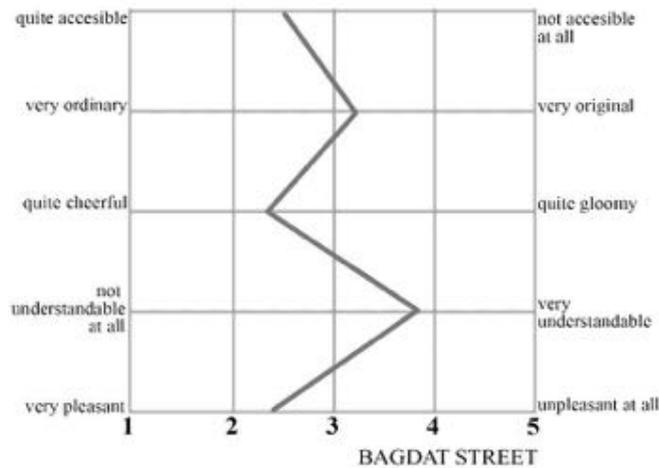


Figure 13. How the street makes the users feel

In the last inquiry of the questionnaire, it was asked whether the social distance, which was frequently paid *attention* to in recent months, had an impact on urban furniture. This question is open-ended hence the participants made more than one comment. The answers for Bağdat Street have been found quite interesting. 49 people answered that there should be a difference in the design of urban furniture.

3.2.3. Answers to open-ended questions

In the last inquiry of the questionnaire: Do you think that the social distance that we pay attention to these days will have an impact on urban design elements? What are your thoughts on guiding people in this direction with urban design? (Should there be any differences in the design of urban design elements such as urban furniture, surface materials and landscape design?) Professionals were also consulted regarding the COVID19 epidemic, which has come to the fore in Turkey as well as in the world, and which has deeply affected life in Turkey since March 2020.

During the interviews with 80 urban designers, open-ended questions were asked about both the urban planning and design discipline and the Bağdat Street they experienced. In general, 44 people said that urban design will be affected by the epidemic process, while 36 people abstained; but no one said that it will not affect directly. 32 out of 44 people stated that social/physical distance would be effective in urban furniture, while 12 people stated that public spaces would be affected. On the other hand, there were some who emphasized that such a disaster affecting society would also influence the discipline of urban design and planning. On the other hand, there are those who argue that this situation is temporary; however, they have already stated that urban design and urban furniture should address these issues. It was determined that the answers were mostly related to material hygiene, urban furniture organizations, pedestrian area design and individual space. (Table 10).

Table 10. Evaluation of the participants' views on the effects of social distance on urban design elements and the orientation of urban design

Streets	Bagdat Street
Social distance affects urban design elements	32
Affects our public spaces of COVID 19	12

3.3. Discussion

This study focuses on how urban furniture affects user perception and the sustainability of daily life in urban areas. "What are the effects of urban furniture on the user in the perception of space?" It was determined as a research question and an answer was sought for this question. At the beginning of the study, it was assumed that urban furniture has a stimulating effect on people and that urban furniture affects user perception and behavior positively.

A comprehensive literature review on public space, everyday life, urban furniture and user perception and experience, supported by fieldwork; A survey was conducted with urban design professionals on Street.

Although the effects of urban furniture on user perception are generally below 3 and close to negative in the survey results, users find the streets positive. It is seen that building facades, street ratio and planting are effective for this. Answers such as trees, historical buildings and the presence of the sea in questions about positive and negative features directed to users were also effective in the perception of these streets. On the other hand, negative aspects such as traffic, crowd and noise were also emphasized. The deterioration of the urban fabric due to urban transformation in Street was also repeated frequently. When the streets were evaluated holistically, the answers were more constructive. When focusing on questions specific to urban furniture, it has been observed that these elements do not have a direct effect on user perception; however, it was seen as an effective necessity in a holistic approach.

Users also frequently mentioned different issues. It has been seen that these are problems caused by user density such as crowd, traffic, parking problems. It is seen that urban design professionals give the answer of changing the urban texture due to urban transformation, regarding the problems arising from the built environment. It is stated that the green texture has been lost and its silhouette has changed over time regarding the urban transformation process experienced on Street (Berkmen & Turgut, 2019; Mollaahmetoğlu & Yürekli, 2011).

In addition, the approaches of urban design professionals regarding the COVID-19 epidemic experienced during this study, which explores space perception, user experience and urban furniture, were briefly learned with open-ended questions. As a result, while some urban design experts said that there was no requirement for an arrangement due to the pandemic, most of them suggested such an arrangement. They stated that issues such as individual space, order and hygiene of urban furniture are normally a matter to be considered and that the urban space already needs these regulations. Some of the participants emphasized that a global phenomenon will definitely affect urban design and planning, moreover that it will also affect the space since the subject of a social issue is human. A group of participants said that there is no need for regulation and that this process is temporary.

This study focuses on how urban furniture affects user perception and the sustainability of daily life in urban areas. "What are the effects of urban furniture on the user in the perception of space?" determined as a research question and an answer to this question was sought. In addition, the following sub-research questions were also addressed within the scope of the study.

- How are the different nature of the street and user performance affected in the use and design of urban furniture?
- How do urban designers deal with the use of urban furniture and its relationship with the street, and what do they suggest?

At the beginning of the study; It is assumed that the furniture in the urban space has a stimulating effect on the people and that the urban furniture affects the user perception and behavior positively. A comprehensive literature review on public space, everyday life, urban furniture and user perception and experience was supported by a field study; A survey was conducted with urban design professionals on the street.

Urban design professionals were asked to answer questions about urban furniture with adjective definitions. In this way, both the opinions of the users as experts and their preferences as space users were learned. On the other hand, the findings obtained with the observations made on Bağdat Street were also tested. Open-ended questions were also asked to the participants.

It has been observed that the districts on Bagdat Street, which stretches from Kızıltoprak to Bostancı, are decent, and changes have occurred within the scope of physical facilities and urban functions. An example of this is that Erenköy and Suadiye are mostly used for shopping and Caddebostan is mostly used for entertainment purposes. Although shopping, entertainment, spending time, being a home-work route are along the street, it has been observed that the weights vary according to the districts. In some districts, physical conditions such as the street getting closer to the beach and the narrowing of the pedestrian area have been observed. Despite the narrowing of the pedestrian areas in places, it has been determined that urban furniture is used extensively throughout the street. As a result of the interviews and observations made with the experts, it was concluded that the presence of subjects such as facade, building to street ratio, public space, plant and landscape in addition to urban furniture contributes to the evaluation of the space as a whole. It has been seen that the presence of herbal design elements has a constructive effect on users.

When we look at the studies on user experience in Bağdat Street; Sami and Erdönmez Dinçer (2020) discussed the street as a public space in terms of its functional, social and physical structures. In another study, Lotfata and Ataöv (2019) evaluated the street in the context of urban streets and social sustainability. In this study, Bagdat Street is evaluated from a different perspective on “what the effects of urban furniture can be on user perception” and the user experience on the streets is evaluated. This evaluation was made through questionnaire and observation. The answers to the questionnaire, which gave the opportunity to examine the study area in depth, also supported the observation findings. Although the effects of urban furniture on user perception are generally below 3 (neutral) and close to negative in the survey results, users find the streets positive. It is seen that building facades, street ratio and planting are effective for this. Answers such as trees, historical buildings and the presence of the sea in questions about positive and negative features directed to users were also effective in the perception of these streets. On the other hand, negative aspects such as traffic, crowd and noise were also emphasized. The deterioration of the urban fabric due to urban transformation has also been observed frequently in Bagdat Street. The answers are more constructive when the streets are evaluated holistically. When focusing on questions specific to urban furniture, it was observed that these elements did not have a direct effect on user perception, but it was seen as an effective requirement in a holistic approach. Users also frequently mentioned different issues. It has been determined that these are problems caused by user density such as crowd, traffic, parking problems.

When urban design professionals were asked about the problems arising from the built environment, they stated that urban transformation caused the texture to change. Regarding the urban transformation process experienced on Bagdat Street, it is stated that the green texture has been lost and its silhouette has changed over time (Berkmen & Turgut, 2019; Mollaahmetoğlu & Yürekli, 2011). In addition, the approaches of the experts regarding the Covid 19 epidemic experienced at the time of this study, which investigated space perception, user experience and urban furniture, were briefly learned with open-ended questions. As a result, while some urban design experts said that there was no need for an arrangement due to the pandemic, most of them suggested such an arrangement. They stated that issues such as individual space, order and hygiene

of urban furniture are normally a matter to be considered and that the urban space already needs these regulations. Some of the participants emphasized that a global phenomenon will definitely affect urban design and planning, and that it will also affect the space since the subject of a social issue is human. A group of participants said that there is no need for regulation and that this process is temporary.

4. CONCLUSION

After a general discussion of the answers given to the questionnaire, it is understood that the questions about urban furniture do not directly affect the spatial perception, but when space is evaluated holistically, the elements have an effect. It has been observed that urban design professionals evaluate the space holistically and focus on internal and external factors in their answers.

In this study, which is a user experience research, the perception and atmosphere of urban space were investigated, how users perceive urban furniture, what the effects of urban furniture on user perception and pedestrian movements are, and the factors that are effective in the sustainability of daily life. In this context, a field study was conducted to find answers to the research questions. In this study, which aims to measure the effect of urban furniture on user perception, Istanbul Bağdat Street was chosen as the research area. While 'observation' and 'interrogation (questionnaire)' were chosen as the research technique, the Semantic Differentiation Scale was used in the prepared questionnaires. As a result of the observations and surveys, it was seen that the users use Bağdat Street for eating and drinking, shopping and socializing. The wide sidewalks, the presence of trees and plants along the street, the benches in the shaded areas and the places that provide all kinds of different services are the reasons why this street is preferred.

Considering the effect of urban furniture on the user experience, it was seen that although each furniture received an average or nearly negative response when evaluated alone, they created a positive impression when the street space was considered as a whole. In addition to urban furniture, the presence of landscape elements (trees and plant elements), building/road ratio, scale, continuity, proximity and landmarks within the scope of street view are other factors that affect the user experience. In the examinations on the perception of space and user experience in the theoretical framework; It has been concluded that the individual experiences the space holistically with multiple senses. In other words, while the user on the street, which is a component of public space, evaluates the street space as a whole, his/her own experience and needs are also important.

