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IN MEMORIAM

We dedicate this issue to the memory of our esteemed professor and formal editor of the journal, Prof. Dr. Orhan Hacıhasanoğlu.

We share with you an excerpt from his opening editorial from 2004. His legacy in academia, his students, and the world around him will continue to live on in our memories and our work.

Editorial
Orhan HACIHASANOĞLU*

"Everybody accepts that conducting research, which has contributions to education and practice, must be the first condition for being a university. Publishing papers, which are based on research, is as important as conducting research. Istanbul Technical University has encouraged much scientific research and has helped to publish it to contribute to the national and the international arena. There were four periodicals in the late 1970's which were published by the Institute of History of Architecture and Restoration, the Institute of City Planning, the Institute of Building Research and the Institute of Architectural Planning and Design in the Faculty of Architecture. These periodicals published the works of researchers and academicians from Istanbul Technical University and from the other universities and research centers. ITU-Faculty of Architecture has tried to publish an international journal for many years after these periodicals finished publishing in the 1980's because of the changing activities of institutes.

This journal has been realized by studies of the Publishing Committee of the Faculty of Architecture, which was began this work in 1999. The aim of the journal is to contribute to scientific research, practice and education by publishing national and international studies on architecture, city and regional planning and industrial product design."

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Contact
İTÜ A|Z Yayın Sekreterliği
İstanbul Teknik Üniversitesi, Mimarlık Fakültesi Taşkışla, Taksim, 34437 İstanbul Türkiye
Fax: 90 212 251 4895 • ***E-mail:*** az@itu.edu.tr • ***Web:*** www.az.itu.edu.tr

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Rethinking Disciplinary Boundaries
Editorial

Aliye Ahu GÜLÜMSER • *Editor*

Architecture, planning, and design have long developed in proximity, yet often in isolation. While each field brings its own logics, languages, and epistemologies, the challenges facing the built environment today, such as climate transformation, socio-spatial inequality, technological saturation, and global urbanization, reveal the limitations of siloed thinking. The demand is clear: to cultivate deeper interrelationships across domains that have too often been positioned apart.

The concept of interrelationship is not a call for disciplinary fusion but for meaningful dialogue. It recognizes the reciprocal shaping of space, society, and systems. Architecture gives form to intention and identity; planning governs temporal and spatial distribution; design, in its broadest sense, connects aesthetics, usability, and adaptability. Yet none of these practices occur in a vacuum. As Lefebvre (1991) asserted, space is socially produced; thus, it is always a product of intersecting forces that are material, regulatory, symbolic, and political.

Today's spatial practitioners confront problems that are increasingly networked and non-linear. Urban resilience, for example, requires both design sensitivity to place and architectural form and planning foresight grounded in systems thinking and long-term governance (Ahern, 2011). Questions of justice in the built environment cannot be addressed solely through zoning reforms or formal typologies but must attend to affective, everyday, and infrastructural dimensions (Soja, 2010; Rawes, 2013). Even sustainability, long treated as a design problem or a planning goal, increasingly demands integrated frameworks that bridge ecological thresholds, spatial equity, and material agency (Roggema, 2012).

This interrelationship is also methodological. Interdisciplinary research that combines qualitative, quantitative, and speculative approaches is gaining ground. For instance, critical spatial practices (Rendell, 2006) challenge the neutrality of design and planning, insisting instead on reflexivity, participation, and embeddedness. Digital tools, ranging from GIS to urban simulations, now inform both architectural and planning decisions, enabling new forms of cross-scalar analysis. At the same time, theories of assemblage (DeLanda, 2016) and actor-network (Latour, 2005) invite scholars and practitioners to trace spatial configurations not as fixed outcomes but as evolving, relational ecologies.

The implications extend beyond theory and technique. They touch on pedagogy, professional identity, and institutional structures. How might we educate spatial thinkers who are capable of navigating between scales and systems, without losing sight of material specificity or political consequence? What kind of collaborations become possible and necessary when architecture, planning, and design are positioned not hierarchically but relationally? How can academic journals foster a platform that sustains both disciplinary rigor and transdisciplinary experimentation?

These questions point to a broader epistemological shift: from disciplinary sovereignty to shared stewardship of space. As we move further into an era shaped by planetary pressures and spatial uncertainties, the interrelationship of architecture, planning, and design becomes not just a conceptual tool but a working necessity.

Let us then approach the spaces we study, inhabit, and imagine, not through isolated lenses, but through a mode of relational thinking that embraces complexity, invites pluralism, and foregrounds the interdependencies at the heart of spatial practice.

Enjoy our summer issue!

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Dynamics of population change in rural areas of Türkiye: A spatial analysis of villages

Şeyma Gül KIRDI[1*], Zeynep ELBURZ[2]

[1] seymakirdi@iyte.edu.tr • Department of Urban Planning, Graduate School, Izmir Institute of Technology, İzmir, Türkiye.
[2] zeynepelburz@iyte.edu.tr • Department of Urban Planning, Faculty of Architecture, Izmir Institute of Technology, İzmir, Türkiye.

** Corresponding author*
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Abstract
The migration from rural to urban is a critical issue handled by different disciplines. Rural development strategies aim to improve rural areas and reduce inequalities. To formulate the various strategies, it is important to identify the causes of migration. This study aims to analyze the spatial tendency of population change in rural areas in Türkiye and put forward factors that cause this migration. First, LISA analysis is used to reveal spatial patterns of migrations. Then, the causes for migration have been analyzed with aspatial and spatial regression analysis. According to the study results, the change in the rural population in Türkiye shows a spatial autocorrelation. Settlements with high/low populations tend to cluster geographically. According to regression analysis, the presence of primary schools, the presence of the service sector, and the manufacturing sector employment positively affect rural population growth. Contradiction to this, distance to first-tier cities and the presence of a livestock sector have a negative effect. These results can guide policymakers to control and evaluate urban-rural population balance by providing local-scale suggestions for an emerging economy.

Keywords
Rural-urban migration, SAR, Migration factors, LISA analysis, YER-SİS.

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1. Introduction

The global rural population has been diminishing over an extended period. Internal migration, spurred by urbanization, is an ongoing process, involving not only movement from rural to urban areas but also between different cities (Julide & Okşak, 2021). The reduction in rural population is attributed to both the attractiveness of cities and the unappealing aspects of rural life (Hu et al., 2023), with economic factors playing a predominant role. Kalinowski et al. (2022) characterize the challenges in rural areas as a cycle of decline, where economic stagnation adversely affects rural employment, prompting the migration of financially struggling young individuals to urban centers. This migration exacerbates economic downturns, disrupts essential services in rural areas due to depopulation, and, consequently, leads to more migration to urban areas. This cyclic process creates a self-sustaining pattern.

Figure 1 illustrates the evolution of rural and urban populations in certain regions from 1950 to the projected data until 2050, as reported by the United Nations in 2018 (United Nations 2018). Globally, there has been continuous growth in the urban population, and this trend is expected to persist. Notably, between 2005 and 2010, the world witnessed a significant milestone as the urban population surpassed the rural population for the first time. While China managed to mitigate the decline in rural population between 1965 and 1975, the subsequent years saw a rapid continuation of this decline. In low-income countries, rural populations still hold an edge over urban populations, despite the increasing urbanization trend.

As seen in Figure 1, Türkiye's urban population started to increase in the 1950s and gained momentum, especially after the 1980s. The urban-rural gap has consistently widened over time. Güler & Kâhya (2019) conducted a study assessing migration reasons from rural areas in Türkiye, categorizing them into human and natural factors. A total of 28 reasons, falling into these two categories, were identified in their study. According to the

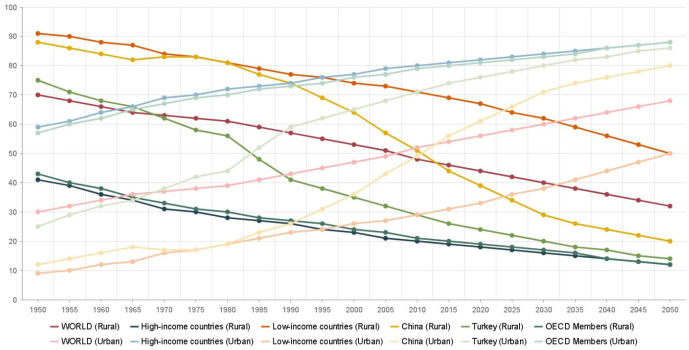

Figure 1. *Rural and urban population rates between 1950-2050 in the world (created by the authors based on the United Nations data).*

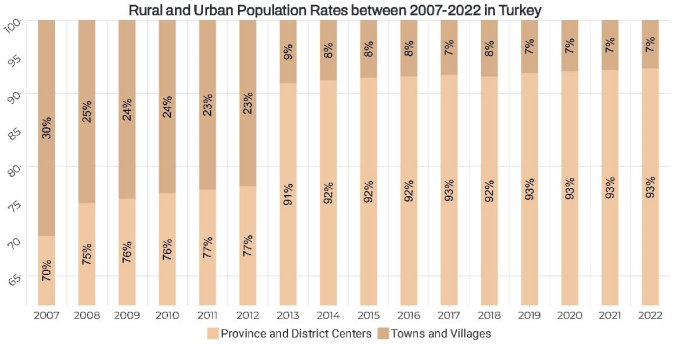

Figure 2. *Rural and urban population rates between 2007-2022 in Türkiye (created by the authors based on the Turkstat data).*

National Rural Development Strategy (2021-2023), a downward trajectory is expected to persist in Türkiye's rural areas, with some settlements projected to experience more significant population declines than others (Republic of Türkiye Ministry of Agriculture and Forestry, 2021).

Prepared from Turkish Statistical Institute (TurkStat) data, Figure 2 shows the changes in rural and urban areas of Türkiye between 2007-2022. According to Figure 2, it can be observed that the trend of decreasing rural population continues, with a dramatic rise in urban population in 2012. The reason for this critical change in 2012 was the change in the status of rural settlements in Türkiye introduced by Law No. 6360. This change resulted in a shift from administrative rural to urban status of rural settlements in 30 metropolitan provinces. Before 2012, Türkiye officially used two criteria for distinguishing between urban and rural areas. The first criterion was administrative, designating all provincial and district centers as urban areas. The sec-

ond criterion was demographic, using a population threshold of 20,000 for urban areas (State Planning Organisation, 1985). However, in 2012, Law 6360 classified all settlements, including rural settlements and villages, in 30 metropolitan provinces as urban settlements, regardless of their previous rural characteristics. This regulatory change triggered debates and discussions about the uncertainty of rural-urban definitions. The Law implemented in 2012 has many negative aspects that are discussed in the literature. First of all, with this law, settlements with rural status were transferred to the same level as urban neighborhoods. This has caused rural settlements to have similar economic obligations as urban settlements and has increased the cost of living (Kızılaslan et al., 2016). Consequently, in 2023, TurkStat introduced a new definition that categorizes settlements into three classes: densely populated areas (cities), intermediate-density areas (towns and suburbs), and thinly populated areas (rural areas) which is based on the system used by the European Statistical Office (TurkStat, 2023).

This study aims to contribute to the existing debates on rural population changes by examining the settlements that have changed within the rural-urban definition. It compares settlements that have been transformed into neighborhoods (*mahalle*) by changing their status with rural settlements that still retain their village status (*köy*) and tries to develop a perspective on Law No. 6360. The study also examines the factors affecting rural population change in Türkiye and their impact levels. By conducting regression analysis, the study aims to provide a comprehensive understanding of the various variables that contribute to population changes in rural areas. This approach improves the interpretation of factors affecting rural population dynamics, leading to more effective results. Considering that population change is a dynamic process (Chi & Ventura, 2011) and this change has spillover effects that can affect neighboring settlements, this study also analyzes rural population changes spatially and evaluates the clustering tendencies of settlements. This approach allows the spatial patterns of population decline in Türkiye's rural settlements to be examined and sheds light on spillover effects in these settlements. In consideration of the need to study rural areas at the micro (local) spatial scale highlighted by Wang et al. (2018), given the potential variability of rural population changes at the micro settlement level (Julide & Okşak, 2021), our approach involves using rural settlement boundaries and analyzing data at this local scale. This allows us to gain more specific insights into rural areas. Unlike previous research, our study uses the dataset of the Research Project on Urban and Rural Settlement Systems in Türkiye (Türkiye'de Kentsel ve Kırsal Yerleşim Sistemleri (YER-SİS) Araştırma Projesi) conducted by the Ministry of Industry and Technology to evaluate rural population change. This dataset stands out as the most comprehensive and the most recent dataset as it is the first study to assess the whole of Türkiye at such a detailed scale. While many studies are based on a limited number of settlements, the analysis in this study utilizes a large dataset with 37020 samples and provides a solid basis for a comprehensive examination of rural population changes. As a result, this study is expected to contribute to the literature by providing analysis at the rural settlement scale, analyzing different variables associated with rural population change, enabling comparison of settlements with changing status, and providing aspatial and spatial analysis.

The study consists of 5 chapters. The first and second chapters of the study include general information about the study and a literature review on population change in rural areas and the factors affecting change. In this chapter, the current situation was revealed by examining the sources on the subject, and the deficiencies were identified. The third chapter presents the dataset used in the study and the methods used to analyze the data. The fourth chapter presents the data. The spatial distribution of the population in rural areas in Türkiye, the spatial distribution of population changes in rural areas, and the status of population change are an-

alyzed. In the last chapter, the results of the analysis are interpreted, and the conclusions and interpretations of the study are given.

2. Literature review

As the rural population declines, it is stated that the age group that migrates the most from rural areas is young people (Johnson & Lichter, 2019). Settlements with declining populations due to youth migration are likely to experience a decline in services and economic sectors. Some studies suggest that settlements with already low populations tend to experience a faster decline in the future (Johnson & Lichter, 2019). Similarly, a high population of rural settlements in the initial phase has a positive effect on future population change. The mass exodus of young people perpetuates the negative cycle of rural decline (Johnson & Lichter, 2019; Julide & Okşak, 2021; Lorenzen, 2022). Research into the factors and causes influencing population change is typically categorized into three areas: economic, public services, and spatial.

Economic condition is one of the most critical factors causing rural decline (Keddie & Joseph, 1991). Research has shown that unemployment and income levels strongly correlate with population change (Millward, 2005). Economic differences between urban and rural settlements, such as income differences and GDP per capita rates, encourage migration from rural areas to urban areas (Julide & Okşak, 2021; Liu et al., 2017; Lorenzen, 2022; Yu et al., 2022). Many people migrate from rural areas to cities for better economic conditions. In addition, economic diversity in urban areas is another reason for migration (Julide & Okşak, 2021; Lorenzen, 2022; Xingwei et al., 2023; Yu et al., 2022). In a study analyzing the factors affecting rural population change in China, it was observed that the importance of the variable of arable land per capita decreased over time and was at a lower level of importance between 2010-2017 (Yu et al., 2022). This might be due to the modernization of agriculture, people living in rural areas have become more dependent on economic conditions rather than environmental factors (McLeman et al., 2022). It has also been seen that the importance of non-agricultural economic opportunities and agricultural crop productivity has increased over time (Yu et al., 2022). Drought, on the other hand, stands out as an effective factor in the long run as it indirectly affects households' economies, even if not directly (McLeman et al., 2022). This can be attributed to the increasing importance of crop productivity, the growing importance of non-agricultural economies, and the increasing dependence on economic conditions.

The underdevelopment of public services in rural areas is another factor that negatively affects population change. Especially health and education factors can be very effective (Xingwei et al., 2023; Yu et al., 2022; Yürük & Batmaz, 2023). Studies investigating the impact of education on population change in rural areas show that the lack of educational facilities negatively affects population change (Lykke Sørensen et al., 2021). This makes the distance to cities, where the service sector is well-established, an important issue. The effect of proximity to urban areas on population change in rural areas is frequently mentioned in the literature (Cawley, 1994; Oruç & Çağlar, 2022; Sheludkov et al., 2021; Yu et al., 2022; Zhang et al., 2020). Especially the distance to highly populated and developed cities may affect rural population changes more (Liu et al., 2017; Wang et al., 2018). This is mainly due to the high employment opportunities and improved basic services in developed cities (Bülbül & Köse, 2010; Millward, 2005). Transportation infrastructure is also considered in some studies as it affects accessibility to cities. Since easy access to highways increases access to services and economic activities, it can eliminate some factors that prevent rural population growth (Lorenzen, 2022). Wang et al. (2018) in their study on the relationship between rural poverty and different variables, stated that the distance variable can provide various results and the distance of rural settlements to different provinces may affect rural poverty differently.

In the literature, many researchers emphasize the impact of geological

Table 1. *Population change variables in literature (Created by the authors).*

DIMENSION	INDICATORS	A	B	C	D	E	F	G	H
Population	Annual natural growth rate	X							
	Number of rural population	X			X				
	Rural population density		X			X		X	
	The percentage of population change				X				
	The total population living within five road-kilometres of the settlement				X				
	In-migrants population					X			
Economic	The gross product of the primary industry	X							
	Gross industrial production	X							
	GDP per capita / Change rate of per capita regional GDP	X							
	Rural electricity consumption per unit area		X						
	The growth rate of real GDP			X					
	The income difference			X					
	Presence of a tourist sector				X				
	Unemployment rate					X			X
	Household income/Rural residents income	X	X			X		X	
	Resource-industry employment					X			
	Commuting outside census subdivisions (CSD)					X			
	Change rate of agricultural labor productivity						X		
	Agricultural economic density							X	
	Off-farm economic opportunity							X	
	Poverty/low wages								X
	Small local market								X
Spatial/ Natural	Average slope	X							
	Surface fragmentation and terrain	X						X	
	Urbanisation rate	X	X	X			X		
	The altitude of the settlement				X				
	Accessiblity to road				X				
	The distance to the administrative centre or city center	X		X	X	X		X	
	The distance to the nearest neighbouring settlement				X				
	Rainfall		X					X	
	Tempature		X					X	
	Wind speed		X						
	Annual relative humidity		X						
	Climate change								X
	Quality of landscape								X
	Biodiversity, soil quality, etc.								X
Agriculture	Potential productivity for crops	X							
	Output value of agriculture, forestry, animal husbandry, and fishery per unit area		X						
	The per capita arable land	X		X				X	
	Change rate of cultivated land area						X		
	Declining agriculture								X
	Change rate of nonagricultural output value						X		
Services	Provision of public services							X	
	Living conditions								X
	Social/public services								X
	Health services								X
	Telecommunications/Internet								X
Social	Fertility level			X					
	Ageing population								X
	Women, young people								X
	Education level								X

A=(H. Zhang et al., 2020), B=(L. Zhang et al., 2021), C=(Liu et al., 2017), D=(White, 1985), E=(Millward, 2005), F=(Hu et al., 2023), G=(Yu et al., 2022), H=(Karcagı Kováts & Katova Kováts, 2012)

and topographic factors on population distribution (Yu et al., 2022). Zhang et al. (2021), in their study in Jiangxi Province, China, state that population distribution is significantly correlated around lakes and mountainous areas. Zhang et al. (2020), also noted that the population living in rural areas generally prefers plains, basins, and deltas. Therefore, it can be said that slope is also effective in the spatial distribution of the population.

Table 1 shows a list of variables included in some studies in the literature that spatially address population change in rural settlements. Indicators are grouped under six dimensions: population, economic, spatial/natural, agriculture, public services, and social. Considering the diversity of the indicators, it can be said that economic variables are mostly discussed. Secondarily, spatial variables show diversity. The population dimension in the table shows that the most used population variable is rural population density. In the spatial dimension, distance to the administrative center or city center and urbanization rate were the most mentioned variables.

Chi & Ventura (2011) highlighted four crucial elements to be considered when investigating population change: temporal aspects, spillover effects, and spatial dimensions. Their study investigated population changes in the USA across three distinct periods, employing a comprehensive four-step analysis. This analysis incorporated 32 variables categorized under five dimensions: demographic factors, livability, accessibility, developability, and desirability. In another study on rural population change, Keddie & Joseph (1991) conducted a non-spatial analysis, calculating population change percentages and utilizing ANOVA analysis to assess the effects of variables. Hu et al. (2023) performed a spatial analysis of the rural population in China, examining 357 administrative units. The analysis explored the variables influencing population change during the periods 2000-2010 and 2010-2020. The study employed Moran's I analysis in the first stage to assess spatial agglomeration patterns. In the second stage, Geographically Weighted Regression (GWR) was utilized to analyze spatially varying data between 2000-2020. Another study by Yu et al. (2022) spatially analyzed population change in rural areas using the GeoDetector method. This approach examined the effects of various factors on population change and their interactions with each other. Bijker & Haartsen (2012) investigated migration patterns in rural areas based on the popularity of settlements, categorizing rural areas into three classes using the material values of dwellings. They analyzed rural population changes related to these groups using different indicators.

In Turkish case studies, the rural population is interpreted with proportional data and graphs at the country

level (Canpolat & Hayli, 2018), while in some studies, rural population change is evaluated with data and graphs at the provincial level (Yılmaz, 2015). Most of the studies in the literature do not employ spatial statistics. Although spatial studies at the scale of rural settlements are limited, there are studies that reveal the causes of rural-urban migration through descriptive analysis. Addressing these studies will contribute to the creation of rural-urban migration indicators specific to Türkiye. Studies in the literature draw attention especially to economic concerns in rural-urban migration movements in Türkiye (Öztürk et al., 2018). In Canpolat & Hayli (2018), it is stated that employment opportunities in urban areas increase the seasonal or daily population mobility between rural and urban areas in Türkiye. Lack of sufficient support for agricultural activities in rural areas, lack of social security and economic instability are some of the factors that trigger migration to the city (Baybaş et al., 2023). Based on these findings, it can be said that economic variables are important for research on rural population change in Türkiye. In addition, the fact that public services in urban areas are more developed compared to rural settlements is another important reason (Canpolat & Hayli, 2018). Lastly, it is underlined in the literature that villages are lacking in social activities (Baybaş et al., 2023).

The spatial studies conducted in Türkiye are based on basic statistics and generally provide an analysis of the current situation (Gümüş & Körhasan, 2009). Gürbüz & Karabulut (2008), which carried out a similar study with this research, evaluated the population change on a provincial scale and evaluated the population change in rural areas with 39 variables. Correlation analysis was used to test the relationship between migration and the determined variables. According to the results of the study, the variables with the highest degree of relationship with rural migration are the amount of land per household (decare), physiological population density, and mortality rate (Gürbüz & Karabulut, 2008). Canpolat & Hayli (2017), spatialized the settlements with decreasing and increasing populations in the rural settlement scale. The reasons affecting rural population change are discussed through descriptive analysis. According to the results of the study, the differences in living standards between rural and urban areas and the limited economic opportunities in rural areas due to the agricultural policies pursued after 1980 led to a decrease in the population in rural settlements. Improvement of transport infrastructure, location of rural settlements, high accessibility to public services, and favorable economic conditions are considered as factors that positively affect population growth in rural areas (Canpolat & Hayli, 2017).

It has been observed that rural-urban migration is an important problem worldwide and various studies have been conducted on the subject. In this section, the general situation of the rural-urban migration problem and the general factors affecting migration in the literature are examined. According to the research, it has been observed that the causes of migration vary according to time and place. Therefore, it is thought that it is important to perform analysis specific to each settlement and to support the current population change analysis with recent data.

3. Materials and methods

3.1 Data

In this study, spatial and non-spatial data are considered to evaluate rural data. A dataset was created by considering variables from the literature and available data at the rural settlement scale. Table 2 shows the settlement dataset used in this research. Population data for rural settlements between 2018-2022 were obtained from the TurkStat. The YERSIS database created by the Ministry of Industry and Technology in 2018 was used to obtain the economic variables influencing population change. From this database, economic activity data showing the existence of different sectors and agricultural production structure data showing the diversity of agricultural production were obtained. In the YER-SİS database, a dataset of 37036 settlements was created, including settlements

***Table 2**. Data information table (Created by the authors).*

Source	Qualification	Settlement Types	Number of Settlements		2022 Population	2022 Population (%)
YERSIS (2018)	Rural Settlements	Town *(Belde)*	37,036	386	1,165,760	6.90%
		Town to Neighborhood *(Beldeden Mahalle)*		1,346	3,767,439	22.31%
		Village *(Köy)*		18,186	4,491,502	26.59%
		Village to Neighborhood *(Köyden Mahalle)*		17,118	7,465,197	44.20%
TurkStat (2018)	Neighbourhood	Town Neighborhood/Town *(Belde)*	50,255	1,587	1,165,192	1.37%
		Metropolitan District Neighborhood *(Büyükşehir Belediyesi Mahallesi)*		25,842	66,510,399	78.16%
		Province Center Neighborhood *(İl Merkezi Mahallesi)*		1,468	7,715,597	9.07%
		District Center Neighborhood *(İlçe Merkezi Mahallesi)*		3,163	5,215,281	6.13%
	Village	Village		18,195	4,489,049	5.28%
MAKS	Neighbourhood	Neighbourhood	50,686	32,060	80,606,469	94.72%
	Village	Village		18,195	4,489,049	5.28%

***Table 3.** Description and descriptive statistics of variables (Created by the authors).*

Variables	Description	Source	Mean	Min	Max	Std
Primary School	1 if there is a primary school within the neighbourhood's boundaries, 0 if not.	YERSIS	0.3394	0	1	0.4735
Health Center	1 if there is a family health centre within the neighbourhood's boundaries, 0 if not.	YERSIS	0.1349	0	1	0.3416
Manufacturing Emp.	1 if there is factory work within the neighbourhood's boundaries, 0 if not.	YERSIS	0.1621	0	1	0.3685
Service Activities	1 if there is a labour force in service activities (Hotels, restaurants, tourism, etc.) within the neighbourhood's borders, 0 if not	YERSIS	0.0495	0	1	0.2169
Distance (log)	The distance to the cities with the highest socioeconomic development level	HGM	5.4590	0	7	1.0240
Population (log)	Total population in 2018	TurkStat	5.5167	1	11	1.0881
Livestock	A value of "1" is given if animal husbandry is practised as agricultural production and "0" if it is not.	YERSIS	0.9840	0	1	0.1255
Population Change (log)	Total population change in rural areas between 2018 and 2022.	TurkStat	8.3582	0	10	0.0653
Settlement Type 1	The settlements have village status according to the YERSIS	YERSIS				
Settlement Type 2	The settlements that changed their status from village to neighbourhood by law, according to YERSIS.	YERSIS				
Settlement Type 3	All settlements that have a rural function, according to YERSIS.	YERSIS				

with village status, towns, and settlements transformed from towns to neighborhoods and from villages to neighborhoods within the scope of Law No. 6360. The YER-SİS analyzed settlements that were considered rural before Law No. 6360, even if they did not have rural legal status. As a result of matching the population data obtained from the TurkStat and the economic data obtained from the YER-SİS, 37,020 rural settlements were evaluated for this study. For the specialization and visualization of the data, digital boundary data of urban and rural settlements in Türkiye were obtained from the General Directorate of Population and Citizenship Affairs (MAKS). As shown in Table 2, according to the settlement types of the YER-SİS, the settlements that converted from village to neighborhood (the settlements that changed status with Law No. 6360) had the highest percentage in 2022. According to the TurkStat data, Metropolitan district neighborhoods have a population of 78.16%, while villages have a population of only 5.28%.

ArcGIS 10.8 software was used for geographical analysis. Road and highway data obtained from Open Street Maps and point data of settlements obtained from the Ministry of National Defense General Directorate of Mapping (HGM) were used for spatial analysis. With the highway data obtained from Open Street Maps, distance analysis was created in a GIS environment, and the minimum distance of each settlement to the highways was calculated. Digital distance data of city centers were created using the point data of settlements. Distance analysis was created for each rural settlement, and the distance of the settlements to the city center was analyzed. Slope and elevation data were obtained in the GIS environment, and Min-Max values for each settlement were calculated and included in the analysis.

The variables are given in Table 3 with their descriptions and sources. Variables obtained from the YER-SİS, such as primary school, family health center, manufacturing employment, service activities, and presence of livestock in agricultural production are included in the analysis as dummy variables. The distance to the cities in the highest socioeconomic development level, population by rural settlements in 2018, and population change between 2022-2018 contain data in different ranges. In order to be analyzed correctly and compared with each other, the data that were not in the range of 1 and 0 were normalized with the logarithmic normalization technique recalculated in the range of 1 and 0, and

included in the analysis. Lastly, we use the natural logarithm of the dependent variable (population change). The descriptive statistics of variables are given in Table 3.

3.2 Methodology

In the literature, it is stated that there is an interaction between settlements when different variables are evaluated (C. Wang et al., 2023). After collecting and organizing the necessary data, spatial autocorrelation methods were used to reveal this situation and to understand the existence of the interaction between the population variables in Türkiye. Figure 3 shows the steps performed in the study and the methodologies used. LISA analysis reveals the pattern of interaction between settlement populations before analyzing the spatial factors affecting rural population change. Regression analysis is then conducted to understand how much the variables affect population change. OLS (Ordinary Last Square) and SAR (Spatial Autoregressive) methods were used to analyze the impact of variables on population change. While OLS analysis does not take spatial interaction into account when analyzing the relationship between the dependent variable and the independent variables, SAR analysis includes clustering in the analysis when evaluating the relationship between variables. To understand how spatial interaction affects the relationship between variables, both of these analysis are conducted and the results are compared.

3.2.1 Global Moran's I

Global Moran's I method is one of the analysis that reveal the spatial distribution pattern of settlements. With this method, the distribution and clustering pattern of settlements are analyzed, and all settlements are evaluated simultaneously and assigned a value between 1 and -1. A Moran's I value close to 1 indicates clustering and a value close to 0 indicates random distribution (Moran, 1948).

$$I = \frac{N \sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{\left(\sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij}\right) \sum_{i=1}^{n} (x_i - \bar{x})^2} \quad (1)$$

In this formula, N represents the number of observations, and $\bar{x}$ is the variable's mean. x_i shows the variable value at a particular location. x_j is the variable value at another location. w_{ij} is the weight indexing location of i relative to j.

Equation 1 . *Global Moran's I formula.*

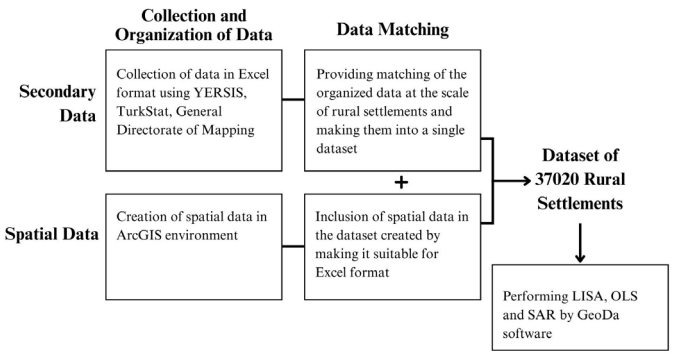

Figure 3. *Methodology diagram.*

3.2.2 Local Moran's I

The Moran's I model, introduced by Anselin (1995), is used to analyze each value with its neighboring values and to show spatial interaction. In this study, the k-Nearest Neighbors method is used for calculating the weights of rural settlements, and six neighbors are considered. With this step, whether the population changes clustering or not is evaluated spatially. The formula for LISA analysis is given below.

$$I_i = \frac{x_i - \bar{x}}{S_i^2} \sum_{j=1, j \neq i} \omega_{i,j}(x_j - \bar{x}) \quad (2)$$

The symbol I_i in this formula represents the Local Morans I value calculated for the observation unit. x_i and x_j represent the values of observation units i and j. $\omega_{i,j}$ is the weight matrix value of the spatial relationship between observations i and j. $\bar{x}$ gives the mean value of all observations. S_i^2 gives the variance of the observation units.

Equation 2. *Local Moran's I formula.*

In the scatter plot of this model, the upper right section shows the high-high (H-H) distribution, and the lower left section shows the low-low (L-L) distribution. The values located in the H-H or L-L sections indicate a clustering pattern. The values in the lower right and upper left sections show low-high (L-H) and high-low (H-L) distributions. The settlements in these sections have an opposite relationship with neighboring settlements.

3.2.3. OLS (Ordinary last square)

Variables affect population changes for different reasons, such as economic, topographic, or ecological. Thus, the relationship between population change in rural areas and other variables has been revealed by the OLS method. The formula of the OLS method is given below.

$$y_i = \beta_0 + \beta_1 x_i + \varepsilon_i \quad (3)$$

In this formula, y_i represents the dependent variable, and x_i represents the independent variable. β_0 represents the value of the dependent variable at $x_i = 0$. β_1 represents the slope of the linear regression equation. ε_i is the error term.

Equation 3. *OLS (Ordinary Last Square) formula.*

This formula aims to minimize the error term, that is, to minimize the difference between the observation and the actual variable value.

3.2.4. SAR (Spatial autoregressive)

The Spatial Autoregressive (SAR) model controls spatial interaction which is included with the spatial weight matrix. Therefore, the SAR model is used in this study to have spatial interaction in the correlation between variables obtained with OLS (Anselin, 1980).

$$y = \rho w_y + x\beta + \varepsilon \quad (4)$$

In this formula, y represents the dependent variable. ρ represents the spatial autoregression parameter: how the observation value is related to neighbouring units. The symbol w_y is the spatial weight matrix value. x is the independent variable. β represents the coefficients of the independent variable. ε represents the error term (Anselin, 1980).

Equation 4 . *SAR (Spatial Autoregressive) formula.*

With these methods, the relationship between population change in rural settlements and its determinants will be analyzed and spatially addressed.

