An Exploration of Public Open Spaces with Data Driven Approaches: A Case Study of Beyazıt Square

Gülce Kırdar[1]

ORCID NO: 0000-0002-4700-6077O[1]

[1] Istanbul Kültür University, Interior Architecture and Environmental Design, Architecture Faculty, Istanbul, Türkiye

Data-driven approaches are widely used to gain insight in urban dynamics and support urban decisions with pervasive adoption of information technologies. In the presented study, the students adopt data data-driven approaches to observe, and analyze public spaces, and make conceptual decisions for urban furniture in the context of the workshop. This workshop is developed within the scope of the Environmental Computing course. It is conducted with 27 students in Beyazıt Square as a case study area. In the scope of the study, open public spaces were observed and analyzed using data-driven approaches. Based on the analysis results, the students were expected to develop urban furniture design that would enhance user experience and activities in the area. This study questions how data-driven approaches aid in exploring public spaces and support design decisions. The objective of the study was to explore user-generated urban dynamics using multiple data and make decisions for urban furniture that augments urban dynamics. The conceptual design process of urban furniture is shaped as results of data-driven approach. The students were introduced to the Public Life Tools developed by the Gehl Institute for site observation. They were divided into particular groups and used relevant digital tracking applications to measure user activities, user profiles, and live traffic in the area. They evaluated the quality of place based on predetermined criteria by Gehl Institute. The phases of the study involve (1) the exploration of digital observation methods, (2) mapping observational, data, urban data, and locative media data in Geographic Information System (GIS), and (3) defining the relationships between the parameters affecting urban dynamics. (4) This was followed by making conceptual design decisions and (5) developing the design of urban furniture considering data analysis results. According to the findings, the use of data-driven observation and analysis methods has been effective in developing user scenarios, determining user profiles, identifying needs, and taking functional decisions in urban furniture design. Based on the students' evaluation, the data-driven decision-making process was effective in identifying needs, problems, and potentials in the area. As the limitations of the study, the students stated that the use of digital observation methods and the learning process of GIS software were challenging. This study contributes to the field of urban computing through its conducted fieldwork.

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Corresponding Author:
g.kirdar@iku.edu.tr

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Keywords: Public open spaces (POS), Digital observation methods, Geographic Information Systems (GIS), Data-driven approaches, Urban dynamics.

Kamusal Açık Mekanların Veriye Dayalı Yaklaşımlar ile Keşfi: Beyazıt Meydanı Örneği

Gülce Kırdar[1]

ORCID NO: 0000-0002-4700-6077O [1]

[1] Istanbul Kültür Üniversitesi, İç Mimarlık ve Çevre Tasarımı, Mimarlık Fakültesi, Istanbul, Türkiye

Bilişim teknolojilerinin yaygınlaşması ile veriye dayalı yaklaşımlar karmaşık kent dinamiklerini anlamak ve kentsel karar alma sürecinde yaygın olarak kullanılmaktadır. Çalışmada veriye dayalı yaklaşımlar kamusal mekanın gözlemlenmesi, analizi ve tasarım kararlarında uygulanması ders kapsamında geliştirilen atölye çalışması ile deneyimlenmiştir. Çalışma kapsamında geliştirilen atölye Çevresel Bilişim dersi kapsamında 27 öğrenci tarafından yürütülmüştür. Çalışma alanı Beyazıt Meydanı'dır. Çalışma kapsamında açık kamusal mekanlar veriye dayalı yaklaşımlar ile analiz edilmiş, analiz sonuçlarına dayanarak öğrencilerden mekandaki kullanıcı deneyim ve aktivitelerini arttıracak kentsel mobilya tasarımı geliştirilmesi beklenmiştir. Araştırma sorusu veriye dayalı yaklaşımların kamusal mekanların dinamiklerini keşfetmede nasıl yardımcı olacağını ve tasarım kararlarını nasıl destekleyebileceğini sorgular. Çalışmanın amacı kamusal alandaki kullanıcı kaynaklı kent dinamiklerinin farklı veri kaynakları keşfedilmesi, ilişkilendirilmesi ve kent dinamiğini arttırabilecek kentsel mobilya tasarım kararları alınmasıdır. Kentsel mobilya tasarımının kavramsal süreci veriye dayalı yaklaşımların sonuçlarına göre şekillenmiştir. Çalışmada öğrencilere alan gözlemi için Gehl Institute tarafından geliştirilmiş Kamusal Yaşam Ölçme Araçları (Public Life Tools) tanıtılmıştır. Öğrenciler belirli gruplara ayrılarak ilgili dijital takip uygulamaları ile alandaki kullanıcı aktivitelerini, kullanıcı profilini, canlı trafiği ölçmüşledir. Alanın kalitesini Gehl Institute tarafından belirlenen kriterlere göre değerlendirmişlerdir. Çalışma aşamalarını kamusal alandaki veriye dayalı ölçme ve gözlemleme yöntemlerinin dijital araçlar ile keşfi, verinin Coğrafi Bilgi Sistemi'nde (Geographic Information Systems: GIS) haritalanması, veri haritalama sonucunda veriler arasındaki ilişkinin tanımlanması oluşturmaktadır. Daha sonra veriye dayalı olarak kentsel mobilya konseptinin kavramsal tasarım kararlarının alınması ve tasarımını geliştirilmesi ile takip etmektedir. Veriye dayalı gözlem ve analiz yöntemlerinin kentsel mobilya tasarımında kullanıcı senaryoları geliştirme, kullanıcı profili belirleme ve ihtiyaçlarını belirleme bu bağlamda işlev kararlarını almada etkili olmuştur. Öğrencilere göre veriye dayalı karar alma süreci alandaki ihtiyaçların, problemlerin ve potansiyellerin belirlenmesinde etkili olmuştur. Öğrenciler çalışmanın kısıtları olarak dijital gözlem yöntemlerinin kullanımı ve GIS programının öğreniminin zor olduğunu belirtmiştir. Çalışma yürütülen alan çalışması üzerinden kentsel bilişim alanına katkı sağlamaktadır.

Anahtar Kelimeler: Kamusal açık alan, Dijital gözlem yöntemleri, Coğrafi Bilgi Sistemleri (GIS), Veriye dayalı yaklaşımlar, Kent dinamikleri.

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g.kirdar@iku.edu.tr

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1. INTRODUCTION

With the age of computation, data becomes an important source to create the computational approaches to understand complex urban dynamics. Observing and measuring becomes key aspects to gather data aiming to understand the public life in the cities. The dynamics of the cities become representative and measurable through the computational models generated with computation tools and methods. In urban informatics, Spatial distribution maps are closely linked with computational models. A spatial distribution map is utilized to visualize data in a spatial context. In this manner, it supports spatial computational models, that used to compute complex urban systems with intend to understand and predict an urban phenomenon. It can be said that the spatial distribution map of an urban parameter creates a baseline for computing it. The spatial distribution map of an urban parameter sets a basis to compute its dynamics.

On the other hand, spatial maps of urban dynamics get support from digital technologies. Locative media data, and digital tracing technologies enable to take the pulse of the public life. Locative media is location-based data obtained through mapping or navigating applications, or social media platforms (Wilken & Goggin, 2017). According to Wilken and Goggin (2017, p.1) locative media technologies are "linked to the places and spaces in which they are used and experienced. GPS coordinates, geotagged photos or videos, social media check-ins, or any other digital content linked to a specific physical location". Digital tracing tools provide to count people in activities, track and trace people movement, which are grouped under advanced tracing technologies (ATT). The ATT involve GPS, mobile phone positioning, Wi-Fi tracking, RFID, Bluetooth, video monitoring, machine learning technologies, and mobile applications like Counterpoint (van der Spek, 2008; van Schaick, 2010). They contribute to urban knowledge by supporting spatial and functional maps (van Schaick, 2010). These technologies are used to collect spatial and temporal data with high accuracy, supporting urban planning decisions by providing data on pedestrian movement patterns, speed, transportation mode, and time spent at specific locations (van der Spek, 2008; van Schaick, 2010). In the scope of this research, digital tracing methods and locative media data have been employed to conduct data-driven decision-making process in order to improve the quality of public

space. In the time of digitization, this study poses the question of how to include digital technics for understanding the urban place experiences and develop a design product that increases place experiences.

This study employs a data-driven approach to urban furniture design, in Beyazıt Square as the case study area. The aim is to incorporate data-driven decision-making into architectural education within the context of the workshop. This workshop forms part of the Environmental Informatics course, hosted by the Istanbul Kültür University's Faculty of Architecture Interior Architecture and Environmental Design Department. This lecture, comprised of 50 third and fourth-year undergraduate students from the fields of interior architecture and environmental design, promotes collaborative efforts with group projects involving 3 or 4 students each.