If urban furniture is to be re-evaluated; It is suggested that it should be designed both on the basis of the user's perception and senses, and considering the atmosphere and spirit of the space. With the urban furniture design and arrangements discussed in this context, livable environments that establish the relationship between the user and the space, and sustainable in terms of visual quality can be created. It should not be forgotten that the street is evaluated holistically as well as in its design and urban furniture is only one of the urban design elements. Undoubtedly, different and new parameters will be the subject in the public sphere, such as the pandemic process mentioned in this article. In essence, when the opinions about the pandemic, which changed the flow of life with the end of 2019, are evaluated through urban furniture and the perception of space, it has been seen that these issues are a necessity - a matter that needs to be addressed in the selection and arrangement of furniture and materials, even though there are changing issues such as hygiene and distance.

The result of this study, which shows that the environment is evaluated as a whole, is thought to be an important issue for the continuity of public life. While the continuity of daily life changes with many phenomena on a local and global scale, the holistic evaluation of the space by taking advantage of the developing opportunities sheds light on an important point.

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DETERMINING THE COASTAL CONNECTIVITY OF ISKENDERUN IN THE SCOPE OF SOCIAL QUALITY

ZEHRA TUGBA GUZEL¹

ABSTRACT

The coastal areas where the overlapping of terrestrial and marine ecosystems have occurred by the geographic structure of the sea and land transition zone. These unique formations shape with temporal and spatial alteration by erosion&deposition of natural items and anthropogenic interventions with port, bench, production, and accommodation facilities that the economic structure provides to enhance from past to present. Mainly, increasing settlements, industrial production and transportation zones of coastal landscape cause to destroy the natural balance, missing of the blue scenery, and interrupt the human and nature relationship. These limitations need to evaluate over the affect of direct (marine activities) and indirect (green areas) connectivity in terms of the landscape quality and environmental justice in the design of coastal for the community. The aim of the study is that determining the coastal connectivity of the Iskenderun coastline that owns the significant heavy ship industry of Turkey while assessing the social connectivity related to the users and the recreational activities. According to evaluating the spatiotemporal changes of coastal formation, land use, and public-private status, the region possesses social (zone 5,6), economic (zone 1,2,4), and socio-economic (zone 3) connectivity. Zone 5 by artificial (soft-engineering), and zone 6 by natural coastal formations shape and are located in the most southern of the city, are defined as social connectivity areas because of the interaction with the sea through active and passive activities by the artificial irrigation channel which provides similar activities diversity and users' profiles. The urban coastal park (Zone 5) is the highest social connectivity owing to the region's single uninterrupted coastal pedestrian line, while zone 6 becomes prominent with the single swimming region in Iskenderun. Interacting with water in two regions has certain possibilities with the presence of limited activities, but social coastal interaction can develop by water sports; Courses and appropriate spatial platforms should create for all age groups; Races should organize to increase the popularity of the region according to the popularity and natural potential of the area. As a result, the coast of Iskenderun on which considers as the production and transportation resource partly satisfies the recreational needs of the community despite its natural potential that enables more socialization.

KEYWORDS: Coastal formation, Coastal connectivity characters, Social quality, Activity diversity, Users

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1. INTRODUCTION

The coastal areas where the overlapping of terrestrial and marine ecosystems have occurred by the geographic structure of the sea and land transition zone. This significant zone has those diverse opportunities that occurred from the natural deposition of sand or the building of artificial structures that have interacted with the society as economic and ecological (Song et.al. 2018; Seingier et.al. 2011).

Coasts shape by alteration progress with anthropogenic or natural reasons, while the organization of transportation networks, market potential, recreational and tourism activities enhance by the presence of healthy, diverse coastal habitats and the large array of facilitators for society (Ghermandi & Nunes, 2013; Martínez et.al. 2007). Primarily, interaction with coastal areas has been established to meet the fundamental living needs such as nutrition, economic opportunities. Coastal connectivity as a part of culture has shaped the lifestyle of Asian countries that produce to develop the society's economic structure with agricultural goods (Johnston et.al. 2011). Currently, the rapid realization of production, the increase of globalization, and the easy access to basic needs have highlighted the use of coastal areas for industrial production and commercial flows and reshaped the coastal-city relationship.

Since industrilization, transformation of land cover toward settlement and heavy industry cause that the coastal landscape have gained artificial character by ports. Cities organized and developed land space and ports & transport terminals, while the land-sea connectivity from ecological aspect degraded the freshwater wetland, pollution diversity, urban infrastructure (Dutt et.al. 1994; Waterhouse et.al. 2016). The ports on a global scale began primarily in Venice with the aim of trade, while these ports' development zone expanded toward North America and European cities in the middle of the 20th century, and Australia and the Far East towards the end of the 20th century. However, the economic contributions of ports weaken the social relationship between the city and the sea. Built axes to provide transportation to the ports in Toronto have prevented the connection between the coasts for recreational and leisure activities and have interrupted the relationship of the people with the sea. Even though the built ports were, the residential areas in England settled between these (Guo et.al, 2020; Hoyle, 1989).

Generally, coastal landscape character by the biophysical structure occur the social connectivity that attracts the human and activities. The social and ecological connectivity of the coast enables direct connection to the society by the marine activities like fishing, snorkeling, swimming, and diverse water sports (Eger & Doberstein, 2019). However, alteration of coastal characteristics by ports causes to redevelop of existing areas for public habits and generate novel activities for social connectivity. In this scope, the indirect connection between the coastal and society figures out with coastal green areas that are a sustainable strategy to increase urban resilience by the conservation natural balance. And these areas benefits to the society over phycial and mental healthy, social cohesion and community satisfactions (Cox et.al. 2006; Jeong et.al. 2020).

The quality of social activities is evaluated by the user audience, usage diversity, equality and the interaction rate of individuals according to the literature of landscape quality. On the other hand, the water quality, the attachment of place by water, accessibility and the network size affect the social quality level for the life quality (Bruni, 2016; Ghermandi & Nunes, 2013; Cox et.al. 2006; Arslan, 2005). According to this information obtained, determined that the user and recreational activities need to consider in the design of the coastal landscapes, for the community life is positively affected by the sea contact.

Turkey is surrounded by the sea from three sides, shapes by the relationship that has economic and tourism targets between the city and the sea. Presently, The port cities located along the Mediterranean and the Black sea get involved in the international trade axis. But the social connectivity with the sea needs to achieve for these cities' societies.

The aim of the study is that determining the coastal connectivity of the Iskenderun coastline that owns the significant heavy ship industry of Turkey while assessing the social interaction of the coastal with the users and the activities.

2. METHODOLOGY

Iskenderun is evolved along the coastal belt as a gigantic port city between the harbors on Turkey's Mediterranean and the Black Sea region since the Ottoman period (Doygun & Alphan, 2006). Developing economic structure on a global scale with the industrialization and the change of the coasts affect the alteration of the city. So, it should examine in terms of physical, social, and economic aspects. The aim of the study is that determining the coastal connectivity of the Iskenderun coastline that owns the significant heavy ship industry of Turkey while assessing the social interaction of the coastal with the users and the activities. Some research questions ask according to the titles considered to be investigated within the scope of the study;

- How does the diversity of land use is affected social and economic relations between the city and coast? Is there a relationship between urban density and social connectivity?
- What are the elements that cause the social relationship to develop and deteriorate? How do citizens generate the directly or indirectly coastal connection to the sea?
- How are natural coastal formations important in social connectivity?

Coastal areas are the natural development zones between the shoreline and the shore edge line, which reach the waves to the final line from the shoreline. The formation of built-up areas initiates to take shape after 50 m from the coastline towards the land (Coastal Law, 1990). Sorensen & McCreary, (1990), Gutiérrez de MacGregor & González Sánchez, (1999), and Seingier et.al. (2011) working on the social interaction of coastal areas have determined their study areas as a horizontal distance of 200 m from the coastline to the land. Within the scope of this study, the land-use status of the city analyzed at a distance of 1 km from the coastline to the land, while the social connectivity of coastal also assessed within 200 m.

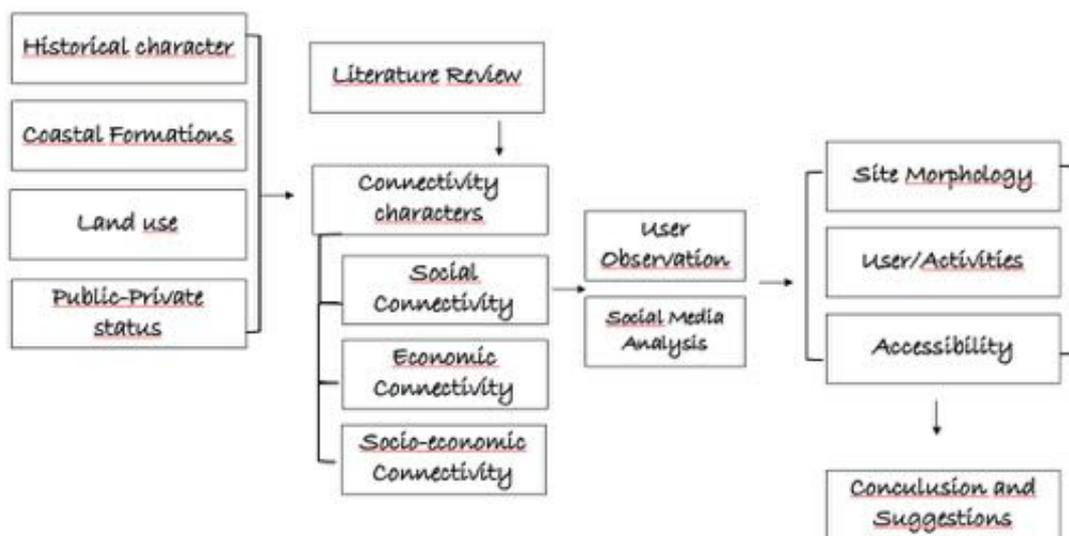


Figure 1. Method of the study

Within the scope of the study, the coastline is examined by three main stages with analyzing coastal characters, determining the social quality situation, and giving suggestions (Figure. 1). On the first stage, the connectivity types of the region are determined by observation of the historical characters with 1764 Carte de la

Mediterranean map (Chez Joseph Roux Hydrographe du Roy), 1814 Palestina and Syria map (Syria Antiqua et Palaestina) and 1942 Hatay map (URL, 2021), and coastal formations, land use plan, public-private status plan created by ArcGIS base map. According to observed results, the coastal characters of Iskenderun have been a culture in terms of both social and economic way, yet direct or indirect connection and usage diversity have altered between the urban system and the sea in time. The second stage of the study occurred the inquisition of the social connectivity areas, which is determined due to analyzed land use, public-private status, coastal formations, with site morphology, by the field crossings, prepared accessibility data by ArcGIS base maps, the measured number of users and activities with the two observations and posted photos in Google Maps. The observations at 09:00 AM, 05:00 PM on 15.06.2020, 01.00 PM on 22.06.2020 and at 09:00 AM, 01.00 PM, 05:00 PM on 27.01.2021 were figured out to measure the user gender, audience, activity types, the direct and indirect connection of water. The obtained results are planned to be evaluated in terms of social quality. Therefore, some of the activities suggest according to the usage potential of the Iskenderun coast.