4. Results

This study includes various visualization techniques and spatial factors to analyze the spatial variation of population and change in rural settlements. The population change map of all rural settlements in Türkiye between 2018 and 2022 is analyzed in Figure 4. Although rural areas generally experience population loss, the population of some settlements is increasing. When the population change map (Figure 4) is evaluated, it is observed that rural settlements in the Aegean and Mediterranean coastal regions of the country and rural settlements located near metropolitan cities generally show positive population change. While the population decrease is high in the Eastern Black Sea Region, the population decrease is low in the Western Black Sea Region, and in some settlements, the population is even increasing. To understand whether the decreases or increases in settlements show a regional characteristic, clustering analysis should be performed. In this study, LISA analysis was used to analyze spatial clustering.

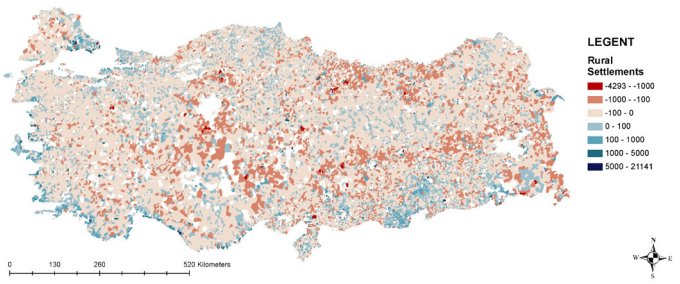

Figure 4. *Population change between 2018-2022.*

Initially, the cluster analysis of the total population changes of rural settlements for the years 2018 and 2022 was analyzed separately. According to 2018 LISA cluster analysis results (Figure 5), a low population is clustered in Eastern Anatolia, Central Black Sea regions, and southeast of the Marmara region. The high rural population shows a high clustering pattern in Central Anatolia, Thrace, and the coastal settlements of the Mediterranean and Aegean regions. In 2022, low population clusters are observed especially north of Ankara and in the eastern regions (Figure 6).

In addition, the clustering trend of population change values in rural areas of Türkiye between 2018 and 2022 is revealed by conducting a LISA analysis (Figure 7). Regions with population growth are clustered especially along the coasts of the Mediterranean and Aegean regions. On the other hand, rural settlements with declining populations are clustered in parts of Central Anatolia, the Eastern Black Sea region, and the southern Eastern Anatolia region. The clustering of population changes in certain regions may be a consequence of the fact that population change is regionally affected by certain variables. To ascertain this, regression analysis was employed to ascertain the extent to which and in what direction the variables affect population change.

In the regression analysis, population change in rural settlements between 2018 and 2022 was taken as the

dependent variable, while the presence of primary schools, the presence of family health centers, manufacturing sector employment, the presence of service sector activities, the presence of livestock sector in the agricultural sector, distance to cities in the first tier in terms of socioeconomic development level and total population in 2018 were taken as independent variables. In regression analysis, three models were created according to the type of settlements. Model 1 includes 18183 settlements with village status in non-metropolitan provinces, while Model 2 includes 17104 settlements that have been transformed from villages to neighborhoods in metropolitan provinces. In Model 3, all rural settlements, regardless of their current legal status, are considered and evaluated comprehensively. Settlement Type 1 and Settlement Type 2 comprise settlements (villages or urban neighborhoods) defined solely by the legislation (Law no. 6360), without considering the specific characteristics of each settlement. It also highlights the problematic nature of the former rural definition by Law No. 6360. Such changes emerging with the law can be expected to affect population change in rural settlements. Therefore, the change in status must be included in the study to understand its impact on the factors influencing population change in rural areas.

According to the results of the OLS (Table 4), in all three models, primary school, manufacturing sector employment, distance to first-tier cities, and initial population have statistically significant effects on rural population change. Since we use the natural logarithm of rural population change as a dependent variable, a lower rate of rural population change does not directly imply decline in population. It suggests a slower growth or a decrease in population. Based on the coefficient signs, it is possible to argue that the presence of primary schools and higher manufacturing sector employment opportunities cause higher rural population change. Conversely, lower rates of rural population change can be experienced in settlements with a higher distance to cities and a higher initial population. Model 3 excels with a lower AIC and higher log-likelihood, showcasing a better fit and simplicity compared to other models. This result is expect-

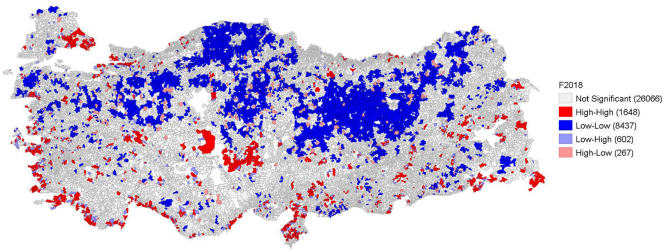

Figure 5. *LISA map of rural population in 2018. (Moran's I Value: 0,314).*

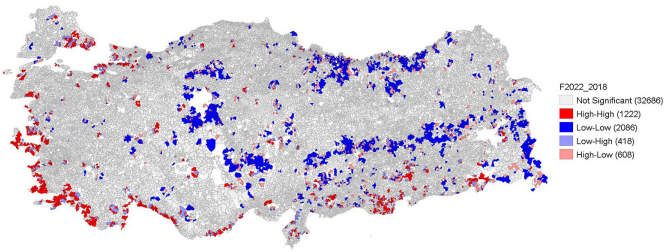

Figure 6. *LISA map of rural population in 2022. (Moran's I Value: 0,308).*

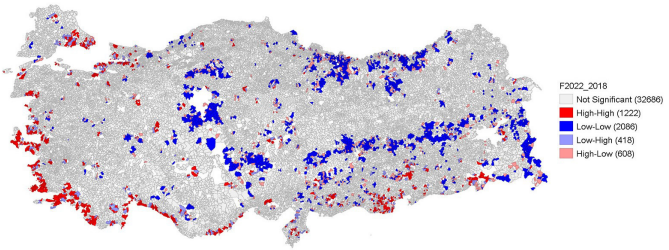

Figure 7. *LISA map of rural population Change Between 2018-2022 (Moran's I Value: 0,166).*

Table 4. *OLS (Ordinary Last Square) and SAR (Spatial Lag Model - Maximum Likelihood Estimation) results.*

Variables	Model 1 Settlement Type 1		Model 2 Settlement Type 2		Model 3 Settlement Type 3	
	OLS	SAR	OLS	SAR	OLS	SAR
W_Pop Change		0.2528***		0.0803***		0.2283***
		(0.0114)		(0.0137)		(0.0086)
Primary School	0.0043***	0.0039***	0.0049***	0.0046***	0.0033***	0.0027***
	(0.0004)	(0.0004)	(0.0016)	(0.0016)	(0.0009)	(0.0009)
Health Center	-0.0018***	-0.0019***	0.0017	0.0015	-0.0017	-0.0016
	(0.0005)	(0.0005)	(0.0022)	(0.0022)	(0.0011)	(0.0011)
Manufacturing Emp.	0.0017***	0.0019***	0.0037**	0.0036*	0.0035***	0.0031***
	(0.0005)	(0.0005)	(0.0017)	(0.0017)	(0.001)	(0.001)
Service Activities	0.0052***	0.0047***	0.0021	0.0016	0.0191***	0.0160***
	(0.001)	(0.001)	(0.0026)	(0.0026)	(0.0016)	(0.0016)
Distance	-0.0025***	-0.0019***	-0.0011*	-0.0010*	-0.0035***	-0.0027***
	(0.0002)	(0.0002)	(0.0006)	(0.0006)	(0.0004)	(0.0004)
Population	-0.0075***	-0.0068***	-0.0038***	-0.0037***	-0.0020***	-0.0022***
	(0.0002)	(0.0002)	(0.0008)	(0.0008)	(0.0004)	(0.0004)
Livestock	0.0016**	0.0017**	-0.0064*	-0.0059*	-0.0139***	-0.0111***
	(0.0008)	(0.0008)	(0.0036)	(0.0036)	(0.0018)	(0.0017)
Constant	8.4069***	6.2873***	8.3892***	7.7173***	8.3997***	6.4851***
	(0.0016)	(0.0959)	(0.0063)	(0.115)	(0.0034)	(0.0719)
Log-likelihood	45555.4	45800.7	18970.6	18988.6	48652.8	49021.2
Akaike info criterion	-91095	-91583.4	-37925	-37959.2	-97290	-98024.5
Number of Observation	18183	18183	17104	17104	37020	37020

*p<0.1 **p<0.05 ***p<0.01 Dependent variable is population change between 2018-2022.

ed since the other two models employ different dependent variables based on legally defined types of settlements. LISA analysis reveals that there are spatial clusters in population change in rural areas. Since OLS analysis does not consider spatial interaction when analyzing the effects of variables on population change, SAR analysis has been conducted to include the spatial dimension in the effect of variables on population change.

According to the results of the SAR (Table 4), all three models consistently exhibit a significant and positive spatial lag coefficient (W_Pop Change) in relation to rural population change. This finding strongly indicates that changes in rural populations in one spatial unit are positively influenced by the changes in neighboring units. The observed spatial spillover effects corroborate the initial hypothesis, thereby substantiating the existence of significant spatial interdependence within the dataset. Similar to the OLS results, Model 3 displays a better fit than the other two models for the SAR findings. Model 3 demonstrates that an increase in primary school services, manufacturing employment, and service sector activities variables leads to a higher rate of rural population growth. Our findings regarding the impact of educational services on population changes in rural areas are consistent with existing literature such as in Lykke Sørensen et al. (2021). They also found that inadequacy of educational services in settlements has a negative effect on population change. Surprisingly, no statistically significant relationship was found between the presence of health centers and rural population change even though the importance of health services is emphasized in the literature (Yürük & Batmaz, 2023).

Non-agricultural sectors gain importance as economic income is not satisfactory due to reasons such as insufficient agricultural support (Baybaş et al., 2023; Yu et al., 2022). The increasing tendency of the rate of population growth of rural settlements with service activities such as hotels and restaurants and settlements with manufacturing labor can be associated with the importance of non-agricultural economic sectors on population change (Öztürk et al., 2018). The other variable that has a significant effect on the rate of rural population growth is the presence of livestock activities. Interestingly, an increase in the livestock activities variable can cause a decrease in the rate of rural population growth. This finding supports the arguments in the literature on the importance of a non-agricultural economy.

Along with livestock sector activities, an increase in the distance to first-tier cities, and initial population, are also associated with slower rural population growth. This can be interpreted as areas with remote locations, larger populations, or higher livestock activities experiencing less dynamic population changes between 2018 and 2022. The distance to the main cities, especially, attracted a lot of attention in the literature. It is possible to say that the population decreases with increasing distance to developed cities (Liu et al., 2017; Wang et al., 2018). One of the reasons why rural settlements close to urban centers do not tend to decrease in population is that they have access to basic services and some economic activities through these cities (Lorenzen, 2022). Similarly, studies conducted in Türkiye indicate that seasonal and daily mobility from rural to urban areas is highly related to economic reasons and accessibility of areas (Canpolat & Hayli, 2018).

5. Conclusion

Research on changes in rural populations reflects diverse perspectives and determinants. When reviewing various studies on rural areas, several limitations become evident. Firstly, migration studies often operate at higher scales, such as city and province levels, due to data constraints. Moreover, some studies focus exclusively on specific regions and lack spatial analysis, restricting their examination to only descriptive analysis. Recognizing the importance of comprehending the reasons for rural population changes, this study adopts a village-scale (micro level) approach, acknowledging the distinctive characteristics of each rural settlement. In this study, the analysis of

population changes in Türkiye's rural areas involves Moran's I statistics to uncover spatial interactions in rural areas. The results confirm the spatial interactions between rural settlements and support the idea that changes in one settlement affect the surrounding settlements, leading to clusters in certain areas. The cluster maps of LISA analysis also indicate a strong tendency for a clustering pattern of settlements with low population, especially in the eastern provinces. In contrast, settlements located in the Aegean coast and Thrace region experienced a clustering of high population growth between 2018 and 2022. The OLS and SAR analysis investigate factors influencing population change in rural areas, utilizing three models: settlements labeled as "village" (Model 1), those transitioning from "village to neighborhood" (Model 2), and all rural settlements (Model 3). According to the OLS results, variables such as the presence of primary schools, manufacturing employment, service sector activities, and the livestock sector significantly impact population change. While certain factors contribute to population growth, others, like distance to developed city centers and the absence of basic services, lead to a decline in the population growth rate. The SAR analysis corroborates these findings, highlighting the influence of various variables on population change in rural settlements. Model 3 underscores the positive effects of primary schools, manufacturing employment, and service sector activities on population growth rates.

Drawing insights from the study's conclusions, several recommendations emerge for policymakers and stakeholders involved in Türkiye's rural development. Firstly, the recognition of the important role of primary schools in influencing population change highlights the need to increase investment in educational facilities and underlines that education is a key driver of rural development. Secondly, to stimulate population growth, policymakers should encourage the diversification of economic activities within rural settlements, focusing on the promotion of manufacturing employment and service sector activities that have demonstrated positive impacts. Thirdly, the SAR analysis underscores a notable and positive correlation between changes in population within Türkiye's rural settlements and their neighboring units, highlighting the significance of regional interdependence. In response, policymakers can adopt targeted strategies to harness these spatial dynamics. Initiatives fostering collaboration and information exchange among neighboring settlements should be prioritized to amplify positive population trends. Additionally, the findings emphasize the need for nuanced, tailored rural development policies that account for the distinctive characteristics of each settlement, acknowledging that a uniform approach may not be effective. Finally, conducting field studies is suggested to gain in-depth insights into the positive and negative factors influencing population change, accounting for the specific context of each settlement. By embracing these recommendations, we believe that policymakers can formulate more effective strategies for sustainable and balanced rural development, ensuring the well-being and prosperity of Türkiye's rural populations.

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Exploring the nexus of genius loci, heritage and vernacular architecture: A systematic literature review

Vivek CUCKEMANE[1*], Arulmalar RAMARAJ[2], Bhoomika UMASHANKAR[3]
[1] vivekcg@sit.ac.in • Department of Architecture, Faculty of Architecture, Sathyabama University, Chennai, India
[2] arulmalar.arch@sathyabama.ac.in • Department of Architecture, Faculty of Architecture, Sathyabama University, Chennai, India
[3] bhoomikau@sit.ac.in • Department of Architecture, Faculty of Architecture, Siddaganga Institute of Technology, Tumakuru, India

** Corresponding author*
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Abstract
According to Norberg-Schulz, genius loci is the "spirit of a place" and architecture creates an impression. Human identity is created by the identity of a place, which means place as a geographical entity gives humans the identity. There are various theories that have emerged on the topic of genius loci and most of them have similarities in defining it. On the other hand, heritage and vernacular architecture also determine the identity of a place, both in tangible and intangible ways. While genius loci are intangible, heritage and vernacular architecture have both tangible and intangible expressions imbibed. But, genius loci, heritage, and vernacular architecture are three strands of study having their own set of theories. This paper aims to interpret the various theories and find the relationship among the disciplines. Many authors have tried to explore these concepts through various perspectives but a clear connection is yet to be established. A systematic literature review adopted PRISMA 2020 guidelines to establish an interrelationship followed by the categorization of the expressions identified by various authors.

Keywords
Expressions, Genius loci, Interrelationship, Heritage, Vernacular architecture.

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1. Introduction

The term "loci" is derived from the Latin word "locus," which means "place" or "location." The word "locus" was commonly used in Latin to refer to a specific point or position, both in physical space and in more contexts (Vecco, 2020). Over time, "loci" became the plural form of "locus." The concept of "loci" has been used in various fields such as mathematics, genetics, and memory techniques. The Latin origin reflects its fundamental meaning of "place" or "location" and how it is applied across different disciplines to denote sets of points, genetic positions etc.

Genius loci holds significance in various domains. A "locus" denotes a collection of points satisfying specific conditions in mathematics. In genetics, it refers to particular spots on chromosomes where genes or markers reside, aiding the comprehension of inheritance (Björkegren et al., 2015). Memory techniques, such as the method of loci, employ this concept by associating data with imagined mental locales to enhance recall. Even in ancient Roman education, "loci" represented passages memorized to facilitate oratorical compositions (Christou et al., 2019).

The notion of genius loci, a term rooted in Roman mythology, encapsulates the very essence of a place—a culmination of its intangible spirit, emotions, and narratives (Jiang & Lin, 2022). This exquisite quality has inspired architects and theorists to craft spaces that resonate with the identity of their surroundings. A pioneer in this discourse is Christian Norberg-Schulz, whose formative work "Genius loci: Towards a Phenomenology of Architecture" delves into the idea that architecture should mirror and engage with the intrinsic spirit of its locale. Norberg-Schulz argues that a sense of identity and belonging emerges when architectural spaces are thoughtfully designed to align with the unique character of their environment. His influence is evident in the works of contemporary architects such as Steven Holl, who is a master of site-specific design that harmonizes with the genius loci, fostering a deep connection between people and place. However, in the context of architecture, various authors have professed that genius loci is firmly intertwined with heritage and vernacular architecture. Hence, these terms are discussed elaborately in the forthcoming paragraphs.

Heritage borrows its core from the concept of inheritance. Inheritance is a multifaceted concept that plays a pivotal role in the perpetuation of traits and knowledge across generations (Marilena Vecco, 2010). In the realm of biology, genetic inheritance involves the transmission of genetic material from parents to offspring, culminating in the display of diverse traits and characteristics (Mercuri et al., 2010). This process is integral to the continuity of species and the driving force behind the evolutionary changes observed over centuries (Mc Auley, 2023). Simultaneously, inheritance extends beyond the genetic sphere into the cultural domain, where it encompasses the passage of traditions, languages, art, and values from one generation to another (Mc Auley, 2023). Cultural inheritance knits societies together through shared practices and historical awareness, shaping collective identities and fostering a sense of belonging. In both contexts, inheritance serves as an intricate thread that weaves the past with the present and lays the foundation for the future (Bakar et al., 2014).

The exploration of heritage, in the context of architectural discourse, delves into the historical and cultural legacy that structures carry. Architecture itself acts as a repository, embodying the stories, values, and societal evolution of bygone eras (Hegazi et al., 2022). Heritage, as a concept, transcends mere physical artifacts—it encapsulates the collective memory and identity of a community (Ahmad, 2006). In this context, heritage is synonymous with cultural inheritance, the thread that weaves together generations, transcending time and place (Aigwi et al., 2023).

As a branch of Heritage, "Vernacular" pertains to the ordinary, native expressions that originate from a particular region or community (Fu et al., 2021). It encompasses various aspects of everyday life, such as language, architecture, art, and culture. In linguis-

tics, it refers to the common language spoken by people in a specific area, reflecting their shared identity and communication (Kumar & Pushplata, 2013). In architecture, vernacular architecture and design arise from local materials and traditions, adapting to the environment and needs of a community (Philokyprou & Michael, 2021). Artistic expressions and cultural practices unique to a region are also considered vernacular, showcasing the creativity and heritage of ordinary individuals. Overall, "vernacular" captures the essence of local authenticity and tradition in various aspects of human life (Karahan & Davardoust, 2020).

The significance of heritage is not confined to the preservation of historic buildings; it extends to the broader context of vernacular architecture theories. The work of scholars like Sentosa investigates how traditional architecture, deeply ingrained in local cultures, reflects the heritage of a community. Sentosa's exploration of traditional Java and Malay architecture in "Architecture as Cultural System" presents a case study that epitomizes the intricate interplay between cultural symbolism and architectural form. Sentosa's work highlights how architectural structures become repositories for heritage, expressing cultural meanings and broader societal narratives within their physical fabric. Weiwei Jiang and Lin's exploration of "Rural vernacular architecture in Northern China" unveils the confluence of traditional craftsmanship with contemporary design sensibilities, yielding sustainable architectural solutions that respect local resources and cultural heritage. This study emphasizes the importance of heritage in the vernacular context, where architecture is a tangible realization of cultural continuity (Carboni & de Luca, 2016).

Amidst the infinite voices shaping the discourse on architecture, this systematic literature review aspires to synthesize diverse perspectives, creating a narrative that encapsulates the essence of genius loci, heritage, and vernacular architecture theories. The synthesis seeks to interpret, bridge gaps, and trace emerging trends, offering a direction for future research. The review helps us see architectural places in a new way, uncovering deeper meaning as it explains how genıus locı, herıtage, and vernacular archıtecture ideas connect. It uncovers the delicate equilibrium between cultural identity, historical narratives, and design innovation. In the end, the review encourages readers to look closely at where architecture, culture, and nature come together. This helps us understand and admire how architecture plays a big part in shaping the world we live in.

The research paper aims to systematically review and analyze literature studies on genıus loci, heritage, and vernacular architecture to unravel their origin, and historical evolution, and conceptual frameworks, and interpret the interrelationship. Drawing inspirations from the intellectual fabric woven by revered scholars and thinkers, this literature review contributes to the enrichment of architectural discourse and practice by uncovering the hidden connections that bind architecture with its heritage in specific contexts. This systematic literature review delves into the nexus formed by these three fundamental concepts, aiming to unravel their synergies and implications within the realms of architecture, culture, and context. This systematic literature review is to study a diverse array of scholarly works that converge upon the intertwined nature of these concepts. By traversing the literature, this review seeks to illuminate recurring patterns, conceptual intersections, and the holistic implications that emerge when genius loci, heritage, and vernacular architecture are interwoven.

identity, and intergenerational cultural transmission.

Vernacular architecture gained attention in the 20th century due to cultural, and historical movements, anthropological studies, and sustainability concerns. Traditional building practices gained recognition for their diversity, sustainability, and contextual relevance. Vernacular architecture organizations, research, and projects contributed to its recognition, influencing contemporary design by emphasizing local knowledge and cultural connections (Fafouti et al., 2023).

1.1.1. Tracing the roots

The evolution of genius loci, heritage and vernacular architecture throughout history has been shaped by a variety of cultural, philosophical, and societal influences. This journey showcases how these concepts have evolved and intertwined over time, culminating in contemporary architectural practices that are more holistic and contextually informed.

During the ancient civilizations from around 3000 BCE to 500 CE, genius loci were rooted in the belief of protective spirits tied to places, influencing their character. This notion was manifested in structures like temples and shrines dedicated to these spirits. Concurrently, civilizations such as Egypt, Mesopotamia, China, and Greece valued heritage, preserving structures and artefacts to honour ancestry and assert cultural identities. The architecture of these eras demonstrated a harmony between culture, environment, and spirituality (Pinsent, 1976). The Renaissance period (14th - 17th century) experienced a resurgence of classical architecture, emphasizing proportion and harmony. Although aesthetics were central, an appreciation for the cultural significance of historical structures emerged. In the Enlightenment (17th - 18th century), a rational and functional approach prevailed, somewhat distancing architecture from the emotional aspects of genius loci. The Romantic Movement (18th - 19th century) reignited interest in emotions and nature, aligning with the emotional qualities of places. The landscape architecture of this time highlighted the aesthetic value of natural environments (Mahanty, 2020). The Industrial Revolution (late 18th - mid-19th century) led to heritage preservation efforts as historical structures were threatened by urbanization and industrialization. The Arts and Crafts Movement (late 19th - early 20th century) responded to industrialization's drawbacks. Advocates like William Morris revived vernacular architecture, valuing craftsmanship and local materials. Modernism (early to mid-20th century) marked a departure from historical references for functionalism, while Postmodernism (late 20th century) reintroduced history and ornamentation. Sustainable architecture (late 20th century - present) rekindled interest in vernacular architecture, genius loci, and heritage, driven by environmental concerns. Contemporary architectural theories emphasize a holistic, contextual approach (Smith et al., 2003). Present-day architects incorporate these concepts to create spaces that respect cultural identity, local context, and sustainability. In the current architectural landscape, genius locı, heritage, and vernacular architecture converge to celebrate herıtage, promote sustainability, and ensure design resonates with inhabitants and surroundings. This journey through history reveals the continuous interplay and evolution of these concepts, contributing to the creation of meaningful, enduring, and environmentally sensitive architecture.

1.1.2. The chronological development of three concept theories

The evolution of the genius loci theory, centered on recognizing the unique essence of a place within architectural and design contexts, has unfolded over the course of several decades. Its foundations can be traced back to ancient cultures that attributed guardian spirits or deities to specific locales, influencing architectural choices. In the 20th century, early advocates like Karl Friedrich Schinkel and Jorn Utzon brought attention to the importance of considering a site's distinct character. However, it was Christian Norberg-Schulz's who popularized the term and solidified the concept. Norberg-Schulz underscored the interconnectedness of architecture, place, and human experience, urging designers to integrate a location's history, culture, and ambience into their creative processes. This emphasis continued through the late 20th century, with architects such as Alvaro Siza, Glenn Murcutt, and Juhani Pallasmaa further exploring the theory's implications in their designs. Today, the "Genius Loci" philosophy remains influential, shaping architectural practices and extending its influence beyond buildings to urban planning, landscape design, and

heritage preservation, underscoring the ongoing relevance of creating meaningful connections between people and their surroundings.

With respect to development heritage, The United Nations Educational, Scientific and Cultural Organization (UNESCO) has created a set of guidelines and agreements to steer the safeguarding of important cultural and natural sites globally, known as UNESCO World Heritage Sites. These documents, often referred to as charters, play a crucial role in setting standards for conserving these sites and promoting international cooperation. One of the earliest international agreements is the Athens Charter for the Restoration of Historic Monuments in 1931 (Gowen et al., 2023), also known as the Athens Charter. It stressed the need to respect the historical and artistic value of monuments while allowing for necessary restoration and adaptation. The Venice Charter for the Conservation and Restoration of Monuments and Sites in 1964 (Gowen et al., 2023), or the Venice Charter, focused on guiding the careful conservation and restoration of architectural heritage. It emphasized a scientific approach to restoration while upholding the authenticity and integrity of cultural heritage sites. Another key document is the Nara Document on Authenticity in 1994 ("ICOMOS Charter for the Interpretation and Presentation of Cultural Heritage Sites," 2008), which highlighted the importance of authenticity in cultural heritage conservation. It underlined how authenticity is vital for understanding and preserving the significance of cultural heritage, considering various values like historical, artistic, social, and spiritual.

Moving to more recent charters, the Burra Charter in 1999 (Truscott & Young, 2000) offers principles and guidelines for conserving cultural heritage places in Australia. It underscores the importance of understanding cultural significance and involving communities in decision-making. The Charter for the Conservation of Historic Towns and Urban Areas in 2002 (Taylor, 2004) guides preserving historic towns and urban areas, emphasizing maintaining their unique character and fabric while accommodating modern needs. Lastly, the Florence Declaration in 2011 (Gowen et al., 2023) focuses on preserving historic gardens and landscapes, stressing the recognition and protection of their cultural, aesthetic, and ecological values .

The evolution of theories regarding vernacular architecture, rooted in local building traditions and indigenous methods, has unfolded across distinct stages. Early awareness in the Arts and Crafts Movement and regionalist movements during the early 1900s laid the foundation for the value of local craftsmanship and architectural heritage(Ndoro & Pwiti, 2001). By the mid-20th century, anthropological studies by scholars such as Amos Rapoport and Bernard Rudofsky spotlighted the diversity and sustainability of vernacular architecture, fueling its significance(Zhou et al., 2022). The 1960s and 70s saw a surge in environmental concerns, fostering a deeper understanding of how indigenous practices align with sustainable principles. In the 1980s, scholars like Paul Oliver delved into systematic exploration and documentation. Today, contemporary architects like Hassan Fathy and Balkrishna Doshi continue to integrate vernacular principles into their designs, underlining their relevance in expressing cultural identity and ecological consciousness. This journey reflects a growing recognition of vernacular architecture's enduring value, spanning from informal acknowledgement to formal academic integration.

2. Methodology

This study conducted a systematic literature review to explore the interrelationship between genius loci, heritage, and vernacular architecture. The literature search was carried out from January 2023 to August 2023, encompassing articles published between 2012 and 2022, ensuring an up-to-date review. Original research papers, published in English-language journals, were obtained from reputable electronic databases, including Scopus, Science Direct, Web of Science, Google Scholar, and Semantic Scholar. To identify relevant articles, specific keywords such as

genius loci, Guardian spirit, spirit of a place, heritage, Intangible and tangible heritage, Inheritance, vernacular architecture, Contextual architecture, and local HERITAGE were utilized. These keywords were combined within the literature to identify relevant manuscripts and articles. The research focused exclusively on peer-reviewed articles to ensure each selected paper had undergone evaluation within its discipline and was recognized as suitable for academic publication (Page et al., 2021). Filters in the utilized databases were employed to narrow down the research within the social sciences, humanities, and architecture disciplines, resulting in the identification of around 228 articles during the search process. To enhance the quality of review, the study adhered to PRISMA 2020 (Page et al., 2021) guidelines.

PRISMA 2020 (Page et al., 2021) guidelines provide a transparent framework for reporting systematic reviews and meta-analyses, aiming to improve the quality and credibility of research in various fields. The guidelines offer a checklist and flow diagram to enhance reporting and ensure adherence to rigorous research methodology. Articles on PRISMA 2020 guidelines (Page et al., 2021) were followed to understand the implementation of guidelines for systematic research review as shown in Figure 1.

Out of 562 papers identified, 228 papers were found to be relevant and included in the literature study. For the analysis of the literature, first, the essence from each paper was extracted and translated as a flow diagram. The research papers were identified as the definition of genius loci, heritage and vernacular architecture. The factors influencing and determining, the relation among the three areas, the origin of the theories, and the Tangible and intangible expressions of the study areas. These flow diagrams' content was analyzed to interpret the common parameters and the relationship among the disciplines.

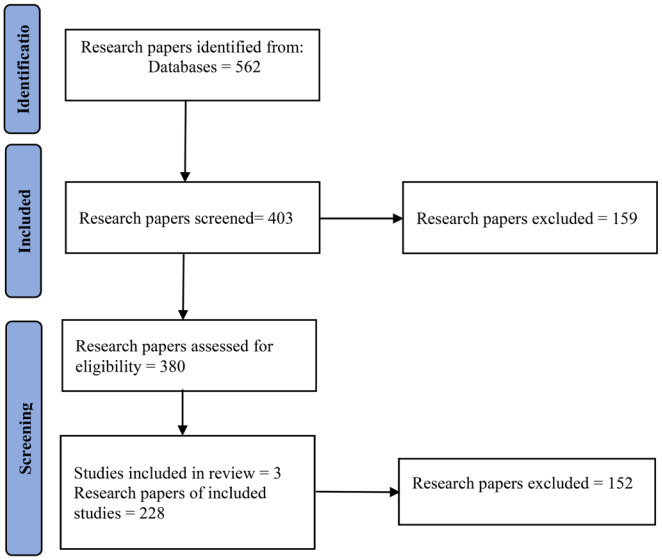

Figure 1. A PRISMA Flowchart adapted from "The PRISMA 2020 statement: An updated guideline for reporting systematic reviews" by Page et al., 2021.

2.1. Data collection

The research approach involved three main steps. Firstly, a comprehensive search was conducted to gather relevant research articles related to the concepts of genius loci, heritage, and vernacular architecture. The search criteria encompassed terms such as place, spirit, cultural and natural heritage, inheritance and indigenous architectural traditions. Secondly, the scope was refined to investigate genius loci in heritage and vernacular architecture more specifically, leading to the exploration of articles related to cultural heritage conservation, historical preservation, and vernacular architectural heritage, people, place and time. This step aimed to identify scholarly content discussing the significance and methods of safeguarding heritage and vernacular architecture. Furthermore, the study delved into theories, methodologies, and approaches prevalent in the architecture and conservation domains. By synthesizing and analyzing the collected materials, a holistic understanding of genius loci, heritage, and vernacular architecture was developed, forming a comprehensive foundation for further exploration and analysis within these realms.

A total of approximately 562 research papers were identified as relevant to the themes of Genius Loci, Heritage, and Vernacular Heritage within the architecture, construction

sector and genetics. These papers were categorized into distinct themes, including heritage preservation, cultural sustainability, architectural conservation, and indigenous architectural practices. The titles and contents were systematically organized and reviewed, allowing for a coherent overview of the concepts. This compilation provided a comprehensive framework for understanding the interplay between genius loci, heritage, and vernacular architecture within the context of architecture and construction.

2.2. Data analysis

During the data analysis phase, the identified 562 papers were classified based on geographical locations, time and themes. Accordingly, 40% of the papers were related to the combined theory of genius loci and heritage, 50% was the combination of heritage and vernacular architecture, and 10% was related to genius loci and vernacular architecture. The papers were categorized based on the themes which were related to the interrelationship of concepts. A total of 562 research papers were categorized into themes like heritage preservation, cultural sustainability, architectural conservation, and indigenous practices based on the themes professed by the authors. This organized compilation provided a comprehensive foundation for understanding the interplay between genius loci, heritage, and vernacular architecture in architecture and construction. The analysis highlighted diverse perspectives, methodologies, and cultural spans, emphasizing the interdisciplinary nature of the study and contributing to a holistic understanding of the concepts.