The workshop aims to introduce participants to digital tools and methods for investigating place dynamics and developing design concepts that enhance people's interaction with public spaces. The workshop begins with an introduction to the concepts of public space, public life, liveability and placemaking in public open spaces (POS). A range of digital tools, within various applications, analysis techniques, design strategies, and representation tools, are introduced to the students as a method to understand the place dynamics and formulate a design concept for urban furniture to augment public interaction with the space. The data-driven decision-making process (DDSS) workflow is depicted in Figure 1.

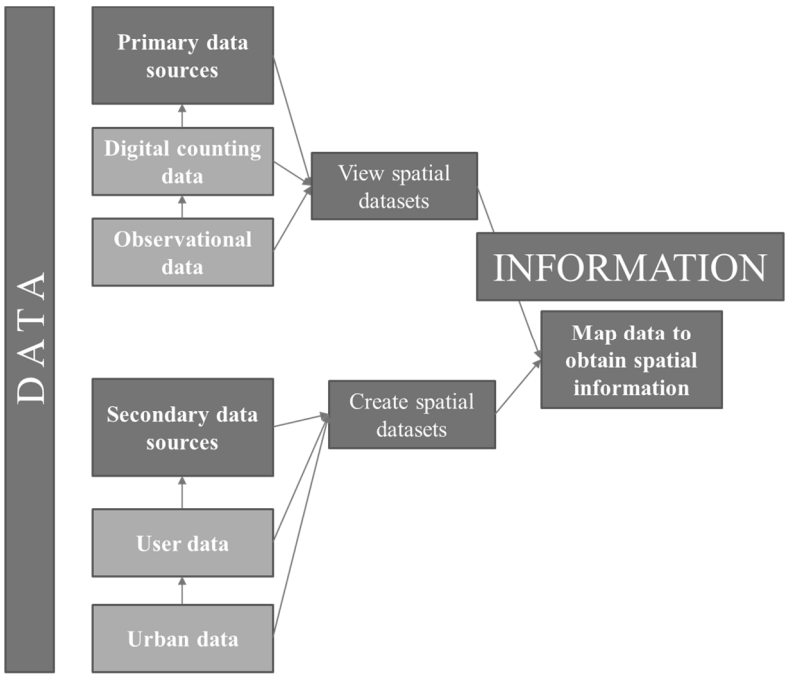


Figure 1: The workflow of data-driven decision process (developed by the author).

2.LITERATURE REVIEW

2.1 An Exploration Of Successful Public Spaces

Public spaces serve as the foundation for the public life of cities, where people engage with society and different activities (J. Gehl, 2007). These spaces play a crucial role in enhancing place image, fostering place attachment, and promoting a sense of place through people-place interactions (Urban Design Guidelines for Victoria, 2017). Public spaces used to be evolved organically according to human experiences, activities and uses. With the rapid urban growth, public life has been neglected through the car-dependency and large-scale urban development (J. Gehl & Svarre, 2013). Modernist cities have faced criticism due to their poor living environments, large-scale urban development, loss of control over public life, social segregation, inequality, and a decline in place attachment and place identity (A. Jacobs & Appleyard, 1987).

Since the 1960s, the focus of environmental design has been increasingly concentrated on the interaction of public life with public spaces, to gain a better understanding of the user dynamics and urban functioning (J. Gehl & Svarre, 2013). Jacobs' (1961) seminal work pointed out the drawbacks of modern cities for livable urban spaces and the need for livable urban spaces that center around human needs

and experiences. Alexander et al., (1977) further emphasized community-centered design, which laid the foundation for the concept of public life. Kent (1975) asserts that everyone has the right to live in a good place, and therefore, individuals also have the right to contribute towards making a place better (PPS, 2007). Regarding the emphasis on human-centered public spaces, Kent (1975) established the organization of Public for Project Spaces (PPS), which played a pivotal role in implementing placemaking initiatives to improve the quality of life in public spaces (PPS, 2007). The placemaking approach empowers people to shape physical, cultural, and social aspects of public realm (PPS, 2016). The Project for Public Spaces (PPS, 2007) introduced 'the place diagram,' a tool designed for the assessment of public spaces. This diagram represents the key attributes, within their qualities and quantities for successful place, as shown in Figure 2. Four primary attributes are delineated for successful places, which are accessibility, comfort, and image, uses and activities, and sociability (PPS, 2016). Accordingly, the successful places are accessible and well connected, comfortable and have a good urban image, attract people for different activities, and sociable environments to visit (PPS, 2016).

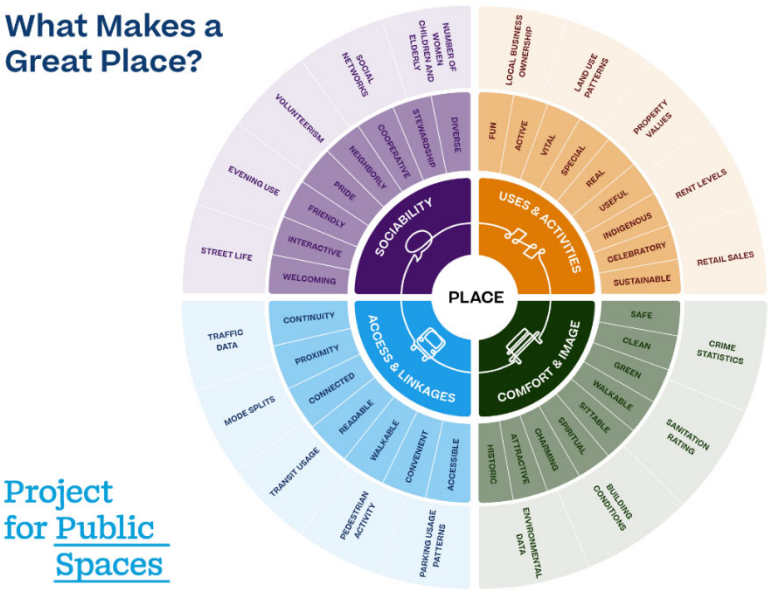


Figure 2: The key attributes for successful public spaces (PPS, 2016).

To achieve successful public spaces, architects and urban planners have increasingly underscored the social life in public open spaces (POS) considering the comfort, use, activities, access and attractions. Gehl

(1987, 2007, 2010) further emphasized the need to design spaces that align with human scale and accommodate various activities by highlighting 'life between buildings.' New methods, measurements, and tools have been developed to monitor the public life in the cities. These advancements signify a growing effort in both academic and practical fields to prioritize human-centric, sustainable, and livable urban spaces.

2.2 Observation and Measurement in Public Spaces

Observation is the key to measure and understand the public life (Gehl & Svarre, 2013). Observing people experiences through the activities enables to understand the interaction of people with public space and reveal the potential of public space (Gehl and Svarre, 2013). There have been many methodologies and indexes to assess public life by conveying observations into quantitative measures. While Whyte (1980) concentrates on user behavior in public spaces, Brower (1988) focuses on the physical qualities of public space affecting people use. The focus of public space evaluation is on use and activities in Gehl and Gemzoe (1996) study. Addition to physical and activities, Mehta (2014) assesses social qualities of public spaces based on inclusiveness (tolerance for different people), meaningful activities (activities foster socializing and place attachment), comfort (physical, climatic), safety (sense of safety with eyes on street, and traffic safety), pleasurability (spatial attributes for likeability). Similarly, Skjæveland et al. (1996) also assesses social qualities through the lenses of social interaction, sense of community and place attachment. Zamanifard et al. (2019) present an index for measuring experiential qualities (EQs) of public spaces, based on qualities of comfort, diversity, vitality, inclusiveness, image and likeability. The reference studies indicate that, the key theme across these measurement approaches is their focus on assessing the success of public spaces from a user perspective, through social, physical, experiential factors. This study focuses on user activities and diversity, therefore Gehl's (2010) observation methods have been applied in this study.

Gehl (1987) categorizes the activities taking place in urban spaces in terms of its relationship with place. According to Gehl (1987), the activities, taking place in public spaces, are as necessary, optional and social activities. This categorization is useful to conduct observatory methods to understand how public open space (POS) is functioning.

Commuting to work, going to school or buying groceries are examples of necessary activities (Gehl, 2010). They are daily tasks or obligatory activities, which are independent from the physical quality of urban environment. Walking or relaxing in a park are optional activities, which take place under favorable conditions of urban environment. Making conservation, communicating, greeting other people or passive contact are examples of social activities, which are the outcome of the necessary and optional activities (Gehl, 2010). The more people in public space means more activities, more spending time and leads to more meaningful contact. It can be deduced that the quality of urban public space matter for the activity types, and people amount engaged in activities. Figure 3 displays the relationship between place quality and the rate of activities (Gehl, 2010). Accordingly, when the place quality is high, the optional activities' occurrence increases in parallel. Additionally, the increase in optional activities results a rise in social activities' rate (Gehl, 2010).