3. RESULTS AND DISCUSSION

Iskenderun district between the Mediterranean Sea, Amanos Mountains, Payas, and Arsuz districts as a part of Hatay is located at the eastern coast of Iskenderun Bay and in the eastern Mediterranean region of Turkey. Iskenderun is located at the southernmost of Turkey, in the center of Hatay's Mediterranean coastal, gradually rises from the Mediterranean coast toward Amanos Mountains as the topography (Figure 2). Mediterranean climate, characterizes by hot dry summers and mild winters, is dominated in the region where the annual average temperature is between 15°C and 25°C. The highest average precipitation is recorded in the winter (December-January-February), the lowest average in the summer (July-August) (Turkish State Meteorological Service, 2021).

Hatay, which is accepted as a city of civilizations, has been a region where several societies, possess diverse beliefs, cultures, and rituals, lived since 100,000 BC (Hatay Governorship, 2021). Iskenderun, defines currently in the second center of Hatay, established by the Great Alexander who is the king of Macedonia in BC 333. This area, which was first a part of the Ottoman in the 16th century, was the district of Aleppo and became a trade center with the commercial relations and pier. However, existing different ports such as Samandag and Payas in the area affected the commercial development of the city during the Ottoman period. According to the Seyahatname of Evliya Çelebi in the 17th century, Iskenderun defined where there is an absent settlement, consisting of reeds and swamps, and where 200 Frankish and Islamic ships arrive every year. The city began the development of residential areas in the 19th century, with the draining of the marshes, changing the administrative border, and building of trade route with Aleppo. The enlargement of international commercial and administrative relations increased the immigrant population, causing a search for a solution to the unofficial trade problem such as smuggling. Iskenderun, whose international significance developed, began to function the first modern port in 1922 and the second in 1977. The city, which has more than one port, is currently carried out in industrial production as well as commercial activities (Tutar, 2002; Urkmez, 2013; Doygun & Alphan, 2006). Therefore, Iskenderun has been adopted as a port city since its establishment and has been planned as the gateway of Hatay to the globalizing world in economic, social, and cultural terms.



Figure 2. The study area location according to Turkey and the topographical structure.

Iskenderun coastline has altered in the 250 years that have passed since the 18th century until today due to natural and anthropogenic effects, mainly economic developments. According to Figure 3, when the natural coastal formations of Hatay between 1764-1942 examined that the area which occurred with the bays, estuaries, tombolos, have filled with natural components like alluvium, stone, sand. Besides, in the 16th century, Payas and Samandag harbors were located around the estuaries that existed at that time. While Iskenderun located in the inner part of Iskenderun Bay in 1764, this bay and around substantially filled in 1942. Iskenderun, where the natural coastal formation is hardly ever present, stands out with the artificial coastal formations like harbors and filling areas together with economic developments.

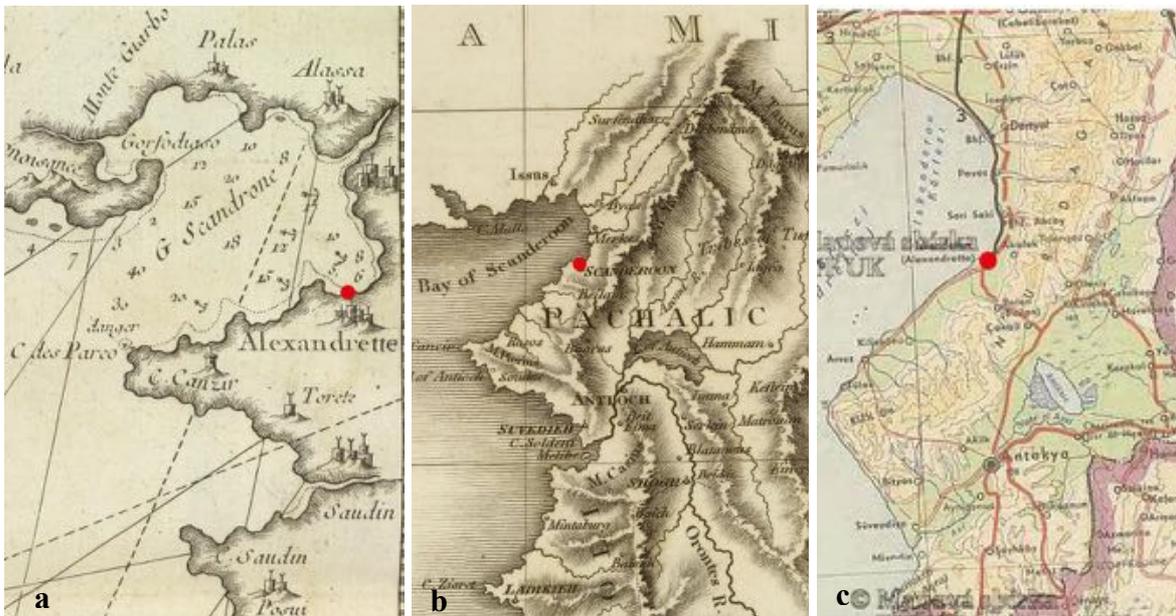


Figure 3. Spatio-temporal alteration of Iskenderun coastline a: 1764 (*Carte De La Mer Mediterranee en Douze Feuilles*), b: 1814 (*Syria Antiqua et Palaestina*), c: 1942 (URL, 2021).

The present coastal formation of Iskenderun is under dense urbanization (Figure 4a) by existing artificial formations where soft and hard engineering techniques are applied. While soft engineering techniques ensure that interventions on coastal areas are made per the natural structure, hard engineering techniques completely shift the biophysical structure of the coastal (BBC, 2021). The artificial formations of the city are formed with ports and filling areas in the northern parts and rock and gravel armours, and groyne in the southern parts. Natural coastal formations consisting of beaches and dunes just disperse among artificial formations (Figure 4b-4c). Natural and artificial coastal formations enable the city to connect directly or indirectly with the sea. Connectivity ensures the continuity of the relationship between the changing natural conditions and species (Eger & Doberstein, 2019). In this context, the economy-ecology-society balance improves by adapting artificial coastal formations (soft engineering) to the natural process.

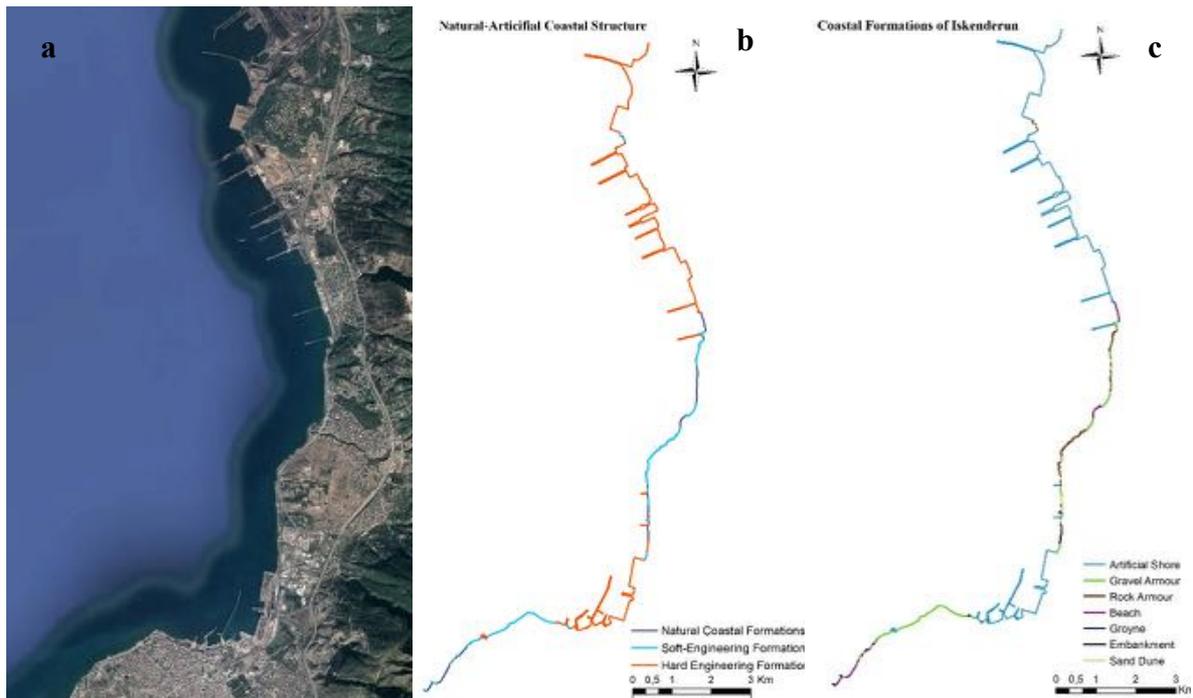


Figure 4. Current coastal formation of Iskenderun **a:** current city structure, **b:** natural and artificial coastal formations **c:** types of coastal technics.

Coastal formations inspire finding out the development of city structures and land use situations. Iskenderun represents the importance of industrial areas in land use with the ports. However, the land-use situation should examine to discern the use of social interactive areas. According to the current land use plan of Iskenderun prepared in Figure 5a, the city is divided into 6 various zones (Figure 5b). Zone 1, consists of heavy industrial facilities and gated community areas where the facilities' workers live in the northernmost parts of the city. Zone 2 and Zone 3 also form by the union of two residential areas from this region to the south. These residential areas, divided by natural green areas, comprise detached buildings and industrial ports in Zone 2, cluster buildings, fishing shelters, partly used residential as natural & semi-natural coastal formations in Zone 3. Military, industrial and logistic facilities are situated in natural-artificial coastal formations of Zone 4, while Zone 5 as the oldest residential area of the city, consists of urban business centers, attached buildings, and urban green areas. Zone 6, separated from the north of the city by an artificial irrigation channel, shapes by natural coastal formations, agricultural lands, active&passive urban green areas, and attached, detached, and clustered buildings.