Table 1. *Tangible and Intangible Aspects: Exploring the Interconnections of genius loci, heritage, and vernacular architecture.*

<table>
<tr><th></th><th>Genius Loci</th><th>Genius Loci & Heritage</th><th>Heritage</th><th>Heritage & Vernacular Architecture</th><th>Vernacular Architecture</th><th>Interrelationship</th></tr>
<tr><td rowspan="6">TANGIBLE EXPRESSIONS</td><td colspan="4">Architecture and Built Environment</td><td></td><td>Cultural Context: All three concepts are deeply rooted in the cultural context of a specific region or place. They reflect the customs, traditions, and values of the local community.</td></tr>
<tr><td colspan="3">Landscape and Natural Features</td><td>Local materials and landscape features</td><td>Local Materials and Construction Techniques</td><td>Adaptation to Environment: They are typically designed and constructed in harmony with the local climate, materials, and surroundings, showcasing a sustainable approach.</td></tr>
<tr><td colspan="2">Artefacts and objects</td><td>Documentation and archives</td><td>Art, artefact, documentation, details and proportions</td><td>Proportions, Layout and Details</td><td>Historical Significance: Genius loci, heritage, and vernacular architecture often have historical significance, representing the evolution of a place over time.</td></tr>
<tr><td rowspan="6">INTANGIBLE EXPRESSIONS</td><td colspan="2">Stories, Myths, and Folklore</td><td>Oral Traditions and Narratives</td><td rowspan="2">Traditional Knowledge</td><td>Cultural Identity and Traditions</td><td rowspan="2">Symbolism: These concepts often carry symbolic meanings and cultural symbols that hold significance to the people who inhabit or visit the area.</td></tr>
<tr><td colspan="3">Rituals and Ceremonies</td><td>Environmental Adaptation</td></tr>
<tr><td colspan="3">Language and Dialects</td><td rowspan="3">Social and cultural traditions</td><td>Community and Social Interactions</td><td>Community Involvement: The creation and preservation of these elements often involve the active participation and contribution of the local community.</td></tr>
<tr><td colspan="3">Traditional Knowledge and Practices</td><td>Traditional Knowledge and Skills</td><td>Cultural value: Genius loci, heritage, and vernacular architecture are deeply connected to the culture of a place. They showcase the artistic, spiritual, and social values that have shaped the community's lifestyle and practices.</td></tr>
<tr><td colspan="3">Social and Cultural Traditions</td><td>Sense of Place and Identity</td><td>Sense of Place: All three emphasize a unique sense of place and identity, capturing the essence and spirit of a particular location.</td></tr>
</table>

3. Findings

The interrelationship between genius loci, heritage, and vernacular architecture is a profound and symbiotic connection that shapes the built environment and preserves the cultural identity of a place in a meaningful and enduring way. Each of these concepts is intricately woven together, and their synergy produces a cohesive narrative that celebrates the history, traditions, and wisdom of local communities. The findings were first categorized as Tangible and intangible expressions of the concepts and later classified as primary and secondary relationships among genius loci, heritage and vernacular architecture. The Interrelationship was then established among the three concepts.

3.1. Tangible and intangible expressions

The relationship between tangible and intangible expressions within the contexts of genius loci, heritage, and vernacular architecture holds significant importance in shaping the character, identity, and atmosphere of a place or region. In examining these concepts, a distinction can be drawn between their tangible and intangible components as shown in Table 1.

Tangible Expressions in genius loci encompass architectural and built elements, which include physical structures, buildings, and landmarks that embody the architectural style, materials, and craftsmanship of the area (Craith & Kockel, 2015). The tangible

facets further extend to the landscape and natural features, such as topography, vegetation, bodies of water, and geological formations, which contribute to the sensory and visual experience of the location. Additionally, historical artifacts, archaeological findings, artworks, and cultural objects associated with the place form tangible expressions, offering insights into the historical and cultural significance (Currie & Correa, 2022). In contrast, the Intangible Expressions in genius loci encompass intangible elements like stories, myths, and folklore that are passed down through generations, encapsulating the beliefs, values, and cultural heritage of the locale (Lin Xiaoyu & Jia Beisi, 2015). Rituals and ceremonies carried out in specific areas offer intangible expressions that hold deep-rooted symbolic meanings, enriching the spiritual and social fabric of the place (Melis & Chambers, 2021). Similarly, the unique language, dialects, and idioms spoken in a region constitute intangible expressions, embodying linguistic heritage, local identity, and cultural vibrancy. Additionally, traditional knowledge and practices, alongside social and cultural traditions, contribute intangible dimensions by fostering a sense of community, identity, and continuity (Chen & Cheng, 2020).

In the realm of Cultural and Natural Heritage, the tangible manifestations include architectural structures like historic buildings, monuments, and archaeological sites that encapsulate architectural styles, construction techniques, and the craftsmanship of past eras (Tavares et al., 2021). Likewise, objects and artefacts such as artwork, tools, and religious items hold tangible value by providing tangible evidence of historical civilizations, traditions, and artistic mastery. Landscapes and natural features, often imbued with cultural, spiritual, or historical significance, also contribute tangibly to heritage (Wahurwagh & Dongre, 2015).

The documentation of historical records, photographs, maps, and archival materials further represent tangible expressions by offering evidence and context of past events and traditions. Conversely, the Intangible Expressions in Cultural and Natural Heritage encompass narratives and oral traditions that transmit cultural values, beliefs, and collective memories. Rituals, ceremonies, festivals, and performances reflect the intangible heritage by embodying cultural practices, customs, and symbolic meanings (Cassalia et al., 2016). Traditional knowledge and skills, such as indigenous practices and craftsmanship, constitute intangible heritage, preserving skills, techniques, and wisdom that are passed down through generations (Ahmad, 2006). Language, dialects, and vernacular expressions are other intangible facets that mirror linguistic diversity, cultural vibrancy, and historical roots. Furthermore, social practices and traditions, encompassing customs, music, dance, theater, and culinary practices, enrich the intangible heritage by reflecting the social interactions, values, and ways of life within a community (Currie & Correa, 2022).

In the context of vernacular architecture, tangible expressions are embodied in architectural forms, structures, materials, and construction techniques. The physical buildings and houses, alongside their design principles and aesthetic details, form tangible manifestations that represent the specific architectural style and local context. Furthermore, the choice of indigenous materials and construction methods contributes tangibly, often adapting to climatic conditions and available resources (Artese & Gagliardi, 2022). In parallel, the Intangible Expressions in vernacular architecture are represented by cultural identity and traditions, where local customs, beliefs, rituals, and values are embedded in the design and construction principles passed through generations. Environmental adaptation, an essential aspect of vernacular architecture, reflects the intangible understanding of environmental factors and the incorporation of design elements that provide comfort and protection against climatic challenges (Lin Xiaoyu & Jia Beisi, 2015). Moreover, community and social interactions are intrinsically linked to vernacular architecture, fostering a sense of belonging, collaboration, and shared values within the community. Lastly, traditional knowledge and skills

encompass intangible dimensions, preserving craftsmanship, construction techniques, and skills transferred from one generation to the next, thus promoting sustainable building practices (Abdel-Azim & Osman, 2018). The overarching outcome of vernacular architecture lies in its contribution to a sense of place and local identity, which forms an intangible dimension that encompasses emotional attachments, memories, and collective experiences intertwined with the built environment (Zhou et al., 2022).

The exploration of tangible and intangible expressions in Genius Loci, Cultural and Natural Heritage, and Vernacular Architecture underscores their crucial roles in shaping the unique character, identity, and atmosphere of a place or region. These expressions intertwine to create a comprehensive understanding of the cultural, historical, and architectural dimensions of a locale, reflecting the intricate interplay between physical forms and intangible essence.

3.2. The Interrelationship

The theories concerning genius loci, heritage, and vernacular architecture are inherently interconnected, creating a cohesive framework that significantly shapes architectural design and cultural preservation. These interrelated theories underscore the profound importance of context, cultural identity, and sustainability. Moreover, they mutually inform and reinforce each other in distinct yet interwoven ways as shown in Table 2, 3 & 4.

Contextual Sensitivity (Van Bavel et al., 2016) is a cornerstone of all three theories. Genius loci highlights the necessity of comprehending and responding to a place's distinctive character, including its historical evolution, cultural essence, and environmental context (Bostenaru Dan et al., 2024). Heritage preservation is founded on the belief that understanding and preserving the context of historical structures and traditions is essential for cultural continuity. Vernacular architecture embodies context, evolving harmoniously with local conditions and cultural practices. Cultural Identity is deeply embedded in the theories of genius loci and vernacular architecture. Genius loci emphasizes the intangible spirit of a place, representing the collective memory and identity of its community.

Vernacular architecture encapsulates cultural values through traditional building styles and techniques. Heritage preservation endeavors to safeguard cultural identity by conserving both tangible structures and intangible customs. Sustainability is promoted by the interconnected theories (Alves, 2017). Vernacular architecture inherently embraces sustainability through its utilization of local resources and design principles. Genius loci, when integrated into architectural design, encourages environmentally harmonious approaches.

Heritage preservation contributes to sustainability by repurposing existing structures, reducing the need for new construction (Fafouti et al., 2023). Community Engagement is emphasized by these theories. Understanding genius loci and embracing vernacular architecture often involve collaborating with local communities to integrate their insights and needs. Heritage preservation thrives on community involvement, fostering a sense of ownership and pride. Global and Local Dialogue is facilitated by the interconnected theories. Vernacular architecture's local roots can benefit from global insights (Aburamadan et al., 2021). Genius loci appreciates the uniqueness of a place while acknowledging its connections to broader contexts. Heritage preservation often collaborates with international efforts to protect

Table 2. *Macro, meso and micro level parameters and interrelationships in Genius loci.*

Framework	Genius Loci			
	Parameters	Macro level	Meso level	Micro level
Geographical context	Primary	Physical geography	Regional Ecosystem	Site-level micro conditions
		Climate	Landscape features	
		Topography		
	Secondary	Geographical formations	Microclimate	Microscale environment factors
		Natural resources	Soil composition	
		weather patterns		
Cultural context	Primary	Historical narratives	Cultural practices	Sensory connections
		Cultural heritage	Faith, belief and rituals	Individual experience
		Traditions		
	Secondary	Demographic	Indigenous knowledge systems	Family history and linage
		Linguistics pattern	Folklore	Local narratives
		Social structure		
Architectural expressions	Primary	Architectural styles	Regional building traditions	Architectural details
		Typologies and patterns	Construction materials and techniques	Spatial configurations
	Secondary	Symbolic representations	Traditional craftsmanship	Local interpretation of regional architecture Local narratives
		Epigraphs	Ornamentation details	

sites of universal significance. Cultural Continuity (Kato, 2009) is supported by these theories. Heritage preservation ensures historical buildings and practices are passed on to future generations. Vernacular architecture, as a living tradition, sustains cultural wisdom while adapting to modern needs. Genius loci fosters a sense of belonging and continuity.

In summary, the theories related to genius loci, heritage, and vernacular architecture are intricately intertwined and mutually reinforcing in the realm of architectural practice and cultural preservation. They collectively underscore the paramount significance of context, cultural identity, community engagement, and the global-local dialogue. Architects, when embracing these interwoven theories, are empowered to conceive designs that seamlessly harmonize with the distinctive essence of a place, paying homage to its cultural heritage, while fostering a sustainable and meaningful connection between architecture and society. This holistic approach encourages architecture to not only respect the physical and historical context but also the aspirations and traditions of local communities. By striking a balance between global influences and local contexts, architects can create structures that are both culturally resonant and globally relevant, contributing to a richer, more sustainable, and more culturally significant built environment.

4. Discussion and conclusion

When it comes to the significance and essence of places, concepts like Heritage, Genius Loci, and Vernacular Architecture are important. These terms hold unique meanings and play important roles in understanding the cultural, historical, and architectural aspects of different locations. Heritage encompasses a vast range of both tangible and intangible elements that contribute to the value of a place. On the other hand, genius loci focuses on the distinct spirit or character of a place, while vernacular architecture refers to traditional building practices shaped by local conditions and cultural traditions.

Table 3. *Macro, meso and micro level parameters and interrelationships in Heritage.*

Framework	Heritage			
	Parameters	Macro level	Meso level	Micro level
Historical context	Primary	Historical layers	Rulers and dynasties	Local histories and stories
		Chronology	Cultural movements	
	Secondary	Chronological and historical narratives	Significant persons in history	Local experience of heritage sites and monuments
			Cultural shifts	
		Significant stages in history		
Social significance	Primary	Community attachment	Heritage policies and frameworks	Oral and art histories
		Collective memory	Local guidelines	Books and local narratives
	Secondary	Cultural landscape	Community engagement in heritage	Local traditions, belief, faith and worship
		Intangible heritage	Social cohesion towards heritage	Indeginous craftmanship
Heritage management	Primary	Global heritage initiatives	Regional heritage management plans and frameworks	Local heritage programs
		National and local heritage Initiatives	Heritage conservation through history	Community involvement and initiatives
	Secondary	International conventions, charters and agreements	Collaborative projects	Adaptive reuse projects and community outreach initiatives
		National heritage significance and values	Funding and resource management	

4.1. Holistic vantage point

Heritage encompasses a broader scope that includes both tangible and intangible aspects of cultural significance, historical value, and natural heritage (Deacon & Smeets, 2013). It encompasses not only architecture and built structures but also cultural practices, traditions, landscapes, artefacts, and intangible elements such as language, music, rituals, and knowledge systems. Heritage can be associated with specific sites, regions, communities, or even entire nations. Genius loci, on the other hand, refers specifically to the unique spirit, character, or essence of a place (Badowska, 2008). It focuses on the distinctive qualities that define a specific location, including its architectural elements, cultural

Table 4. Macro, meso and micro level parameters and interrelationships in vernacular architecture.

Framework	Vernacular architecture			
	Parameters	Macro level	Meso level	Micro level
Environmental adaptation	Primary	Environmental factors	Regional climate patterns	Local microclimates
		Climate and weather changes	Ecological zones	Site-specific conditions
	Secondary	Deforestation	Indigenous Species	Environment-driven building design factors and techniques
		Natural resource depletion	Flora and fauna	
Cultural identity	Primary	Cultural diversity	Regional cultural identities	Family linage and networks
		Indigenous traits	Ethnic traditions and beliefs	
	Secondary	Cultural heritage protection	Linguistic characteristics	Local adaptive strategies
		International conventions	Communal rituals	Community networks
Community resilience	Primary	Progressive development stages	Regional resilience patterns and frameworks	Local adaptive strategies
		Resilient planning and strategies	Traditional knowledge systems	Indigenous building techniques
	Secondary	Risk reduction strategies	Risk and disaster management initiatives	Community networks and cohesion
		Global frameworks and strategies		

associations, and natural environment (Elsorady, 2012). Vernacular architecture, meanwhile, refers to the traditional and indigenous building practices that have evolved over time in response to local environmental conditions, cultural traditions, and available resources. It embodies the architectural expression of a specific region or community, showcasing their local identity and cultural values.

While both genius loci and vernacular architecture can be elements of heritage, they represent specific aspects within the broader framework of heritage. Heritage encompasses a wider range of cultural and natural elements, including but not limited to architecture and the genius loci of a place (Alexandrino Ocaña, 2023). Therefore, heritage can be seen as the broader term that encompasses both genius loci and vernacular architecture, as well as other aspects of cultural and natural heritage

4.2. Integration

Integrating the realms of genius loci, heritage, and vernacular architecture requires a thoughtful and holistic approach that acknowledges the importance of context, culture, and landscape. This intricate integration, while holding immense potential, is a complex undertaking that is yet to be realized to its full extent.

One method for harmoniously integrating architectural design with its surroundings involves conducting thorough contextual research and analysis (Dewi, 2017). This process encompasses understanding the historical, cultural, and environmental context of a site, which serves as the bedrock for making informed design decisions that resonate with the essence of the place. Design adaptation is a pivotal strategy, where the principles of vernacular architecture are utilized designs to local conditions. This entails incorporating traditional materials, construction techniques, and design elements that reflect the cultural identity of the region, thereby ensuring a seamless blend with the existing built environment. This integration necessitates cultural sensitivity, achieved through engagement with local communities and stakeholders to gain valuable insights into the cultural significance of the site (Carboni & de Luca, 2016). By integrating elements of heritage valued by the community, the design not only respects but also celebrates their identity. An additional approach involves adaptive Reuse, preserving and repurposing historical structures to meet contemporary needs, thereby bridging the past and present (Zhao & Greenop, 2019). This approach underscores the value of heritage and the enduring relevance of vernacular architecture in modern contexts. Sustainability constitutes a crucial facet of integration, demanding the incorporation of eco-friendly design principles inspired by both the spirit of the place and vernacular architecture (Zhang et al., 2022). This could encompass the use of locally sourced materials to minimize the carbon footprint and enhance energy efficiency, thus aligning with the ecological harmony advocated by the spirit of the place (Jive´n & Larkham, 2003).

In crafting site-specific solutions, architects tailor designs to the unique attributes of the location, including climate, topography, and landscapes, creating structures that seamlessly extend from their surroundings (Ben-Hamouche, 2021). Storytelling through architecture emerges as a compelling technique, intertwining heritage and cultural narratives into the design through architectural features, patterns, and motifs that narrate the site's history and cultural significance (Jeannotte, 2016). Community involvement remains pivotal, as collaborating with local communities during the design process not only enhances authenticity but also fosters ownership and pride (Deacon & Smeets, 2013). Designing adaptable spaces further enriches integration, allowing for spaces to evolve and accommodate changing needs, echoing the adaptable nature of vernacular architecture and perpetuating heritage as a living tradition (Artese & Gagliardi, 2022). Modern interpretations complement this process by integrating contemporary technologies and materials while honoring the essence of the site, thereby exemplifying the evolution of heritage and vernacular architecture (Hapenciuc & Bănescu,

2022).

However, this integration is rarely realized to its full potential. The multifaceted nature of such an approach demands a holistic perspective, an interdisciplinary approach, and a deep commitment to preserving cultural identities, historical legacies, and the environment. When executed successfully, this integration creates architecture that is not just functional, but resonates deeply with its surroundings, celebrating the past while contributing to a sustainable future.

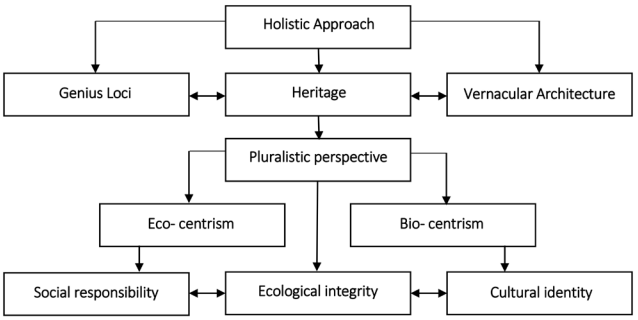

Figure 2. *Holistic Approach to Architecture: Integrating Environmental Consciousness with Bio-centrism and Eco-centrism.*

4.3. The Future Perspective

The intricate exploration of the broader context of environmental consciousness intertwines deeply with the themes of Genius loci, heritage, and vernacular architecture. These foundational pillars of architectural theory not only highlight the rich fabric of cultural narratives but also serve as points guiding towards a more profound understanding of shaping the built environment. As architecture looks to the future, embracing bio-centrism and eco-centrism brings new energy to longstanding conversations, paving the way for a remarkable harmony between human creativity and environmental preservation as represented in Figure 2.

Within the framework of bio-centrism, the essence of Genius loci assumes a devine quality, promoting the research to delve deeper into the intrinsic spirit of a place and its ecological context ("Maintaınıng the human species," 2013). This paradigm shift redefines architecture as a dynamic interaction between human aspirations and the natural world, in harmony with the rhythm of the environment. In this narrative, buildings cease to be static entities; they become living things, intricately woven into the fabric of the landscape, propagating the vibrance of the environment ("Maintaınıng the human species," 2013).

Simultaneously, the lens of eco-centrism expands the horizons of heritage preservation beyond the realm of cultural artefacts, embracing the broader spectrum of ecological inheritance. As mentioned by Guy and Farmer 2001, this holistic approach acknowledges the interconnectedness of cultural and ecological diversity, propagating for the conservation of not only architectural landmarks but also indigenous ecosystems and biodiversity. Eco-centrism almost embraces the aesthetics, cultural and social logic which makes it much broader (Karahan & Davardoust, 2020). Vernacular architecture, when reframed within the context of bio-centrism, emerges as a witness to the adaptive genius of local communities, embodying centuries of ecological knowledge and resilience. By embracing indigenous materials and design principles, architecture can forge a deeper connection with the landscape, fostering practices that honour both cultural heritage and environmental integrity (Iakovaki et al., 2023).

The convergence of these theoretical frameworks with bio-centrism and eco-centrism heralds a paradigmatic shift in architectural studies, one characterized by a holistic appreciation of the symbiotic relationship between built environments and the natural world (Aplin, 2007). By synthesizing concepts such as genius loci, heritage, and vernacular architecture, designs can be created that resonate harmoniously within the ecological fabric of their surroundings (Wu & Chen, 2023). This integrated approach transcends the boundaries of conventional architecture, transforming buildings into living systems that nourish both the human spirit and the natural environment.

As architects navigate this transformative terrain, they must grapple with

the complexities of ecological management and cultural preservation, recognising that the two are very well intertwined. Embracing the principles of bio-centrism and eco-centrism can cultivate a more profound sense of responsibility toward the places that are inhabited, fostering a symbiotic relationship with the land that sustains them (Venkatachary & Kawathekar, 2018). In doing so, they have the potential to guide a new era of architectural understanding, one in which buildings serve as witness to the enduring resilience of the human spirit and the inherent beauty of the natural world.

In essence, the integration of genius loci, heritage, and vernacular architecture with bio-centrism and eco-centrism represents a holistic approach to architectural practice, one that transcends mere aesthetics to embrace the deeper interconnectedness of all living systems. By weaving together the threads of cultural identity, ecological integrity, and social responsibility, architecture can be created that to celebrate the past and also inspire a more sustainable and harmonious future. In this vision, architecture becomes more than just a profession and becomes a dedicated mission, a means of fostering harmony and balance within the web of life.

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Ludic architecture: An agency beyond ready-made narratives

Abdullah Yasin DÜNDAR[1]*, Can BOYACIOĞLU[2]
[1] a.y.dundar@tudelft.nl • Department of Architecture, Faculty of Architecture and the Built Environment, Delft University of Technology, Delft, The Netherlands
[2] cboyacioglu@gtu.edu.tr • Department of Architecture, Faculty of Architecture, Gebze Technical University, Kocaeli, Türkiye

*Corresponding author
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Abstract
Unlike static and predetermined narratives, games offer dynamic and immersive structures that influence all actors involved. An interesting contradiction exists between static narratives that prefer consistency and unchanging foundations when creating designs and ludic agencies that value relationships and connections to maximise potential. This contradiction suggests the need for a paradigm shift, which involves abandoning the predetermined narrative-driven design approach that justifies design acts and decisions by overvaluing one transcendental foundation or solution in representations and design briefs. This study proposes using "ludic architecture" to playfully understand the built environment beyond its linear aim of reaching an idealised conception. Rather than using mottos, canons, and grand conceptions, this study argues that the non-hierarchal medium of ludic architecture provides possibilities for multi-layered acts.
The actions of playful beings, such as intensified tensions, and collectivity, extend architecture beyond mere user participation. The chosen approach involves comparing the literature on architecture and game studies, focusing on specific examples demonstrating the game's ability to create conflict, events, temporality, and distance. This comparison will be made from both an ontological and structural perspective. Games are not inherited with qualities; nevertheless, they are differential events leading to intensifying relationships between disparate play-beings. Ludic architecture emphasises that multiple agency creators named play-beings individuate continuously evolving and changing operations, understanding games and architecture via an inclusive agency where every entity creates their voluntary meanings. Therefore, the actors of architecture add to the playful experience where the structure, movement, and rules are defined solely to produce architecture.

Keywords
Architectural agencies, Games, Productive environments, Playfulness, Generativity.

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1. Introduction

Throughout history, play has been an engaging part of socialisation for species, including humans. Playing helps individuals interact, establish relationships, and create a sense of solidarity. Many scholars from different academic fields, such as historians, anthropologists (Caillois, 1961; Huizinga, 1949), sociologists (Han, 2015; Han, 2017), philosophers (Fink, 2016; Nguyen, 2020; Suits, 1978), and psychologists (Cole et al., 2015; Cole & Gillies, 2021), have made attempts to understand how games operate as an agency. They have also tried explaining why people must interrupt their daily routines and engage in gaming activities. According to anthropologist Johan Huizinga (1949), who is considered one of the leading researchers in the field of game studies, games cannot be reduced to either a solely human aspect, as a conscious act, or an animal aspect, as an expression of inner instincts such as hunting or releasing surplus energy. He argues that the game is a complex notion requiring a more nuanced understanding. In this context, he suggests that the emergence of culture could be based on games, so games are older than the culture of human beings (Huizinga, 1949). Games both have a playful, arbitrary nature and a contextually serious structure with rules. Games contradict the result-oriented, idealised, and linearly structured forms of life. Unlike grand narratives of life, based on mottos, static canons, mandatory principles, and meta-concepts, games cannot be understood through an articulated analysis of fundamental aspects, such as other acts in life that aim to reach predefined goals. While playfulness can be described as arbitrary and joyful movements of beings, including humans and more-than-humans, games define a more structured and constrained system where emergent features and governing features exist to sustain a consistent form with productive functions. In other words, games are playful acts with goals, rules, constraints and systems where tools and technology are vital elements that create generativity and consistency. Playful acts of cats do not consist of any toys and tools that would push the boundaries of their play to create novel assemblages, as one can see in the games of humans, such as ice skating, dodgeball, soccer, and all video games.

The relationships and interactions in games are derived from themselves. They do not affect other acts of life efficiently or morally, which means that the act of play has no exterior restrictions and impositions. Thus, games cannot be positioned at a point beyond itself. In this sense, ludic acts are generated through playful beings, game rules, and the interplay of players interacting with these elements. Philosopher Eugen Fink (2016) argues that in an emancipated situation with no concept of true or false, humans can reach a point where they are free from the irreversible choices dictated by life. In this rift known as the game, players interact with the play without fear of failure or other concerns caused by goals. With an agency where neither social oppression nor idealised narratives about life have priority over one another, play-beings can freely produce their individuation and go one step further to unfold novel individuals.

Definitions of a game have always been debated since their eventful characteristics are irreducible to essences. Thus, according to Jensen (2013), precise delimitations or thorough definitions of games are demanding issues because of their changing operations and concrete and rational rules. In that sense, philosopher Ludwig Wittgenstein (1986) states that defining games thoroughly and satisfactorily is impossible since human conceptualisation only defines games according to their restricted and linear aspects and perceptions of the world. The philosopher illustrates this impasse with an analogical example of "family resemblances". Although there are some similarities among family members regarding appearances, attitudes or gestures, the only shared aspect of one person that addresses all the shared qualities of a family cannot be determined. No all-inclusive trait or one-applies-for-all rule does not exist to define the entire family. In this context, games are members of the "game family", whose

similarities are too complex to be determined by any definition.

Regarding games, how play operates can be examined through constantly changing dynamic structures that alter. These alternations are based on interactions between players and the game's flow, including all actors contributing to the ongoing movement, including humans, animals, technologies, architecture, and rules. Games give opportunities for becoming and act as an agency where the solidarity between individuals is valued in themselves. Having a non-linear, dynamic, flexible, arbitrary, but also strictly ruled structure and following Wittgenstein's line of thinking, games are ambiguous phenomena, so the rules of this phenomenon are established during the playing process (1986). In that sense, the rules are subject to continuous change and transformation. Therefore, the philosopher places a communication-oriented structure at the centre of games. Games have a dynamic structure of continual change in the interaction between the actors, constraints, rules, values, and tools that share a milieu. In that sense, philosopher Bernard Suits (1978) argues that the rules of games differ from other real-life acts. While the rules of ethics or rational works, such as production lines or hierarchical orders, define the truth or indicate and determine an efficient way of working, the rules of play only encourage various types of interactions and movement, described by the concept of being auto-telic[1]. The rules of a game do not have to imply any moral truth or efficient way to reach the goal of adequately sustaining the temporal world of the game and its system. Due to its rules, the play has an alterable and interactive structure where the interaction of players may occur in various ways to contribute to the game's flow.

Games from a social perspective, what Huizinga (1949) profoundly investigates in his work "Homo Ludens," have numerous vital points to provoke and sustain the culture. When playing games, play-beings act voluntarily within a limited time and space. In other words, all the assemblages and interactions that are part of games are reflected playfully rather than seriously. The main difference between these terms is their approach to creating rules and constraints. While serious rules are created with a tendency to reach efficiency or to have a representation approximating ideals, playful rules only focus on the ludic process and the interactions that are taking place in it. Games occur in an isolated environment called the "magical circle" (Huizinga, 1949), where ordinary life does not function appropriately due to deviations from finalised aims. These deviations exist in virtual worlds of games where interactions occur solely within the delimitations of games. In this way, all social play assigns new roles and values to play-beings, such as being a footballer, which limits the use of hands. This interruption and provocation to act differently allude to players' common aspirations and intentions. The architectural context of the play, which is the subject of this study, has a different meaning in the plaything context of postmodern architecture, which employs playfulness as a tool to justify representational or efficient foundations. Nevertheless, diverse architectural reflections carry similar traces of design discussion in their roots, and therefore, these two approaches create a fruitful spectrum.

In that sense, the study aims to argue the potential of a collective agency called games between architecture and play beings, including not only designers, users, and more-than-human, but also rules, constraints, and values that share a milieu. Within this context, Bridge Sprout at the west bank of the Isar River in Munich, designed by Japanese architecture firm Atelier Bow-Wow in 2020 and the High Line project in Manhattan, New York, designed by DS+R and constructed between 2009 and 2019, are discussed using the theoretical background of the act of play (Figure 3). The reason behind choosing this example is its tendency to have playfulness in a non-reducible and relational way that may stem from its philosophical background based on Japanese thinking of in-betweenness and appreciation of performativity and processes rather than materiality, as this paper will later exemplify with Metabolists. The aim is to understand

how architecture, through playfulness, operates and creates novel meanings during the interplay. The rejection of a permanent make, which operates the system of games, is questioned by comparing contemporary projects, which explicitly show temporality, contingency, and an integral understanding of time and space.

2. Literary review

"What is the ideal architectural design that can ever be made, and how could it be done?" concern has been a challenging question since the first theories about what architecture is. This question bothered architectural theorist Marc-Antoine Laugier (1755), one of the first modern architectural theorists to propose fundamentals through the first materialised image of a house, the "primitive hut". According to Laugier, Western architects and thinkers have used different methods to create coherent and harmonious designs, and they all tried to materialise the idea of a flawlessly built environment. He argues that all architectural decisions are justified based on imperishable and perfect foundations, which is essential, so he suggested an ontological base for righteous architectural decisions. The basic architectural principles of Vitruvius (1914), used to create an orderly and harmonious building, are also based and constructed upon a similar motivation of making architecture. Renaissance architect Leon Battista Alberti (1991) invented human-centric architectural design, which separates design and building and values the ability to retrieve perfect forms and angles from the human mind (Carpo, 2011). Alberti defined and separated the practice of architect and constructor through this effort. As in modernism, science, truth, and aims are valued over other terms and concepts in the discourse (Adorno, 1991; Lefebvre, 1971), and culture, history, and the future in postmodernism (Foster, 2013; Harvey, 1989).

In the East, Kisho Kurokawa (1993) summarises the theoretical approach of Japanese architecture based not on the matter but its meaning. This approach opposes heavy reliance on the materialistic aspect of reality in Western thought, such as linear result systems, which define reality through action, reaction, and static snapshots of the present. Opposed to this end-product-oriented understanding, Japanese Metabolists adopt a different design approach, replacing these material concepts with process-oriented approaches in Eastern thought, such as cause, motivation, and effect (Engel, 1964). This design approach emphasises the interaction of users with each other and with the built environment, as well as the importance of activity and the process, rather than any static and predefined form-based architectural design approach. As an architectural example, the temple of Ise Sengu is an ancient temple built more than 2000 years ago, according to the Japanese but not UNESCO. The disputable point between these two is caused by the very same issue about the valued aspect of reality. As a tradition, this temple is rebuilt every 20 years with state-of-the-art technological tools and materials that would still carry the sound of the temple by attuning to its flow. Similar to the Ship of Theseus conundrum of Plutarch, whether this building stays as it was after completely replacing all of its parts differs from one perspective to another (Britannica, n.d.). The Japanese thought it was the same temple built 2000 years ago, but according to UNESCO, or for Western understanding, it is only a building with a maximum lifespan of 20 years (Lopes, 2007). One of the most notorious Metabolist architects, Kenzo Tange, shows an impeccable example of process and event-driven understanding in architecture, defying the will of producing monumental and static objects which will endure for eternity. After winning a competition for the design of the Tokyo City Hall and building it in 1957, Tange re-attended another competition that opened due to the lack of functionality of the very same city hall, and he won and built it again in 1991 (Lopes, 2007). Another famous Japanese architect, Toyo Ito, designed the Nomad Restaurant, which would have a three-year lifespan and be removed as it was (Keleher, 1992). These examples emphasise the importance of meaning

and performativity of architecture in both Metabolists and Japanese thinking.

According to philosopher Kojin Karatani (1997), architecture with a capital *A* denotes the act of making and imposing grand concepts of the human subject on the environment and other beings. "Architecture", which stands against the so-called disorder of nature and its chaos, must express its desire for permanence and monumentality with a grand narrative. In this sense, "Architecture", which tries to determine and prove that every unpredictability is under its control, ought to make organisations, orientations, transformations, and motivations for a predetermined final that will lead everyone to the accurate way. The unshakeable faith in the human subject brings with it the exclusion and instrumentalisation of the non-human. With the increased moral responsibility toward humans, the concern of reaching the ideal becomes inevitable. At this point, all that exists is approximated to ideal concepts by isolating them following a linear attitude that is preconceived as the efficient or right way.