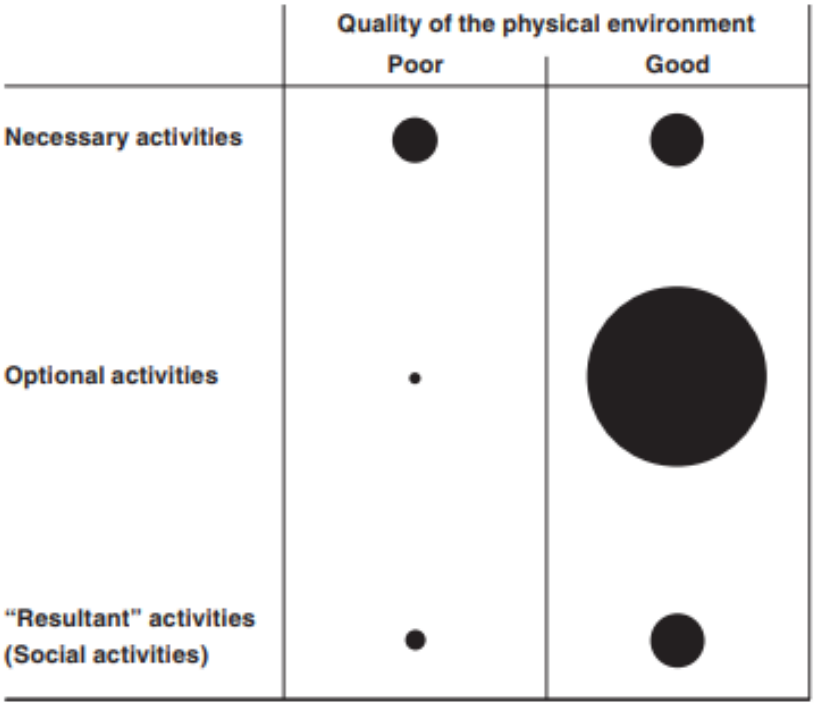


Figure 3: The graphical representation of place quality and rate of activities (Gehl, 2010).

For observing the activities in POS, the questions of "how many, who, what, where, how long" are helpful to delineate the urban dynamics. They are grouped under observatory questions in the scope of this study. The "how many" question is fundamental in assessing city life, by quantifying people's actions and movements. The "who" question is

central to understanding public space usage, implying the need to identify and categorize people based on gender or age attributes. The "what" question explores the types of activities carried out in public spaces, which can range from necessary tasks like shopping or commuting, to optional activities like jogging or reading. The "how long" question is associated with the time people spend doing activities in public spaces (Gehl & Svarre, 2013). Gehl and Svarre (2013) categorize the main methods to measure the public life and answer abovementioned questions:

- Counting the people in activities to answer *who* and *how many* questions;
- Mapping the activities on the survey area (behavioral mapping) (what);
- Tracing to follow people movement (where);
- Tracking to observe people movement and presence (shadowing) (where);
- Photographing (what/how);
- Keeping an activity diary (what/who/how/how many) (Gehl & Svarre, 2013).

Public Space Public Life (PSPL) survey methods, developed by Gehl, to measure the human-place interactions in the public spaces These survey tools, developed by the Gehl Institute, employ various data collection methods, including activity mapping, people counting, and interviews, to gather observational data (Gehl Institute, 2017). ***Stationary Activity Mapping*** method is used to capture people's postures and activities (Figure 4a). This method involves observing and documenting different postures such as standing, sitting (in public, private, or commercial spaces, as well as informal settings), lying down, and in movement. Furthermore, it captures various activities including waiting for transportation, consuming food and beverages, engaging in commercial activities, conversing, participating in cultural activities, and recreational activities such as play or exercise. The Stationary Activity Map visually depicts people engaging in different activities and adopting various postures using different symbols. ***Age and Gender Tally*** focuses on observing people of different age groups and genders to gauge to what extend this area is inclusive for all age and gender groups (Figure 4b). Individuals are divided into several categories based on their age ranges, including toddlers (0-4 years old without gender distinction), kids (5-14 years old), young adults (15-24 years old), adults (25-64 years old), and seniors (65 years and older).

Gender distinction is considered for all age groups except toddlers. *Twelve Quality Criteria* is used to evaluate to what extend the area provides protection, comfort, and enjoyment for the people engaging in activities (Figure 4c). The protection criteria encompass the availability of protection against unpleasant exterior conditions such as traffic, climate and noise. Comfort involves the availability of options for conducting stationary activities. Enjoyment encompasses the factors that enhance people-place interactions, including appropriate scale, aesthetic quality, pleasant climate conditions, and sensory experiences (Gehl Institute, 2017). By utilizing these PSPL survey methods, urban planners and designers can gather valuable data on to assess the quality and effectiveness of public spaces, within the needs, desires and interactions of the individuals.

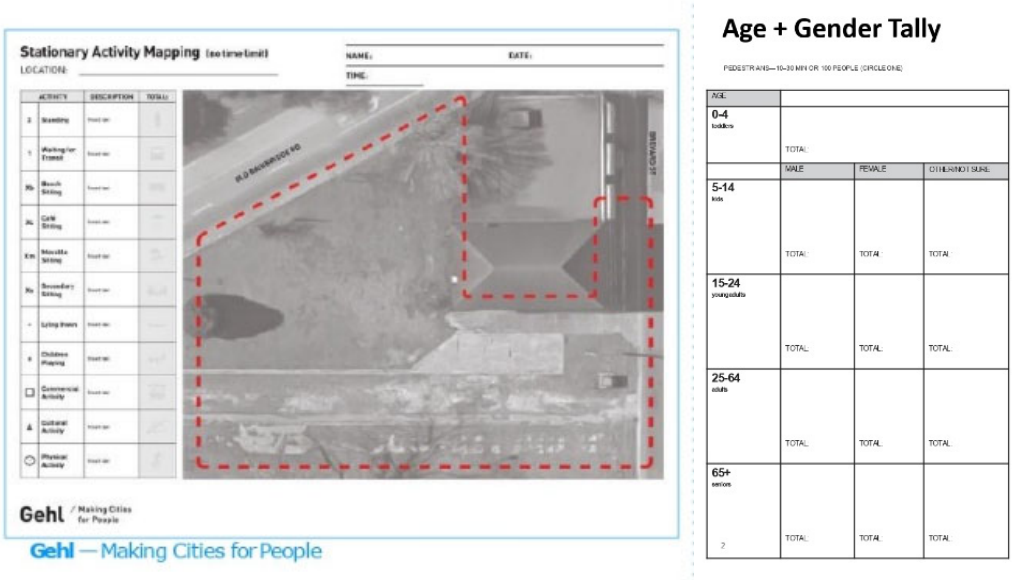
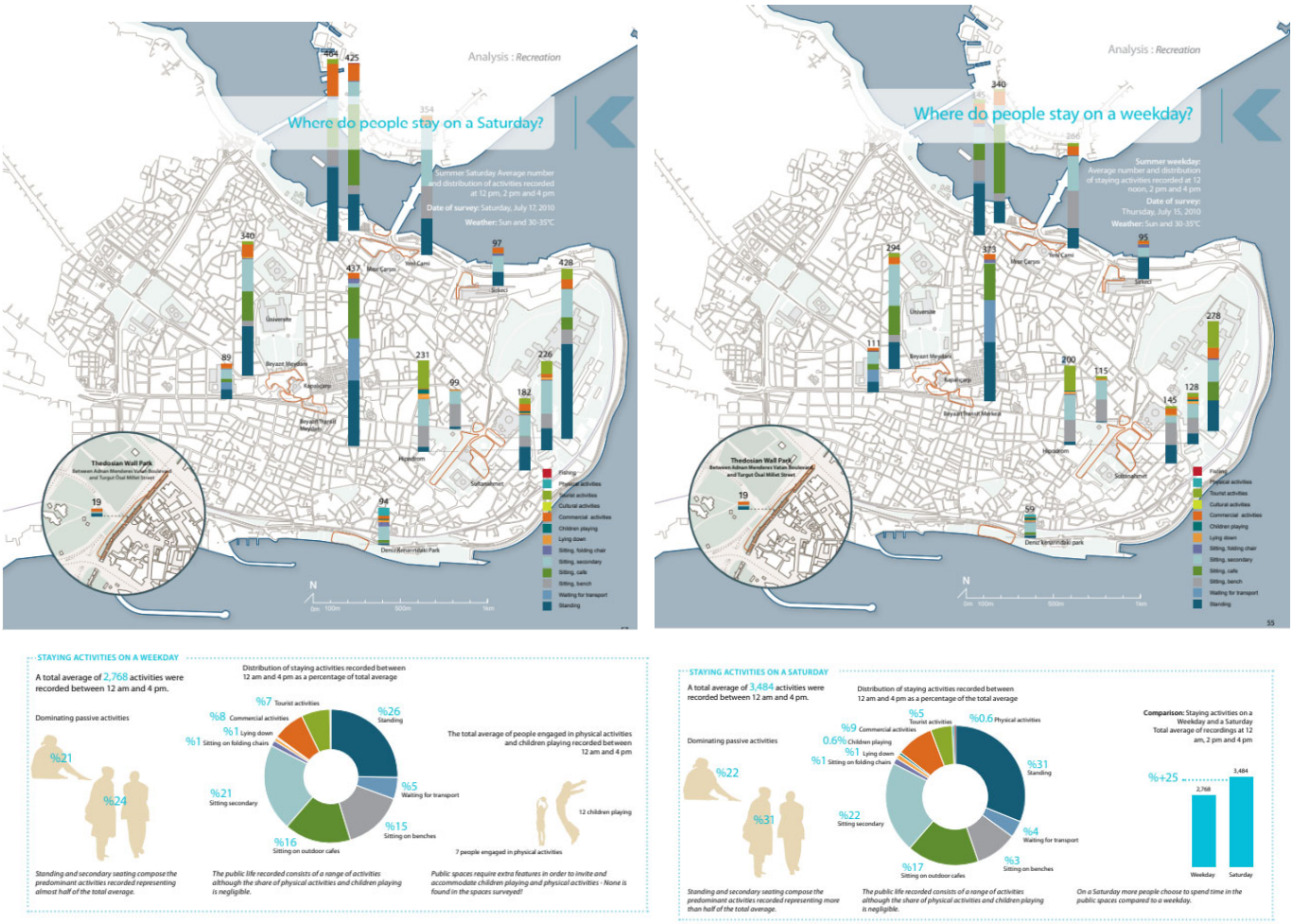