All determined zones are associated with the Iskenderun-Mersin railway line, Iskenderun-Adana highway, and urban roads to transport industrial productions and humans. According to the analyzes made so far, while roads, as one of the elements of the urban image, enable the use of every point in the urban structure, they disrupt the social balance by separating the natural systems (Forman 2014; Lynch, 2016). In this scope, northern parts of Iskenderun are the most affected in terms of coastal-city connectivity from these industrial purposes roads. Also, this railway and highway eliminate coastal-city interaction up to Zone 5-6.

The private and public status of the lands is an essential parameter for coastal-city interaction to provide the creation of recreational areas. Public spaces should identify for social interaction, as no rights claim for access to the shore in private areas (housing, industry). As presented in Figure 5c, while the northern part of the Iskenderun coastline belongs to industrial facilities and private use, the southern regions have a slightly more public profile. Regions with natural and semi-natural coastal formations are mainly public areas that are close to residential areas. However, some regions like residential areas located in the natural coastal formations cannot function due to private property. Likewise, although there is an artificial coastal formation, there are areas reserved for social use. Therefore, land use, coastal formations and the existence of public spaces are considered as a whole for coastal social connectivity (Figure 5c).

With all these investigations, the land use situation affects the development of the city structure in the horizontal direction and the coastal connectivity of the city in the vertical direction. In terms of coastal city interaction, Iskenderun had to horizontally divide due to the railway and road systems that were built very close to the sea, and vertically due to the inclusion of urban business areas in residential areas. Iskenderun's transportation networks and industrial facilities prevent social interaction with the coastal areas that local people need.

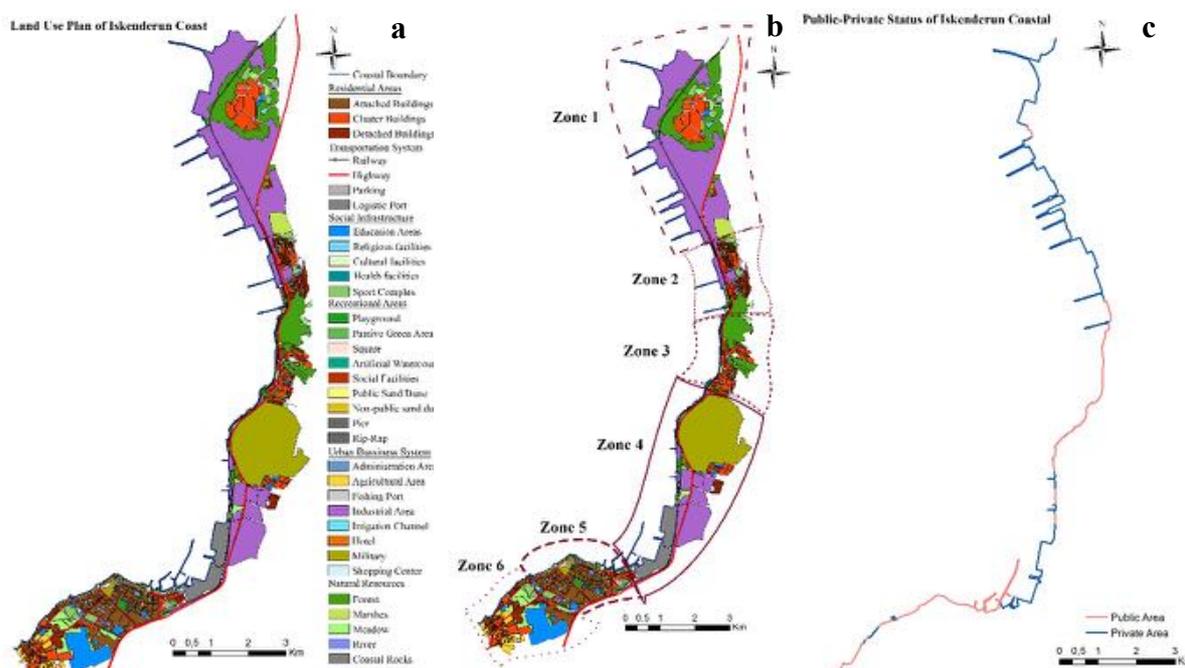


Figure 5. Analysing of **a**: land usage and **b**: public private status of Iskenderun coastline to evaluate the sociality potentials by **c**: determined zones.

While Iskenderun is a region where both social and economic connectivity with the sea takes place with the historical and cultural value, the city was divided into three as Arsuz-Iskenderun-Payas in 2012 according to the 6360 no Municipalities Law. This division caused the city's socially interactive areas to be concentrated in Arsuz (south part) and economically interactive areas in Payas (northern part). For this reason, Iskenderun is

a region where both social and economic coastal interaction is observed. From the past to the present, the people of Iskenderun migrate to Arsuz in the summer months due to the climate and spend the whole season in this region (Cetin, 2012).

Coastal connectivity for social and economic purposes has been determined in 6 zones, analyzed according to the area use, coastal formation patterns, and public-private property status. Coastal areas with industrial, logistics and military use, privately owned, developed with artificial coastal formations have economic connectivity. As a result, Zone 1, Zone 2 and Zone 4 are areas with economical connectivity on the coastline of Iskenderun. Social connectivity realizes in natural and nature-friendly coastal formations, closeness to residential areas, accessible public areas in Zone 5, Zone 6 of Iskenderun. Zone 3 exist in socio-economic connectivity because coastal fishermen in the economy and the location are proximity to residential areas, the coastal formation shaped by natural structure, and the area belongs to the government (Table 1). According to the results, the southernmost region of Iskenderun where urban settlement is concentrated satisfies the community in terms of accessibility to the sea. So, the types and concentrations of developments in the coastal plain must organize to consider both inhabitants and producers of the city in terms of the interaction between the economy, recreation, and tourism. (Wolanski et.al. 2004).

Table 4. Evaluation of social connectivity status of the zones.

	Coastal Formation			Public-Private Status			Land usage						Coastal Connectivity				
	Natural	Artificial		Public	Private	Mixed	Closeness of road	Contunious	Pedestrian road	Green area	Industry	Military	Logistic	Residential	Social	Economic	Socioeconomic
		Soft-engineering	Hard-engineering														
Zone 1			x	x		x					x					x	
Zone 2			x		x		x				x					x	
Zone 3	x	x		x			x			x							x
Zone 4		x	x			x	x				x	x	x				x
Zone 5		x		x			x	x	x					x	x		
Zone 6	x					x	x							x	x		

3.1. Social Quality

While cities that are higher economic development status, fulfill the fundamentals of individuals, ignore natural systems (Forman, 2008) despite the necessity of interaction between humans and nature. But, the adaptation of green and blue infrastructure systems with the urban structure is significant to satisfy this interplay need between nature and humans (Guzel & Turer Baskaya, 2020).

Iskenderun, with its green and blue infrastructure system, has suitable potentials to supply the requirements of people for nature. Zone 5 and Zone 6, which are determined as the intersection point of green and blue in the Iskenderun coastline, is appropriate for satisfying the society's needs to nature in the context of connection between sea and green areas.

According to Figure 6, Zone 5 (east of the irrigation channel) consists of passive and active green areas with an artificial harbor, playground, city square, mosque, social facilities, basketball, and skateboard in intense urbanization. This area as the single urban coastal park located between the Mediterranean Sea and the highway provides an uninterrupted sea connection with its along-the-coast pedestrian road and pier (Figure

7a). In this scope, different coastal interactions exist that the first is the rip rap zone of about 2 m and the presence of a 70 cm wall on the roadside, and the second is from only the rip rap zone. Extending from the pier to the military area, The former design arranges urban furniture away from the sea, to the left of the pedestrian road (Figure 7b). People who prefer to be near the sea utilize this wall as a sitting unit, for passes to the rocky area. The latter approach set urban furniture after the 2m rip rap zone, keeps up until the end of the coastal park, and provides direct sea interaction (Figure 7c).

The uninterrupted walking path of the park is completed in a beginning part of Zone 6 which directly interacts with the water, especially the sailing club. Middle part of this region, consisting of groyne and natural dunes, cannot interact with the sea in certain areas due to the coastal location of the residential areas (Figure 7d). Social interaction develops with the dune areas in the end of the zone, suitable pedestrian paths, parking and social facilities (Figure 7e). Therefore, zone 6 has areas where social interaction cannot be established continuously or at all.

In terms of accessibility, both areas can be accessed from residential areas by vehicle or walking, whereas Zone 5 is the only area where continuous interaction with the sea is seen in terms of walkability. Providing the sea interaction without any restrictions, Zone 6 gains diversity to the social life of the city. However, the fact that this area is far from the main road and the insufficiency of lighting are factors in shaping the usage situation.