On the other hand, games create a method that can be understood as an alternative to efficient and representative ways, as it creates a temporal world beyond the world of ideals and reverses the cause-effect relations (Huizinga, 1949; Suits, 1978). When creating playful movements, play-beings include sentient and moving entities such as designers, users, and more-than-human, constraining and orienting factors like rules and norms. In other words, games which interrupt the established systems by changing the rules of the world (Fink, 2016) create an agency that opens novel ways to relate and act. This playfulness encourages problem-creating and acting following it rather than relying on grand narratives that solve all problems. The aim of playing the piano, which delimits infinite potentials of creating sounds to a constrained set of tiles, is not to have an efficient result as soon as possible but to generate a rhythmic play that reflects and unravels novel meanings and relations with the world. The goal of playing a piece of music is only derived from the playful acts shaped by the act itself. Playfulness challenges the linear mindset in all acts, including architecture. By adopting a relation-oriented approach, evaluating modes of play-beings and their ongoing changing rules and values disrupt architecture's static and permanent attitude from the beginning (Karatani, 1997). The game's structure starts to break down human-centred, goal-oriented ideologies. It may be possible to expand the play, which can interrupt the isolated concepts by presenting indeterminate understandings of architecture. In that sense, the line of argument from Metabolists to various contemporary Japanese architects, such as Atelier Bow-Wow and games, have similarities regarding their highlight on the web of interactions, loose integrities between two poles, and the multiple exploration potential.

3. Understanding architecture as a ludic agency

Having a non-hierarchical structure where all play-beings are equally involved in the flow and are evaluated based on their effects on the flow of play, the ludic approach understands architecture from an alternative perspective where neither form nor function is praised over the actors. By focusing on interactive and continuously evolving relationships, the linear understanding of architecture to create a design to achieve a final purpose would be differentiated. The predetermined and anthropocentric functions would not be overvalued from a ludic perspective since the play's capability to reverse the ongoing and established system of the world as one knows it. Games generate a dynamic and organised agency where every actor becomes a kind of nomad, leaving fixed positions to unfold potentials to act in the world to create novel norms and values. The ludic process provokes that each play being involved in the play would have a vital role in shaping shared experiences. This playful understanding also denies a literal and static understanding of form, where the design is seen as a product's finalised and stabilised shape.

Form-oriented approaches to architecture tend to undervalue the events and potentials that could unfold during the act of architecture. Instead of understanding architecture as an agent vital to sensibility and meaning, this kind of approach sees architecture as an end-product that will be finished at some point, similar to Alberti's definition of the architecture profession, where the roles of designer and constructor are separated (Carpo, 2011). This definition of an ideal point of no return established what an architect is and delimited and alienated the architect from what would happen after the design. Due to their heavy focus on thoroughly predetermined aspects of architecture, approaches to ready-made narratives have become the foundation for architecture. Contrary to indeterminate and productive agencies of life, ready-made narratives can be understood as story-driven approaches to architectural design that justify design acts and decisions by sticking to one transcendental foundation or solution. These over-relied foundations and solutions limit its actors' capability and capacity to approximate sterilised and praised essences, notions, concepts or solutions. The mighty designer-driven understanding of architecture can be achieved by overemphasising that the architect's role starts here and ends there, so the act of architecture ceases at some point, as Alberti did. Alternatively, it can be in the form of having a foundation on a conceptual idea and basing it on the primary properties of such concepts, such as Laugier's Nature (1755).

What is Alberti's definition of the profession of architecture saying for today's praxis, and how does Mario Carpo stress it by showing the effects of separating what is material and non-material, as in the distinction between builder and designer, or Cartesian mind and body underlies the importance of indeterminacy in design thinking. Today, most discussions on overcoming problems and creating solutions that would make the world a more liveable and inhabitable place neglect the need for coherence and solidarity between every duality. Assigning responsibilities towards subjects creates a need to develop thoroughly planned and conceived, in other words, determined ways to foresee the future or rely on the past, which is dormant due to its mostly abstract nature. Nevertheless, philosopher and physicist Karen Barad coined a new notion called response-ability to show the importance of increasing capacities and capabilities of responding towards the environment without relying on biases or predetermined paths (Barad, 2010). This paper proposes that all the approaches based on assigning responsibilities to affirm the empowerment of the human subject would lead to a ready-made and non-productive understanding of the built environment, as it started with Alberti's separation, and its traces can be followed even today in the conventional understanding and representations of buildings through static plans and section that was invented in Renaissance (Latour & Yaneva, 2017) to show an ideal point of no return. Thus, architectural design is not an end-product of the brain, which translates thoughts into the material world or makes subjective matters materialised by the designer's tools, as Latour and Yaneva argue. They argue that one of the most difficult acts is to conceive buildings not as "desperately static" objects but as a movement within a flow where all the fibres of the environment entangle each other (2017).

Nonetheless, it is a complex system consisting of the compatibility of different actors and processes that is moulded into a non-statical and vital composition of forms and functions. This moulded assemblage of ideas and materials is more than what was conceived in the first place, which leaves a blank, named black box in design that cannot be filled out or analysed easily. Offering a non-anthropocentric perspective, philosopher Bruno Latour's "Actor-Network-Theory" focuses on what happens between actors and their intricate and continuously unfolding relations and dynamism rather than sticking to finding the essence of an object or yet-to-come optimised solutions to problems. This understanding of architecture through the continuous flow corresponds to the indeterminacy of generativity and the need to produce

an agency where actors can establish a network rather than a solution or foundation.

In contrast with ready-made stories about nature and the built environment and their assigned responsibilities over the environment and more-than-humans, ludic architecture unfolds its agencies by interrupting existing contextual structures and habits. Thus, architecture becomes an agent of interactions that change as they change. At this point, the most vital aspect is not the form, function, or pinpoint condition of a building but the multi-layered dialogues created based on novel meanings and information of play-beings. Play is focused on motivation and the act itself rather than overfocusing on grand goals or ideas that need to be achieved or approximated ideally without considering interwoven relationality between play-beings. As a provoking mechanism, games freely express the act without further imposition or orientation that would cause dynamism (Vella, 2021). Focusing on the free interactions in the play through the "agency," philosopher C. Thi Nguyen (2020) highlights the ludic capability of offering new solutions to unexpected situations in life. Coining the term "agential posture", Nguyen claims this characteristic of play makes it possible to experience situations never experienced before in real life. For example, the word game Scrabble provokes its players to find words rarely used by improvising according to existing words in the game and the players' letters. Delimiting players to think and act within the letters it has through an agential provoking mechanism, this game pushes the limit of the player's potential of continuing the flow of play further. Thus, Scrabble is not based on conceptual truth as a proper way to follow or a physical base to follow the most efficient way to reach the end of the game. Nevertheless, players of Scrabble as an agential structure tend to find novel ways to relate to the game by its rules. Having new strategies to gain more points through various combinations or reading other players' moves, Scrabble opens up new capacities to act with the world.

Making room for the emergence of new assemblages and the use of rules of play, the agential aspect could give a new perspective on the built environment as a non-hierarchical and productive actor. Ludic architecture creates a structure contingent upon dynamic play-beings when freed from external restrictions. Ludic architecture is situated between the imaginary and material worlds since it is not solely an abstract conception in the real world nor a serious and so-called rational action due to its eventful characteristics. In this way, it facilitates the capacity and capability of the world, its operations, and the potential that would occur in the play.

In brief, the emergent properties of play that could benefit understanding architecture from a new perspective could be considered in two aspects. This differential understanding should not be assumed as an isolated separation of two poles that are not affecting each other. Contrarily, this ambivalence and variety of emergent aspects of games causes novel ways to act playfully. The first aspect, the passive aspects of a play, could be defined as passive characteristics, such as in-between and orderly structures, highlighting its intensive aspects that affect every other aspect that occurs. On the other hand, active emergent properties of play denote operational aspects of the ludic approach, such as being an agent to provoke new connections or creating a point of crisis to interrupt the teleological phenomena of the natural world (Figure 1). These two sets of properties are not seen as essences inherited from games but as emergent dynamisms that unfold during relations between play-beings. These dynamic structures increase the capacities and capabilities of play-beings to be more playful. These aspects act and relate in a network that influences one another to increase playfulness. Figure 1 shows the intertwined agency between different aspects of the games and play-beings.

Some features and dynamisms of games have various interdependent actors, such as conflicting: being connected to the temporality of relationality, having occurred at a distance between disparate individuals, fictionality of events that assign roles to

sides and make them act according to assigned behaviours as we see in most of the rituals and games. Fictionality also creates distance towards physical and behavioural limitations of the ordinary world, as Huizinga highlights (1949). Fictional events must also have a contingent structure that makes space for indeterminacy and generativity, making a system open to productive speculation without relying on any essence, foundations, or archetypes. Nevertheless, there needs to be a form of productive repetition, allowing differences to be both consistent and destabilising as a line of flight from one domain to another, as Deleuze and Guattari propose in their book A Thousand Plateaus (Deleuze & Guattari, 1987). According to philosophers, the deterritorialising effect of the line of flight makes multiplicity vital and proliferating. All these dynamic features and aspects of games show the interwoven relationality, as illustrated in Figure 1. These intertwined connections also stress the need for and importance of a differential-based approach to understanding systems as agencies beyond predetermined structures.

Similar to the point of view of architectural theoretician Steen Eiler Rasmussen (1959), Ludic architecture implicitly unravels its potential to the players but to the designers with an open attitude. For designers, says Rasmussen, analysing and understanding various vertical capabilities of architecture show itself explicitly in a game. In terms of play-beings, they transform and change architecture with a sense of responsibility and appropriation. Rasmussen made this analysis through one of the rigorous observations on the interaction between architecture and games in his book "Experiencing Architecture". He underscores architecture's passive and active dynamism by watching the children playing a football-like game on the terrace of a historical church in Italy. In this architectural observation, he says that he realised something he had never seen before. Children were not experiencing the terrace like a tourist would. Typically, tourists experience historical places confined to the route that a tour guide shapes. After that, tourists leave the place to go and consume other historical experiences tailored for them before the experience takes place.

On the other hand, children playing games on the terrace were adapting their football games to that terrace by responding and adapting to both the physical constraints of architecture and the ludic constraints of football. By doing this, they were also transforming the spatial experience into a living one with the agency of ludic architecture. As a result of using the flexible and dy-

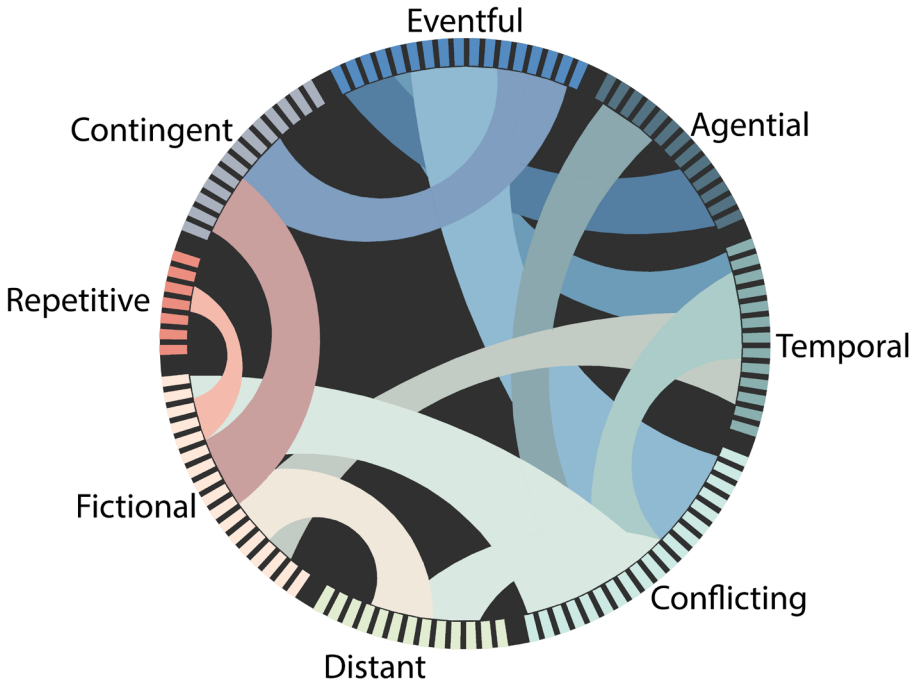

Figure 1. *Relationship between Different Aspects of Play.*

namic structure of the game, the stairs, the terrace, and the curved wall are all integrated into the built environment, creating a multi-levelled, reformable architecture in which a player could facilitate the play. After that, Rasmussen (1959) argued that children may not have understood that they were adding a layer to the architectural experience. However, a beholder with architectural knowledge, like Rasmussen, could realise that architecture could create multiple interactions and relations. The vital aspect of creating emergence and novelty is not a thorough understanding of extensions and possible influences of a game but the creation of new meanings through architecture itself. The collective ludic agency of children changes according to newly joined play-beings and their contributions to the place. Consequently, ludic architecture unravels an agency that satisfies the desires of solidarity and a feeling of responsibility towards the built environment.

Put succinctly, Huizinga's new perspective that understands games as playful and voluntary acts can be reflected in architecture by engaging and relating with them voluntarily and playfully through the inversion of reductionist approaches and acts. In his analysis of playful and social roles, it can be suggested that one designer can create social solidarity and appropriation of architecture through the interruption of existing contextual structures. On the other hand, Fink shows architects a way to discuss the built environment without restrictions of the routine world. In that way, having a relationship with architecture based on emergent rules without any outer imposition and restriction would create an emergent architectural state that embraces playfulness and, thus, relationality (Table 1).

Table 1. *Thinkers of Games, Their Approaches and Architectural Reflections.*

Ludic Thinkers	Methods	Architectural Reflections
Johan Huizinga 1872-1945	Playful and Voluntary Acts	Engaging with architecture voluntarily and playfully through inversion of reductionist approaches and acts
	Playful and Social Roles	Creating social solidarity and appropriation of architecture through interruption of existing structures
Eugen Fink 1905-1975	Overcoming restrictions of the routine world	Having a relationship with architecture based on emergent rules without any outer imposition or restriction
Ludwig Wittgenstein 1889-1951	Rules of games are set during the act	Setting design limitations and constraints to structure a system with alternation that is derived from act
	No possible definition of primary properties that would encompass all	Without any concern to sorting out all the properties of a building, showing the web of relations between play-beings operates
Bernard Suits 1925-2007	Autotelic rules	Setting constraints of architecture with a rule set just based on the act of architecture rather than being based on any teleological pinpoints and paths
	Voluntary attempts to overcome unnecessary obstacles	Relating with architecture voluntarily and playfully through inversion of serious approaches and acts
C. Thi Nguyen 1979-	Agential Posture	Understanding architecture as a provoking plane interrupting every established action to unfold novel and indeterminate approaches
Steen Eiler Rasmussen 1898-1990	Opening to novel capacities	Focusing on architecture's capability to unravel novel ways of relating with environment because of its manipulations

Reflecting Wittgentein's understanding of the rules of games (1986) created during the playful act of architecture, setting design limitations and constraints to structure a system with alternation derived from the act of architecture can facilitate more vital and productive architectural experiences. Also, his emphasis on the impossibility of defining primary properties encompassing the act itself will denote the importance of a shift in architecture to understand how the web of relations between play-beings operates rather than sorting out and listing all the properties and qualities. It must be noted that the playfulness of Postmodernism, where arbitrary manipulations and speculation of both architectural elements and discourse overfocus on what is playful instead of questioning how it could unfold between actors through the agency of play-beings. Following that, a replacement of a column with a colourful steel pole or a concrete wall with glossy glass panels can be seen as a playful architectural manipulation at first glance, but static and foreseeable changes cannot be a medium for productive and transformational relationships unless indeterminacy of games cannot be employed in architecture. Even if it contributes to the immersiveness and excitement of play, colourful balls in football or shiny textures of marbles are not provoking to put the play further if it only stays as a property of a being. Thus, games emphasise the agency and generativity of play rather than what is hidden in its essence.

Analysing Suit's autotelic aspect of the rules of games, setting architecture constraints with a rule set just based on the act of architecture would be more emergent rather than basing it on teleological pinpoints and paths (1978). His ludic definition of games also implies a new method of architecture regarding deconstructing the linear ways of seeing architecture. Nguyen's agential posture has the potential to offer designers a method to understanding architecture as a provoking plane interrupting every established action to unfold novel and indeterminate ways. Similarly, Rasmussen's observation of the church also underscores the vitality of focusing on architecture's capability to unravel novel ways of relating with the environment because of its manipulations.

4. A Ludo-architectural potential for solidarity

Before analysing the architectural aspects of ludic solidarity, it is vital to address philosopher Timothy Morton's descriptions of symbiotic relationships and solidarity to understand any action's social, inclusive, and productive aspects. According to Morton (2017), a symbiotic relationship is a loose integrity that contains the implosions of its actors, and these implosions are caused by joint problems that affect the ongoing life of humans or non-humans. In a symbiotic life, beings share a jagged and flawed environment to reconcile with their deficiency. In that sense, creating an environment that is neither chaotic nor orderly became a quintessential work for designers. In this context, ludic architecture creates moments of crisis and conflict through playful rules and systems, rejecting any ideal architectural concept or system which allows no room for flaws. Due to their relational, agential, and eventful characteristics, architectural agencies of play-beings that follow ludic rules could be based only on their own reality as opposed to mainstream canons that rely on abstract predetermined ideas. Besides, ludic architecture also creates auto-telic rules to make room that would create loose structures for potential solidarity. In Fink's words (2016), the primordial ground of life where any established rules are yet to be achieved overcomes the restrictions and boundaries of the routine human world and recalls that humans are part of nature. The architectural agency of play makes possible the transition from anthropocentric ideals that assign the most critical role to humans and understand the world as a tool to reach perfect ideals to a more-than-human way that produces dynamic architectural interactions and solidarity with non-humans. As an architect who focuses on the eventful aspect of architecture, Bernard Tschumi argues that his Folies complement the axiomatic structural logic of the

design and transformative copies of structure (1988). In other words, Folies balances the consistency of a structure, which creates a persistent form and meaningful repetitions of a design, which provoke yet-to-come methods of experiencing architecture through emergent and dynamic features. According to Hatipoğlu, who analyses "folies" in the context of their agency, the main element that integrates the structural dynamism of these entities with the park is their symbolic functions (Hatipoğlu, 2014). Referencing Deleuze, the researcher argues that the symbol of Folies belongs neither to the pre-existing reality of the material world nor to the imaginary elements of the conceptual world. The symbol, which lies in the in-between of these two realities and reconciles between the two opposites, creates a new situational as a third in-between-ness, similar to what Latour's Actor-Network Theory insists. Since there is an endless repetition between the objects in the real world and the images in the virtual world, the symbol itself never remains dormant since a definite resemblance is impossible.

Architectural design could consider the building's function within its context instead of just the end goal or any other reduced aspect of the built environment. Playful design elements can be incorporated to disrupt traditional linear approaches to functionality. By adding an ontological layer to the architectural experience, the ludic approach bifurcates the interactions as a web structure that cannot be interpreted based only on a single path (Crawford, 1997). A design that extends the experience of play-beings to the unintended aspects of design unravels the jagged and partial dimensions of the symbiotic relationship between humans and nature. Not relying on ready-made narratives structured at the influence of a higher concept or mottos, such as flexibility, inclusivity, immateriality, and ludic architecture of solidarity, means mediating the shared built environment of beings by only creating interaction potentials. The player whose movement is interrupted by the environment gets into a play on an agency where one could think about all the in-betweenness that architecture underscores. For example, the game "taboo" provokes players to find unexperienced ways to explain words in the context of following ludic rules, such as avoiding using forbidden words, explaining only within 15 words, using only the puppet, or drawing with a pencil. Similarly, the ludic architectural elements of the High Line project sheds light on undervalued aspects of the built environment and daily life (Foster, 2013). The project transforms the elevated train line abandoned since the 1980s into a more-than-human agency for humans and various species that promotes the natural biodiversity and ecosystems living in solidarity.

Even if this elevated train line has existed unused for years in New York, DS+R realised its significant potential for the neighbourhood (Figure 2). Architects rehabilitated the environment as a solidarity agent where the in-betweenness of the city and humans or nature and the built environment or flow of daily life and architectural experience is rediscovered and retraced in various aspects. In this design, where agencies of architecture are made upon the temporal appropriations of play-beings onto architecture, the architectural experience is shaped not so much by ready-made narratives of architects but by themselves with an auto-telic method that contains all aspects of it owing to its contingent and eventful nature. "High Line", as an architectural project, does not advocate for an ideal method to recreate and sustain the ecological balance or suggest rhetoric that it would create a unique public place that would unite New Yorkers. This contingent aspect of the project also comes with the contingent creation of fiction of play-beings. Rather than having a story that relies on ready-made conceptions and ideas, High Line only facilitates an agential approach that would provoke unnamed relations and assemblages between play-beings that would open new potentials between them. In that temporal collectivity of disparate beings located at an abandoned train line, intuitively conflictual backgrounds of beings instead proliferate yet-to-come ecologies.

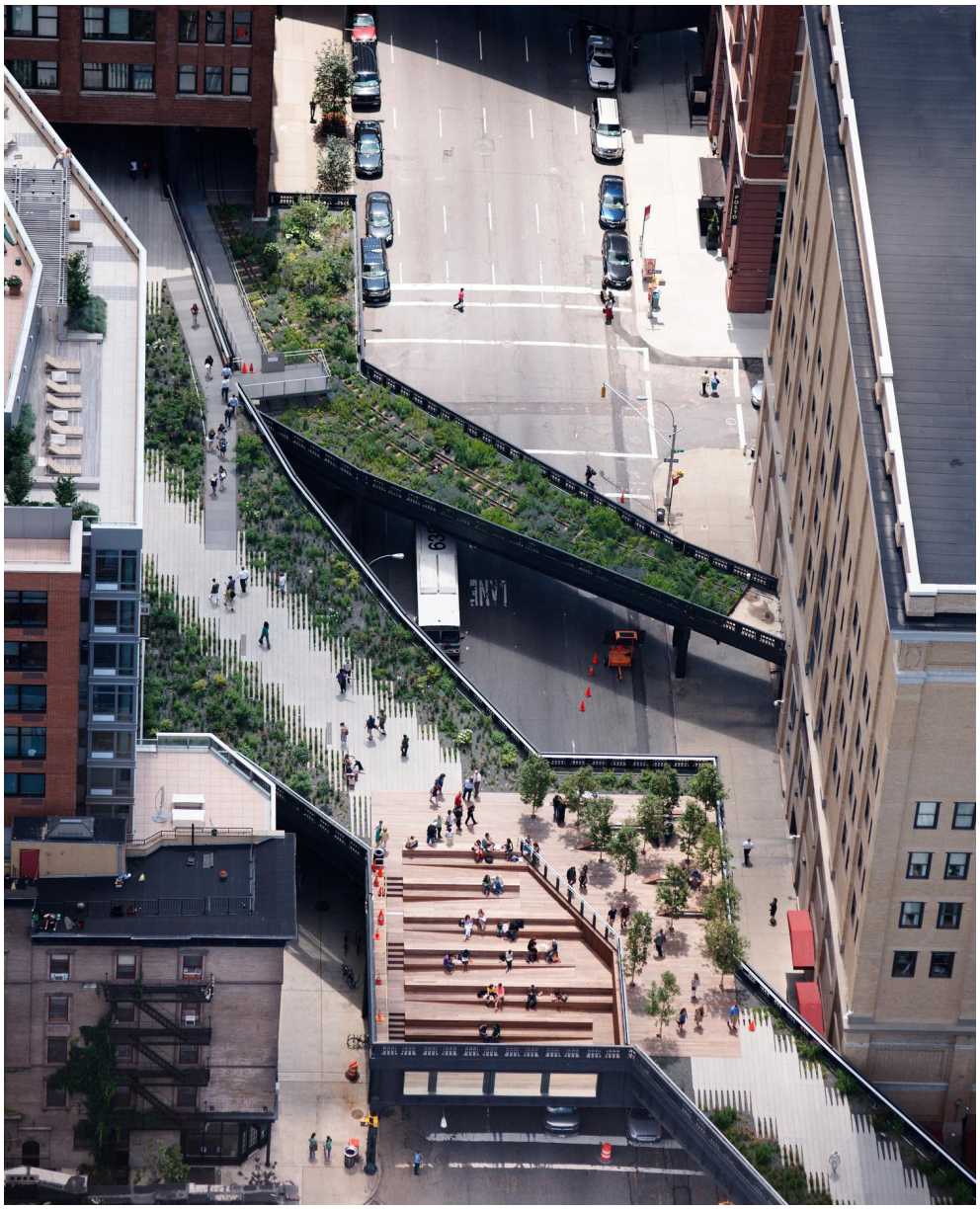

Figure 2. *High Line, New York (Diller Scofidio & Renfro, n.d.).*

Understanding architecture as an agent that makes the rules through the act of architecture, the design focuses on rifts between New York's chaos and the natural habitat's tranquillity of the project, similar to what is solidarity for Morton (2017). Thus, this design could be discussed as a vitalising agent that makes the zone suitable for appropriation by adding new horizontal and vertical planes, making room for creating new ecosystems in a non-anthropocentric way. So, play-beings respond to the built environment to sustain its playful flow according to their needs and desires. City-dwellers in New York define what is playful and solidary in a "magical circle" (Huizinga, 1949) between the chaos of the city and the peace of nature. By having an agential base in-between, High Line refuses any armchair critics' definition of chaos or nature that is wholly sterilised from the milieu. With its micro-environments that have the potential to create productive interactions, the project puts dwellers into a series of ludic provocations that would create unexpected events. High Line is unique not for its flexible architecture but for its ability to inspire vibrancy in humans and non-humans, free from imposed concepts or mottos. In this way, architectural experience strongly connects with the ludic experience through its agential posture, interrupting every

established action to unfold novel and indeterminate ways of experiencing the built environment.

Following Morton's (2017) solidarity, memory and expectations of a built environment could be vitalised and vibrated through a flawed and undone medium. This medium creates a milieu where any so-called deficiency or flaw is utilised as an initiator of unnamed interactions. In that sense, the Bridge Sprout project of Atelier Bow-Wow was designed as a half-done bridge trying to reach the Isar River of Munich. In this way, the project has gained more vibrancy and liveliness regarding the plural modes of movement it offers to play beings instead of promoting pure activity. In other words, Bridge Sprout does not favour activity over passivity or interrupted activity, including proactiveness and reactiveness. Similar to a football game, it limits play-beings from using their hands to score, and its creativity and novel strategies emerge based on this playful constraint; this bridge produces its meaning and emergent approach owing to its limitations. This limitation of being unable to reach across the river adds different layers to the architectural activity of a user. Like the children playing at the church in Rasmussen's example, play-beings of Bridge Sprout also adapt their acts and the capability and capacity of a built environment by adopting a playful manner. This playfulness shows itself when users can visually reach the other side of the river. The visual continuation of the project is interrupted by the material discontinuity of the bridge. There is loose integrity between physical embodiment and visual perception of the project, and this solidary in-betweenness produces disparate types of movements and, thus, creativity. According to philosopher Immanuel Kant (2003), imagination is closely linked to play and a playful environment, which should have a structure that allows for unpredictability and the freedom to try new attempts. Kant argues that imagination and play are rooted in breaking free from predetermined rules and restrictions. So, ludic architecture would also have rules that allow for breaking attempts and are consistent enough to structure and sustain a system.

In this context, ludic architecture necessitates multi-layered thinking and acting in time, including activity, passivity, or, in philosopher Edmund Husserl's (1991) words analysed by Maurice Merleau-Ponty (2005) later, retention (memory) and protention (expectation). These intentionalities, discussed by the philosopher, allow individuals to position themselves within their environment and derive meaning from a time that's not just self-centred or linearly progressive (Merleau-Ponty, 2005). Since we do not progress from a timeline that is constantly lived in the present, each moment experienced brings with it a change in the previous experience. What has just been experienced is with the present as it is; however, as the present gradually increases, the previous begins to remain at the bottom. This moment that was just here and is starting to fade away has to be reached to create a memory; it is not separated from the previous time and is still connected with the present. Nevertheless, this connection is still weakly related to the self's perception of time. When a third moment is experienced, separate from the present and the previous one, the second moment passes from being a retention, that is, the present moment living in memory, to being a retention of retention.

The reactive attitude of the dodgeball player, after dodging the first move and overcoming the second move, is considered by the second move that has passed and the first move that preceded it. As these retention processes advance, the present moment in memory begins to solidify and take on a structure called memory. In his analysis of Husserl, Merleau-Ponty (2005) argues that time has a structure closer to being defined as a network of intentionalities rather than linear. The point where the game differentiates itself from any action and separates movement and waiting over time into layers exists thanks to this network structure where interactions intersect. By containing all these active and passive states, both the game and architecture have the potential to create agencies that produce movement without imposition and provide a satisfying and sharing process. With this method, play-beings

can shift from experiencing architecture linearly with one type of movement to a shared and loose integrity, a network of intentionalities similar to Merleau-Ponty's analysis (2005), where dialogue is established between the actors and the built environment.

Regarding Bridge Sprout, the most vital experiential aspect for its play-beings is not to reach across the river directly but to intervene in the established act of crossing a bridge to unravel the unnamed potentials of architecture. As this intervention differentiates, relation potential increases regardless of the architect's intentions. Play-beings of Bridge Sprout have memories of crossing a bridge in a standard and predefined way. Even if the visual continuity of the bridge supports those established memories and imagining through the project in an established manner, the physical discontinuity disrupts the architectural experience and, consequently, offers a novel way to experience and understand architecture with a loose integrity between continuity and discontinuity (Figure 3). By interrupting existing ways of relating with the built environment, Bridge Sprout, with its playful agential posture, produces lively and evolving architecture through various solidarity between river, island, metropolitan city and play-beings that are there to sense it and create individual meanings with it. Consequently, memories and expectations are shaped within Bridge Sprout, not as a linear way of defining what is functional and what is not but as a web of interactions and intentionalities of users, designers, and all other actors in the environment.

In this way, by opposing ready-made narratives, the agential posture of Bridge Sprout makes room for open-ended agencies between its actors. This project uses a ludic method to sustain a non-hierarchical act of architecture, valuing every aspect of play and play-beings in its environment. The architect's mission is changing from designing a building that pretends to last forever to creating ludic agencies to generate multiple interactions and relations that would not exhaust linearly but unfold into various yet-to-be-experienced ways. With no concerns of realising the purpose of a building thoroughly, the playfulness of Bridge Sprout vividly reveals and questions the overlooked details and meanings of everyday life. The potential for inclusive relationships in a collective built environment has emerged due to the contingently defined fictional structure. Play-beings who voluntarily create and appropriate the milieu would also sustain and provoke architecture since every experience, meaning, and interpretation is individual. In this sense, ludic architecture can avoid static imagery-based, momentary reactions in its shared milieu.

Figure 3. *Bridge Sprout, Munich (Authors' Archive, 2022).*

Atelier Bow-Wow's architectural projects are not just a combination of form and story. Instead, they use playful design to connect humans and non-humans, blurring their boundaries. This approach allows for open-ended and collective agencies to emerge, where everyone is included and can contribute to the unfolding assemblages. Ludic architecture creates materiality with the potential of disparate agencies reflecting the relationship between all

play-beings and the importance of solidarity. In this context, the design does not include grand concepts or narratives, such as building a bridge between nature and humans or organising a public place to resolve the fixated division between nature and culture. With a playful approach respecting nature's existence and not seeing humans as a saviour, the architects show that architecture could highlight problems without imposing solutions or interfering and strictly defining acts upon them, similar to in-betweenness in Japanese thinking. Organising a cooperative and dynamic system that allows both activity and passivity, agents of architecture could be facilitated to unravel the capacities and capabilities of a collective relationship. Following that argument, the appreciation and value that is put at Bridge Sprout Project is not about efficiently accomplishing an architectural act or ideally achieving a state of society, which would be a perfect and well-thought remedy for sociological, ecological, economic problems. Contrarily, the focus is on the agential posture of an architectural project to experience situations never experienced before in real life that would unfold yet-to-come assemblages and indeterminate productivity between all play-beings. Such an approach to the built environment valuing processes, performativity, and yet-to-come events through action would contradict a method that reduces all the relations to one praised aspect, feature, or concept.

Suggesting a limited lifespan of the design to deconstruct the permanency of architecture, having a dynamic and open structure capable of producing multiple meanings and interpretations, Bridge Sprout aims to exist only partially. As an architectural installation, Atelier Bow-Wow plans this project to last only three years. The ludic architecture of Bridge Sprout suggests an alternative lens at what already exists and takes part in everyday life by making it ephemeral. Creating an open system without final images produces a dynamic built environment. The project maintains the flow of play and creates an evolving architectural system. This type of architecture, therefore, values the "displacement" of actors in the built environment as much as "emplacement", as philosopher Paul Ricoeur (2006) when underscoring the importance of inhabited space. According to him, architecture needs to be cooperative, where continuation and discontinuation are performed with a balance, similar to Morton's concept of loose integrity. An ideal, flawless and perfectly designed project that leaves no space for playfulness and various modes of architectural experiences would eventually favour a utopic and static image of the human mind.