Figure 4.: **(a)** Stationary Activity Mapping, **(b)** Age and Gender Tally, **(c)** Twelve Quality Criteria (Gehl Institute, 2017).

Gehl Architects (2015) developed a public life diversity toolkit as a prototype for measuring social mixing and economic integration in public space. They prototyped three different tools, to give a snapshot of social mixing between people in different economic groups (Gehl Architects, 2015). They apply intercept survey, observational analysis using Public Life methodology, and social media data to understand how diversity of public life occurs in public space (Gehl Architects, 2015). EMBARQ and Gehl Architects (2013) also evaluated public spaces and public life in Istanbul Historical Peninsula to increase urban vibrancy by using the public life methodology (PSPL survey tools). The quality of place has been assessed considering People activities, and

different user profiles, quality of public spaces, pedestrian movements and network, traffic and mobility, perception of safety, have been assessed and visually represented through informative maps and diagrams. Accordingly, EMBARQ and Gehl Architects (2013) assert recommendations interaction to promote accessibility, walkability, traffic calming, public transportation use, attractive public spaces, and successful mix-use with variety of activities for revitalization of the place (EMBARQ & Gehl Architects, 2013). **Figure 5** depicts the stationary mapping analysis in Istanbul Historical Peninsula.

Figure 5.: Activity analysis in Istanbul Historical Peninsula (EMBARQ & Gehl Architects, 2013).



In this study, the PSPLs are used as a guideline to answer the observatory questions. This study takes advantage of Stationary Activity Mapping, Age and Gender Tally, and Twelve Quality Criteria Tools to measure to what extend this area is attractive for activities, inclusive, and inviting. It employs utilizes the Counterpoint mobile application as

a digital tracing method to track live traffic, gender and tally within activities in POS. As locative media data, this study benefits from the user check-ins in Foursquare, photo-sharings in Flickr platforms, and activity places in Google Places. Data is obtained through web scrapping of the Foursquare, Flickr and Google Places APIs. Web scraping is a technic of data extraction from public websites or APIs, and structuring data sets using automated with programming tools. The aim of integrating digital tracing and locative media data is to support the observations with user generated data to gain better understanding of user dynamics and pattern in public space.

2.3. Beyazıt Square

The Istanbul Historic Peninsula District, renowned for its rich and layered cultural heritage, was among the earliest settlements in Istanbul (EMBARQ, 2014). This district has been included in the UNESCO World Heritage List in 1985, as 'outstanding universal value' (Site Management Directorate of Istanbul Historic Peninsula, 2011, 2018). The district is characterized by its diverse vernacular architecture, building and social patterns, and a population with varied socio-economic backgrounds (Turgut & Özden, 2005). Moreover, it is also recognized for distinctive skyline, shaped by historical urban fabric and topography, significant historical masterpieces, and the unique, layered urban pattern formed by multiple civilizations. As a cosmopolitan city center, the Historic Peninsula District serves as a primary hub for commerce, history, culture, and education (Site Management Directorate, 2011). It combines its unique historical center value with the dynamism of a cosmopolitan city that continues to adapt to changing times. This duality of historical and metropolitan elements offers both challenges and opportunities, influencing the functionality of the urban environment.

The Historical Peninsula encounters imbalances in functions, activities, and user demographics in different times and places, alongside a decline in place attachment, awareness, and social interaction, within the low quality of POS (EMBARQ & Gehl Architects, 2013; IMM Cultural Assets Conversation, 2016). The quality of open public spaces is 'underperforming' due to limited size, undefined spatial definition for activities, and low engagement with surrounding areas and green spaces (EMBARQ & Gehl Architects, 2013). The public spaces fail to

offer diverse activities and multiple uses; resulting in low attraction for users (EMBARQ & Gehl Architects, 2013). This study selects Beyazıt square as a case study area. Beyazıt Square is among the vital public spaces in the area, that embraces the potentials and drawbacks of the site.

Beyazıt Square has historically been a central shopping location throughout the Ottoman Period (Kuban, 1994). During the Byzantine Period, this square housed the Tauri and Theodosius Forum (Kuban, 1994). The square has continually served as a market area (Kuban, 1994). Beyazıt Square holds a significant position in city history due to its historical background, strong image, and dynamic attributes (Kuban, 1994). It has served to different functions for social and cultural, religious, administration, education, and shopping purposes (Site Management Directorate, 2018). Situated on the historic axis of the Historic Peninsula (Eminönü-Hagia Sophia-Beyazit-Aksaray axis), the square is at the center of commercial, tourist, and cultural activities. From the early Republican era, numerous modifications have been applied to the square to centralize this place for activities and mobility (Site Management Directorate, 2018). More recently, efforts have been made towards pedestrianization and revitalization to prevent the square from being solely transport-oriented (Site Management Directorate, 2018). Figure 6 illustrates a tag cloud compiled by students, reflecting their initial impressions of the site. The common perception is that Beyazıt Square is bustling, noisy, and a tourist hub, full of cultural activities.

Figure 6.: Tag cloud about Beyazıt Square.

3. METHODOLOGY

3.1. Data Collection and Representation

The students conduct site observations to observe functioning of the place, and quantify user movement and activities. For observational site analysis, the Public Life Toolkit (Gehl Institute, 2017) is utilized as a digital application to record the place activities (Gehl Institute, 2017). The Counterpoint smartphone application is employed for crowdsourced traffic counting (Counterpoint, 2023). The students are divided into different groups based on the observation tasks. These observation tasks are live traffic counting, stationary activities counting, age and gender tally, building types, and twelve quality criteria observation. They are conducted using the related extensions of Counterpoint mobile application. The students use the digital app and count the people in activities, different age and gender groups, live traffic on the streets and assess POS in twenty-minute timeframe. The Live Traffic Counting Group counts the live traffic at five determined locations, located at the street intersections (Gehl Institute, 2017). The Stationary Activities Counting Group observes and counts people engaged in activities (Figure 4a). The Age and Gender Tally Group tallies people and categorize them based on gender and age group in twenty minutes (Figure 4b). It gives information about the age and gender tall, which is the baseline of this application. The Building Types Group classifies building functions along the street facades and ranks the buildings based on their types. Finally, The Site Observation Group evaluates the square based on twelve quality criteria (Gehl Institute, 2017). They map the locations that met or did not meet the quality criteria, found in Figure 4.c (Gehl, 2010).

Geographic Information Systems (GIS) has been employed to process the observation data into digital environment. GIS serves as a tool to organize, analyze, visualize, and disseminate a range of data from different time and analysis scales (Campbell & Shin, 2011). GIS is a unique form of information technology that aids in understanding the "what", "when", "how", and "why" questions by answering "where." The database system of GIS has the ability to combine the spatial and temporal data and attribute data of an object, thus creating knowledge for spatial analysis (Campbell & Shin, 2011).