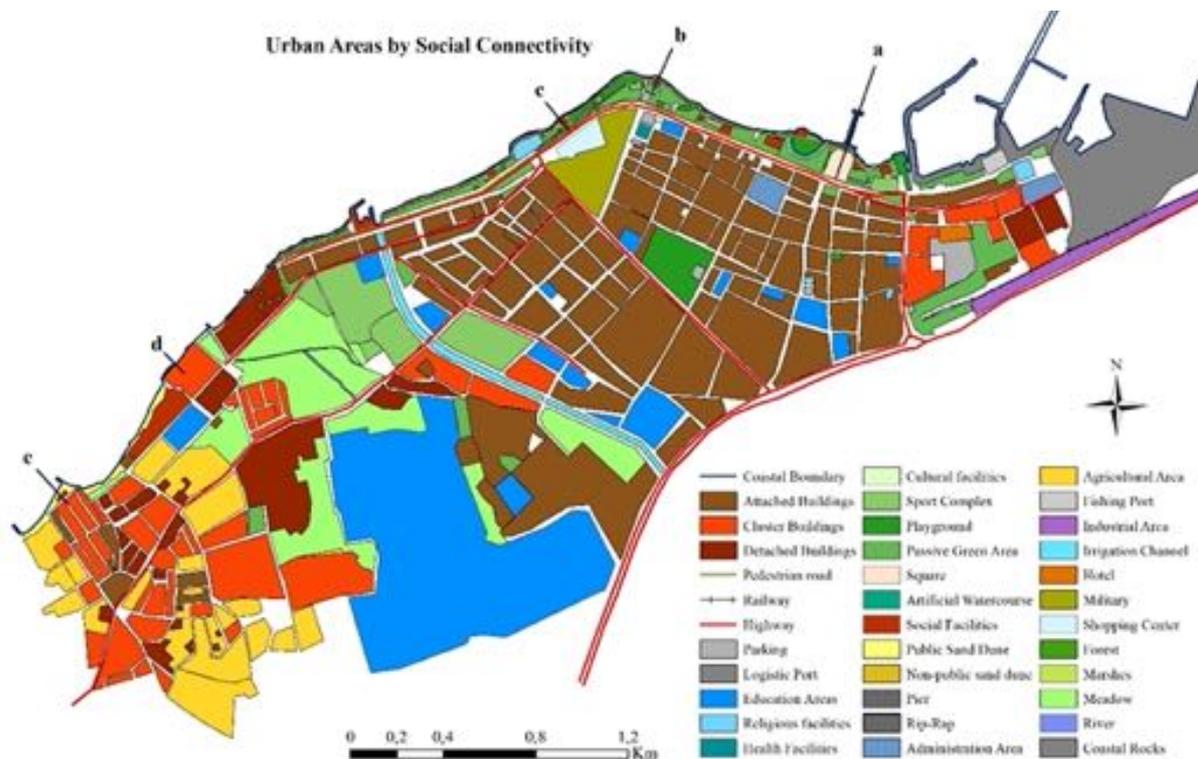


Figure 2. Determined urban areas with social connectivity through coastal connectivity analysis

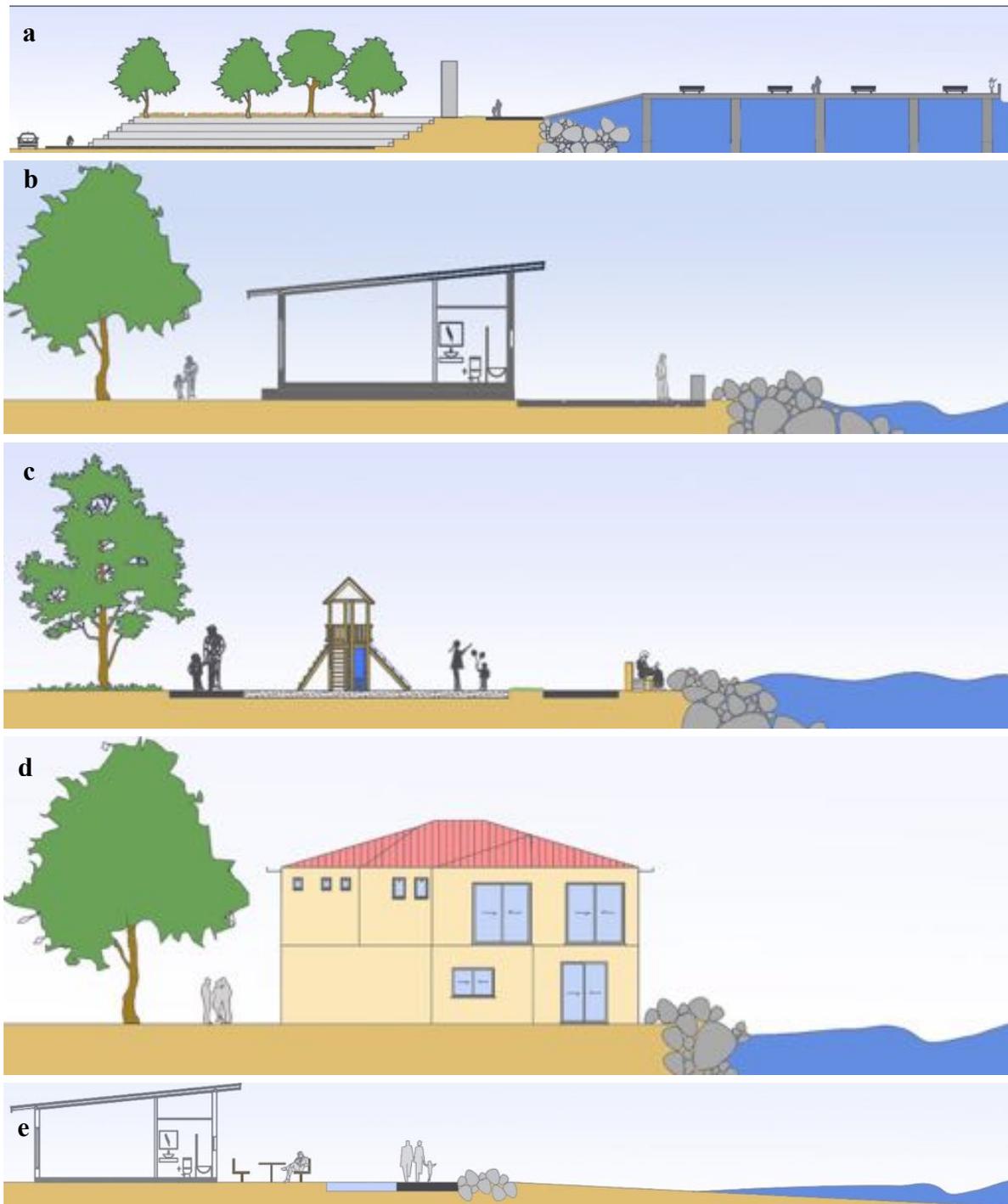


Figure 7. *Determining the human-sea connectivity through different site characteristics in a: harbor, b: between the harbor and the military, c: from the military to the end of the coastal park of Iskenderun, d: limit of the sea connection by the resident e: beach in end of the Iskenderun.*

The diversity of social activities is also formed along with accessibility, and provided opportunities by coastal formations. The existence of beaches and social facilities determined in Zone 6 allows permanent use of the area. When the use of beaches evaluate from the photos shared on social media (Google Maps), the area prefers is preferred for swimming and picnic in the summer months, throughout the year fishing, playing with sand, cycling, watching the sea, and spending time in social facilities by families and elder men. Due to the lack of urban furniture, the area is less favored for walking and resting than Zone 5. Therefore, individuals

who want to watch the sea need to bring their own equipment or have to sit on the curbs. The sailing club is a type of activity practiced by young and where direct interaction with water takes place.

Iskenderun coastal park possesses seasonal and daily usages with active and passive activities. According to Table 2, the number of users and their profile are the same through seasonal and daily values. But, the area mostly use by male at noon in winter and the evening in summer. The reason for the change of usage hours depending on the seasonal shady and sunny time. The morning hours are the least preferred time for both seasons.

Table 5. Users of Iskenderun coastal park by the observations.

		15.06.2020	22.06.2020	15.06.2020	27.01.2021		
		09.00 AM	01.00 PM	05.00 PM	09.00 AM	01.00 PM	05.00 PM
Users	Male	10	102	153	24	126	116
	Female	3	53	98	18	88	60
	Child	1	10	37	1	23	19
Total	Daily	14	165	295	43	237	195
	Seasonal	474			475		

According to Table 3, when the daily and hourly activities in the region are evaluated, the park is mainly used for hiking, fishing, and resting. In addition, active activities (basketball, skateboarding, cycling, children's playground) are carried out in the evening in the summer and at noon in the winter, whilst fishing (harbor) and sitting (rock) among the passive activities happen all year round. The utilization rate of social facilities is also very high during the summer months, but they have never been used in winter. The reason for this alteration is that the use of social facilities throughout the country suspends due to the Covid-19 epidemic, which affected the whole world and was declared a pandemic.

Table 6. Through the observations, activities performed in the urban coastal park.

Activities		15.06.20	22.06.20	15.06.20	27.01.21			
Time		09.00 AM	01.00 PM	05.00 PM	09.00 AM	01.00 PM	05.00 PM	
Active	Playground	3	4	8	-	4	4	
	Basketball	-	-	2	-	-	-	
	Paten/Skateboard	-	3	2	-	3	-	
	Cycling/Motorcycle	1	1	5	-	6	8	
	Picnic	-	-	4	-	9	-	
	Street musician	-	-	-	-	1	-	
	Walking the dog	-	-	-	-	2	-	
	Walking	4	42	106	21	90	54	
	Total	8	50	127	21	115	66	
	Passive	Fishing	Harbour	-	6	8	4	12
Rocks			4	2	3	1	-	3
Sitting		Bench	1	26	48	10	50	31
		Rocks armours	1	2	29	1	38	30
		Under the green	-	-	4	1	-	-
Photo shooting	-	2	1	3	8	14		

Social Facilities	-	77	75	-	2	-
Total	6	115	168	20	110	102

The two regions of the Iskenderun coastline, determined as social connectivity, give the socialization status of the individuals by evaluating transportation facilities, walkability, connection with the sea, usage period, user profile, activity diversity in Table 4. According to the data obtained, Zone 5 and Zone 6 appeal to every user, while Zone 5 is more open to social use in terms of accessibility and walkability. According to the interaction with water in the recreational use of coastal areas; three parts define as "dependent on water, related to water and independent from water" (Craig-Smith & Fagence, 1995). Water-dependent (fishery) and water-independent (basketball, skateboard, sitting) activities are carried out in Zone 5, and water-related (swimming), water-dependent (fishery), and water-independent activities (picnic) in Zone 6. Iskenderun, where all usage patterns can be seen, shows that social use of water takes place in different ways.

Table 7. Through activities, accesibility, site morphology and users, evaluate the social quality.