Having a temporal lifespan that would only be a part of memory in

Table 2. *Ludic Architectural Projects, Ludic Methods and Effects on the Architectural Design Methods.*

Ludic Architectural Projects	Ludic Methods	Effects on the Architectural Design Methods
High Line (DS+R) 2009	Agential Posture	A more-than-human agency for not only humans but for various species that promotes the natural biodiversity and ecosystems living in a solidarity
	Overcoming restrictions of the routine world	Unique not for its flexible architecture but for its ability to inspire vibrancy in both humans and non-humans, free from imposed concepts or mottos
	Opening to Novel Capacities	Vitalising agent that makes the zone suitable for appropriation by adding new horizontal and vertical planes, making room for creating new ecosystems in a non-
Bridge Sprout (Atelier Bow-Wow) 2020-2022	Autotelic Rules	Play-beings can shift from experiencing architecture linearly with one type of movement to a shared and loose integrity, a network of intentionalities
	Opening to novel Capacities	Loose integrity between physical and visual perception of the project, and this solidary produces disparate types of movements, thus creativity
	Playful and Social Roles	A living being that is sensible to manipulation and responds with multiple feedbacks rather than a static object

three years, the playfulness of Bridge Sprout highlights a different mode of architectural experience, which would eventually end and be a part of memory. Consequently, ludic architecture provokes its play-beings to continuously manipulate the environment and shape different variants of the built environment in novel ways after the end of its life. Following that, architecture becomes a living being, just like any other being, that is sensible to manipulation and responds with multiple feedback rather than a static object established and finalised at some point (Table 2). Examples of ludic architecture are far from a completed and fully defined, ideally shaped functional system. In other words, they are not rigidly shaped and concrete, with the danger of not making room for creativity and solidarity. An agential built environment for productive relationships, ludic architecture is positioned at in-betweenness since it does not favour any aspect over another. In this way, conflict and contingent characteristics of these projects also differ from chaos and order.

5. Conclusion

Creating an architecture that allows individuals to produce their own meanings and values, rather than being subject to narratives imposed by a kind of authority, is vital in having an inclusive and non-anthropocentric approach. This type of architecture allows for the individual's agency and helps to maintain it in the memory of those who experience it. In such projects, play-beings express themselves at loose integrity where there is a need for individuation so that the novelty of architecture emerges. In this sense, facilitating a ludic perspective in architecture allows beings to have solidarity and interactive relationships. Through its disparate attitude that interrupts the established continuation of life, the ludic approach offers an alternative approach to architecture by reconsidering existing architectural designs and thoughts in dynamic contexts. Ludic architecture, which offers a departure from the status quo approach in architectural design, moves away from designs seen as end-products and static beings. Limitations of this approach are speculation based on predetermined narratives, disregarding the unnamed potential of play-beings.

On the other hand, adopting a playful approach, in which the fiction is constantly reshaped and transformed within the inclusion of the beings, ludic projects show that it is possible to understand individuals through in-betweenness, unlike an understanding that sees matter as an assigned final product. It presents an alternative perspective on approaches to solving current issues rather than changing the attitude pragmatically. Ludic architecture rejects the result-oriented hierarchical methods in architectural design, such as favouring one aspect. The ludic approach evaluates every play element in its own modes and context if it creates ludic movements.

The interaction of the play-beings with others in a setting where they create solidarity through their loose integrity provides a collective structure in which they sustain the architectural experience. The ludic architecture acts as an agency for many yet-to-come assemblages. By avoiding the pursuit of an unattainable ideal or being weighed down by grand concepts, this approach remains purposeful in its system. Architecture can develop without being realised for any purpose other than itself, free from imposed restrictions and ideals, which comes closer to an ecological and playful understanding of architecture, its actors, and its rules.

Endnotes

[1] The term auto-telic is derived from the Greek words "auto," which means "self," and "telos," which means "ultimate end or goal" (Merriam-Webster Dictionary, n.d.)—indicating that the structure of the game has an aim that is only operating within its system and has no exterior extension.

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Exploring data-driven design in landscape architecture

Sheida SHAKERI[1]*, Muhammed Ali ÖRNEK[2]
[1] shakeri20@itu.edu.tr • Department of Landscape Architecture, Graduate Program of Landscape Architecture, Faculty of Architecture, Istanbul Technical University, Istanbul, Türkiye
[2] ma@maornek.com • Department of Landscape Architecture, Faculty of Architecture, Istanbul Technical University, Istanbul, Türkiye

**Corresponding author*
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Abstract
Currently, technology is growing exponentially, and with rapid urbanization, vast quantities of data are generated by the urban environment that is more spatial than before. Cities and ecological linkages become more complicated, and as the quality of the urban environment is determined mainly by how the data is used, the capacity to deal with data is becoming increasingly important in design processes and protocols. Therefore, this paper aims to introduce the data-driven design approach and distinguish the existing projects in landscape architecture based on their input and output types. Besides, it contributes mainly to bringing together the existing information in this field. The literature review process was applied to conduct potentially relevant literature on the research topic. Then, the existing projects were identified and reviewed. As the primary research outcome, most of the reviewed data-driven projects in landscape architecture received input data from environmental or human sources. At the same time, only 16% benefited from a mixed combination of environment and human-sourced data. Besides, only about 35% of the existing projects had adaptive or performative outputs, the most desirable characteristics towards environmental progress, while most were interactive. Although these projects are still in their early stages, this article illustrated the potentials of data-driven design to boost landscape performance in many ways. By unifying projects under a single framework, data-driven design can benefit more.

Keywords
Adaptive, Data-driven design, Interactive, Landscape architecture, Performative.

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1. Introduction

Technology is growing exponentially, and we have reached the "fourth industrial revolution" that deals with automation, sensing, and scanning (Melendez et al., 2020). With the presence of sensors, smart meters, social media, and mobile phones, vast quantities of more spatial and urban data are being generated in the physical environment. It has fundamentally changed our understanding of the environment and shaped our relationship with cities and the techniques we design architecture, urban, and landscape systems. Thanks to the development of these data collection techniques, we can monitor and detect even subtle changes in the environment in real time, including light, sound, temperature, energy consumption, traffic flows, pollution emissions, and communication flows. However, greater data volume only sometimes implies meaningful information (Fricker & Münkel, 2015), and the quality of the environment in which we live will be determined by how we use that data. Without any application or a critical eye, data is entirely worthless. The approach by which we gather, evaluate, and apply data matters the most. Data would be beneficial if we could interact with the information by seeing, hearing, or touching when the environment becomes a massive interface for transmitting data. When properly implemented, these environments can make our lives more pleasant and accessible and reduce resource consumption. In fact, in these environments, wireless sensor networks, transceivers, and physical actuators are combined with information systems to offer places where humans and the environment interact.

Indeed, how to better serve everyday life by embedding information and knowledge into surroundings through real-time interactions between natural or artificial environments and people has been a significant topic for data-driven design in the previous decade. Achieving this ideal infrastructure means using data productively (Batty et al. 2012). The premise is that data-driven design should create a feedback loop from concept to implementation and use (Bier & Knight, 2014).

Besides, rapid urbanization and city connectivity have resulted in increased data generated by the urban environment. Today, for the first time, we have more data than we need (Carpo, 2017). This massive amount of urban dataset has the potential to be a beneficial tool when it is made available to the public. Representing urban data or data having a contextual connection to the surrounding environment within the public, the physical environment of a city has the potential to share meaningful information with residents. This mode of transmitting information boosts our understanding of the environment and acts toward a more qualitative and environmentally sustainable urban neighborhood (Moere & Hill, 2012). This issue holds great significance because cities nowadays encounter the problem of the urban space, which is unpleasant and does not encourage residents to engage in activities and environmental changes.

2. Data-driven design

The development of data usage in design results from technological advancements that allow data to be gathered, measured, and evaluated in various ways. However, designers have always utilized data, even without being aware of it. Data of various types and sources have always been used in the design processes (Melendez et al., 2020) that enhance the design process's efficiency and meet user needs.

These data can originate from various sources: humans, senses, likes and dislikes, political views, medical records, Earth, the environment, climate, geography, oceans, companies and organizations, revenues, stock rates, and countries.

Today, although using qualitative and quantitative data (Babich, 2017) in design disciplines, architecture, the arts, and urban studies, is becoming increasingly important. How to define data-driven design is still up for debate. According to Speed and Oberlander (2016), the relationship between design and data may be approached

in three different ways: "design from data", "design with data", and "design by data". "Design from data" refers to systems designed by designers inspired by measurable characteristics of the context. These designers employ various techniques to collect social, technological, and environmental data, including interviews, user observations, ethnographic methods, and contextual mapping. At the same time, design with data refers to systems designed by designers who consider data flow through systems combined with the ability to preserve and promote human values. While these methods primarily collect data and report from sources before analysis, easy access to ubiquitous computing technologies allows researchers to link with a participant or community to understand better how data-centric prototypes, products, and services affect the user. This paradigm is referred to as one in which it is possible to "design with data" because information may flow in several directions.

On the other hand, "design by data" refers to systems that are built by other systems, not designers. Vast margins of autonomy and morphologies regulate them to create information. The final area is the possibility that data, with the help of an algorithm, would become a designer.

This paper is concerned with the "design by data" category in which the input of data is generated by computational platforms like microcontrollers, environmental sensors, or virtual models and then processed and returned as output data by virtual models or actuators, which are mechanisms that operate physical devices like servos, LED lights, motors, and valves. The ability to enter input and generate a response provides the potential for responsive systems (Melendez et al., 2020) that enable real-time interaction between natural or artificial environments and users (Bier & Knight, 2014). This process consists of sensing, processing, visualizing, and feedback phases. Indeed, this concept of data-driven design is loaded with unintended ambiguity. However, vagueness can be beneficial in allowing various and competing notions to evolve (Senagala, 2006). Data-driven design covers a broad scope of subjects because the projects involve adaptability, responsiveness, and interaction through various protocols and scales, always giving a framework for data to be altered and activated as a type of exchange.

2.1. Scope and definitions

Data-driven design refers to a system comprising two or more entities that communicate with one another through data exchange. This system operates responsively, adaptively, performatively, or interactively through the utilization of smart systems. However, the distinctions between adaptive, responsive, and performative techniques in design research still need to be clarified. Several definitions exist in the literature for these concepts, and they have been used loosely and interchangeably among professionals (Barozzi et al., 2016). In order to clarify the use of these terms, the authors suggest general definitions listed in Table 1.

Adaptive techniques have long been popular in design to address sustainability and efficiency issues. They can be as essential as doors and window shutters that allow occupants to make temperature and airflow changes as needed. The main aim of adaptive systems is to make design more responsive to residents' daily requirements (Kalantari & Ghandi, 2017). On the other hand, the term responsive was first coined by Nicholas Negroponte, who pioneered the use of digital technology in the area of architecture in 1975, when spatial design challenges were first being studied, owing to breakthroughs in cybernetics, artificial intelligence, and digital technologies (Kolarevic & Parlac, 2015). Indeed, while adaptive systems deal with problems with multiple variables, responsive systems respond to individual problems. Adaptive is a much broader notion than responsive, since it aims to maximize function and waste reduction (i.e., energy usage and material resource availability) (Al-Obaidi et al., 2017). Hereafter, the term "responsive" is taken as "adaptive" for ease of use.

According to Al-Obaidi et al. (2017), two main adaptive approaches exist: adaptive behavior based on the motion

Table 1. *Definitions of the terms.*

Term	Definition	Source
Responsive system	"Responsive means that the environment which has an active role, initiating to a greater or lesser degree changes as a result and function of complex or simple computations".	(Negroponte, 1975)
	Refers to a system moving and responding from the outside based on specific factors, thus allowing interaction with a passive environment.	(Hasselaar, 2006)
	Refers to the control of environmental conditions with the use of computational algorithms, thus allowing a system to learn new concepts while educating the occupants.	(Brown & Cole, 2009)
	A system with the objective of physically reconfiguring themselves to meet changing needs with variable mobility, location or geometry.	(Pesenti et al., 2014)
	A process of feeback, a conversation between two actors.	(Cantrell & Holzman, 2015)
Responsive landscape	The environment that combine sensor networks and actuators to provide interest, beauty, comfort, and engagement for visitors, occupants, users. These sensor networks typically are controlled by some central or distributed set of algorithmic and logical (or perhaps random) controls, that generate the outputs and thereby the perceived sensation(s) of the place.	(Ervin, 2018)
Adaptive system	The ability of a system to adjust by itself in relation to a changing environment. An adaptive system, as in the case of building skins, has the ability to adapt the features, behavior or configuration of the external environment.	(Dewidar, 2013)
	Refers to a morphogenetic evolution and real-time physical adaptation of a design in relation to its surrounding environment.	(Al-Obaidi et al., 2017)
Performative system	Refers to systems that can mediate surrounding environment for user comfort.	(Turrin et al., 2012)
Interactive system	Systems with mutual or reciprocal action of influence to external stimuli.	(Ahmed, 2018)

that changes the structure by sliding, folding, creasing, expanding, rolling, hinging, fanning, inflating, rotating, or curling, and adaptive behavior based on material characteristics that directly change a material's internal structure, such as light reflection or absorption properties, or energy transfer from one form to another.

Additionally, according to Ahmed (2018), the difference between interactive and adaptive systems is that in interactive systems, users are permitted to take their path through the content, while in adaptive systems, users may enter their content and control how it is employed.

2.2. Data visualization

Our sensory-motor system allows us to interact with our surroundings. Specific senses are aroused due to the contact between our bodies and the items in our surroundings. We can see, hear, touch, and smell the tangible creatures around us. However, we require external "interfaces" to interact with digital information in the digital world since digital entities have no physical representation. Data visualization provides an appropriate mode of interaction with digital technologies (Tahouni, 2018).

Despite being fundamentally multidisciplinary, data visualization has a solid academic foundation and tradition in computer science, where the earliest computer-mediated data visualizations emerged from the study of computer graphics (Swackhamer et al., 2017). Data visualization helps a wide variety of users to grasp information hidden inside the data (Hosseini et al., 2019). Data is often represented in abstract forms in data-driven contexts to enhance understanding. Visual representations of information can aid memory, make abstract concepts visible, support problem-solving and decision-making, and make the analysis of large datasets more efficient (Myatt & Johnson, 2011).

Data may be represented in a variety of ways. While using numbers and

graphs to represent data is a beneficial technique because it requires little display space and it is simple to comprehend (Consolvo et al., 2014), the use of metaphors to represent data is believed to be more engaging, inspiring, and simple to understand (Lin et al., 2006). Data representation using text, play elements by gamification techniques, and data sculptures that are defined as "data-based physical artifacts, possessing both artistic and functional qualities that aim to augment a nearby audience's understanding of data insights and any socially relevant issues that underlie it" (Zhao & Vande Moere, 2008) are among the categories of data visualization. These data are transformed into a physical form and released into the physical environment as a tangible representation of the action (Khot et al., 2020), called physical visualization. Physical media can be felt, and its physical features, such as shape, texture, temperature, or weight, may all be used to depict different parts of the received information.

In contrast, standard computer representations cater primarily to visual senses. Data physicalization has expanded in recent years, and it now encompasses a wide range of disciplines, including computer scientists, artists, designers, psychologists, practitioners in human-computer interaction, and many others (Hogan et al., 2020). Scientists, architects, artists, and designers work together to visualize data innovatively to spark and expose new connections, interpretations, and readings. When combined with three-dimensional space, a visualization can alter spatial perception skills. Furthermore, incorporating data into sculptures and installations can broaden the public's discovery and comprehension of crucial, complicated data (Jovanovic et al., 2016).

2.3. Sensors and actuators

Data-driven investigations are fueled by the advent of Arduino, Raspberry Pi, and other microcontroller kits, as well as rapid developments in sensors and smart materials (Khot et al., 2020). Today, data collection is supported by sensors. Sensors can be defined as devices that generate an output whose characteristics (amplitude, frequency, voltage) are in a known and repeatable scaled relationship to their inputs across a range of size and temporal scales or distinct segments of the electromagnetic spectrum or various electrical, physical, chemical, and other inputs (Ervin, 2018). Sensing technologies include visual, sound, motion, weather, human/health, Radio-frequency Identification Tracking (RFID), cellphone, Bluetooth, GPS, location, mobile, and environmental sensors.

Besides, actuators are electromechanical devices that turn a signal into a physical effect. It is the last part in a sequence of controls, which is in charge of the body's movement in line with the control system's directives. Every kind of sensor has a corresponding type of actuator. Visual actuators include lights, projectors, and displays/screens; auditory actuators include loudspeakers, bells, buzzers, clappers, and other similar devices; tactile actuators include pressure sensors, buttons, and 'touch panels.' Olfactory actuators are technically possible but have yet to be created or implemented, whereas gustatory actuators, also known as "taste emitters," are difficult to imagine. Interconnected sensors and actuators that can operate various devices and actions, from solenoids, valves, and motors to digital audio-visual and website contents, give new potential for monitoring environmental systems. This fundamental structure – sensor input from the environment; sensor output to actuator input; actuator output back into the environment – serves as the foundation for an indefinite number of response systems (Denardin et al., 2009).

2.4. Materials

Materiality is a fundamental part of the design process. Materials that demonstrate structural durability provide protection and shelter from external environmental conditions and affect our visual, haptic, and acoustic experiences through surface qualities such as textures, colors, and patterns that have shaped our built environment for centuries. Traditional and modern materials, such as stone and wood, as

well as steel, glass, and concrete, have long been employed in the construction of present constructions and will continue to be used in the future. However, present socioeconomic, political, and environmental situations are putting traditional materials and production processes to the test, necessitating the development of new material research procedures in the design process. Working with materials, manufacturing, and data-driven processes to promote performance, optimization, sustainability, and circular design approaches are all part of these innovative methodologies (Melendez et al., 2020).

Current technical advances in material development give designers new options to develop new material systems and employ form-changing adaptive materials. According to López et al. (2015), four types of adaptive materials exist: temperature-reactive materials, light-reactive materials, humidity-reactive materials, and carbon dioxide-reactive materials. Temperature-reactive materials include thermo-bimetals, heat-sensitive plastics, shape memory alloys, thermochromic polymers, and phase-change materials. Light-reactive materials include phosphorescence pigments, light-responsive polymers, and photochromic dyes. The cellular structure of wood and hydrogel are among humidity-reactive materials, and CO2-responsive polymers and titanium dioxide are among carbon dioxide-reactive materials. These shape-changing materials can be integrated with other sensing materials, creating the programmable matter concept. The concept of programmable matter is closely tied to the idea of developing materials that embed computing. Programmable matter is "materials whose properties can be programmed to achieve specific shapes or stiffness upon command" (Hawkes et al., 2010). These materials differ from robotic materials. The critical difference is that robotic materials allow programmability by directly embedding electronic components and microcontrollers in the material. In other words, rather than depending on the physical qualities of materials and structures to give certain levels of programmability, robotic materials have a microprocessor that can be programmed in any way imaginable and can determine the overall behavior (Tahouni, 2018).

The essential factor is choosing the suitable material and technique to achieve the design's technical criteria. Designers must evaluate underlying material qualities while selecting an appropriate material for representations to serve the intended goal. The selected materials must have inherent performative and self-actuating capacities and the ability to respond to changing environmental conditions in real time. Along with the mentioned tangible materials, intangible materials such as air, scent, and light are the elements that can represent digital data in physical space (Khot et al., 2020).

3. Data-driven design in landscape architecture

Landscape architecture is a comprehensive discipline rooted in natural sciences, problem-solving, engineering, visionary imagination, social psychology, and aesthetic composition. The discipline encompasses various issues focusing on design and environments (Cantrell & Mekies, 2018). However, defining the goals and scope of the effect is a constant challenge for the discipline; with the current accelerating rate of urbanization, even more challenges are on the horizon. This rapid urbanization, climate change, and growing social inequity have all become significant issues that need landscape architects to reconsider the communities and make them more adaptable to changing environmental circumstances (Hermansdorfer et al., 2020).

Additionally, increasing urbanization has led to a surge of data generated by the urban environment. In this new context, landscape architects must understand the possibilities and transform how they analyze, design, and affect city policy decisions. Cities are now opening up vast amounts of data with the proliferation of data-collecting tools. Indeed, far more technology devices are implanted in our urban fabric than we realize. We are immersed in an interconnected ecosystem of

ubiquitous communication infrastructures, which includes sensors, global positioning systems, automated systems, and locative media (Melendez et al., 2020). Most daily life elements are tracked and evaluated in real-time (Fricker & Münkel, 2015). According to McCullough (2013), modern city dwellers live in a constant cloud of ambient data and are always linked to digital information flows. Cities, urban environments, and ecological linkages become more complicated. As the quality of the urban environment is determined mainly by how the data is used, the capacity to deal with data is becoming increasingly important in design processes and protocols. In other words, the ability to sense, gather, and retrieve data provides landscape architects with new opportunities to make well-informed design decisions that are more responsive and adapt to residents, just like a biological creature adapts to its environment (Kalantari & Ghandi, 2017).

These applications lead to the concept of data-driven landscapes. The data-driven landscape is a type of landscape that uses the characteristics of sensors and intelligent machines to collect data and feedback about the environment. These environments combine sensor networks and actuators to provide interest, beauty, comfort, and engagement for visitors, occupants, and users (Peiyi,2019). Data-driven design concept differs from the traditional landscape design. While traditional landscapes are generally designed according to the people's will and interests and are strongly tied to the requirements and needs of the government, developers, and customers, data-driven landscape design is no longer a human product but a collaborative work of nature and humans. This design concept is managed by algorithmic and logical controls that create the space's outputs and perceived sensations (Ervin, 2018). In other words, it is based on connected input and output sub-systems.

This concept brings new forms of media, resulting in landscape installations that can be located in public spaces. Landscape installations are closely linked to the physical characteristics of a site, offering a direct response to and interpretation of a location (Kwon, 2004). Several installations have been developed in city centers, train stations, urban parks, and nightlife zones in responsive, adaptive, or interactive forms. These installations can be interactive, spatial, social, or environmental tools added to the existing design solutions in the landscape (Suurenbroek et al., 2017). Considering the crisis of the unattractive and unhealthy urban space today that does not encourage the activity of the inhabitants (Gołębiewski, 2019), having these installations in landscapes is becoming increasingly significant. In the first place, by having these installations, our designs become more responsive and gain the ability to share information within an urban environment to create the opportunity for designers and planners to create places better attuned to the people who use them. Thus, rather than the commodification of user data for profit-driven operations, landscape architects and planners can design for social interaction, human comfort, and health (Van Ameijde, 2018). The data-driven installations in landscapes provide or enhance essential human-needs-oriented services for shelter, comfort, community, and engagement, involving aesthetic, intellectual, curiosity-based, and information-motivated pleasures. They use networked sensors to enhance the primary human senses of sight, sound, and touch, and actuators that can control a wide range of devices and actions, from solenoids, valves, and motors to digital audio-visual contents that enable dynamic aspects of landscape experience, and extend the performative and expressive variety of designed landscapes (Ervin, 2018). Correspondingly, this setting enables us to perceive invisible, intangible, and multilayered environmental data.

Besides, such installations have both ecological connotations and social function that gives character, meaning, and order to the environments that lack identity or give expression to shared meanings and forms of use; they make places more recognizable and appealing. Due to varied users ' differing rhythms, they can function as a linking component in places that take on a dif-

ferent character at different times. Various responsive installations encourage people to participate and engage with the installation and other visitors, or just view them from afar as spectators. These responsive installations encourage certain 'dramaturgies' and significantly impact the nature of all or a portion of the public area (Suurenbroek et al., 2017). They can also encourage interaction among visitors to a place, help people with personalizing their experience of a place, and finally help reinforce the public domain qualities of public spaces. These installations simply draw people out of their bubbles.

However, the study of how responsive technology could be employed in spatial designs to assist in activating public places is still in its early stages (Cantrell & Holzman, 2015; Ratti & Claudel, 2016). Similarly, landscape architecture needs a better track record of accepting new technology paradigms and needs to catch up to related disciplines in adopting innovative techniques and tools (Cantrell & Mekies, 2018). Indeed, the main problem for the industry is to gain from developments in computer science and other related fields in order to correctly identify and evaluate reliable data before integrating the results into a dynamic and adaptive system for landscape architecture (Schwab, 2016) that responds to human needs and emotions deduced from data. Hence, landscape Architecture must evolve from being a passive vessel for humans and their actions to an organism that interacts independently with our minds and needs and ensures the best possible response to the environmental conditions.

4. Method

This paper aims to give landscape architects a clear image and guidance on how data can be used or adjusted in physical urban projects rather than conceptual design phase. After extracting essential knowledge about data-driven design, a systematic literature review approach was carried out in order to provide an overview of the state-of-the-art of existing data-driven landscape architecture projects. A combination of academic databases, including Elsevier (Science Direct), Google Scholar, ResearchGate, and Scopus, have been used. The string of keywords and combinations employed to identify pertinent studies are: computational design, responsive, adaptive, interactive, performative design, landscape architecture, architecture, data-driven design, and smart cities. These keywords were extracted based on the initial screening of the data-driven design concept. Additionally, not only further searches were performed by combining the keywords, but also a reference list of included studies was examined for potential sources. While publications from any timeframe were considered, the focus was on recent studies to capture the latest developments in the field. Besides, to complement the academic search, an online exploration of projects was undertaken. Key websites such as Archdaily, Dezeen, and Designboom were searched using relevant keywords to identify contemporary examples of data-driven landscape architecture. Criteria for case selection were to find projects that relied on computational processes to translate the input data as an abstraction to various configurations within urban ecologies.

5. Case studies

Landscape architecture projects that use a data-driven design process have a data input that initiates the activation leading to system changes or output. According to our findings, input data can be obtained from environmental or human sources or a combination of both. We also found three categories of focus for the data output: adaptive, performative, and interactive (Figure 1). These terms were defined previously in Table 1. These projects mainly engage performance, adaptation, and interaction through a range of protocols and scales based on smart systems and provide a computational framework for data to be manipulated and triggered as a form of exchange.

5.1. Environment-sourced inputs

Projects employing information conveyed through the environment include data from ambient sound,

weather data, ambient temperature, soil moisture, and air quality.

First and foremost, various projects employed ambient sound as the input; one of these examples is the interactive installation of Sonic Runway. In this installation, live sound signal input is analyzed and converted into light patterns based on the sound speed (Sonic Runway, 2017). The project uses LED-lined arches to visualize the speed of sound. Lightweave (FUTUREFORMS, 2018) is another interactive installation that translates ambient sounds into dynamic light patterns and auroras. Sound events in the surrounding vicinity of the installation often range from 50dB+ to 100dB+. Future Forms employs this project, previously known as Future City Lab. It is located under a pedestrian tunnel in Washington, DC, and aims to investigate if urban environments can become sentient participants, which can turn neglected voids into immersive spaces. Likewise, Sonomorph (Hildonen, 2011) is an adaptive installation made of nickel-titanium alloys (Nitinol) with shape memory properties that absorb sound and emit light by opening and closing cells. It is a research collaboration with Cornell University that functions as an augmented physical environment and engages people in a playful, dynamic context. Sonomorph cells are made of aluminum outer panels and glass-reinforced plastic inner panels with multiple sensory devices, servo motors, and LED lights. Infinity Field (SOFTlab, 2024) is another interactive installation that receives sound input. It encompasses fifty vertical mirrored chambers with a random distribution that provides a forest-like arrangement of shifting reflections for visitors while passing through the mirrors. Mirror Mirror (SOFTlab, 2024), another similar installation by the same lab, is programmed to respond to sound by producing light, allowing visitors to engage with the artwork and influence its appearance through their voices and bodies. Finally, Lightswarm (FUTUREFORMS, 2014), an interactive light installation applied to the façade of a building, investigates how buildings can become informative and dynamic urban interfaces that respond to data. Real-time data is collected from the building lobby and the surrounding city by sound-sensing spiders attached directly to individual glass panels in the lobby. These sensors provide data into a swarming algorithm, which coordinates the flowing light patterns to create an artificially intelligent installation that can sense, compute, respond, and interact with its surroundings.

On the other hand, the Infiltration Garden (Ervin, 2018) is a performative installation that represents the ambient temperature and the soil moisture with a weather sensor, algorithmic control, and colored LEDs in custom sculptural stainless-steel holders. The light flickers when rainfall penetrates the gardens. Moreover, the colder the temperature, the more intense the glow from the LED lights.

Air quality is another important environmental factor used as input data in Datascape and Living Light (Cantrell & Holzman, 2015). Datascape is a multi-component framework that brings forward hidden information to fight for environmental justice and address air quality issues. The framework contains five major components: a sensing system, data platform, communication platform, data visualizations, and infrastructural implementation. This system stores environmental data collected by the Bay Area Air Quality Management District (BAAQMD) and air sensors across West Oakland. Pollution con-

Figure 1. *The data-driven design process in landscape projects.*

centrations (PM2.5, PM10, DPM, and Ozone) can be measured in real-time using sensors and geo-tagged locations. An Air Quality Index (AQI) color range, as well as a monochromatic color palette, is developed, and a link between real-time data and time interval coordinates based on data given by one central monitoring tower in West Oakland is developed by using Grasshopper parametric modeling. The final interface highlights emission sources, while other essential components like a compass and weather information help users absorb their surroundings even more. Users will learn to read their surroundings based on these color and visual clues to air quality over time. Living Light, on the other hand, is a pavilion in Seoul, Korea, that uses a real-time light map to show air quality. Using community air quality monitoring data, Living Light establishes a link between individual communities and the invisible pollution phenomenon. The pavilion produces an actual and occupiable area that projects from the local to the city scale; this connection displaces territorial environmental data and makes it understandable as an abstract depiction. Living Light, as a prototype, offers a mode of communication between architectural objects, humans, and environmental events.

Dissimilarly, Urban Alphabets (Connecting Cities, 2014) is an interactive public screen installation based on the city's topographic details. Interested people can photograph letters used in graffiti, store signs, advertising columns, and other text located across the city using their cell phones. All of these letters combine to form an alphabet, which is displayed on a public screen. The exhibit invites passersby to notice typographic elements in urban design that contribute to forming a local character. In terms of space, the installation converts a nearly blank wall into a dynamic focal point. Urban Alphabets is also a fantastic illustration of how 'urban screens' may be employed as a stylistic technique in spatial design and how actual space can be activated as an interactive background. The goal of the Urban Alphabets project is to demonstrate to residents and visitors to a specific city how remarkable and unique that city is and to urge participants to look at their city in a new light: using letters as graphic markers for a city's visual identity. Participants create their version of their city's alphabet using the Urban Alphabets smartphone app. All letters are geo-tagged and submitted to the project website simultaneously. The city's letters are used to construct the city's alphabet, displayed on the website. This application proves that smartphone applications do not have to be intended to isolate their users from their surroundings. However, it may instead create a new user engagement experience with space.

Last but not least, drone-based data-driven projects exist in the landscape. Swarm compass (Ars Electronica Futurelab, 2024) is a drone-based routing system that leads pedestrians through crowded streets. They show available or blocked routes temporarily closed due to overcrowding by changing color. Using colored lights and the dynamics of the drones' motions can also enhance a location's ambience. Indeed, Swarm Compass's fundamental concept is to navigate people using swarm intelligence and to deliver an entirely new medium in the entertainment and communication service industry. Franchise Freedom (Studio Drift, 2024) is another performative drone-based installation that examined the natural flying patterns of starlings and converted them into software mainly designed and incorporated in Intel® Shooting StarTM drones. A self-flying flock of hundreds of drones questions the human sense of freedom and social construct. It allows visitors to look at the poetic side of technological advancement and reconnect with nature. An algorithm that reacts similarly to starling murmuration was used to construct their flying patterns. Besides, the intensity and color of each drone are affected by its distance from other drones, emphasizing the group's density.

The details of each project, including input and output types, designer, location, year, and the employed technology, are listed in Table 2, and the projects are displayed in Figure 2.

Table 2. *Data-driven landscape projects with environmental inputs.*

Data-driven landscape projects with environmental inputs							
Project	**Reference**	**Designer**	**Year**	**Location**	**Input**	**Technology**	**Output**
Sonic runway	(Sonic Runway, 2017)	Rob Jensen Warren Trezevant	2017	Chengdu, China	ambient sound	addressable LEDs	interactive
Lightweave	(FUTUREFORMS, 2018)	Jason Kelly Johnson Nataly Gattegno	2018	Washington DC, USA	ambient sound	suspended stainless steel, LED latticesles	interactive
Sonomorph	(Hildonen, 2011)	Blaine Brownell	2009	LosAngeles, USA	ambient sound	aluminum outer panel, glass-reinforced plastic inner panels, servo motors, and LED lights	adaptive
Infinity field	(SOFTlab, 2024)	Softlab	2020	Bangkok, Thailand	ambient sound	mirrorred chambers, LEDs	interactive
Mirror mirror	(SOFTlab, 2024)	Softlab	2019	Alexandria, USA	ambient sound	vertical mirrorred surface, LED fixtures	interactive
Lightswarm	(FUTUREFORMS, 2014)	Jason Kelly Johnson Nataly Gattegno	2014	San Fransisco, USA	ambient sound	sound sensing spiders, 3D-printed light modules, addressable LED strips, laser-cut skins of recyclable PET plastic and synthetic paper	interactive
Infiltration garden	(Ervin, 2018)	Chris Reed	2018	a university campus	ambient temperature, soil moisture	sensors for light, temperature, soil moisture, colored LEDs, stainless steel holder	performative
Datascape	(Cantrell & Holzman, 2015)	Yitian Wang, Yi Liu, and Matty A. Williams	2013	West Oakland, USA	air quality	Arduino, Firefly, Grasshopper	performative
Living light	(Cantrell & Holzman, 2015)	David Benjamin, Soo-In Yang	2009	Seoul, Korea	air quality	LED lighting, pavilion panels	interactive
Urban alphabets	(Connecting Cities, 2014)	Suse Miessner	2014	Helsinki, Finland	city's topographic details	public screen, smartphone app	interactive
Swarm compass	(Ars Electronica Futurelab, 2024)	NTT & Ars Electronica Futurelab	2017	Tokyo, Japan	routing information	drones, colored lighting, swarm intelligence	performative
Franchise freedom	(Studio Drift, 2024)	Drift Studio	2018	Amsterdam, Netherlands	Starlings' flight behavior	drones, software algorithm that reacts similar to murmuration, light source	performative

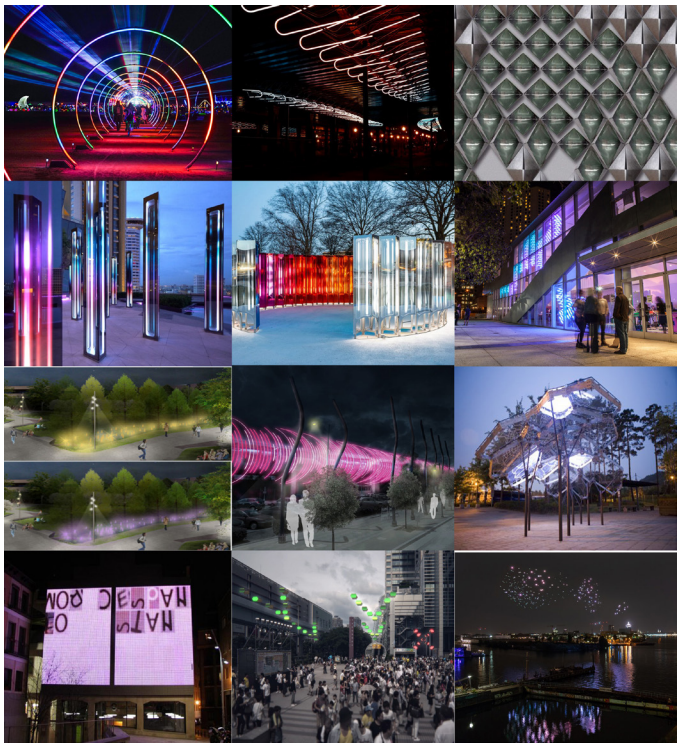

Figure 2. *Data-driven landscape projects with environmental inputs.*

5.2. Human-sourced inputs

Projects employing information conveyed through human-sourced data could vary from users' movements, touch, shadows, facial expressions, and heart rates to their plastic waste donations or their Twitter feeds.