Students use a reference map as a template and create thematic maps to illustrate the spatial distribution of human patterns and urban functioning. Their work has two main parts which are (1) mapping a spatial dataset, and (2) generating a new spatial dataset. In the first

part, they convey the results of digital counting applications into a Geographic Information System (GIS), sourced from the Counterpoint database (Counterpoint, 2023). They download the count results in csv format and transfer them to GIS by adding a delimited text layer. In the second part, they develop a spatial dataset based on their observations. This involves creating a new vector layer and assigning their observations as new attributes to the related location. Once the spatial dataset is defined, the students categorize the attributes to display their density level. In the final step, they customize the symbols with varying colours and pictograms to visually represent the data. These steps outline the process of mapping observational data. Urban data is collected by querying the Open Street Map (OSM), using the building and highway layers from OSM. Additionally, Flickr photo sharing and Google Places data are provided to the students as locative media data. In this study, data gathered through observations and digital apps serve as the primary data source, while urban data from OSM and locative media data act as secondary sources. Students then juxtapose the different datasets and draw conclusions about site issues and design concepts.

3.2. The Relationship Analysis of the variables

A range of data types is compiled to create a QGIS database, as a result of data analysis and site observation. Data types encompasses building form (maintenance, condition, height) and function, to demographic data (age, gender, types of population groups), density of people and transport (bikes, vehicles), activity data, and visit data (visitor density, time and day of visit). Visit data is derived from Flickr analysis, while building function data comes from Google Places Analysis. Both are provided to the students as secondary data sources. Other types of data, are counting and activity data collected digital counting methods, and observation data. Sensorial data (smell and noise) are out of the scope of this analysis in order to limit the number of cases and variables. Data is aggregated using the spatial join method in GIS. The generated spatial dataset is comprised of 17 variables and 71 cases, distributed across grids measuring 15 m x 15m, as illustrated in Figure 7 on GIS, and in Table 1 in tabular form.

Table 1: The dataset, shown partially.

id	tour is_le v	local_ lev	Bike	Ped estri an	Vehi cle	traffic _lev	act_ people	building _ cond	height	ambia nce	crowd_ lev	gender	age	visit _de ns	visit_time	Buildng_ function
1			19	196	54	high	83	new	mid	bad	not crowded	woman	adult	2	weekday_ daytime	shopping
2			19	196	54	high	83	new	mid	bad	not crowded	woman	adult	2	eekday_d aytime	dining
3			19	196	54	high	83	new	mid	bad	not crowded	woman	adult	2	weekday_ daytime	accommod ational
5	3	3	19	229	40	low	86	new	high	bad	not crowded	man	adult	1	weekend_ daytime	shopping
6	3	3	19	229	40	low	86	new	high	bad	not crowded	man	adult	1	weekend_ daytime	accommod ational
7	3	2	11	605	20	low	78	old	low	bad	very crowded	man	adult	32	weekday_ daytime	dining
8	3	2	11	605	20	low	78	old	low	bad	very crowded	man	adult	32	weekday_ daytime	shopping
9	3	2	11	605	20	low	78	old	low	bad	crowded	man	adult	26	weekday_ daytime	dining
11	3	2	3	947	15	high	56	old	low	good	crowded	man	adult	44	weekday_ daytime	dining
12	3	2	3	947	15	high	56	old	low	good	crowded	man	adult	44	weekday_ daytime	shopping
13	3	2	3	947	15	high	56	old	low	good	crowded	man	adult	44	weekday_ daytime	dining
18	3	2	3	947	15	high	56	old	high	good	crowded	woman	adult	44	weekday_ daytime	dining
19	3	2	3	947	15	high	56	old	high	good	crowded	woman	adult	44	weekday_ daytime	shopping
21	3	2	3	947	15	high	56	new	low	good	crowded	man	adult	44	weekday_ daytime	shopping

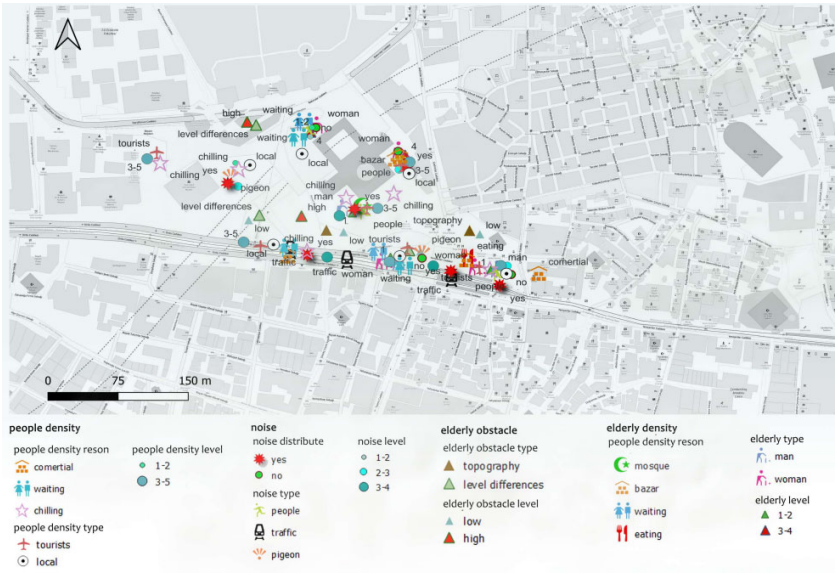


Figure 7: Spaital distribution of the observational data (Dalya Abushhawish, Nada Elgaphry).

Following the database, a mental map is created with students. This mental map is formed according to the relationships of the variables, derived from site observation. The crowd level (target node) is influeced by visitor density including tourist and locals and visit time, age and gender of people, people engaged in activities, traffic (vehicle, bike and pedestrian density), building functions and ambiance (height,

condition). Students were asked to examine the relationship between the state of being crowded and other parameters (Figure 8).

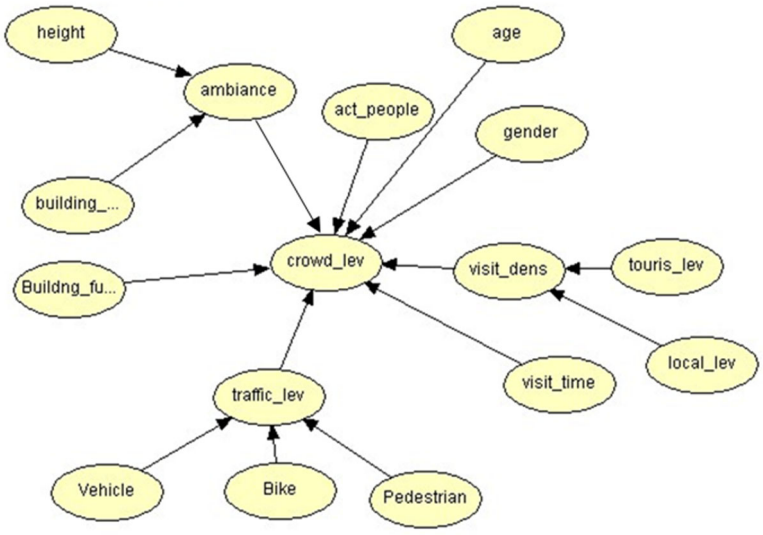


Figure 8: The relationship network, created by students.

The relationship network is assessed with artificial intelligence method, using Bayesian Belief Network (BBN) that imitates human probabilistic thinking to make decisions in uncertain and complex situations (Nilsson, 2010). Pearl (2006) transfers the human probabilistic-intuitive reasoning capabilities in uncertain conditions to artificial intelligence systems through BBNs. BBNs are compact probabilistic graphical models that combine probability and graph theories (HUGIN Expert, 2013). These networks comprise directed acyclic graphs (DAGs) that depict causal associations between nodes and conditional probability tables (CPTs) detailing the conditional probability distribution for each node (HUGIN Expert, 2013). BBNs are valuable tools to be used for knowledge discovery (Fusco, 2008; Han et al., 2012; Heckerman, 1997). Their ability to manage incomplete datasets and learn causal relationships for predictions sets them apart as valuable tools for knowledge discovery (Heckerman, 1997). BBNs provides to visualize intricate relationship networks (Fusco, 2008). In urban studies, BBNs have been utilized to explore relationships between sustainable mobility indicators (Fusco, 2004), traveler satisfaction indices (Yanık et al., 2017), neighborhood popularity (Ardıç et al., 2020) and social network parameters (Kemperman & Timmermans, 2014), and spatio-temporal dynamics (Fusco, 2008). In this study, BBN is employed to explore direct and indirect relationships between variables.