				Zone 5	Zone 6		
Users		Male		x	x		
		Female		x	x		
		Child		x	x		
Walkability		Pedestrian road					
		Uninterrupted		x			
		Interrupted			x		
Accesibility		Highway					
		Main road		x			
		Secondary road			x		
Sea Connection	Site Morphology	Indirect		Rip-rap	x		
				Wall	x		
				Harbor	x		
		Direct				x	
	None				x		
	Activity typology		Dependent of water		Swimming, Fishery, Boating	x	x
			Related to water		Harbor	x	x
Independent of water			Playground, basketball etc.	x	x		
Activities		Active		Playground	x	x	
				Basketball	x		
				Paten/Skateboard	x		
				Picnic	x	x	
				Cycling/Motorcycle	x	x	
				Walking	x		
				Sailing Club		x	
				Swimming		x	
		Passive		Fishing		x	x
				Sitting		x	x
Social Facilities				x	x		

		Photo shutting	x	x
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According to all these results, zone 5 is a region with higher social quality compared to zone 6 due to the fact that the coastal areas of zone 5 remain in constant interaction with individuals and allow active use as activity and equipment. Therefore, zone 6 becomes prominent with the single swimming region in Iskenderun. Actually, interacting with water in two regions has certain possibilities with the presence of limited activities. But, social coastal interaction can be developed according to the popularity and natural potential of Iskenderun.

4. CONCLUSION & SUGGESTIONS

As a port city of Iskenderun, the coastal structure has changed since 1776 with natural and anthropogenic effects. The city, whose urban development expands on the north-south axis, is divided into 6 regions according to the types of residential areas and the land-use. When these allocated regions analyze according to the spatiotemporal changes of coastal formation, land use, and public-private status, their interaction with coastal areas are divided into 3 groups as social (zone 5,6), economic (zone 1,2,4), and socio-economic (zone 3). Zone 5 and zone 6, which determined as social interaction, shape with two different urban development structures and coastal formations due to the artificial irrigation channel. Zone 5 artificial, Zone 6 natural coastal formations interact with the sea through active and passive activities. Both own passive usage year-round with the presence of social facilities. Within the scope of accessibility, Zone 5 is located on the main road and has uninterrupted walking paths, while Zone 6 offers gradual access through intermittent pedestrian paths and neglected vehicle roads. Interacting with water in two regions has certain possibilities with the presence of limited activities. But, social coastal interaction can be developed according to the popularity and natural potential of Iskenderun.

Water sports, which have developed in our country since 1990 and have many types, are frequently chosen to support tourism activities today. This approach, which constitutes 20% of the tourism income (Ozbek, 2014), is one of the water-dependent activities regarding the social interaction of Iskenderun coastal areas. When decisions the diversity of activities, a detailed analysis of the routes of heavy cargo ships located close to the region should be performed. With reviews, can prepare to organize several competitions related to swimming, diving, triathlon, etc. in the field. Also, fishing and sailing activities are seen in the area, while some activities such as windsurfing, water skiing, canoeing, pedalo are possible to perform with climate and terrain opportunities.

Water-related activities are created by floating or elevated platforms such as ports. Many countries such as Noah's Park (Norway), Galveston Island Historic Pleasure Pier (Netherlands) have realized this idea for recreation area design (Cesur et al. 2018). Mediterranean coastal cities also use their unused ports for tourism purposes by transforming them as residences and recreation areas (Unlu, 2013; Driessen, 2005; Koca, 2017). Recreational arrangements cannot be produced due to the lack of access to regions in intense economic interaction. But, the recreational needs of both the workers and the people of the region can be satisfied by planning one of the ports that already exist for Iskenderun as a recreation area. In addition, by placing floating platforms on the shore, training areas can be created for children in water. For areas with socio-economic interaction (Zone 3), Pedestrian traffic arrangements should be made for rail and road that cut access to the shore by adding lights and signs.

As a result, the coasts of Iskenderun are a city where there is both social and economic connectivity, while the urban coastal park (Zone 5) is the region with the highest social quality with the region's uninterrupted pedestrian road with the sea and activity diversity. However, according to their usage potential, these areas

should design by water sports; Courses and appropriate spatial platforms should create for all age groups; Races should organize to increase the popularity of the region.

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INDOOR & OUTDOOR AIR QUALITY IN WORKSPACE

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ABSTRACT

Architects have been moving toward designing enclosed rooms controlled by increasingly complex mechanical systems since the 1950s. Contaminants were frequently released due to the usage of sophisticated materials and inorganic furnishings. Average amounts of breathing gases, such as carbon dioxide, must be maintained in an indoor setting, and the air must be free of significant levels of pollutants and odors. In addition, temperature, humidity, lighting, and sound levels must be comfortable, and physical settings must be ergonomically adjusted to reduce physical weariness and mental stress. Indoor environments are known to contain about 900 different pollutants, depending on the operations and activities in the buildings. The Sick Building refers to a situation or collection of circumstances in which 20% or more of a building's residents exhibit symptoms of disease and comfort effects associated with time spent in a building. The symptoms include Eye discomfort, nasal irritation, headaches, fatigue, disorientation, nausea, sleepiness, rashes, and skin dryness. People have less control over the indoor atmosphere of their offices than they do at home and a variety of other factors linked with today's office buildings, which has increased reported health concerns. Indoor air quality is a relatively recent science that is still in its infancy. To find out more, the Environmental Protection Agency (EPA) recently initiated two significant investigations of indoor air quality in over 150 public and commercial buildings. Indoor air levels of many contaminants are 2–5 times, and occasionally more than 100 times higher than outside levels, according to EPA studies of human exposure to air pollutants. The materials used in construction, as well as the choices made by architects and designers, have an impact on both short- and long-term indoor environmental quality. As a result, ventilation, building materials, and furniture must all be considered. The Sick Building Syndrome relates to a phenomenon in buildings or set of conditions in which 20% or more of a building's occupants display symptoms of illness; and comfort effects linked to time spent in a building. Historically, the topic of air quality has been limited to outdoor air. Recently, the focus has shifted to the indoor environment, where most of us spend most of our time. Poor indoor air quality can have a significant personal and economic impact. In addition, buildings have issues with both indoor and outdoor air quality. This paper will attempt to bring this critical discussion on the indoor environment and its health-related issues. Although it will present a descriptive-analytical study, it shall cover indoor air contaminants and outdoor air contaminants. This paper will show the result of this study in a summarized and focused manner to make it easier to use and benefit from and serve as the tip of the iceberg of the facts and studies that have enabled the researcher to achieve this brevity.

KEYWORDS: Air quality, Indoor environment, Air pollutants - Comfort levels, Sick Building.

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1. INDOOR AIR CONTAMINANTS:

Indoor air contaminants can originate within the building or be drawn in from outdoors.

1-Interior contaminants may include new building materials, products and furnishings that emit a significant number of potentially hazardous chemicals into the air. Figure 1.

2-The operation of high-tech office equipment is a significant new source of contaminants.

3-Use of cleaning agents, aerosols, with cleaning fluids also contribute to the level of indoor contaminants.

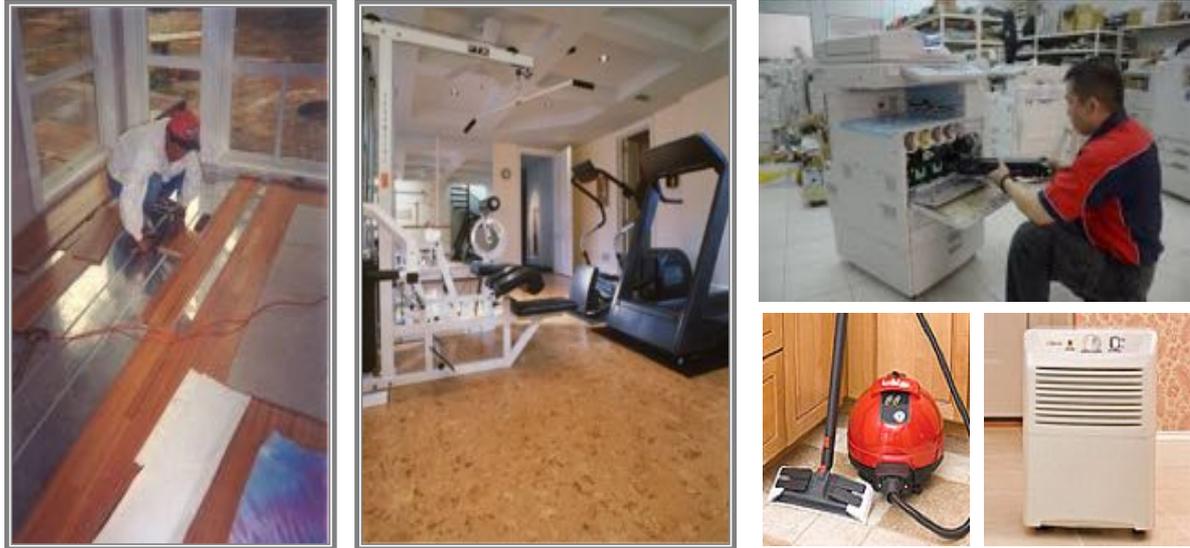


Figure 1. Healthy interior material used in workspaces

4-The presence of people, breathing and emitting body odours, affects indoor air quality. Figure2.

5- Smoking can significantly damage the indoor environment. Figure2.

6-Similarly, glare from artificial lighting and visual stress from computer terminals can cause headaches and eye irritation; chairs and tables that are the wrong height for the task may promote fatigue.

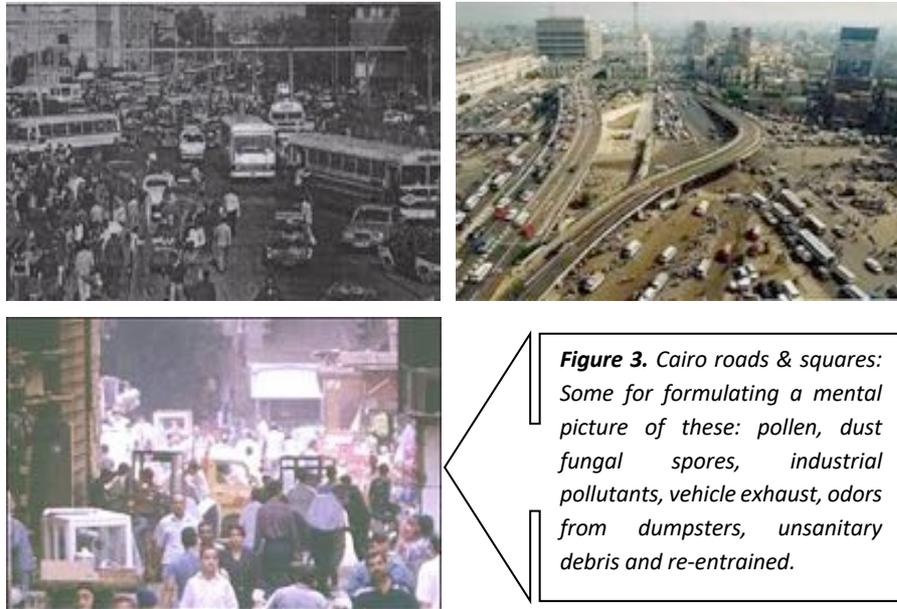


Figure 2. The different odours and smoking damage the indoor environment.