For instance, Swingscape (Grønbæk et al. 2012) is an interactive swing installation that aims to revitalize urban environments by encouraging people to engage in outdoor activities even during the winter, join a collective activity, and let go of their usual behavioral patterns. While using the swing, the users' movement changes the project's light and sound. The installation consists of ten swings, each of which activates a different part of a more significant light and music cosmos. 2 different light zones are illuminated by different colors; variable beats are activated in the blue zone, whereas melodies are activated in the green zone. Depending on which swing and light zone is selected, the aural experience

is distinct. Whereas, using a touch-and-video interface, Karen Lancel and Hermen Maat's Saving Face (Verhoeff & Cooley, 2014) project allows visitors to connect with the public in a place. When visitors stroke their faces in front of a tiny column equipped with a camera, the areas of their faces stroked are displayed on a giant screen. The picture of their face gradually fades until it is merged into a composite image of all the other faces shot up to that point. Public Face (von Bismarck, 2008) is another installation benefiting from the facial expressions of passers-by. This interactive project comprises an eight-meter-tall neon smiling sculpture installed on an ancient gasometer in Berlin, a lighthouse in Lindau, and a block of flats in Vienna. Cameras across the city record people's facial expressions, subsequently utilized to calculate mood. The happier the passersby's facial expressions, the happier the city's smiling faces. The opposite also occurs: unhappy faces in the city cause the smiley's lips to close. Because of its magnitude, this artwork becomes a landmark that draws people's attention to an existing structure in the city.

Additionally, passersby's shadows are applied as valuable input for a data-driven project. Body Movies (Lozano-Hemmer, 2001) is an interactive installation that has been exhibited in cities all over the world. A seventeenth-century illustration of famous shadow plays of the period inspired it.

Passersby are urged to 'project' their shadows onto a blank wall in public by moving in the beams of a vital light source. Dune, Aviary, and ArenA Boulevard are other interactive projects with human-sourced input. The 60-meter-long permanent Dune (Studio Roosegaarde, 2011), located along the Maas River in Rotterdam, Netherlands, is a light landscape interacting with human behavior. The nature-technology hybrid comprises hundreds of strands that light up in response to the noises and actions of passing guests. Aviary (AREA C Projects, 2013) is a small-scale public installation of light poles that interacts with people's touch with light and music responses meant to be played like a musical instrument. The engagement and connection to the reaction are immediate, producing a feedback loop between the installation and the person. Next, Arena Boulevard (Suurenbroek et al.,2017), an interactive installation of LED strips based on pedestrian flows, aims to strengthen the place as a space in order to make the entire boulevard more efficient and reduce the perceived length of the route by improving the spatial quality and making the place livelier with lighting and sound, as well as improving the quality of this strip as a pedestrian passageway.

Then, Heart of the City (Anaisa Franco Studio, 2015) is a piece of urban furniture that invites passersby to sit for a while and create their own space to reflect on their surroundings. Visitors can put their finger on a sensor in the center of the couch; the installation then monitors the user's heart rate, and the LED strips in the sofa pulse in time with the heart rate. Even though individuals approach it individually, this distinctive item and pulsing light contribute to a personal experience of the place.

Contrarily, more performative projects such as Tetrabin and Northside beacons exist. Indeed, Tetrabin (TetraBIN, 2018) is a garbage bin covered with a LED screen that encourages visitors to public places to throw their trash in the trash cans. When litter is thrown into a garbage can, tetris-shaped pixels emerge, the form and direction of which are controlled by the time and shape of the binned object. TetraBIN is the first interactive receptacle with AI and IoT capabilities. It reimagines trash cans and standard information kiosks as interactive receptacles that foster suitable behavioral modifications and add joy to the mundane waste disposal task.

Similarly, Northside Beacons (Kollision, 2018) is a project for collecting and reusing the plastic waste disposed of during the Northside Festival 2018. When users threw a plate into the recycling station, they were rewarded with light pulses from sixteen enormous beacons that extended the whole 160-meter length of the festival grounds. The goal was to get more people to sort and recycle their trash. The beacons were made from a wooden

base with a seat and transparent tops with individually controlled LEDs. Kollision's MAP software controls all of them linked to IR sensors within the collecting station. When not engaged by users, the installation functioned as discreetly lit navigational beacons for festival attendees to find one another.

Whereas adaptive projects such as Hylozoic Ground (Philip Beesley Studio, 2010) work like a vast lung, breathing in and out around its inhabitants. Tens of thousands of lightweight digitally manufactured components were equipped with microprocessors and proximity sensors that detected human presence. This sensitive habitat works like a giant lung, breathing in and out of its residents.

Moreover, some projects receive input from indirect human sources like Twitter feeds and wireless networks. Datagrove, Mimmi, and Immaterials are instances of such installations. Datagrove (FUTUREFORMS, 2012), designed as a "whispering wall," is made up of LEDs, speakers, and LCD monitors that are meant to depict hidden data streams from many sources as they flow through the urban environment, whispering Twitter and other social media information within a protected and quiet atmosphere. It questions the personal and immaterial experience of social media across individual devices. It starts by asking how giving physical and spatial connections to this data could shape architecture in new ways to influence social, political, and environmental behavior. Mimmi (Architizer, 2015), or the Minneapolis Interactive Macro-Mood Installation, is an iconic inflatable cloud hovering above the Minneapolis Convention Center Plaza plaza. It receives emotive data from Twitter feeds connected to Minneapolis residents and visitors to the plaza. It then uses real-time data analysis to respond to the city's input with abstracted light displays and misting.

Table 3. *Data-driven landscape projects with human-sourced inputs.*

Data-driven landscape projects with human-sourced inputs							
Project	**Reference**	**Designer**	**Year**	**Location**	**Input**	**Technology**	**Output**
Swingscape	Grønbæk et al. 2012)	Interactive Spaces Lab	2011	Roskilde, Denmark	user movements	swings, LED lights	interactive
Saving face	(Verhoeff & Cooley, 2014)	Karen Lancel Hermen Maat	2014	56th Venice Biennale	users' touch and gestures	algorithms, social media	interactive
Public face	(von Bismarck, 2008)	Julius von Bismarck Benjamin Maus Richard Wilhelmer	2008	Hamburg, Germany	facial expressions of passers-by	CCTV camera, apparatus mechanism, software	interactive
Body movies	(Lozano-Hemmer , 2001)	Rafalel Lozano-Hemmer	2001	Rotterdam, Netherlands	passer-by's shadow	projectors, transparencies, computerized tracking system, plasma screen, mirrors	interactive
Heart of the city	(Anaisa Franco Studio, 2015)	Anaisa Franco	2015	Sydney, Australia	users' heart rate	blocks of styrofoam, electric chain saw, fiberglass and resin, LED neon flex	interactive
Tetrabin	(TetraBIN, 2018)	Steven Bai	2018	Sydney, Australia	users' waste	AI, IoT, LED screens	performative
Northside beacons	(Kollision, 2018)	Northside, Martin by HARMAN	2018	Northside Festival, Denmark	users' plastic rubbish donation	wooden base, translucent tops,LEDs, Kollision's map software, IR sensors	performative
Hylozoic ground	(Philip Beesley Studio, 2010)	Philip Beesley	2010	Venice, Italy	human presence	microprocessors, touch sensors, shape memory alloy actuator	adaptive
Dune	(Studio Roosegaarde, 2011)	Studio Roosegarde	2011	Rotterdam, Netherlands	sounds and motions of passers-by	fibers, LEDs, sensors, speakers interactive software and electronics	interactive
Datagrove	(FUTUREFORMS, 2012)	Futureforms	2012	San Jose, California	Twitter feeds	text to speech module, Arduino, WiFly shield, Verizon Mifi, LCD panels, LEDs, IR sesnors	interactive
Mimmi	(Architizer, 2015)	Urbain DRC, INVIVIA	2013	Minneapolis, USA	Twitter feeds	web apps, language parsing of social media streams	interactive
Aviary	(AREA C Projects, 2013)	Höweler+Yoon Parallel development	2013	Dubai, UAE	people's touch	capacitive sensing	interactive
Immaterials	(Voyoslo, 2011)	Yourban	2011	Oslo, Norway	wireless networks	rods, LEDs, timelapse photography	interactive
Arena boulevard	(Suurenbroek etal., 2017)	Frank Suurenbroek	2017	Amsterdam, Netherlands	pedestrian flows	timelapse camera, LED strip, gobo projectors, LED screen	interactive

Similarly, Immaterials (Voyoslo, 2011) visualizes wifi networks in cities. It is based on the concept of a surveyor generating maps, offering an abstracted cross-section of the invisible networks and landscapes that are a vital part of how today's cities function. The 4m long rod contains 80 LEDs that pulse and rise in response to the power of a specified wifi network. Using time-lapse photography, the pulsating lights provide a tangible depiction of how different networks respond in their specific environments.

The details of these projects, including their input and output types, designer, location, year, and the employed technology, are listed in Table 3, and the projects are displayed in Figure 3.

5.3. Mixed-sourced inputs

Projects employing information conveyed through environmental and human-sourced data are rare; however, successful projects exist. For instance, Data Garden (Grow Your Own Cloud, 2020) combines nature and technology to interpret data better. It addresses a "new sort of data infrastructure" that creates an environment that encourages interaction and fusion between people, technology, and ecosystems. The Data Garden enables visitors to experience new materiality around data and explore a world in which data storage is green and exists as an accessible public resource that is shared among communities. It is a performative project that includes data-encoded plants. Encoding is done by transferring digital data such as text, JPEGs, and MP3s into a biological format, DNA, utilizing ACGT rather than binary. The DNA of the plants is decoded in real-time within the installation using the most advanced genetic sequencing technology and displayed in space, revealing hidden meanings. This research installation creates new options for understanding data and tackles challenges such as climate change.

Furthermore, ambient sounds plus users can provide inputs for the projects. An example of such installations is BruumRuum (Foges, 2017). Color and sound are combined in this interactive project using 522 in-ground linear luminaires implanted in a 3,300-square-meter area. Using sensors set around the plaza, the LEDs respond to the intensity of people's voices and ambient sound generated by the city. In a like manner, the "Public Sphere" (Wit & Bussiere, 2015) receives input data from ambient sound and users' touch. "Public Sphere" is an adaptive robotic kiosk that redefines a specific public space through information and interaction and re-centers the city around a publicly accessible and globally interconnected network. This project deconstructs the usual typology of an urban kiosk into playful and adaptive urban furniture.

On the other hand, Confluence (SCAPE, 2024) is a performative project depicting four critical phenomena in a park region below a bridge: water quality, fish flow, human flow, and river flow. Each phenomenon is separated and shown separately, resulting in distinct visualizations that clarify a complicated series of overlapping events.

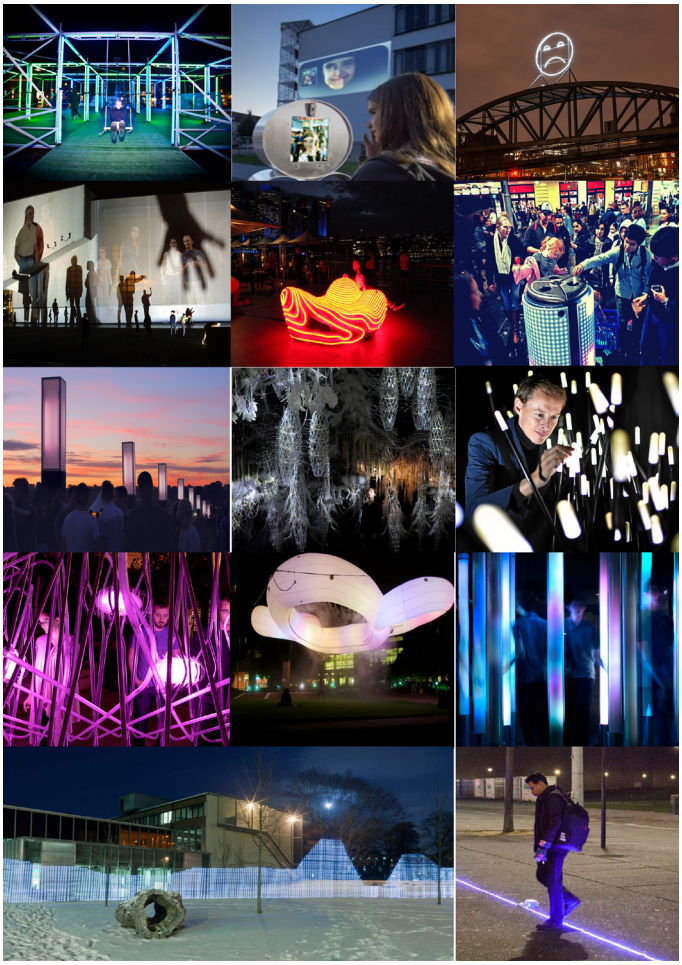

Figure 3. *Data-driven landscape projects with human-sourced inputs.*

Through a light field at ground level and the projection of light onto the bridge structure, the region under the bridge becomes the canvas for these visualizations. Finally, another distinctive example is the interactive space called Weather Report, which is a site-specific installation that represents both the quantitative data of weather information within sixty years of recorded history, including temperature, rain, snow, wind, and cloud cover, and the qualitative and subjective weather data from the memories of users on specific dates in the past (Swackhamer et al., 2017). In this installation, data is presented by more than 800 miniature balloons that are suspended to form two walls and can be touched in an attempt to make scientific data on. The depicted projects affirm that when input data is retained from a combination of both human and environmental sources, many creative processes can be applied and therefore lead to a more successful project that can be achieved in landscape architecture. The details of these projects are listed in Table 4, and the projects are displayed in Figure 4. Understandable to non-scientists.

6. Discussion

This paper presented data-driven design and its applications in landscape architecture. The study and the different examples that had been reviewed introduced a classification of these systems according to their input

Table 4. *Data-driven landscape projects with mixed-sourced inputs.*

Data-driven landscape projects with mixed-sourced inputs							
Project	**Reference**	**Designer**	**Year**	**Location**	**Input**	**Technology**	**Output**
Data garden	(Grow Your Own Cloud, 2020)	Cyrus Clarke Monika Seyfried	2020	Elsinore, Denmark	plants' real time DNA, visitors' digital data	genetic sequencing technology, nanopore sequencer	performative
BruumRuum	(Foges, 2017)	David Torrents Artec3 Studio	2014	Barcelona, Spain	passing visitors' sound, noise of the city	linked sensors, Madrix software, in-ground linear LED fixtures	interactive
Confluence	(SCAPE, 2024)	Scape/Landscape Architecture The Living	2011	NewYork, USA	water quality, fish flow, people flow, river flow	water flow sensors, LED lighting installation	performative
Public Sphere	(Wit & Bussiere, 2015)	Andrew John Wit Simon Bussiere	2015	Chicago,USA	ambient sound, users' touch	Arduino, Raspberry Pi, KUKA, grasshopper plugins like: Ladybug, Honeybee, Firefly	adaptive
Weather report	Swackhamer et al., 2017)	Daniel F. Keefe et al.	2016	Minneapolis, USA	weather data, user interaction	touch display, off-the-shelf steel tube frame, air-filled skin (gridded array of white balloons)	interactive

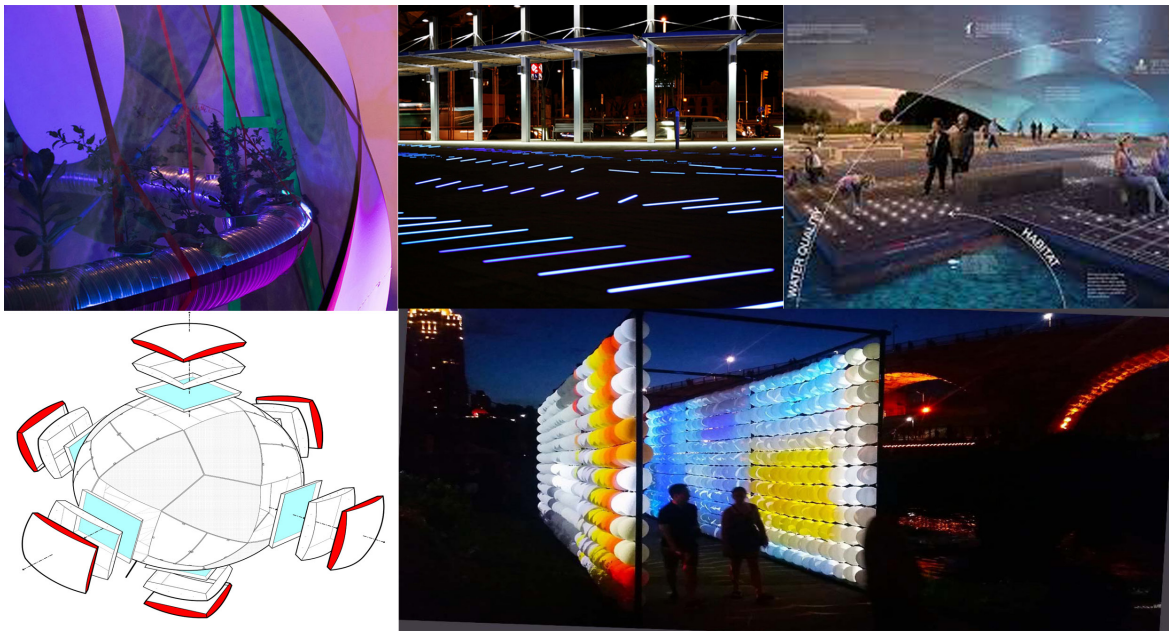

Figure 4. *Data-driven landscape projects with mixed-sourced inputs.*

and output types. As shown in Table 5, it is observed that the majority of data-driven projects in landscape receive their input data from human sources (45.2% of the existing installations) and then from environmental sources. However, only a few benefit from a combination of environmental and human-sourced data (16.11% of the existing installations) that creates the most beneficial projects to meet human needs and changes in landscape architecture. On the other hand, although adaptive and performative structures are the most efficient structures in terms of getting the best performance and the ultimate benefit from data-driven systems, it is observed that the interactive outputs receive the maximum priority while designing by data in landscape (64.52 % here). This finding, although it proved the efficiency of data-driven design in landscape architecture, highlights the area with limited focus but great potential. Thus, future research and projects need to focus on improving the performance and functionality of landscapes, while simultaneously keeping aesthetic possibilities.

Table 5. *Input and output type percentages.*

		Percentage
Input type	environmental- sourced	38.7
	human-sourced	45.2
	mixed-sourced	16.1
Output type	interactive	64.52
	adaptive	9.68
	performative	25.8

7. Conclusion

This research aimed to explore the potentials of data-driven design for various purposes of landscape architecture. After reviewing the state-of-the-art projects, cases demonstrated a variety of social and environmental contexts in which they provide or enhance landscape services. We have classified the cases based on input and output types, revealing a predominant reliance on human-sourced data and a focus on interactive outputs. Landscape architecture is a discipline that is characterized by its expansive, diverse, and fluid nature, and encompasses various elements, including art, engineering, urban design, and architecture. While most of the examined instances were solely artistic and expressive, projects existed that were focusing on functionality and landscape performance as well. Although artistic projects focused on the visual aesthetics mainly, projects with functionality had a broad spectrum of thermal comfort, acoustics, wind, shelter, climate change, etc. This finding helps us better understand Ervin, (2018) who stated that data-driven landscapes are more like "landscape art" than "landscape architecture." Yet, this article illustrated the potentials of data-driven design to boost landscape performance in many ways. Here, landscape performance refers to systems that can reconfigure themselves or mediate the surrounding environment for user comfort (Turrin et al., 2012). The novelty of this study emerges from its comprehensive synthesis and classification of the projects, which, to date, have been dispersed and not categorized. This research is regarded as a fundamental study that unifies data-driven projects under a single, input- and output-based framework. This classification provides an original viewpoint for researchers and designers to observe upcoming projects through, enabling better decision-making and encouraging creativity in the use of data-driven techniques in landscape design. To conclude, for these technologies to improve people's lives in the landscape, additional work must go into creating a system that can constantly adapt itself to suit human needs and changes in the landscapes, much like a living thing does. The landscape architecture can be improved for coming generations by bridging the gap between data, design, and functioning.

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Creolization or mimicry? A study of British colonial architecture in the Niger Delta

Warebi Gabriel BRISIBE[1], Ramota OBAGAH-STEPHEN[2*]
[1] warebi.brisibe@ust.edu.ng • Department of Architecture, Faculty of Environmental Sciences, Rivers State University, Port-Harcourt, Nigeria
[2] ramota.obagah@ust.edu.ng • Department of Architecture, Faculty of Environmental Sciences, Rivers State University, Port-Harcourt, Nigeria

** Corresponding author*
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Abstract
This study examines the concept of creolization in colonial architecture based on a discourse of works by Melville Herskovits, Robert Baron and Jay Edwards. It also highlights the influence of the found architectural knowledge of the indigenous peoples on the emergent colonial-built forms. In previously colonized societies, majority of public heritage architecture is an agglomeration of building ideas, spatial arrangement, and architectural features, mimicked, borrowed and indigent from the colonizers and the colonized. This article argues that creolization in the context of this study is simply reversed mimicry based on found architectural knowledge. Using a combination of archival data, discourse analysis and actual case study research, this paper examines some selected colonial buildings in the Niger Delta which are of British authorship but with noticeable indigenous attributes. This article presupposes that in some settings reversed mimicry masked as creolization thrived by reason of found architectural knowledge, resulting in a distinct stilt architectural style found during the colonial era in the study region.

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Keywords
Colonial architecture, Creolization, Found knowledge, Mimicry, Stilt buildings.

1. Introduction: Concepts and metaphors of creolization

Creolization is a form of cultural change or transformation of vernacular expressive forms resulting from interaction of two or more cultures pressured into involuntary contact by colonialism. It takes its root from linguistic theory which involves creation of a new language structure using a combination of existing building blocks of morphs and syntaxes, which when crystalized and stabilized becomes an existing norm with an identity of its own. Although first formulated through the study of languages in colonial situations, language is only a small part of the expressive means of creolization, as it is also linked to folklore, material culture and other forms of artistic production that emerged as the creative response of the coming together of people from multicultural communities (Baron & Cara, 2011). It is on this basis that the study examines the parallel this linguistic concept finds in an alternate universe like architecture birthed by contact and cultural diffusion. It uses content analysis of scholarly works to investigate the import of these concepts and draw comparisons.

According to Edwards (1994) the word creole (Criollo) derives from 15th century Portuguese. The earliest use of its attribution to architecture was by N.C Curtis (1943), the Cuban architectural historian Frat Puig (1947) and Buford Pickins (1948). He goes further to state that although most scholars agree on the definition of what a creole house is, they generally differ on the origins of its architecture as he discusses in the origins of the Louisiana Creole Cottage (1988).

To comprehend the full import of the concept of creolization as it relates to architecture, it is pertinent to first explore its characteristics. These characteristics are best described under what Baron (2011) terms as "metaphors" of creolization. Metaphors in this context are used to explain a combination of cultural components that typify or to a large extent are indicative of creolization. Baron (2011) maintains in this quote that "creolization which encompasses both form and process is both rendered through metaphors that speak to states of both being and becoming" (Baron, 2011, p. 281).

A series of terms that capture the varied concepts of creolization were made popular by Herskovits from his early studies of black diasporan cultural influences in the United States, Suriname, the West Indies as well as West Africa, in the 1930s through to the 1940s and form part of the Herskovitian metaphors (Herskovits, 1958 as cited in Baron, 2011).

Herskovits created a compendium of metaphors to represent how cultural forms combine and how these in turn have been transmogrified into new entities, all co-existing in a system in spite of their different origins, although not all metaphors have been attributed to Herskovits. Ian Hancock for instance, uses the metaphor of 'compound and mixtures' in describing creole languages. He was of the opinion that creole languages have become whole new entities combined from constituent elements devoid of traces of their original identities due to blending i.e., compounds as opposed to mixtures; chemically combined together as opposed to separable. The restructuring that occurs through or during creolization he believes results in the formation of a new product be it language or in this context architecture (as cited in Baron, 2011). Other theorists do not agree but rather aver to the idea of non-fixed mixtures where distinct identities of the constituent elements are still distinguishable.

Edward Braithwaite views creolization by way of a prismatic concept; a process resulting in subtly leaning towards or drawing inspiration from original ancestral sources, based on a co-operative effort from all parties involved (Braithwaite, 1974). A prismatic concept sees all cultures within it as equal and connected from a single ancestral point of origin. However, over time each culture eventually develops its own lifestyle having evolved through contact with the environment and interface with other cultures, until the style becomes nativized or accepted by all even though it still retains vestiges of their original ancestry and heritage (Brathwaite, 1977).

Transculturation as described by Carranza (2010) is a selective process through which cultural producers take certain elements from an admired or colonizing culture and substitutes them for their own. Other terms popularized by Herkovits, that make up the repertoire of metaphors include: Syncretism, Assimilation, Consolidation, Amalgamation, Cultural Mosaics, Kaleidoscope and Intermingling (as cited in Baron, 2011).

But of all these metaphors, it is the concept of 'syncretism' that is more akin to the concept of creolization as it applies to architecture. Syncretism describes a mixture, a unifying of elements, and a metaphor of interspersal; a mingling, yet appropriately suggesting the retention of the identity of its constituent elements – elements found in a mixture rather than a compound. It is a response to an acculturation process; a combination of European traditions and Aboriginal African patterns to which they are exposed. In syncretism, elements from two distinct sources combine with neither of them losing their individual identities. It was first used by Herskovits in a comparative study between African gods and Catholic saints; identification between the two beliefs and creolized forms that show reconciliation between both systems. Among those of African origin in Brazil, Cuba and Haiti, the evidence of syncretism is most prominent in immediately recognizable traits of ancestral worship in organized religion.

Herskovits is convinced that syncretism is as prominent in Cuba and Brazil as it is in Haiti. Vlach (1978) attributes the design of the caille - a Haitian vernacular-built form, to a three-way interaction between the Arawak Indians, French colonials and African slaves, a marriage of convenience between African, European, and Amerindian. The African slaves in this case being the Yorubas whose culture formed the primary source for the production of the caille. Vlach (1978) summarized the three cultural sources for this house type in these words "it contains the gable door and porch of the Arawak bohio, the construction technique of French peasant cottages, and the spatial volume of a Yoruba two-room house" (Vlach, 1978, p. 125).

This brings into the picture, slaves from Western Nigeria, imported to work in the plantations of Cuba and Brazil whose freed descendants found their way back to Lagos in the mid-1800s and for whom their renowned building artisanry form a large part of the courtyard styled, colonial architecture found in some parts of Lagos and western Nigeria.

2. Creolization in colonial era architecture: A reading of Jay Edwards

Creolization in architecture like linguistics is clearly a product of cultural diffusion, common only to regions considered as the 'new world' (colonies) that were associated with the 'old world' (empires), such as the West Indies, West Africa, Louisiana in the United States etc. According to Edwards (2001) colonial architecture first appeared in and around the coastal insular, riverine forts and trading posts established by Europeans in West Africa in the 1440s (Edwards, 2001, p. 85). He defines creole architecture as "any architectural tradition genetically descended from a synthesized tropical colonial form" (Edwards, 1994, p. 4).

This is based on the conjecture that the tropical vernacular posed the greatest problem of adaptation to the European designer-builder (Edwards, 2001, p. 85).

Edwards' study on colonial adopted variants in architecture, achieved through maritime diffusion patterns over the years credits him as one of the foremost authorities in the study and application of creolization to architecture in a scientific way, especially as it relates to colonial and post-colonial architecture. The study of creole architecture is all about revealing patterns, principles and a unique generic language for which Edwards advocates the use of anthropo-historical study as a means to that end. One thing that remains a constant amongst most creolization theorists is the parallel drawn from linguistic theories.

The transformation of European and local vernacular architecture into creole architecture replicates the transformation process that begats creole

languages. The evolutionary stages and culminating structural patterns in both cases show significant parallels. Just as similarities in the process of koineization (Smith & Veenstra, 2001) and the building of creole language structure in general can be observed in linguistics, Edwards' study argues that creole architecture has become a unified tradition based on its own unique principles similarly across board. This implies that anywhere creole architecture is found there is a universal creole pattern language in operation irrespective of the location it exists. This unique language can be traced by following the historical movements of architectural features and design brokers between countries and colonies across the oceans and across time (Edward, 2001, p. 94).

Nonetheless, he categorically states that "early colonial architecture is not European architecture transported into the colonies, rather it is architecture developed based on found knowledge, which has been harnessed and adopted by colonists for functionality. Knowledge adopted from pre-existing vernacular-built forms, local building techniques and culture of the locales of the colony.

2.1. Vernacularizing indigenous architecture

Over the years, the term 'vernacular' has been generally assented to by most scholars nonetheless; there is still no commonly accepted definition. Paul Oliver who was one of the earliest and widely cited proponents of this discourse is of the opinion that the term has as many meanings as the cultures and languages that exist (Oliver, 2006). There are a few studies that have attempted to clearly define and differentiate what is considered indigenous traditional architecture from vernacular architecture. The summary of it is that while the 'traditional' on one hand, is seen as 'pure' and uncompromising - a form of architecture that develops instinctually, the 'vernacular' on the other hand is more of a 'composite' - a combination of indigenous and borrowed traits in layout, material usage and design features, that came about due to cultural dynamism and environmental need. This definition is more in sync with the concept of creolization and its role in architectural development, especially in poly dialectic societies.

The vernacular is the architectural popular culture of a people in a particular place and a given era or period. It can also be described as the commonplace architecture of the masses, the building types more in use during a certain time, which oftentimes is an agglomeration of ideas, borrowed and indigent (Brisibe, 2020). Upton (1990) asserts that the resulting creole architecture is evident of the invaluable role the humble vernacular buildings of indigenous folks have played in the creative process. For which we might add the creative process of syncretism. This is because, the knowledge that is being referred to, comes about through a complex multiethnic and syncretic process' as seen from Edwards' description of creolization; as the process of cultural reformation and syncretism common to colonial and post-colonial environments (Edwards, 2001, p. 90).

2.2. Creolization and mimicry

Although, the act of creolization in colonial-built forms have been attributed to colonialists as products of colonization by the likes of Edwards amongst others, there is undoubtedly the issue of mimicry embedded in this discourse. Mimicry, copy transfer and duplitecture are all terms synonymous with the exportation of architectural designs and ideologies predominantly from old established cultures in Europe to new cities or their colonies.

A few scholars have also examined the concept of mimicry, copy transfer and duplitecture of iconic architecture and ideologies through colonial influence. Lagae and Matos (2012) in examining the issue of copy transfer, observed that the diaspora of 19th and 20th century architecture is the exclusive result of an export of ideals, models and practices from the 'centre', being Europe and North America to the 'periphery' (being the colonies). Studies in this area have also been conducted by the likes of Roberts (2014) who examined the influence of commercial or trading networks, in particular on the dissemination of architectural ideas and practices in colonies.

But with regards to mimicry, Bhabha's (1994) exposition on the concept especially in relation to colonial imposition throws more light on the issue. He suggests that

"colonial mimicry is the desire for a reformed recognizable other as a subject of difference that is almost the same but not quite….it is the desire that reverses in part the colonial appropriation by now producing a partial vision of the colonizer's presence" (pp. 86-88).

In essence, Bhabha suggests that mimicry leads to mere repetition of the colonial material culture in question, rather than a true representation of the colonial culture itself and with each repetition or stereotype, a difference is created. Yet mimicry has emerged as one of the most effective strategies of colonial imposition especially in relation to architecture (Bhabha, 1994). Although there is limited research in this area, there is however sufficient evidence of such practice emanating from empires to colonies across the world and there's even lesser research of such practice going the reverse direction even with similar sufficient evidence.