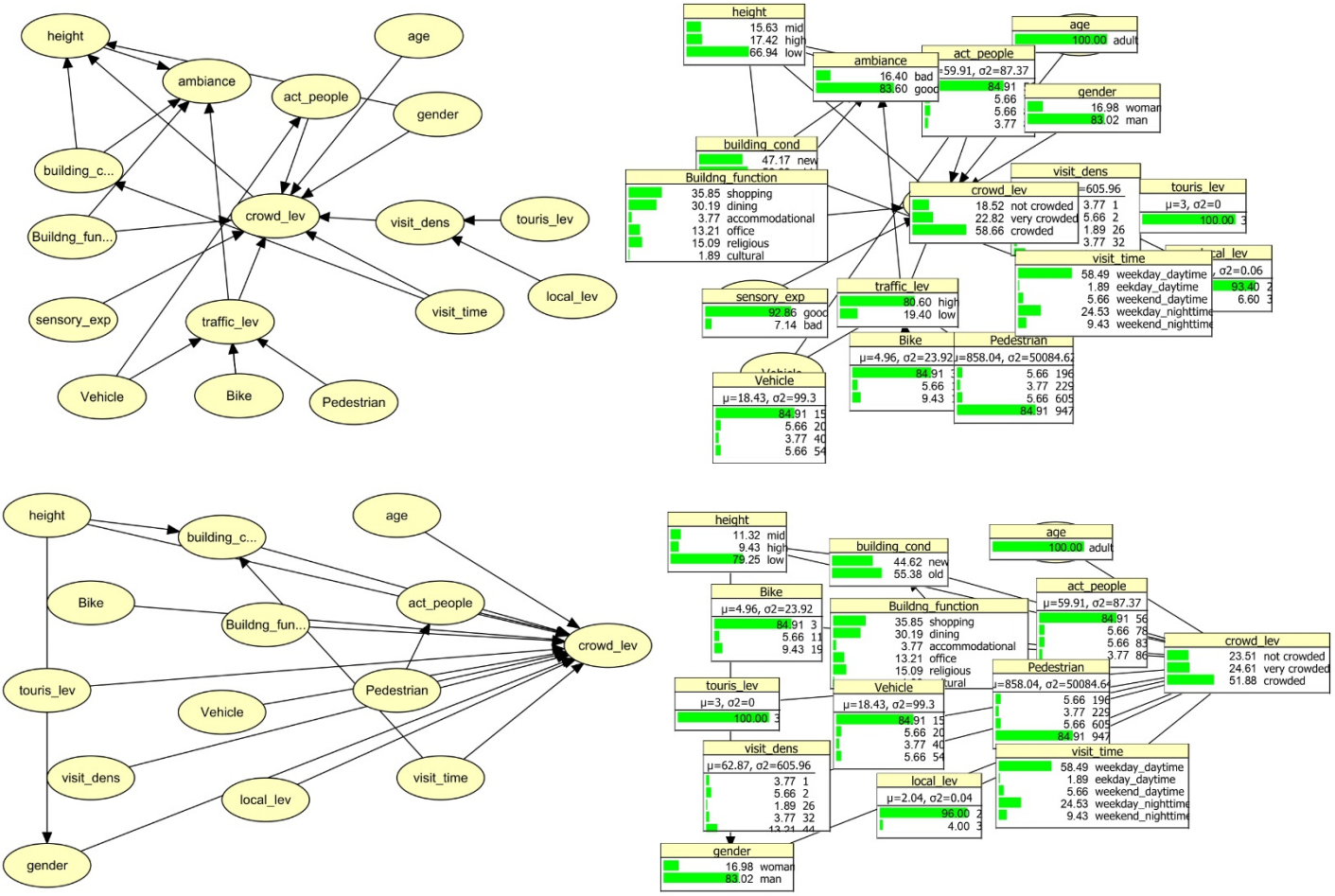
This relationship network is also constructed through Bayesian Belief Network (BBN). The aim is to explore hidden relationships and also to evaluate the performance of this relationship network. This study creates a hybrid BBN that combines expert knowledge and learning algorithm. As learning algorithms, the Necessary Path Condition (NPC) has been used to assesses conditional independencies between nodes using statistical tests (Steck & Tresp, 1999). The relationship network - created by the students- conveyed to Bayesian Network, and applied NPC to find indirect relationships between variables (Figure 9.a, 9.b).

Bayesian Belief Network (BBN) is evaluated based on learning and prediciton performance. The EM algorithm, also known as the Expectation-Maximization algorithm, has been employed to calculate the conditional probability distribution of variables according to the contructed BBN, using dataset. The algorithm performs learning until expectations are maximized; it reaches maximum likelihood, known as log-likelihood (Timmermans and Kemperman 2014). Another BBN is created using NPC without expert knowledge for comparing learning and prediction performance. The expert based hybrid BBN generated a log-likelihood score of -345.596, after performing EM learning to the dataset; while the automated BBN the learning performance is -367.644.

For prediction performance, the dataset is divided into a 70% training set (53 case) and a 30% testing set (17 case). The researcher configures batch propogation to the dataset and propogate belief of being crowded. For this, she selects the crowd level as target node, and being crowded as target state. The beliefs of being crowded (probabilities) and the states (evidences) are compared with binary classification model (BCM). In BCM the ROC (receiver operating characteristics) curve curve divides area as positive (true positive rate) and negative class (negative positive rate). The area under curve indicates how well the BBN correctly predicts the probability of being crowded. In this hybrid BBN the area under curve is 0.875, while 0.625 in automated BBN. This indicates that the 87% of the possibilites are predicted correctly in hybrid BBN, while this rate is 62% in automated BBN. Based on these performance test results, it can be deduced that expert based hybrid BBN shows greater performance in learning and prediction. Figure 9 exhibits automated BBN (Figure 9.a) and hybrid BBN (Figure 9.b) monitoring the probabilities. The expert based hybrid network has more complex relationships. The relationships between building height and condition, traffic level and ambiance, vehicle and active people, visit time and building condition, gender and building height are found

Figure 9: The hybrid expert BBN (Figure 9.a), and automated BBN (Figure 9.b) constructed through learning algorithm.

by the algorithm. Apart from the last two relationships, the relationships seems meaningful based on the observations.



4. CASE STUDY RESULTS

According to the results of site observation, several problems are identified by different groups. The unbalanced distribution of the population in terms of age and gender is one of the most highlighted problems in the site (Group A1, A2, C4, and S4). Another drawback is lack of activities and overcrowding of people and vehicles leading to traffic congestion (Group B1, S1, S3, and S5). The insufficiencies of gathering places for both people and animals in emergency situations is another focused problem (Group Q3). Additionally, lack of place perceptions and experiences pose another problem and Group S2 draw attention to awareness in sensorial experiences. In terms of design concepts, Group A2, A1, and S4 propose an inclusive design approach, while Group C4 emphasizes designing for children. Group B1, S1, and

S3 suggest enriching activities, while Group Q3 focuses on design on emergency considering human and animal protection. Group S5 proposes design for enhancing tourist activities, and Group S2 highlights the importance the audio-visual sensorial experiences in this historical site. Based on the students' assessment, design decisions could involve addressing the unbalanced population distribution, enhancing activities while minimizing overcrowding and traffic congestion, providing gathering spaces for both people and animals in emergency situations, promoting inclusive and child-friendly design, enriching tourist experiences, and fostering sensorial engagement.

The students take into consideration the relationship network to make conceptual decisions. Group S1 focuses on activities. They consider the positive effect of active people, and people diversity (age & gender) on crowd level, and negative effect of vehicles within traffic level on active people. Group S2 concentrated on the relationship between activities, population groups, and sensory experiences. The noise and smell level are evaluated under sensory experience. They consider the relationship between sensory experience and crowd level, sensory level and people activities, and also people activities and crowd level. Based on Group S2 observation, more people density and activities create more smell and noise affecting sensory experience. Lastly, Group S4 focuses on the activities of elderly people. The impact of traffic level, crowd level and visit density on elderly people becomes significant. The affecting factors of crowd level including visit density, active people within age are the focus in this study.