2. OUTDOOR AIR CONTAMINANTS

While there may be too many sources of outside pollutants, the topic in this paper is limited to those that occur only indoors.

Some examples are pollen, dust, fungal spores, industrial pollutants, vehicle exhaust, odors from dumpsters, unhygienic debris, and re-entrained (pulled back into the building) exhaust from the building itself or nearby buildings for forming a mental picture of these. Figure 3.



3.SOURCES/FACTORS AND CAUSES AFFECTING INDOOR ENVIRONMENT

1-Architect must avoid the transport of contaminants through pollutant pathways. It should be noted that the HVAC system might rely on unoccupied areas for the plenum.

2- The materials that are selected for the structural system will affect the air quality in these plenums. For example, if steel is used, it requires fireproofing, and the fireproofing itself can be a source of contamination into the airstreams. Figure 4.

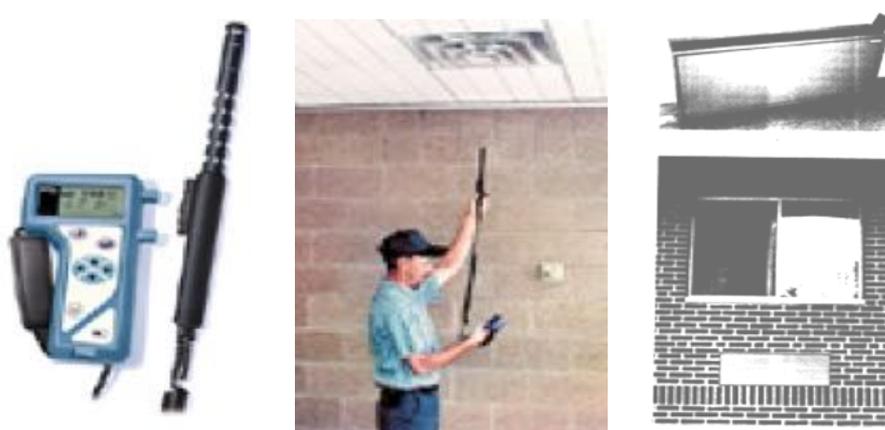


Figure 4. Through-the-wall unit, Interior and exterior views.

- Cementitious fireproofing may turn to dust, flake and generally deteriorate. Figure 5.



Figure 5. The materials that are selected for the structural system will affect the air quality in these plenums.

- Wood poses the danger of harbouring microbes or pests if it is used in an area where moisture is present. Figure 6.



Figure 6. Wood poses the danger of harbouring microbes or pests in workspaces.

- (VOCs) are molecules that evaporate from organic chemical-based products. Many cleaning and maintenance chemicals, as well as construction materials, emit these substances. In addition, aromatic hydrocarbons, alcohol, ketones, aldehydes, ethers, esters, and other compounds are found in indoor pollution. Figure 7

	Corrosive	Chemical cause burns if it comes into contact with the skin
	Highly flammable	Can easily catch fire
	Toxic	Could cause harm if the chemical comes into contact with skin, if ingested or if vapors are breathed in.
	Harmful to the environment	Will cause harm to living organisms if released into the environment.
	Irritant	Damages skin or eyes if they come into contact with the chemical.
	Explosive	Chemical could cause an explosion.
	Carcinogen	Chemical can cause cancer if it comes into contact with the body or is ingested.
	Radiation	Material is radioactive and gives off ionizing radiation



Figure 7. Organic chemical-based products used in office buildings

- They were released by paints, stains, varnishes, carpet dyes, fibers, glues, adhesives and sealants, wood preservatives, and a variety of common building materials. The most well-known (VOC) is formaldehyde, which is emitted by particleboard, interior grade plywood, foam insulation, carpet, and fabrics. Figure 8



Figure 8. Variety of common building materials used in workspaces.

Particulates are considered dangerous to one's health. Particulates include smoke, dust, and pollen.

Lead exposure from paint chips is a continuous hazard that is most common in housing projects and dangerous to children who eat deteriorating paints.

Combustion sources release carbon monoxide, carbon dioxide, nitrogen dioxide, sulfur dioxide, and respirable particles, which can be found in fireplaces, wood stoves, unvented gas or kerosene heaters, and tobacco products. Figure 9

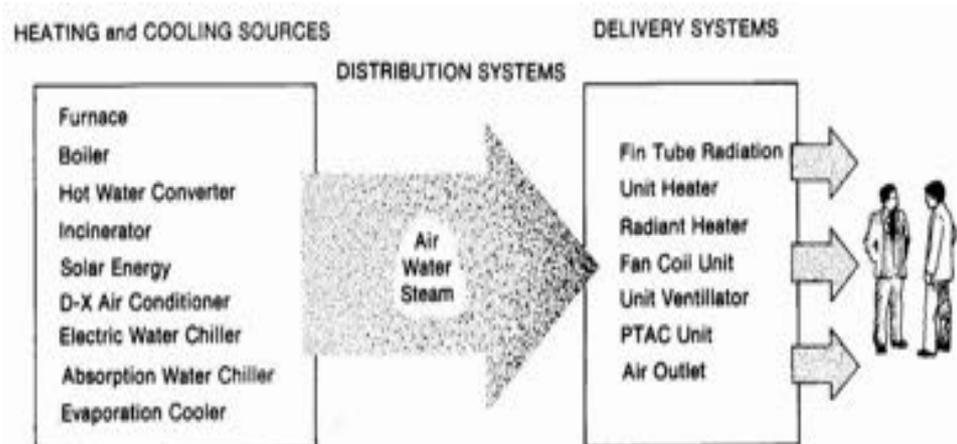


Figure 9. Basic elements of HVAC systems

Radon is a by-product of Uranium-238 decay that can be found in soil and bedrock. Radon gases are suctioned into building walls and floor slabs from the soil and rock through fractures and holes.

Tobacco smoke contains over 3,800 different chemicals, many of which are carcinogenic and mutagens. A carcinogen is a substance that causes cancer. A mutagen is a substance that causes mutations in the genes or chromosomes of live cells.

In 2012, the results of a survey by (NIOSH) (11) based on occupant's complaints were documented in rankings in the following manner: Table 1

Table 1. Percentages of building components

Inadequate ventilation	53%
Inside contamination	15%
Outside contamination	10%
Microbiological contamination	5%
Building material and contamination	4%
Unknown.	13%

Inadequate ventilation was the root cause of the majority of IAQ issues in the tested facilities. Therefore, in 2004, (ASHRAE) recommended increasing the minimum ventilation requirements for commercial office buildings by threefold, from 5 (CFM) to 15 (CFM) per person. As a result of this change, buildings built previously are now considered to be inadequately ventilated.

Return air plenums can be problematic. However, these plenums, which eliminate the need for return air ductwork from the occupied space to air handling units, are undoubtedly cost-effective. Still, the above-ceiling areas of a building that serve as plenums are never clean or well-maintained. Figure 10

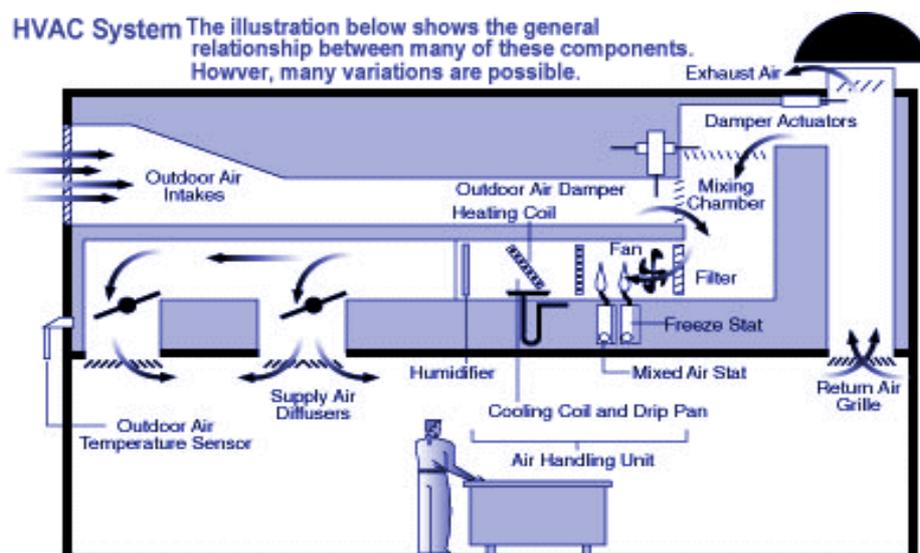


Figure 10. HVAC System, The illustration shows the general relationship between many of these components.

Above ceiling areas of a building that serve as plenum can never be found clean and well maintained.

During operation, office equipment such as wet- and dry-copying machines, computers, and laser printers release various VOCs. This equipment should be kept separate from the building's occupants, and it should

be kept in well-ventilated rooms with different exhaust systems if possible. Obviously, in our daily working environment, this feature is frequently overlooked.

Because it can affect occupants' health, comfort, wellness, and productivity, indoor air quality is crucial for building managers, renters, and employees. Most Americans work indoors for up to 90% of the time, and many of them spend the majority of their time in an office setting. As a result, an employee's urge to walk outside and get some fresh air indicates that IAQ is in poor condition.

Evidence suggests that less-visited public spaces are more responsible for indoor air quality issues than heavily-trafficked areas. Structures that contribute to piled papers serve as a repository for possible pollutants. Architects should plan for accessibility by minimizing cubicles, keeping workplaces open, and avoiding cramped spaces.

4. THE FOLLOWING COMMON CHANGES ARE EXAMPLES OF NEW IAQ PROBLEMS:

Change in occupant load: As occupant density increases, so do heat, humidity, and VOCs. Converting an executive office to a smaller one is a common occurrence, increasing the occupant population from one to several, and the air quality suffers. Figure 11.