The idea of reverse mimicry, where the colonizers copied from the colonized and transferred such knowledge in the opposite direction appears lost in the general mimicry discourse and even obfuscated as it relates to creolization. The picture that has been painted and the point repeatedly driven home is that of mimicry being a one-way street a unidirectional imposition of colonial ideas and material culture. However, mimicry as the term implies connotes copy, imitation and even impersonation amongst other things. From the earlier quote by Edwards (2001) on colonial architecture being based on found knowledge, the terms harnessed and adopted used are simply synonyms for imitation, copying and personalizing - taking something found and making it one's own. But the issue of impersonation comes up when credit for the adopted knowledge is not given to the indigenous original founders, rather it is usurped.

Bhabha (1994), Lagae and Matos (2012) and Roberts (2014) all emphasize the idea of copy as being from the empire to the colonies with the addition of the term 'transfer'. Yet, while the act of copy transfer is not in dispute, the act of copying from the colonies is less emphasized or at best subsumed under creolization as a mixture. The fact is, copying or copy transfer is a reciprocal act on a two-way street and this study highlights what has been copied from the colonized and used by the empire although not transferred back overseas in this particular case.

Based on this premise, we argue for reverse mimicry as inclusive global histories. Inclusivity of non-western views, methodologies and epistemologies have formed part of the advocacy agenda for the Global South in the last two decades (MacDonald, 2016). Reverse mimicry engages with and challenges the issue of who's perspectives are used or from who's viewpoint is a concept seen or established knowledge attributed to. Inclusive histories address misrecognitions or non-recognitions of due accolades. It should therefore, suggest the retelling of reverse mimicry as a key part of our colonial history in a manner that recognizes the contribution of Nigeria's indigenous architectural found knowledge in creating the architectural heritage of the British colonial era.

3. Creolization and 'found architectural knowledge'

Found knowledge is knowledge adopted from pre-existing vernacular-built forms, local building techniques and culture of the locales of the colony. Edwards (2001) emphasizes that creolizations in colonial-built forms are products of the colonialists while that of post-colonial built forms emerge from the thought processes of the indigenous folks. This study focuses on colonial architecture and as such examines the process of creolization from the perspective of the colonialists. Although, the reasons colonialists give for their empire expansion actions are framed in the guise of bringing civilization via knowledge to the darker fringes or peripheries of the world, what has been observed is that in every territory these European empires have colonized they met with 'Found knowledge'. Found knowledge is material culture, resources and

technology existing in the territories prior to the advent of the colonialists. History has shown that more often than not, colonialists find out that what they referred to as primitive societies have always been more advanced in several aspects than they anticipated and are often met with surprise upon arrival at the shores of these so-called primitive worlds. At the top of the list is found architectural knowledge, since architecture has been described as the largest form of material culture (Glassie, 1999; Tilley et al., 2006).

There are several reports of found architectural knowledge in founding cities and old empires across Western, Eastern and Southern Africa. A mini compilation of some scholars and their works depicting existing pre-colonial African Urban centres were succinctly captured in a book section called 'Theorizing African Architecture: Typologies, Buildings and Urbanism by Philipp Mueser (2021). In it he chronicles Olfert Dapper and other scholars' description of found architectural knowledge in some Western, Central and Southern African cities in the 17th century. Some of these depictions were culled from reports and memoirs of Dutch sea farer and Captain Olfert Dapper drawn from other peoples' visitations or experiences.

Two of Dapper's most pertinent historical descriptions with accompanying sketch illustrations, were architectural and planning details of the city of Loango (called Lovango 1641) in today's Congo, Brazzaville and the ancient city of Benin (1668) in modern day Nigeria. Dapper's descriptions were vivid and incredibly detailed, especially for one who never visited these places in person. To this end, Dapper could be considered a master at retelling stories, documenting oral histories while filling in blank spaces with factual embellishments like the placement of puzzle pieces obtained from different sources. His descriptions were delivered with the same dexterity as built environment professionals would deliver building survey and site analysis reports in modern day practice. He commences with exterior macro spaces such as streetscapes, neighborhoods, and general urban layouts and converges to interior smaller spaces and details like specific functional areas, roof designs, building materials, architectural features etc all these described with nautical dimensions.

His depiction of found architectural knowledge of the ancient city of Benin has been described as being more credible than any other having been corroborated by a surviving model of a typical building model that dates back to the ancient Benin era.

"The city has 30 straight streets. Each about 120ft wide and has many wide and some narrow side streets running towards it. The houses have long been in the streets and are built in good order, close together like Europe. They are adorned with gables and steps and covered with palm and banana leaves.... the king's castle is square-shaped and located on the right-hand side of the city when you enter the Guttonic gate. It is probably as big as the city of Harlem and is surrounded by a strange wall. It is divided into many grand apartments, and has beautiful long, square-shaped galleries that are about the size of the Amsterdam exchange; but one is bigger than the other. The roof stands on wooden pillars that are covered with brass from top to bottom and decorated with scenes of war and battle. Everything is kept very clean. Most of the royal apartments are covered with palm leaves instead of square planks. Each gable is crowned with a turret that tapers as it rises and features a bird cast from copper at the top. Its outstretched wings have been inspired by a real bird."

For other pre-colonial architectural masterpieces, such as the Great Zimbabwe, Udo Kultermann (1963) describes them as a fascinating form of construction developed from functional processes which emerged here long before the European architectural revolution: It is artistic architecture expressed in the form of necessity and freedom. This again is found architectural knowledge, although intentionally muffled and subdued as was common with colonialists threatened by other thriving cultures as Mueser rightly states;

"The fact that so little is known about this unique urban centre in the Southern regions of Africa is also a result of

British colonial policy: the history of high African civilizations did not fit into the image of the European occupying power" (Mueser, 2021, p. 65).

With this policy in force, any borrowed architectural forms creolized from indigenous architecture by colonialists were selected. The more striking and architecturally significant forms noticeable in the indigenous architecture appeared to have been intentionally stifled or altogether dropped for what was considered less conspicuous but more practical forms, the likes of which if not adopted would result in the impracticability of the imposed colonial architecture in the region. This may explain why the simple, yet practical courtyard design of the ancient Benin house type was adopted and creolized into the colonial residential architecture while the more imposing brass-covered saddleback roof design with amazing turrets and bronze casted figures were overlooked. This unique roof design was apparently as imposing and exciting as it was threatening to the cultural as well as architectural colonization agenda of the empire expansionists of Europe.

Edwards described the introduction of certain architectural features marking the creolization process in the tropical forest zone of West Africa. The borrowing and adoption of the court-form or courtyard compound architecture was one of the earliest forms of creolization of residential folk architecture in this tropical forest zone. Between Southern Sierra Leone and coastal Cameroon or Liberia and Eastern Nigeria (Edwards, 2001), rectangular gable-roof house forms assembled into enclosed "court-form" compounds predominated. Alternatively, impluvium houses were adopted in coastal areas laid out with a central court, surrounded with interior gallery, covered with a continuous roof and surrounded by peripheral rooms. These rectangular forms originated from the ancient Benin Kingdom and could also be found amongst the Yoruba empires as well as the Igbo culture (Fassassi, 1978, pp. 132-133).

Another notable found architecture documented by colonialists includes the crops and cattle protected villages in Gambia (Moore, 1723, as cited in Mueser, 2021). Moore's travelogue goes further to reveal early forms of creolization, where colonial architecture was influenced by indigenous or found architectural knowledge. It showed a plan of a colonial rubber factory that was developed based on a similar design layout to the typical crop and cattle protected village layout and floor plan.

In a previous study, the author argued that colonial buildings may have evolved into what is considered as 'tropical architecture' in Nigeria. This study argues that colonialist may have borrowed certain traits from the indigenous culture which in several ways contributed to what constitutes the creolization of architecture in Nigeria with the resulting tropical architecture one of its inevitable offspring (Brisibe, 2020). Uduku (2006) refers to this as the 'new way architecture', which is a product of the mixing of different architectural traits of the late tropical era in Nigeria. Examples include the works of Alan Vaughn-Richards who was known to merge traits of certain West African traditional architecture in a bid to reinvent Nigerian architecture.

Osasona (2015) highlights the fact that besides the British, there are other cultures that may have intervened architecturally in Nigeria although not as colonialists. Nonetheless, their presence may have resulted in other forms of creolization as on arrival they also met with existing found architectural knowledge. The cultures consist of emancipated slaves from Freetown and Latin America respectively that brought in their own architectural ideas.

The Saros, who are ex-slaves, repatriated from Britain and resettled in Freetown, Sierra Leone and who subsequently made their home in Lagos, developed a type of architecture based on British influence (Osasona, 2015). Similarly, Afro-Brazilians who were ex-slaves from Brazil and Cuba brought with them architecture reminiscent of popular Baroque styles in Brazil that featured a lot more ornamentation. Okoye (2013) argues that these styles the Afro- Brazilians and British Sierra-Leoneans developed were not entirely influenced by the

cultures they were repatriated from. He believes the architecture these groups promote is a creolized mix of colonial and local influence similar to what is obtainable in linguistics. He argues that the repatriates would have encountered indigenous tribes in the regions, like the Yorubas and Bini amongst others and borrowed aspects of their traditional architecture to create their own styles. This he also attributed to 'Found architectural knowledge'. An example is the courtyard concept which has been associated with Bini kingdom and also used by their ancient neighbours the Yorubas long before the repatriates arrived but has been spotted as a key feature in some Afro-Brazilian architecture. Edwards (2001) mentioned that courtyards became a staple feature of the "new way architecture" of all cultures found along the West and Central African coastline at the turn of the 20th century.

It is our supposition that some select architectural built forms in the Niger Delta region falls under this category. But unlike Osasona's viewpoint we perceive that the resulting structures are architecture developed based on a syncretism of imported and found knowledge, which has been harnessed and adopted mainly for functionality. What has been found here can be considered a syncretism of the British and other predominant indigent cultures represented in the area, having being brought together by empire expansion through colonialism. However, these different cultures did not form a hybridized blend; rather it is similar to a 'mosaic' where the different architectural components can be easily distinguished in the mix (Brisibe, 2020).

4. Creolizing buildings to fit: Case studies from the Niger Delta

To understand creolization within the context of colonialism and architecture is to examine its tacit purpose as a revolutionary tool for decolonization. Baron and Cara (2011) believe that the main reason for creolization is that both the new language and new expressive forms developed by combining the indigenous and foreign, embodied some form of resistance to colonial domination and subjugation. They maintained that through creolization colonized people resisted imposition, systematization, and standardization of norms from the colonizers.

By the late colonial era, in the Old Port-Harcourt Township, early records indicate that the population was made up of at least five nationalities, namely: Indigenous Nigerians, British, Sierra Leoneans, Syrians and Lebanese and People of the Gold Coast region - present day Ghana (Dixon-Fyle, 1999). A previous study explored the architectural contributions and influences of these foreign contacts in Nigeria's Niger Delta region but with emphasis on the architectural influences in Rivers State of which Port-Harcourt is the capital. It was observed that while some of the buildings bore the distinct markings of their foreign influences, others were a cocktail of two or more of these influences put together (Brisibe, 2023).

As a result of the nature and duration of the British contact, it is expected that British colonial influence can be observed in architectural built forms in Nigeria. The British formed the bulk of the foreign actors of change in Nigeria coming in first as explorers and traders and then through military conquest and finally colonialists. The distinct architectural features that characterize the British influence were mostly early 20thcentury styles. For residential structures, the predominant style exported to the Nigerian colony were those reminiscent of the Late Victorian and Edwardian architecture from the 1880s to the early 1900s and British domestic architecture developed between the world wars (1918 to 1939). Within these periods, certain architectural elements that characterize the residential building types were adopted and creolized.

One of the early 20th century British dwelling types to be creolized is the 'bungalow', a British adaptation of a previous dwelling model found in Bengal, India Introduced into the Niger Delta regions of Nigeria as practical staff housing for the colonial officers, it however quickly struck a chord with wealthy chiefs who wanted a second home in the township leading to several copies being built in the rural areas (Brisibe, 2020). "The bungalow was in the first place, a technological device

- a form of Shelter for British colonial officials providing protection against malaria and reducing the effects of tropical heat. In its construction and design, it drew on over two and a half centuries of tropical experience from India, South East Asia, the Caribbean and West Africa, incorporating ideas from the other people over whom they ruled" (King, 1984).

In a previous study by one of the authors, the popular bungalow structure in Port-Harcourt Township reveals traits from the British influences as well as indigenous expressions of culture all of which invariably describes the vernacular birthed by the process of creolization (Brisibe, 2020). Although a lot of the indigenes put their own spin on the British bungalows, there were however, a few constant features that distinguish it from the likes of French colonial buildings such as:

- Use of bricks for walls with or without white render
- Use of front porches
- Use of chimneys and vents (Features carried over from early British domestic architecture)
- Interior fireplaces with less relief ornamentation
- Gabled or Hipped roofs and the occasional Dutch-hip roofs (with shingles or cup tiles)
- Straight-flight stairs
- Large eave overhangs
- Timber-board construction or columned and massive masonry structuring
- Roof gutters and use of spouts
- Timber paneled window shutters or timber slatted jalousies (earlier versions)

Figure 1. *Map of Southern Nigeria depicting core Niger Delta States.*[1]

- Multi-paneled glass casement windows (later versions)
- Use of Bay windows for spaces on the façade

Finished concrete or brick was the building material of choice, some with ornamented patterned finish and others with a simple plain finish (Brisibe, 2023).

The British-styled bungalows comprised of either one or two floors. Usually elevated on iron stilts or brick vaults to achieve better airflow and adequate height against floods. This study examines bungalows elevated on stilts as its main case buildings.

4.1. Stilt buildings: The indigenous architecture of riverine dwellers in the Niger Delta

The tropical rainforest and mangrove swamp regions of the Niger Delta are full of dwellings on stilt, particularly around the creeks and brackish water belts of the region. Although these buildings are often associated with the fishing tribes native to the Niger Delta region, they are also just the everyday buildings of the people in these places. Carter and Collins (2005) defined vernacular architecture as the common form of building in a given place and time. We can therefore surmise that this building type is the architectural popular culture of a people in a particular place and a given era or period, determined by their unique culture and environment. It was Rapoport (1990) that examined the relationship between culture, environment, climate and natural resources within the geographical location and the eventual architectural product it delivers. In the Niger Delta region, the terrain and climate play key roles in the formation of the built product. The region experiences between 1500 – 2500mm of rainfall per annum and is highly susceptible to flooding, with recent flood depths of up to 2m. Building houses on stilts are part of the age-long indigenous knowledge applications for dealing with annual floods common to the region. This was one of the most prominent bits of indigenous architectural knowledge the colonialists 'found' and adopted. It became a feature for the colonialists

in residential buildings around flood prone rainforests or mangrove swamp regions of the Niger Delta.

Figure 2. *Stilt dwellings of migrant fishermen, Bayelsa State.*[2]

The height of the wooden stilts supporting the dwellings are gauged for adequacy in height against flooding using local knowledge acquired over time. Their numbers are also based on calculations using the grid system. This grid system was identified in all such dwellings since drawings are not used by the local builders; ground plans are developed in-situ from the positioning of the main structural frames (stilts) on ground. The technique of spacing stilts to ascertain the required grid for a particular size of dwelling is part of the found structural knowledge. The floor plan of the dwelling unit is often rectangular in shape, with the longer side (length) being approximately twice the dimension of the shorter side (width) i.e. L ≈ 2W. In almost all cases, 2 to 3 stilts are used for the width of small buildings while a minimum of 4 stilts are used for the width of larger buildings (Brisibe, 2011). The alignment of key partition walls along grid lines shows how the dwelling is developed using the grid system. It enhances speed, repetitiveness and it is economical. Also, the grid system makes the estimation of the number of structural support components required fairly accurate. An example of how estimation of building components work, based on the grid system is shown in this interview extract, "To build a small house we use at least 10 – 15 stilts and to build bigger houses we use between 20 – 40 stilts normally, depending on the size of the house" (Headman Inegerman II, Bakassi - interview April 2008)

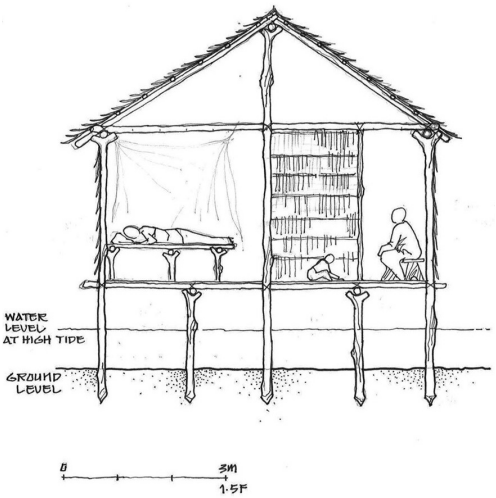

Figure 3. *Section of a typical stilt building.*[3]

Figure 4. *Stems of the palm frond used in construction.*[4]

Figure 5. *Stems of the palm frond used in construction.*[5]

The raffia palm is found in abundance in the mangrove swamps and rainforest areas. It is easy to collect as the fronds hang low. The stem of the palm frond stripped of the leaves or the leaves themselves woven or braided together are used as cladding for walls. The woven raffia leaves are also used as thatch for either cladding or roofing. Braiding or weaving requires specialized knowledge, which is hand-

ed-down from elders. Although the use of thatch as wall cladding material is more popular than the use of fronds due to its easy assemblage, yet fronds are preferable due to their durability in terms of weather resistance and strength.

The creolized buildings in the case studies below are designed to mimic a typical stilt dwelling in a migrant fishing base camp, both in structure and appearance. Structurally, the same calculations for the use of stilts to raise the building above water levels are deployed. Also, the use of corrugated metal sheets as cladding material mimics the appearance of vertical flutings or grooves reminiscent of palm frond stems used in the migrant fishing base camps.

The two examples of buildings creolized by colonial administrators based on found architectural knowledge are the colonial stilt buildings in Bonny Island, Rivers State. One of them is fully restored and currently in use as the headmaster's residence in a local primary school in Bonny Island (see Fig 7), while the other although still inhabited was in a dilapidated state at the time fieldwork was conducted (see Fig 9). Both buildings are clad in weather resistant steel corrugated sheets, with wooden shutter windows and timber panel doors. The windows and doors both have fixed panels above for lighting. Dutch hip roofs with and without vents were used respectively with large eave overhangs in both cases.

The traditional method of building stilts by using Y-peg stakes pinned into the ground was replaced by thick round metal pipes cast in concrete footings. The traditional cross beams of unprocessed Iron-wood timber logs on top of which joists and hand cut floorboards would rest, was simply replaced by seasoned machine-sawn timber beams (4" by 6") and 2" by 4" joists with equally seasoned hard wood floor boards.

5. Discussions and conclusion

As long as the creolization discourse exists, the question of mimicry is inherent, no matter how subtle or muffled it may be. Fortunately, these questions of who copied whom can always be raised and these claims can

Figure 6. *Y-shaped stilt pegs carry the beams, joists and framework for partition wall of the traditional stilt building.*[6]

Figure 7. *Old Colonial bungalow on stilts, Bonny Island, Rivers State.*[7]

Figure 8. *Metal stilts cast in concrete foundation footings.*[8]

be reviewed as long as the buildings which are the subject of these claims exist. Buildings speak or at least express character albeit through silent voices which are a collection of disparate contributions of ideas, convictions, assertions, eccentricities and manifestoes of an individual expressed in built form (Brisibe, 2023). By studying buildings, we can extrapolate meaning, identity, culture, and most of all origin.

We have earlier established that syncretism describes a mixture, a unifying of elements, a metaphor of interspersal; a mingling, yet appropriately suggesting maintenance of the identity of component elements. In syncretism, elements from two distinct sources operate within the same system and all the while maintaining their various

Figure 9. *Old Colonial bungalow on stilts, Bonny Island, Rivers State.*[9]

Figure 10. *Figure showing round stilts made of steel holding up timber cross beams on which the joists rest.*[10]

identities. As such, a syncretism of indigenous and colonial features could be observed from the case studies shown and the origins of the built forms deduced from comprehensive case study research. As shown from this study, syncretism is simply unblended creolization which is imported architecture from the empire mixed with copied indigenous found knowledge authored by colonialists.

To understand creolization within the context of colonialism and architecture there is need to examine generative concepts of built forms and its tacit purpose as a revolutionary tool for decolonization. Baron and Cara (2011) believe that the main reason for creolization is that both the new language and new expressive forms developed by combining the indigenous and foreign, embodied resistance to domination by colonial powers. This action is reminiscent of the concept of the architecture of revolution, developed as a response to possibly imposed application of European traditions during colonization (Carranza, 2010). Similarly, Henni (2016) posits that just as there are built environments all around previous colonies that showcase obedience to colonial directives, there are also those that clearly show direct disobedience to those directives in the area of planning and building design. She discusses this extensively in her work on 'The Architecture of Counterrevolution' and 'Discreet Violence: Architecture and the French war in Algeria' or architecture produced as direct defiance to the oppressive systems of colonization. It infers therefore that different architectural solutions reflected the varied understandings of the revolution's significance to various members of the indigenous populace. So, if architecture reflects the needs, desires and struggles of a society, it can be understood as material expression of that society. As such, like Carranza and Henni we can equally infer that the complex and multiple expressions of revolution and decolonization are observable through residential architecture of a previously colonized people.

These scholars maintained that through creolization subaltern communities resisted the imposition of mechanistic, systematizing, standardizing norms from official, politically dominant cultures. But in addition; we argue that creolization created opportunities for reversed mimicry through appropriation of found architectural knowledge. Through this and other studies we have observed that found architectural knowledge, especially those that offer practical solutions to geo-climatic problems encountered by the colonialists were often coopted as part of building design solutions in the otherwise harsh tropical regions.

Endnotes

[1] The Niger delta of Nigeria is made up of six states, Akwa Ibom State, Bayelsa state, Cross River State, Delta state, Edo State and Rivers State. But the core Niger delta region is made up of Bayelsa State, Delta State and Rivers State and they are known for their vast networks of rivers, creeks and mangrove swamps. From "The Merchant-Venturer's Bungalow: A Vernacular Archetype in Nigeria's Niger Delta," by W. G. Brisibe, 2020, *International Journal, 7*(1). p. 59 (https://www.researchgate.net/publication/342579453).

[2] The stilt-dwelling was adopted in most riverine areas in the Niger Delta. For flood prone areas, Mangrove swamps and rainforests. From "The dynamics of change in migrant architecture: A case study of Ijo fisher dwellings in Nigeria and Cameroon" by W. G. Brisibe, 2011, *(Unpublished doctoral dissertation) Newcastle University, Newcastle upon Tyne, United Kingdom*.

[3] This section was sketched during one of the author's fieldworks, showing details of the stilt building type prevalent for the Ijo migrant fishermen. From "The dynamics of change in migrant architecture: A case study of Ijo fisher dwellings in Nigeria and Cameroon" by W. G. Brisibe, 2011, *(Unpublished doctoral dissertation) Newcastle University, Newcastle upon Tyne, United Kingdom*.

[4] The Palm frond was a key material for different parts of buildings such as the walls, roof, partitions amongst others. It was also readily available, flexible and sustainable. From "The dynamics of change in migrant architecture: A case study of Ijo fisher dwellings in Nigeria and Cameroon" by W. G. Brisibe, 2011, *(Unpublished doctoral dissertation) Newcastle University, Newcastle upon Tyne, United Kingdom*.

[5] This figure is an example of the application of the palm frond. From "The dynamics of change in migrant architecture: A case study of Ijo fisher dwellings in Nigeria and Cameroon" by W. G. Brisibe, 2011, *(Unpublished doctoral dissertation) Newcastle University, Newcastle upon Tyne, United Kingdom*.

[6] This Y-shaped pegs are used for may purposes apart from those mentioned above. They are also used as floor supports which provides dry raised flooring for the stilt houses. From "The dynamics of change in migrant architecture: A case study of Ijo fisher dwellings in Nigeria and Cameroon" by W. G. Brisibe, 2011, *(Unpublished doctoral dissertation) Newcastle University, Newcastle upon Tyne, United Kingdom*.

[7] A colonial-styled stilt building Rehabilitated for use as head masters residence in Bonny Island, Rivers state, in the Niger Delta region of Nigeria. From "Stakeholder efforts in heritage building conservation in the Niger Delta region of Nigeria" by W. G. Brisibe, 2019, *Association of Architectural Educators (AARCHES) Journal*, p. 58. *(https://www.researchgate.net/publication/341413126)*

[8] This shows an adaptation of the stilt style using steel stanchions cast in concrete in a flood prone area in Bonny Island, Rivers state, in the Niger Delta region of Nigeria. From "The dynamics of change in migrant architecture: A case study of Ijo fisher dwellings in Nigeria and Cameroon" by W. G. Brisibe, 2011, *(Unpublished doctoral dissertation) Newcastle University, Newcastle upon Tyne, United Kingdom*.

[9] A dilapidated stilt styled residential area in a flood prone area in Bonny Island, Rivers state, in the Niger Delta region of Nigeria. From "Stakeholder efforts in heritage building conservation in the Niger Delta region of Nigeria" by W. G. Brisibe, 2019, *Association of Architectural Educators (AARCHES) Journal*, p. 58. *(https://www.researchgate.net/publication/341413126)*

[10] A closer view of the stilt foundation of the dilapidated building area in Bonny Island, Rivers state, in the Niger Delta region of Nigeria. From "Stakeholder efforts in heritage building conservation in the Niger Delta region of Nigeria" by W. G. Brisibe, 2019, *Association of Architectural Educators (AARCHES) Journal*, p. 58. *(https://www.researchgate.net/publication/341413126)*

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Spatial fragmentations in the shadow of capitalism: *Parasite* movie

Berrin TUZCUOĞLU[1]*, Asu BEŞGEN[2]
[1] berrin.tuzcuoglu@avrasya.edu.tr • Department of Interior Architecture and Environment Design, Faculty of Engineering and Architecture, Avrasya University, Trabzon, Türkiye
[2] abesgen@ktu.edu.tr • Department of Architecture, Faculty of Architecture, Karadeniz Technical University, Trabzon, Türkiye

**Corresponding author*
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Abstract
Spatial fragmentation due to unequal distribution of resources plays an important role in the human-space relationship. David Harvey (1935, United Kingdom) one of the prominent thinkers of spatial science, sees the changes in capital accumulation as a game played in space. The fragmentation of spaces, produced at the center of capitalism and contributed to its continuity, brings about the transformation of social relations which give rise to class consciousness and reveal class differences.
Based on the interaction of philosophy, cinema, architecture, this study analyses the spatial fragmentations in the contemporary society under the shadow of capitalism over Parasite Movie. The research question of the study mainly bases on the axes of class inequalities and spatial formations suggested by Harvey's phenomenon of social justice and spatial differentiation, and exemplifies it through the spaces of the Parasite movie, directed by Bong Joon-ho in 2019. In this context, the study aims to discuss Harvey's phenomenon of spatial organizations due to class inequality in the specific case of the Parasite movie and, to reveal the other dynamics of the disciplines of philosophy, cinema, and architecture that feed each other. Another goal of the study is to reveal the elements of the space that the individual uses while defining their existence and making sense of their surroundings, which affect them intellectually and visually with the data presented in the fictional world of cinema.
The spaces in the movie depicting the relationship between two families of different socio-economic levels have been analyzed through descriptive analysis method.

Keywords
Capitalism, David Harvey, *Parasite* movie, Space, Spatial fragmentation.

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1. Introduction and methodology

Contemporary, architectural spaces are differentiated depending on the unequal distribution of resources. David Harvey, who stands out with his work on this subject, which is attractive to sociologists and philosophers, sees spatial fragmentation as capitalism-centered. According to Harvey, capitalism, as defined by Marx, results from the interaction between social relations, labor, and power. Spaces exist due to social processes and practices and thus constitute the cause and effect of social life (Harvey, 2010).

In capitalist societies, class differences arise between those representing production, the rent obtained from production, labor, and capital (Harvey, 2022). Capitalism-centered cities are differentiated by differentiating at the point of resource access (Giddens, 1973). The system reproduces and redefines the spaces where communities live with the appropriate labor force. For example, communities with white-collar labor live in white-collar spaces, while people with blue-collar labor live in the same units as blue-collar workers (Harvey, 2010).

Harvey critiques the neoliberal world where all aspects of life, including the economy, have been commodified, and success or failure is attributed solely to individual efforts. He argues against the reduction of everything to personal performance, highlighting that in a world where institutional and class contexts are disregarded, all individual activities will come under the pressure of market relations.

Drawing from various political, social, and cultural structures, neoliberalism manifests in cinema studies through the concepts of urban privilege and injustice. In this context, Cooper (2019) highlights in film studies' insights into the liberal transformations of society, culture, and aesthetics. The intersections between labor, selfishness, gender, race, colonialism, urban space, and the aesthetic, creative, and dramatic aspects of cinema are significantly interconnected.

In this context, the study exemplifies spatial fragmentations under the shadow of capitalism, addressing them within the axes of "class inequalities and spatial formations" proposed by Harvey's concept of "social justice and spatial differentiations". Because the *Parasite* movie addresses the issues of class inequality and spatial divisions, specifically the study uses the spaces depicted in the movie directed by Bong Joon-ho in 2019, to illustrate these concepts.

The movie tells the story of two families representing the capitalist and working classes of the socio-economic level, where the family representing the working class enters the living spaces of the family representing the capitalist class like a parasite and feeds on them. In the series of bad events that occur in the process, the director makes us question who or what the natural parasites are.

When reviewing the literature, the *Parasite* movie has been the subject of numerous studies. Related to the subject, Karabağ and Yazıcı's study focuses on analyzing the interior-exterior relationship of the windows used in the *Parasite* movie and the narrative/discourse, as well as the ways of looking and seeing within the same frame. They argue that by examining these aspects, the study reveals the construction of the "meaning" of social segregation (Karabağ & Yazıcı, 2023). Us, on the other hand, evaluates the spatial elements in the *Parasite* movie within the context of class distinction (Us, 2023). In contrast to previous studies focusing on the subject and examples, this study questions how capitalism-centered spatial forms affect individuals' modes of thinking and behavior in social life. It aims to reveal the factors of space used by individuals in defining their existence and understanding their surroundings, both intellectually and visually. The selection of the *Parasite* movie as the subject for the study was influenced by the effective portrayal of relationships in the story through architectural spaces and elements. This is because the individual and societal relationships in the film setting are conveyed through spatial fragmentations and organizations. Class inequalities are observed through metaphors associated with architectural spaces. In this context, the study aims to discuss Harvey's concept of spatial organiza-

tion through the lens of the *Parasite* movie, thereby revealing the interplay between the disciplines of philosophy, cinema, and architecture, which mutually enrich each other's dynamics.

In line with these aims and objectives, the study employs a qualitative approach. The case study, defined as the collection of comprehensive data on a single case through qualitative research, determines the research type of this paper (Kümbetoğlu, 2020). In qualitative research, the data analysis process is categorized as descriptive and content analysis (Yıldırım & Şimşek, 2016). Since the research aims to examine the movie scenes through spatial descriptions, this study adopts a descriptive analysis design. Descriptive analysis is typically used in situations that do not require a detailed examination of qualitative data (Miles & Huberman, 1994). The purpose of descriptive analysis is to describe individuals' thoughts about an event or phenomenon in a direct manner, involving the interpretation of data based on predetermined variables (Willis et al., 2016; Sandelowski, 2000; Yıldırım & Şimşek, 2016). Additionally, a descriptive analysis can be conducted based on the symbolic expressions and analogies used (Kümbetoğlu, 2021). When analyzing qualitative data using descriptive analysis, researchers can make their own interpretations and draw conclusions (Yıldırım & Şimşek, 2016).

Within the scope of the study, descriptive analysis has been conducted based on the living spaces of the two families. Fragmentations through the spaces of the two families, representing the visible and invisible aspects of the upper and lower parts of the city, have been discussed within the axes of class inequalities and spatial formations proposed by Harvey's concept of social justice and spatial differentiations. The scenes selected within the scope of the study focus on the living spaces of both families, from building interiors to urban exteriors. The living spaces of both families align with Harvey's concept of spatial organization as it relates to class inequality. Another factor considered in the selection of scenes is their contribution to the story's breaking points.

In the subsequent sections of the study, emphasis is placed on the theoretical framework consisting of cinema, architecture and space concepts. Following this, the representation of space in architecture and in the city is discussed, after which Harvey's theory of class structure and spatial differentiations within the axis of social justice and spatial formations is presented over *Parasite* movie.

2. On cinema, architecture and space

Born out of the basic needs of humanity, such as protection and shelter, architecture is defined as the art of creating space (Zevi, 2015). Architectural space, which has many definitions in the literature, is, in its most general description, a space that contains people, human relations, and the necessary equipment for these relations, a space whose boundaries are determined depending on the structure and character (Gür, 1995). Architectural spaces also contain elements that affect human behavior and emotions (Roth, 2000). In this sense, spaces have a structure that envelops individuals throughout their lives. Spaces exist as they are put into certain patterns and arranged formally (Ching, 2019). Humans cannot think of themselves independently from the spaces that play a decisive role in their relationships, behaviors, and emotions. This is because human existence is spatial, and human consciousness cannot be imagined before space (Merleau-Ponty, 1962).