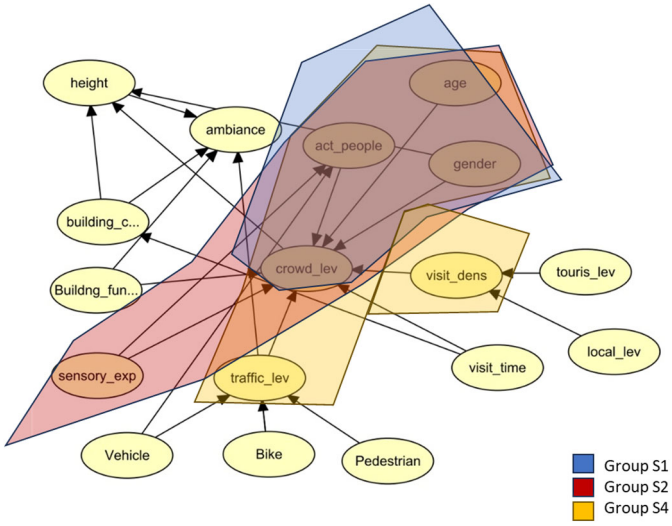
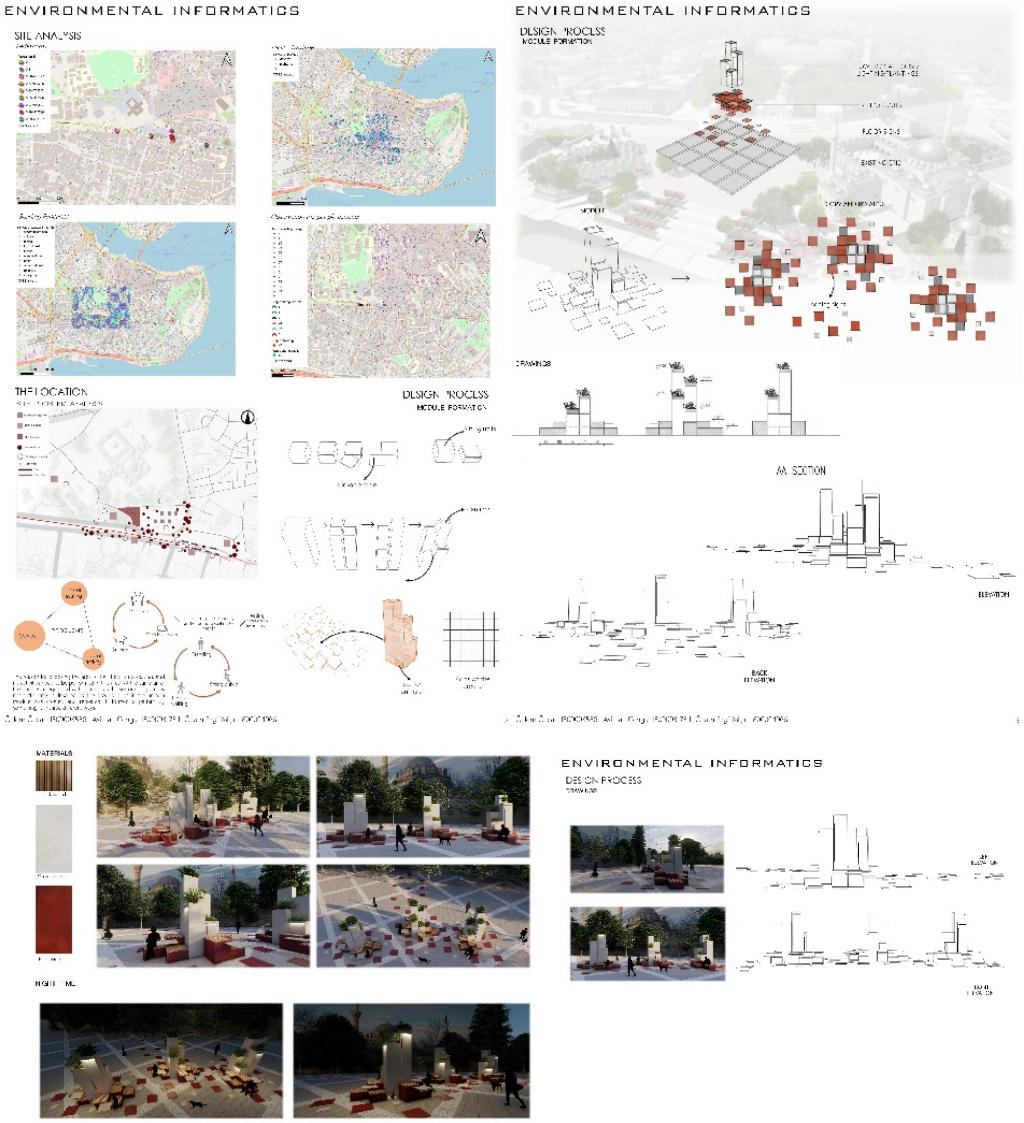


Figure 10: Mapping relationships used by students in conceptual decisions.

This study concentrates on a selection of case study projects from among the student submissions, to present the outcomes of the data-driven process. Students in Group **S1** identified activities as the most significant parameter, subsequently activity is the central focus of their urban furniture design. They pointed out lack of activities, seating, and lighting as key issues preventing the efficient use. To address these problems, they leveraged modular design approach for urban furniture to provide additional opportunities for sitting, walking, waiting for transport, relaxing, and participating in social activities. They target to make this area attractive for conducting social and optional activities, which are place-dependent activities during both day and night time (**Figure 11**).

Figure 11: Group S1 proposals for augmenting place activities (Özlem Özcan Özüm Ezgi Yalçın, Asiman Cengiz).



Group S2 investigates the relationship between activities, population groups, and sensory experiences. They observed that increased activity and diverse population groups (including tourists and locals), along with higher people density, influenced the levels of noise and the range of smells at the site. More activities led to high level of different sound and smells. Focusing on the aspect of sound, Group S2 designed a space to enhance the auditory experience while protecting users from external noise. In their audiovisual hub, individuals can experience the soundscape of the place and learn the history of place; while relaxing in a semi-open area that is insulated from external noise (Figure 12).

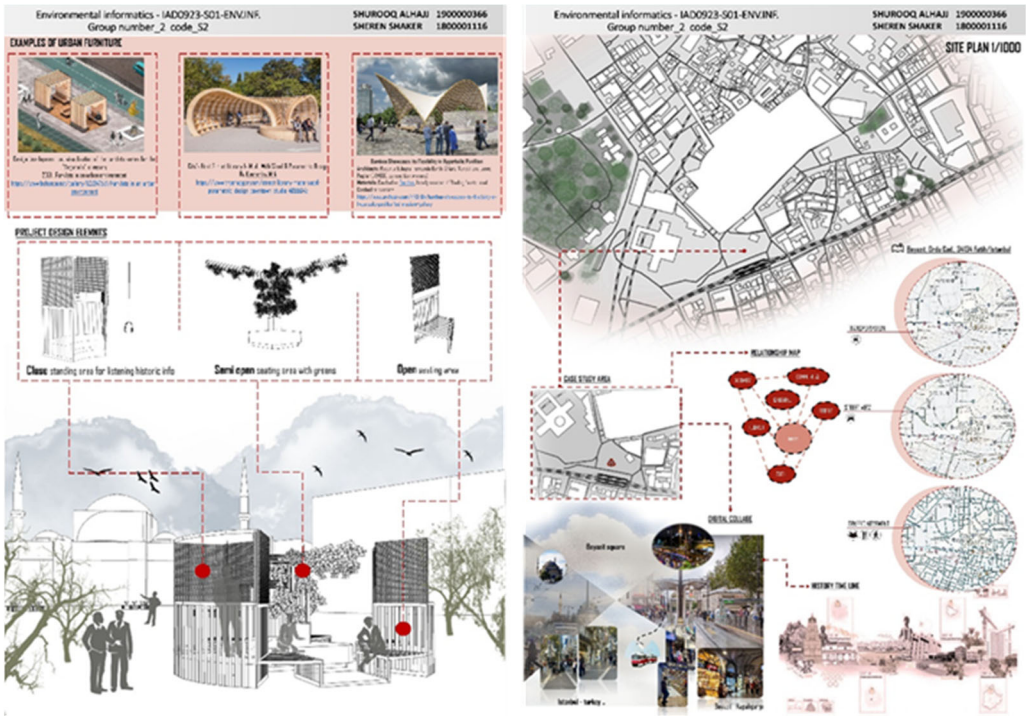


Figure 12: Group S2 proposals for improving sensorial experiences (Sheren Shaker, Shurooq Ali Mohammed).