Figure 11. Change the design for interior office to reduce the number of occupants

Changes in occupant activities: Converting an office space into an aerobics class will raise activity levels, which influences metabolic rates and, as a result, the rate at which the inhabitants produce carbon dioxide. Figure 12



Figure 12. Converting an office space into an aerobics class.

Change in equipment load: Adding equipment like copiers and computers changes the amount of heat and VOCs emitted and the possibility of airborne particles. Such a change may necessitate the installation of a new dedicated exhaust system, which is often overlooked.

General office space is frequently changed to a break room, print shop, smoking lounge, copy center, or laboratory, involving changes to the electrical or lighting systems and the inclusion of specialist equipment. Figure 13.

Pressure relationships between the particular use areas and surrounding areas may be affected. As a result, local exhaust or additional capacity may be required.



Figure 13. ,,,,,,,one office changed to a break room

Changes in the interior layout: Rearranging workstations, significantly when partitions must be relocated, may alter an area's airflow and air distribution patterns. Unfortunately, this is a common occurrence in facilities after a few years of use, and the impact of such changes is frequently overlooked. Table 2 depicts the health effects of the contaminants found in the buildings.

Table 2. depicts the health effects of the contaminants found in the buildings.

Contaminant	Contaminant Classification						Comments
	Irritant	Asphyxiant	Anesthetic/Narcotic	Systemic toxicant	Pathogen/allergen	Carcinogen	
VOCs	■	■	■	■		■	Many of these contaminants are neuro/behavioral toxicants, hepatotoxicants and cardiac sensitizers.
FORMALDEHYDE	■					■	May induce allergic responses.
PESTICIDE	■			■		■	Many of these contaminants are neurotoxicants, hepatotoxicants, reproductive toxicants and sensitizers.
LEAD				■			Neurotoxic and behavioral effects which may not be reversible.
CARBON MONOXIDE		■					Increased frequency and severity of angina in patients; decreased work capacity in healthy adult males; headaches, decreased alertness, flu-like symptoms in healthy adults; exacerbation of cardiopulmonary dysfunction in compromised patients.
CARBON DIOXIDE		■					Can also act as a respiratory stimulant; increased respiration and decreased ability to perform strenuous tasks in humans; changes in blood pH and PCO ₂ calcification of kidneys and structural changes in lungs of guinea pigs.
NITROGEN DIOXIDE	■						Decreased pulmonary function in asthmatics; effects on pulmonary function in children, perhaps adults; synergistic effects with other contaminants in animals and children; increased susceptibility to infection in animals; animal studies indicate decreased immune capability, changes in anatomy and function of the lungs.
SULFUR DIOXIDE	■						Decreased lung function in asthmatics and normal exercising males, animal studies show decreased lung function.
BIOLOGICAL CONTAMINANTS (bacteria, viruses, molds, fungi, pollen, animal and human dander, insects and arachnid excreta)	■				■		Infectious diseases; allergic reactions; toxic effects.
ENVIRONMENTAL TOBACCO SMOKE	■					■	Irritation of mucous membranes, cardiovascular stress, chronic and acute pulmonary effects in children.
POLYCYCLIC AROMATIC HYDROCARBONS	■					■	Some are irritants and can results in cardiovascular effects.
ASBESTOS	■					■	Asbestosis at occupational exposures, mesothelioma.
RADON						■	

SOURCE: Adapted from U.S. EPA (1989).

CONCLUSION:

- As a leader of the design team, the architect must play a vital role in the quality of the indoor environment. Figure 14.



Figure 14. Project: Misr University for Science and Technology (MUST), Location: 6th October City, Giza Egypt. Architect: Prof. Dr. Ahmed Abdin.

- The architect will need a profound grasp, and frequently a solid working knowledge, of the numerous factors necessary for the quality of the indoor environment when designing more advanced buildings in the future and when renovating existing buildings. In addition, the competent architect must recognize that the needs for different building types vary while analyzing the indoor environment. For example, the indoor environment for schools, with its various roles, high occupant load, and often-poor maintenance, requires a different approach than the indoor environment for hospitals, which has many pollution sources. Likewise, residences, workplaces, conference halls, daycare facilities, eateries, nursing homes, and indoor sports complexes have different requirements.

All occupants of a building can contribute to the indoor air quality by being aware of indoor air issues: For example, keep vents and return air grilles unblocked so the HVAC system is not unbalanced. Figure 15.

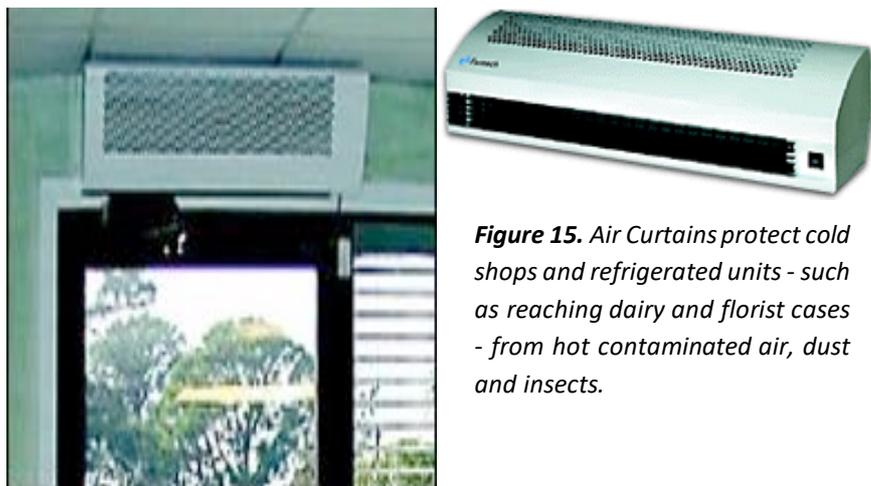


Figure 15. Air Curtains protect cold shops and refrigerated units - such as reaching dairy and florist cases - from hot contaminated air, dust and insects.

- Airflow can be hampered by furniture, boxes, or other things near supply vents or return air grilles. Maintain appropriate housekeeping procedures by keeping places clean, swiftly disposing of rubbish, correctly storing food (food attracts bugs), and notifying management if your space is too hot, chilly, stuffy, or drafty. Comply with the office and building smoking policies, which protect nonsmokers from secondhand smoke exposure. Water spills should be cleaned up immediately, office plants

should be watered and maintained correctly, and water leaks should be reported immediately. If you suspect an IAQ problem, notify your building or facility manager right away.

- On indoor environmental challenges, maintain a positive working relationship with building management. For example, air circulation, temperature regulation, and pollution removal functions of the HVAC system should be considered while placing office furniture, walls, and equipment.
- Avoid treatments and items that have the potential to cause issues. For example, many popular office goods, such as solvents, adhesives, cleaners, insecticides, and office equipment, including photographic film development, copiers, printers, and fax machines, can emit pollutants and aromas. If any of these items are utilized in the office, there must be sufficient and occasionally separate ventilation.
- Keep track of reported health complaints from building users and tenants to aid in the resolution of indoor air quality issues.
- Designate a qualified indoor air quality representative who will be held accountable for the quality of the indoor environment and will serve as the point of contact for indoor environmental issues. Provide training opportunities to building staff to educate them. Maintain and operate the building and ventilation system to ensure good interior air quality. Before you rebuild or renovate, establish clear policies for any space modifications and work with building management and the architect to explore strategies to minimize building occupant exposure to pollutants to a minimum while also ensuring that the air distribution system is not interrupted. Encourage the development of a preventive indoor air quality management program by the building management. Integrating three basic ways to control indoor air quality is necessary. Figure 16.

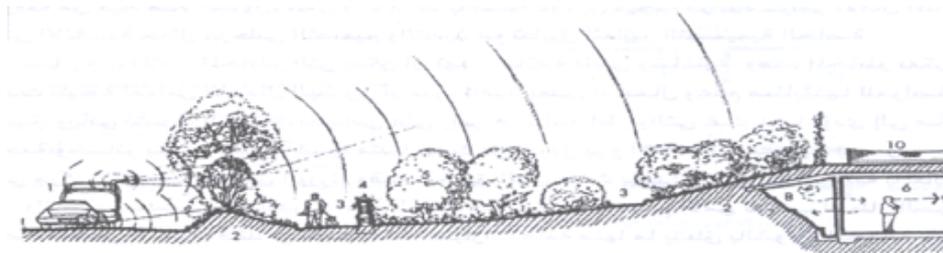


Figure 16. Green built to prevent noise, dust & more from drawn back into the building.

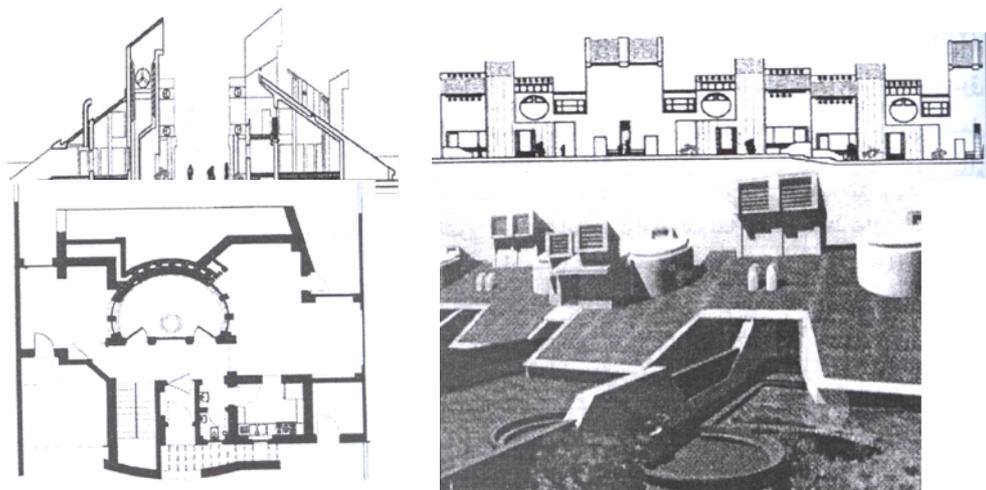


Figure 17. Green architect in TOSKA

- Control polluting sources by removing them from the building or separating them from humans using physical barriers, air pressure relationships, or managing when they are used. Second, use

ventilation to dilute contaminants and remove them from the building. Third, utilize filtering to remove pollutants from the air. Figure 17.

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