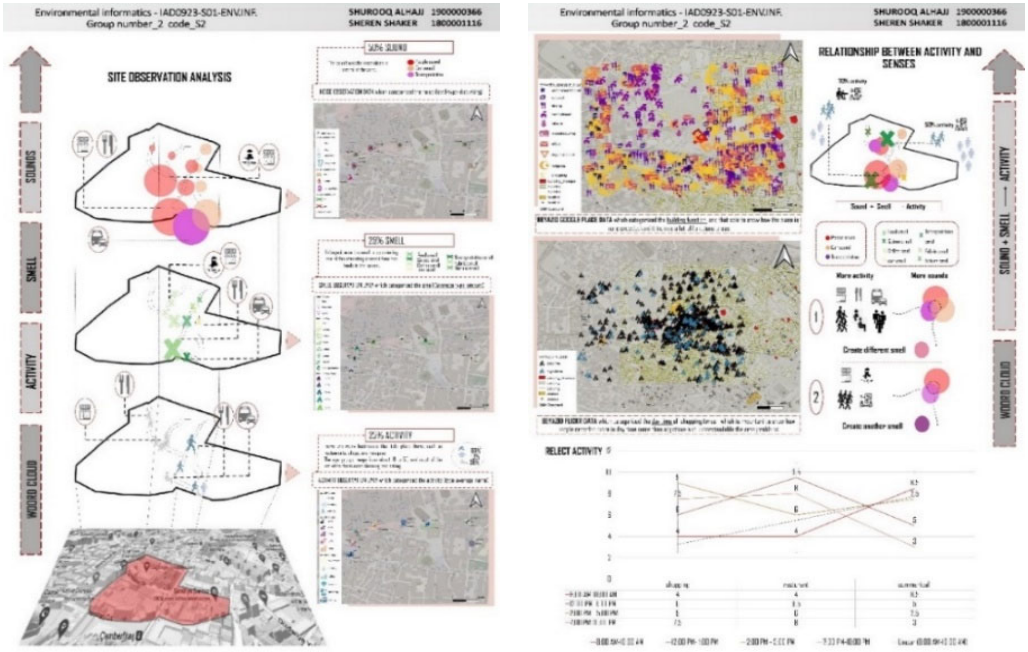
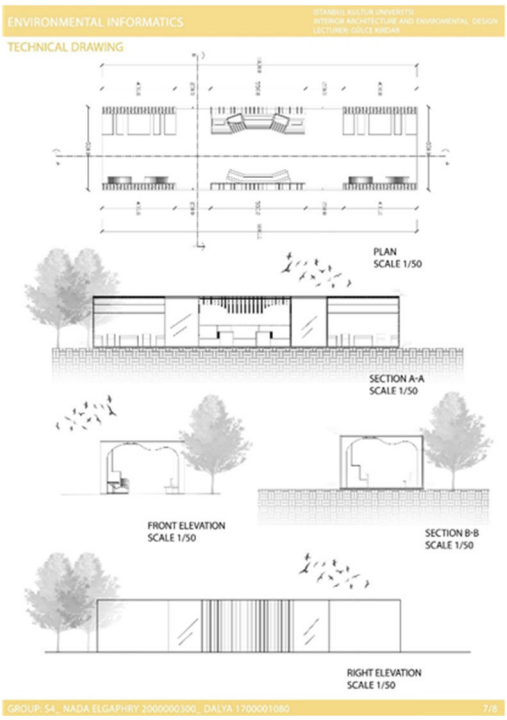


Figure 13: Group S4 proposals for elderly people (Dalya Abushhawish, Nada Elgaphry).

Finally, Group S4 concentrated on the density of the elderly population, their activities, and obstacles in the square. From their observations, they concluded that the elderly population is negatively affected by the density of people and noise. Consequently, they designed urban furniture to facilitate optional and social activities in the area, and protect from density of the crowd (Figure 13).



4. CONCLUSION

In conclusion the aim of this workshop was to introduce the students with the developing design decisions considering observation data. Data driven design process is experimented. Data-driven design process support the conceptual decisions for urban furniture considering urban dynamics. People activities and profiles is monitored, the urban movement is traced, the POS quality is assessed. The collected data are mapped in GIS to create spatial maps. The spatial maps act as a mental map to convey the students' site observation.

The participants find the use of digital tracking application (Counterpoint) challenging, but useful for observing the live traffic and people. The digital observation tools inspired them to determine their focus group for urban furniture. On the other side, the majority of participants assess the use of GIS easier in comparison to digital tracing tool. This tool is useful to process observation data obtained through digital applications, create spatial datasets, and integrate them to create a database. Compared to conventional observation and analysis methods, digital methods offer a range of advantages. Digital methods enhance the process of organizing and analyzing data. This

enhancement is due to their ability to process a variety of data types quickly, thereby improving overall data handling speed. Furthermore, these digital methods are more accurate, providing detailed and precise information. As a result, the versatility, precision, time and labor efficiency of digital methods make them more preferable. They facilitate to observe people movements and activities within the live traffic. Moreover, the digital observation methods inspired them to define their focus and find target user profile.

The spatial distribution of urban elements is represented in GIS. The spatial maps act as a mental map that gives the impressions and observations of the participants. They aid in understanding and monitoring urban functioning, and discovering the problems and shortcomings in the site. The students utilize observational data the most, user-generated data second most, and urban data third when generating the concept of urban furniture. The relational map is useful to create relationships between distinct analysis concept and determine the focus of the concept considering the relations. Overall, the outcomes of the spatial analysis contribute on determining the function, user group and concept of the urban furniture. As the results demonstrate, the application of data-driven observation and analysis methods has been useful in developing user scenarios and detecting target user profile, identifying user needs and demands, and making functional decisions during the design of urban furniture. The students highlighted the challenges posed by the use of digital observation methods and the learning curve associated with GIS software as limitations of the study. The technical glitches and connectivity problems also limit the site observations.

In the further stages, site observation is expanded with a questionnaire to include place perceptions and experiences in the public spaces. Moreover, the site observation methods become limited with counting through digital tracking application; however, site observation methods can be supported with conventional observation methods including sketching, photographing or video recording and keeping activity diaries, as stated by Gehl and Svarre (2013).

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Conflict of Interest Statement

The author of the study declare that there is no financial or other substantive conflict of interest that could influence the results or interpretations of this work.

References

Ardıç, S. İ., Kırdar, G., Lima, A. B. (2020). An Exploratory Urban Analysis via Big Data Approach: Eindhoven Case. *Proceedings of the 38th ECAADe Conference on Education and Research in Computer Aided Architectural Design in Europe*, 309–318.

Brower, S. (1988). *Design in Familiar Places: What Makes Home Environments Look Good.* Greenwood Press.

Campbell, J. E., & Shin, S. (2011). *Essentials of Geographic Information Systems*. Textbooks. https://digitalcommons.liberty.edu/textbooks/2

Counterpoint. (2023). *Counterpoint- Where everyone counts*. https://counterpointapp.org/

EMBARQ, & Gehl Architects. (2013). *Istanbul Public Space Public Life*. https://wrirosscities.org/sites/default/files/Istanbul-Public-Spaces-Public-Life-EMBARQ-Turkey-Gehl-Architects-Oct-2013.pdf

Fusco, G. (2004). Looking for Sustainable Urban Mobility through Bayesian Networks. *European Journal of Geography*, *292*. https://doi.org/https://doi.org/10.4000/cybergeo.2777

Fusco, G. (2008). Spatial dynamics in France. In O. Pourret, P. Naim, & B. Marcot (Eds.), *Bayesian Networks: A Practical Guide to Applications*. John Wiley and Sons.

Gehl Architects. (2015). *Public life diversity toolkit: a prototype for measuring social mixing and economic integration in public space.*

Gehl Institute. (2017). *Gehl Public Life Tool*. https://gehlinstitute.org/tool/

Gehl, J., & Gemzoe, L. (1996). *Public Spaces-public Life.* Danish Architectural Press and the Royal Danish Academy of Fine Arts, School of Architecture.

Gehl, J., & Svarre, B. (2013). *How to Study Public Life*. Island Press.

Han, J., Kamber, M., & J., P. (2012). *Data mining concepts and techniques* (3rd ed.). Morgan Kaufmann.

Heckerman, D. (1997). Bayesian Networks for Data Mining. *Data Mining and Knowledge Discovery*, *1*(1), 79–119. https://doi.org/10.1023/A:1009730122752

HUGIN Expert. (2013). *HUGIN Expert White Paper [White Paper].* https://hugin.com/wp-content/uploads/2016/05/HUGIN-WHITE-PAPER-NEW-AND-REVISED_2013.pdf

Kemperman, A., & Timmermans, H. (2014). Green spaces in the direct living environment and social contacts of the aging population. *Landscape and Urban Planning*, *129*, 44–54. https://doi.org/https://doi.org/10.1016/j.landurbplan.2014.05.003

Mehta, V. (2014). Evaluating Public Space. In *Journal of Urban Design* (Vol. 19, Issue 1, pp. 53–88). Taylor & Francis. https://doi.org/10.1080/13574809.2013.854698

Nilsson, N. J. (2010). The Quest for Artificial Intelligence: A History of Ideas and Achievements. In M. (transl. . Doğan (Ed.), *Cambridge University Press* (Vol. 139, Issue 25). Bogazici University Publishing.

Skjæveland, O., Gärling, T., & Mæland, J. G. (1996). A multidimensional measure of neighboring. *American Journal of Community Psychology*, *24*(3), 413–435. https://doi.org/https://doi.org/10.1007/BF02512029

Whyte, W. H. (1980). *The Social Life of Small Urban Spaces.* Conservation Foundation.

Yanık, S., Aktas, E., & Topcu, Y. I. (2017). Traveler satisfaction in rapid rail systems: The case of Istanbul metro. *International Journal of Sustainable Transportation*, *11*(9), 642–658. https://doi.org/10.1080/15568318.2017.1301602

Zamanifard, H., Alizadeh, T., Bosman, C., & Coiacetto, E. (2019). Measuring experiential qualities of urban public spaces: users' perspective. *Journal of Urban Design*, *24*(3), 340–364. https://doi.org/10.1080/13574809.2018.1484664