The concept of space, which accompanies us throughout our lives, interacts with visual and auditory art branches. In this sense, cinema is one of the branches of art that makes space its subject (Neumann, 1999). Compared to other art components, space experiences are more successfully conveyed in cinema (Grigor, 1994). In cinema, the director uses space, which is used in architecture to define oneself and make sense of one's surroundings, as an effective form of expression (Bowman, 1992). Just as the architect conveys the spaces he designs in his mind by using the language of architectural terms such as plans and sections, and the space transforms and takes shape

with the user over time, the process of the director using the space while telling his story shows parallels (Allmer, 2010). At this point, depending on the story the director wants to tell in cinema, the spaces sometimes appear as a background, sometimes as a complementary element, and sometimes as a focal point. Tanyeli expressed how the space is handled in the interaction between cinema and architecture in three different ways. According to Tanyeli, the first of these is a virtual space that is not used in the plane of reality, the second is the construction and production of real spaces in its time fiction, and the third is the handling of architect and architecture in the event fiction (Tanyeli, 2001). The point to be noted here is that, according to Atilla Dorsay, successful examples of cinema are passed on to the audience through the correct use of the concepts of time and space. Dorsay explains this situation by stating that it is not a coincidence that Fritz Lang and Nicholas Ray, directors who studied architecture, came to the fore worldwide with their success (Dorsay, 2004).

With the bond between people and space, spaces gain identity and become places. In cinema, space transformation into place occurs with the concern of identifying with the characters. In this sense, architecture, and cinema exist by integrating space with movement (O'Herlihy, 1994). The contribution of cinematic space to the production of architectural space is that it creates the foresight of spaces that cannot be constructed in the present moment. The spaces of the future, which are the subject of many movies, also create different design ideas for architects with their fictions and assumptions (Vidler, 2001).

As a conclusion, in its relationship with architecture, cinema highlights the ways in which time and space are produced, more prominently compared to other arts. The concepts of time and space are uniquely and distinctly produced within the disciplines of cinema and architecture. While architecture produces space by utilizing data from the current production time, cinema manipulates time within its own universe to use or reproduce spaces.

3. On space: Urban, spatial fragmentation, capitalism and David Harvey

Urban settlements are described as where agricultural activities are limited, and the population density is higher compared to rural areas. They are characterized by meeting the needs of communities such as settlement, housing, recreation, and relaxation (Keleş, 1998). The structures are the elements that make up the urban spaces (Rossi, 1982). Urban space is defined as a whole perceived by urban dwellers, formed by structures and associated with all urban events (Konuk, 1991). In determining urban forms, variables such as transportation, accessibility, socio-economic factors, and labor force ratio are influential (Erdoğan, 2015). In this respect, cities are like living organisms in constant change. They form the consciousness of urbanity as centers where social developments and cultural activities emerge and intensify. The urban architecture influences the behavior and lifestyle of the society living there and shaping those cities (Hasol, 2008).

Cities, as areas where new ideas and products are generated, increase individuals' social and physical mobility under the influence of capitalism (Yırtıcı, 2005). With the growth of the globalized economy, different spatial divisions emerge (Sassen, 2010). The increase in the service sector in globalizing cities enables the city to grow by attracting migration from other cities and rural areas. This situation also leads to fragmented structuring in the city both socio-economically and physically. Global cities contribute to the formation of unjust spaces (Burdett & Rode, 2007). Urban spaces, which are subject to various disciplines such as architecture, sociology, geography, and cinema, are described by Harvey as difficult and complex concepts. In his book "Social Justice and the City", he discusses the concept of the city by evaluating it through the theories produced by the disciplines of architecture, geography, and sociology within their own frameworks. According to Harvey, the main reason for the inability to explain the complexity of the city is the attempt to explain urban space

itself. In this sense, it is important to reveal the concepts that encompass the relationship between the spatial areas of the city and social practices (Harvey, 2010). He argues that spaces are formed due to social processes and practices. In this sense, he sees space as social life's cause and result. He draws attention to the point that he rejects the idea that space has social or personal effects. In other words, space is produced within capitalism (Harvey, 2022). Space appears as a structure that shapes human beings and consequently shapes society. At this point, the question is which human practices are used in conceptualizing space (Katznelson, 2003).

In the capitalist system where space constantly renews and produces itself, cities become products from which high profits can be made. In this sense, cities are instruments of capital in the capitalist order (Harvey, 1982). Because in the capitalist production process, production is carried out through spaces instead of machines and raw materials. Investments in urban spaces create the face of cities. The transformation of capital into a means of rent in the production of spaces that turn into an industrial product also stimulates the real estate market. Harvey argues that the importance of urbanity parallels the increase in demand for capital products (Harvey, 2022). While the increasing demand for the products of the consumption sector divides urbanization into subdivisions, firms' location choices become an essential tool in shaping spaces. Every investment from land to real estate is a step towards increasing the profitability of the industrial sector, and urban systems are shaped in this context (Harvey, 1982). From factories to schools, from shopping centers to parks, settlements have been created in this direction (Harvey, 1982). In this sense, spaces and spatial differentiation in cities in the capitalist order cause the restructuring of social relations and differences in access to limited resources (Giddens, 1973; Harvey, 2022).

In sum, the relationship between spatial organization and social structure is specific. Spaces are fragmented according to the social relations of societies in the capitalist order. Population densities shaped according to the distribution of capital accumulations serve the formation of different communities. While those with an advantageous socio-economic status can be free in their spatial choices, those outside of the capital can acquire space with what is left over. As a result, urban spaces are fragmented, and class division occurs. Suburbanization, which emerged due to the fragmentation of urban spaces, initially contributed to capital accumulation, but over time, it led to the overgrowth of urban space. This is due to the dynamic structure of capitalism, which harbors crises within itself. Urbanization has also brought about a process that leads people living in cities and towns to think and act differently in producing physical and social spaces. For instance, Harvey explains the impossibility of living without a car in the suburbs or the high crime rates in shantytowns by attributing them to poor housing or the production of suburbs by automobiles. This situation signifies not only the capital but also the consciousness urbanization with capitalism. The consciousness focuses identified by Harvey are the individual, community, family, and the state. The fundamental focus of consciousness in capitalist societies, however, is class (Harvey, 2022).

4. On the movie*: Parasite*

The *Parasite* movie was released in 2019. Directed by Bong Joon-ho, the movie is a black comedy and drama with a duration of 132 minutes. Bong Joon-ho also co-wrote the screenplay with Han Jin-won. *Parasite* won the Palme d'Or at the 2019 Cannes Film Festival and became the first non-English language film to win the Best Picture Award at the 92nd Academy Awards held in 2020. Additionally, at the 92nd Academy Awards, it won awards for Best Director, Best Original Screenplay, and Best International Feature Film. The movie is about the relationship between two families of different socio-economic levels. It is based on the unemployed members of the Kim family, who have low financial means, gradually invade the homes of the Park family, who have advantageous

financial means, with various tricks they devise and take advantage of them like a parasite.

Throughout the movie, the director makes the audience question who or what the "parasite" is. The movie answers this question with the fact that capitalism, which is the cause of injustice in capital accumulation, class differences, and spatial fragmentation due to these differences, is a "parasite".

5. On the spatial analysis: *Parasite* movie

The *Parasite* movie's opening scene starts in the house of the Kim family, which has a low socio-economic status, as the camera shifts from top to bottom. It is understood from the camera's movement that the house is located below the ground level. The house has a window close to the ceiling that overlooks the street along the road. The windows connect the residents of the house with the outside. The viewing angle of the window, which is designed to be relatively high and narrow from the eye level, can only fully see the passers-by when they get close. The elements within the living space of the Kim family are used to reinforce their inclusion in the lowest tier of the hierarchical order (Figure 1).

On the other hand, the two-story house of the Park family, which represents the higher economic level, is located in a quiet, calm, isolated place and in a neighborhood where more socio-economically advantaged communities live. The architectural element that draws attention in the design of the house is the large windows that connect the interior and exterior. (Figure 2). In the movie, it is informed that the house was built by a famous architect named Namgoong.

Harvey's theory that spaces are fragmented and produced according to capital accumulation in the capitalist order is seen in the movie regarding the spaces where the Park and Kim families live. The director provides information to the audience who do not yet know about the story with the scenes depicted through the locations from the movie's opening scene. At the same time, the director changes the degree of light in the transitions between the houses to clarify the place of the Park and Kim families, who belong

Figure 1. *Spatial fragmentations in the shadow of the "windows": Kim family's house (IMDb, 2019a).*

Figure 2. *Spatial fragmentations in the shadow of the "windows": Park family's house (IMDb, 2019b).*

to two different social strata, in the hierarchical order. The scenes of the socio-economically advantaged are depicted as bright, while the scenes of the disadvantaged are depicted as dark.

When we look at the spaces where the two families live on an urban scale, we see the Kim family in gloomy neighborhoods with no infrastructure and the Park family in protected and surrounded neighborhoods. In the neighborhoods where the Kim family is found, apartment buildings and narrow streets without privacy draw attention. The streets are seen as cramped and irregular, just like the interiors of low-income people, and are depicted as dark (Figure 3).

The neighborhood where the Park family lives is seen as an area where high garden walls surround residences, and privacy is prominent. In the streets dominated by greenery, calmness and order prevail despite the chaos in the neighborhood where the Kim family lives (Figure 4).

From the transitions between the spaces used by two families, it is understood that the city has a high-slope structure. In the higher areas of the city, those representing the economically advantaged find settlement areas for themselves. At the same time, people with low incomes are located in the lower part of the city. This is clearly seen through the use of the element of water, which helps the story and the locations in the movie. In the movie's later scenes, it is seen that the Kim family members set out from the Park family's house to their own house during the flood disaster caused by heavy rain, run-down ramps, and very high stairs. In these scenes, the members of the Kim family are depicted as descending from the visible high places of the city to the invisible lower places of the city to reach their own homes (Figure 5).

The spaces within the city are established based on the regulation of power resources. According to Harvey, the city's spaces contain symbolic meanings with their hierarchical order and labyrinth-like state. The city's spaces impose ways of thinking and acting on its inhabitants in line with these

Figure 3. *Spatial fragmentations in the shadow of the "roads": Kim family's neighbourhood (IMDb, 2019c).*

Figure 4. *Spatial fragmentations in the shadow of the "roads": Park family's neighbourhood (IMDb, 2019d)*

symbolic meanings (Harvey, 2022). In the movie, this situation is depicted through the shopping passion and luxury consumption habits of the Park family, representing the rich, and the struggle for survival of the Kim family, representing the poor. The Park family avoids the Kim family's places. On the other hand, the Kim family is looking for a chance to enter the Park family's spaces. The members of the Kim family, who do not have the opportunity to get an education due to their financial impossibilities, can only enter the sheltered places of the Park family as maids, drivers, or teachers. In the movie's later scenes, this situation comes to such a point that the Kim family will even give up their moral values to get rid of the places where they live and reach the places where the Park family lives.

The scenes depicted through the lens of two families parallel Harvey's (2022) idea of urban spaces imposing on individuals a way of thinking and acting in their social lives. Capital influences the formation of urban spaces and the development of urban consciousness, which is the productive power of spaces. Spaces play a determinative role in defining who individuals are and what they represent. Spaces that individuals do not need may harbor elements of which they are unaware.

Harvey talks about the inconsistency of capitalism within itself. For example, if machines replace the workers on the production line, this results in a more economical and productive situation. But the workers are a part of the production line, and at the same time, they are consumers of the products they produce. Therefore, laying off workers eliminates a large market where goods are sold (Hubbard & Kitchen, 2018). The inconsistency of capitalism's reality is evident in the movie through Ki-woo's dreams of attending university despite himself and his family members being unable to afford education due to the roles imposed by the system. The family tries to make a living through temporary jobs such as folding hundreds of pizza boxes. The individual efforts of the family in the face of exclusion in capital accumulation are effective in finding creative solutions. In this sense, their struggle to remain within the system and be visible reveals the production spaces within their residences. All the actions in which they fold pizza boxes, hope for the future, generate new ideas, or make new decisions are carried out in the kitchen spaces in their residences. The kitchen space where they engage in production turns into a consumption space where they consume luxury products as their income increases (Figure 6).

The paths of the two families, representing the visible and the invisible at the extremes of uptown and downtown, intersect in the process that begins when Ki-woo's friend Min, the son of the Kim family, suggests that the Park family's daughter be tutored in English. In the scene in which Min arrives at the Kim family's house, it is seen that Min can get angry with the drunk, whom they could not get angry with even though he had used the toilet and vomited in front of their window many times before. This situation causes Min to be glorified in the eyes of the Kim family, who represent the lower class because Min has a university ed-

Figure 5. *Spatial fragmentations in the shadow of the "transitional spaces": From Kim's to Park's (IMDb, 2019e).*

ucation and belongs to a higher class than the Kim family.

Following Min's job offer, Kim-woo creates a fake university diploma with the help of his sister's digital program knowledge and sets off to the Park family home. In the scenes shown while reaching the Park family's house, the roads he uses in the transitions between places draw attention. Ki-woo walks up the ramps to the Park family home and uses the stairs. Architectural elements such as ramps and stairs have symbolic meanings that describe the transition of the two families in the hierarchical order. In the scene where Ki-woo goes to the Park family's home for the first time, the sun that appears in the scene as Ki-woo climbs the stairs is also used to support the fact that Kim-woo is included in the environment where people belonging to the upper class in the hierarchical order. It is seen that stairs, an important architectural element, are also used in the interiors of the Kim and Park families' residences. The only staircase in the Kim family's house leads to the toilet. In the Park family's house, stairs are used to reach the places where the household performs activities such as sleeping, resting, and working (Figure 7).

One of the most striking scenes in the movie is the view of art between the two families. Since art is seen as a discipline that upper-class people can appreciate, Ki-woo is congratulated by the mother of the house for his interpretation of the painting drawn by Da-song, the youngest son of the house, and hung on the wall in the first lesson when Ki-woo comes to the Park family's house. A similar scene takes place through the stone that Ki-woo's friend Min gives as a gift to the Kim family. When Min's gift is interpreted as an abstract work by Ki-taek, the father of the Kim family, Min congratulates the father by thinking that he understands art. Another remarkable scene in which art is used in the movie is the move made by the Kim family to enter the Park family's house. Ki-woo's sister, Ki-Jung, enters the Park family's house to give art therapy to the young child of the house. Ki-Jung introduces herself as an art therapist even though she does not have such a talent. Here, it is emphasized that individuals' art consciousness is related to their class levels. Art is seen as a discipline that only socio-economically advantaged families can understand.

Figure 6. *Spatial fragmentations in the shadow of the "living rooms/kitchens": Kim family's house (IMDb, 2019f; IMDb, 2019g).*

Figure 7. *Spatial fragmentations in the shadow of the "stairs": Kim's and Park's (IMDb, 2019h; IMDb, 2019i).*

Exclusion triggers the formation of the artist, while art attracts the upper class. Gentrification can occur from bottom to top, but sometimes it happens in the opposite direction as well. For example, structures related to art built in marginalized areas of the city lead to an increase in rents and the departure of residents from that area (Pasquinelli, 2006).

Harvey, on the other hand, discusses a more general process where art and the creative class adapt the concept of monopoly rent to their own needs. Rent and its derivatives possess monopolistic power. In other words, culture sells its material products through capitalist commodities. For example, Barcelona's reputation in Europe is built upon the symbolism of capital and the accumulation of privileges. The artistic achievements and uniqueness of Barcelona's architecture play a significant role in the marketing of the region's culture. At this point, Harvey questions which segments of society benefit the most from this symbolic capital. He draws attention by asking why minorities should be allowed to benefit from this natural monopoly rent from symbolic capital. Whose collective memory and aesthetic feelings does the symbolic capital here serve by prioritizing the benefit of whom? The problem at this point is seen as a powerful weapon in the hands of class struggle (Harvey, 2013). In the movie, this situation is presented by presenting art as a discipline that can be understood by individuals belonging to the upper class in the regions where they live and the communities they belong to (Figure 8).

After Kim-woo finds a job opportunity in the Park family's house with a fake diploma, all family members realize that they can find a job opportunity by similarly disregarding ethical rules. Accordingly, the family first dismisses the employees of the Park family's house with various tricks and then replaces the people they dismissed. Thus, the Kim family's father started working as a driver, mother as a maid, and daughter as an art therapist at the Park family home. Their struggle to move up to the upper class turns into a ruthless competition with the individuals in the class they belong to in the later scenes of the movie.

Harvey explains this rivalry between laborers by the fact that in the capitalist order, capitalists are in control of the laborer's work process. In an order based on the exploitation of labor power, laborers can also put their labor on sale of their own free will. As a result, they compete with each other. However, when the pressures exerted by the business power in control of the process come to a point, laborers find the solution to form a class and compete among themselves (Harvey, 2022).

One of the consequences of capitalist life is that it leads people to loneliness and unconscious consumption frenzy. This is seen in the movie when all members of the Kim family get jobs, and their eating habits increase as their income increases. The most unconscious consumption of the Park family occurs when they are alone at home on the day they go camping to celebrate the birthday of their young child Da- song. The Kim family's daughter, Ki-Jung, overindulges in food and eats dog food without realizing it.

On the other hand, it is seen that the Park family consumes enough fruits, juices, and packaged products

Figure 8. *Spatial fragmentations in the shadow of the "arts": Kim's and Park's (IMDb, 2019j; IMDb, 2019k).*

throughout the movie. In addition, the Park family consumes the traditional South Korean dish called ram-dom by putting beef fillet in it. Here, the director wants to underline the eating habits of the rich by consciously showing that individuals belonging to the upper class consume this local dish, which is very popular among all segments, with meat. However, it is not generally consumed with meat.

At this point, we see that consumption varies according to identities and is also a status symbol (Şentürk, 2007). Consumption embodies parameters that play an important role in the lives of individuals, including variables according to their personalities and the classes they are in.

The concept of smell in the movie constitutes the first breaking point of the Park and Kim families—the odors of the places where the members of the Kim family live have gotten on them. Da-song, the youngest son of the house, first reveals this. In one scene, Da-song says that the Kim family's mother, father, son, and daughter smell the same. Here, the director tells his story through Güvenç's (1971) definition that spaces perceived through visual, auditory, sensory, and tactile senses are also audible and tactile spaces (Güvenç, 1971). Because perceptible spaces are also related to smell (Gezer, 2012) and scents evoke memories of places or individuals (Corbin, 2007). In the movie, the Park family's father categorizes the smell of the Kim family's father by saying that it reminds him of the smell of people riding the subway. The classification of the Park family's father as the smell of the lower class also transforms the relationship between the two families in the movie.

Another turning point in the movie begins when Moon-gwang, the former maid of the house, comes to the house on the day the Park family goes camping to celebrate their son's birthday. The former maid, who had previously lost her job due to the Kim family's tricks, takes advantage of the day when the Park family is not at home and comes to the Park family's house. The woman, the maid of Namgoong, the architect and former owner, also dominates the house's architecture. Moon-gwang, who knew there was a shelter in the house, allowed her husband to live there. This situation actually shows that the Kim family is not the only parasite in the house. There is another parasite living in the shelter. This fact is revealed when Moon-gang comes to care for her husband after she leaves home, curious about his condition. She offers to the mother of the Kim family, Choong-sook, to let her husband live there, but Choong-sook is against it. Choong-sook, who tries to benefit from the Park family like a parasite, cannot tolerate any parasite other than herself when she takes power. However, the balance of power changes when the old maid sees all the members of the Kim family in the house and realizes that there is something strange. While the former maid threatens the Kim family by saying that she will videotape this extraordinary situation in the house with the help of her phone and share it with the owners, the brutality of these two strata belonging to the same class, even to the extent of killing each other, comes to light. The director brings art and the understanding of art back to the agenda in the conflicts between people of the same class. The former maid expresses that the new parasites of the house only enjoy food and luxury, whereas they take artistic pleasure from their spaces in the face of the landscape architecture of the house (Figure 9).

The movie reveals that while population densities shaped according to the distribution of capital accumulations serve the formation of communities belonging to different classes, the lower classes in the hierarchical order make great efforts to move to the upper classes. It also shows that there is ruthless competition within the classes themselves. It is seen in the movie's story that while these two families belonging to the same class aim to survive by improving their conditions, the struggle between them becomes brutal. In the movie, Choong-sook tells her husband that -against his saying that although the Park family's mother, Yeon-kyo, is kind and good even though she is rich-, she is kind and good because she is rich and powerful, she can be good and kind if she has a lot of money, but

that she becomes cruel in the first power struggle she comes across. Harvey (2022) argues that this contradiction between classes explains the dynamics of capitalism.

The struggle between the classes ends with violent events affecting two families. When the father of the Kim family sees his daughter covered in blood at the birthday party of the Park family's son, and when the Park family's father is indifferent to this and only tries to bring his son to the hospital, he loses control and kills the father. At this point, the father of the Park family dies due to the class fragmentation of social relations. The father of the Kim family, who cannot even kill the cockroach in his house at the beginning of the movie, transforms it to the extent of killing the father of the Park family through class struggles at the end of the movie.

In the hierarchical order in the fiction reality constructed by the director, individuals belonging to the upper class are visible throughout the movie and live in spaces where the connection to the outside is established, while individuals belonging to the lower class live in invisible shelters or spaces below ground level. Those belonging to the lower class even become invisible by hiding under the equipment in the upper-class residences.

The movie ends with Ki-taek, the father of the Kim family, who kills the Park family's father and goes on the run, going to the shelter of the Park family's house, saying that he knew where he was going and continues to live as an invisible parasite with the new owners of the house. The father, who tries to be visible among the upper class in the hierarchical order, chooses to be invisible in the spaces of the lower class in the Park family's house. Kim-woo, the son of the Kim family, returns to their residence below ground level and dreams that one day he will buy the house where his father lives like a parasite and that he will save his father, and they will all live happily together. The last scene that enters the frame is the snow scene from the viewpoint of the narrow window in the Kim family's house, where they connect with the outside. The light that comes with the snow falling outside in a dark environment gives the message that the remaining members of the Kim fam-

Figure 9. *Spatial fragmentations in the shadow of the "arts": Park's (IMDb, 2019l).*

Figure 10. *Spatial fragmentations in the shadow of the "windows": Kim family's house (IMDb, 2019m).*

ily still have hope for the future (Figure 10). Thus, the director reveals that the system within capitalism works the same with slight changes in the roles.

6. Results and discussions

Harvey's theory of class inequalities and spatial differentiation, which constitutes the study's theoretical background, is analyzed by doing spatial readings through the scenes of the *Parasite* movie. In his theory, Harvey argues that the capitalist system differentiates spaces according to the unequal distribution of capital accumulations. In this sense, urban spaces are fragmented, so socio-economically advantaged groups create private spaces for themselves. In contrast, working class finds a place for themselves in the excluded areas of the city. This fragmentation shapes individuals' education, culture, and consumption habits according to their regions. As a result, it serves to create class consciousness by fragmenting individuals. The *Parasite* movie critically examines this system created by the capitalist order through the Kim and Park families, who represent the lowest and highest class in the hierarchical order. Throughout the movie, the reflections of the system on human practices intra-class and inter-class competition are described. In the spatial fiction of the city, the family living in lower, excluded, and invisible spaces strives to reach the economically advantaged, sheltered, and visible areas above. However, by the end of the day, this journey leaves them without space, time, and ultimately homeless. In this respect, the movie reveals the disasters caused by the consequences of inequality in the spatial fragmentation of the city through the capitalist system.

The director, Bong Joon-ho, describes his movie as a comedy without clowns and a drama without villains (Akşam, 2022). In response to questions such as how can bad things happen without bad people or how can funny things happen without clowns, the movie points to the capitalist system as the cause of evil or tragi-comic events. Capitalism, which creates different classes and feeds on the confusion between them, dominates our lives with the spaces it creates and the people it transforms. Questions about whether people are similar because they live close to each other because they are similar have come to the fore again through this movie that criticizes the system. With the ending where the father of the Kim family, one of the protagonists of the movie, aims to rise in the class hierarchy but chooses to become a parasite of his own free will, the movie clearly shows that the system does not change even if the topics and subjects in the system change. This situation supports Harvey's (2022) idea that the injustice between spatial formations constructed by the interests of the powerful and social order can only be rectified through structural change and transformation. The movie clearly depicts how the relationships within the capitalist system foster class consciousness, and it also highlights that spaces are constructed precisely at this juncture.

The director constructs spaces, spatial organizations, and social relations in the reality of the time he creates in the movie, creating a network of relations that parallels Harvey's theory of spatial differences. It is clearly seen in the movie that cinema, architecture, and philosophy contain dynamics that feed each other with different methods and perspectives. The spaces and architectural elements that play a leading role in the movie offer different interpretations to everyone who watches the movie.

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Identifying design performance factors for effective shopping center design

Zeynep YILMAZ[1*], H. Murat GÜNAYDIN[2], Gozde Basak OZTURK[3]
[1] yilmazze18@itu.edu.tr • Department of Architecture, Faculty of Architecture, Istanbul Technical University, Istanbul, Türkiye
[2] gunaydinh@itu.edu.tr • Department of Architecture, Faculty of Architecture, Istanbul Technical University, Istanbul, Türkiye
[3] go291@cam.ac.uk • University of Cambridge, Department of Engineering, Civil Engineering Division, Cambridge, the UK

* *Corresponding author*
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Abstract
Effective and sustainable design is essential for the survival of shopping centers in a fiercely competitive business landscape. The success of shopping centers is primarily contingent on the retail stores' sales performance. The objective of this manuscript is to pinpoint and rank the design performance variables for an effective shopping center design and effective sales performance of the retail stores. The measurement factors influencing the retail stores' sales performance were identified after a thorough review of literature. To assess the content validity of the identified measurement factors, researchers conducted interviews with seven retail experts and three customers using the expert judgment method. Each factor received an evaluation value based on their responses. During the process, experts identified additional factors through unrestrictive questions, while less significant factors were abolished. The results disclosed a modified list of measurement factors impacting sales performance. Successively, 16 retail store managers with over 15 years of experience evaluated each factor via a questionnaire survey. Respondents ranked the most crucial factors as 'brand variety', 'presence of carpark', 'heating/ventilation/air conditioning (HVAC) comfort', 'shopping center lighting design'. The findings are discussed in detail and compared to the findings of the expert judgement.policies for coastal areas and calls for a broader public discussion.

Keywords
Retail store design performance, Retail store sales performance, Shopping center design criteria, Shopping center design efficiency.

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1. Introduction

Retail developments constitute a major portion of the economy because they are considered as one of the most secure investment models as they promise a long-term and consistent revenue for the investment (Ying & Alias, 2022). Furthermore, the retail sector holds a prominent position in the economy due to its wide-ranging scope, encompassing various sub-sectors like ready-to-wear textiles, food and beverages, services, electronics. Consequently, the imperative of ensuring the effectiveness and long-term viability of the retail sector becomes readily apparent, as its faltering or recessionary trends could significantly curtail the prosperity of numerous affiliated sub-sectors. Shopping center investments majorly govern the retail industry. Effective and sustainable investments in the retail sector play a pivotal role in bolstering the retail industry and its various subdivisions. Therefore, the shopping center investments' performance holds immense significance in the realm of economic development.

In the ever-increasing competitive landscape of the retail industry, characterized by the rise of e-commerce, the proliferation of retail centers, and the reduction in purchase capacity, new challenges have emerged for retail investments. Given these challenges, shopping center investments must evolve and implement new models to achieve heightened efficiency, productivity, feasibility, and sustainability. The success of shopping centers hinges on a multifaceted set of factors, including their location, accessibility, architectural design, tenant mix, size, the conceptual approach of the shopping center, and most notably, the performance of the individual retail establishments, as underscored by Bakhshizadeh et al. in 2017. High-performing retail stores not only remain within the shopping center but also serve as magnets for visitors, thus making substantial contributions to the overall performance of the shopping center.

On the other side, retail stores which do not have sufficient sales performance are subject to close or to be removed from the shopping center. Consequently, the sales performance of the retail stores is crucial for the sustainability of the shopping center.

The primary focus of this paper centers on the sales performance of retail units situated inside a shopping center and it discusses in detail the factors that impact the sales performance of retail stores. At the initial stage, the researchers created a clear frame and scope of work, where the study examines the criteria for evaluating the retail units' sales performance, which may differ for diverse retail stores. This study omits the predetermined criteria for evaluating the sales performance of retail stores, which are established during the investment feasibility phase. These criteria include factors like location, shopping center dimensions, and shopping center category. These factors are fixed design inputs and remain unchanged following the establishment of the shopping center investment. Nonetheless, sales performance factors for retail stores, such as shop dimensions, shop design, lighting design, and vertical circulation, are significant factors that can differ between one retail unit and another. This study seeks to determine the variables that influence the retail units' sales performance and to assess the significance of these measurement factors.

As discussed more in detail in the Methodology section, researchers determined the sales performance factors of retail stores after an intensive review of literature. Following the literature review, researchers realized an expert judgement and a main study about the evaluation of each factor. Consequently, the findings of both studies are discussed in detail, and they are compared to each other. Finally, this paper consolidates a set of retail store sales performance factors.

2. Research background

By means of extensive literature research, researchers have identified the specific criteria for retail store sales performance which will allow the assessment of factors influencing sales performance. The research background is delimited by keywords, including shopping center design, shop performance, and the overall efficiency

of shopping center design. Researchers analyzed in detail twenty-two major scientific papers about the topic and created a list of performance factors through these papers.

Retail store performance factors such as retail store interior design, shopwindow design, retail store lighting design, retail store dimensions and floor height appear in studies by Yılmaz Çakmak and Yılmaz (2018), Kusumowidagdo et al. (2011), Nebati and Ekmekçi (2019), Webber et al. (2018) and. The last 2 authors focused also on the performance factors related to the placement of the retail unit inside the shopping center. Webber et al. (2018) conducted a study on the remodeling of retail units to enhance their performance. This study delves into the numerous criteria that impact the performance of retail stores and presents strategies for modifying them to enhance shop performance. The study has identified several criteria for evaluating retail store performance. These criteria include shop design, location of the retail unit within the retail center, the shopping center's architectural design, the choice of floor covering materials in public premises, heating/ventilation/air conditioning comfort inside retail center, the overall lighting concept, noise levels, indoor signs.

Another notable research realized by Köksal and Tığlı in 2018 involved a descriptive content analysis. This analysis examined a total of twenty master's theses, thirteen PhD dissertations, and twenty research studies focused on consumer behavior within shopping centers in Turkey. The study identified several major retail store performance criteria, including closeness to key areas such as the food hall, kids' playground, supermarket, event area, customer service centers, and center entrances. Additionally, factors such as indoor climate control systems' comfort, noise levels, resting areas' physical comfort, shopping center accessibility, closeness to the car park, the range of services provided within the shopping center, effective sanitation services, brand diversity, the existence of a leisure center, security measures, availability of a cultural performance hall within the retail center were observed as significant criteria in the study. Retail store performance factors related to the placement of the retail unit in the shopping center appear in the study by Köksal and Tığlı (2018) as well as by Lee (2010), which studies the relationship between the cultural and event areas of the shopping center and the retail stores' performance.

Building design performance factors such as intelligent building technologies, effective utilization of energy and water, the shopping center's design, the flooring material used in public spaces, daylight in retail center appear in the studies by Nebati and Ekmekçi (2019), Jalil Abdullah and Jian (2019), Bakhshizadeh et al. (2017) and John et al. (2016). In overall, these studies examine the impact of these building design performance factors on the retail unit performance.

The research carried out by Chotipanich and Issarasak in 2017 primarily focuses on key performance factors that include the efficiency of fire exit scenarios, the carpark scenario within the shopping center, the security measures and the effectiveness of sanitation services. This study explores facility management operation strategies aimed at improving performance within shopping centers.

Researchers extracted four significant building performance factors from Kısa's master's thesis (2017). These factors include the efficiency of fire escape scenarios, the closeness to fire exit passageways, the existence of a car park within the shopping center complex, and the existence of security personnel and x-ray equipment in the facility.

Another important factor for retail unit performance and shopping center performance is the daylight presence in the building according to the study made by Solovyev (2018). The study argues that spaces flooded by daylight bring more comfort and confidence to the building users. Daylight perception factor appears also in studies by Yılmaz Çakmak and Yılmaz (2018) and Nebati and Ekmekçi (2019). Mayhoub and Rabboh (2022) claim that the daylight perception has a major impact on the customers' satisfaction. El-Abd et al. (2018) also focus on daylighting

performance in shopping centers. Another study about the daylight in retail buildings emphasizes the impact of daylight on energy consumption and thermal performance of shopping centers (Prakash et al., 2021).

Building services performance factors such as brand mix, management service variety, branch mix, service effectiveness, marketing activities appear in the studies by Bakhshizadeh et al. (2017), Burnaz and Topçu (2011), Köksal and Tığlı (2018) and Xu et al. (2022).

As explained in previous paragraphs, studies examined during the literature review do not classify the performance factors according to their variable groups, as shown in Table 1. Therefore, they do not compare the variable groups as a whole. In contrast to the studies covered among literature review, this research endeavors in assessing factors influencing retail unit sales performance through the examination of three distinct groups of dependent variables: building design performance, retail unit design performance, and building services performance. Researchers seek to discuss the interrelationships among the performance factors within these three dependent variables and to compare the importance levels of the dependent variables. Therefore, this study targets to cover a missing analysis point in the previous studies (see Table 1).

3. Methodology

A thorough literature review identified fifty-two performance measurement factors. Researchers grouped this list of factors into three primary domains: 'retail store design', 'building design', 'building services'. The "retail store design" dependent variable is associated with both retail unit interior design and its positioning inside the facility. Factors like "lighting design within the retail unit," "shop window design," and "closeness to center entrances" fall within this variable category. The second dependent variable "building design" is contingent upon architectural, structural, electrical, mechanical design aspects of retail center, established upon the center's design stage and applicable to all retail stores within. Aspects like "shopping center floor height," "heating/ventilation/air conditioning (HVAC) comfort" and "number of entrances" exemplify building design factors. The final dependent variable encompasses criteria for "building services," that pertain to services supplied by shopping center management. Elements like "security services" and "sanitation services" fall under this domain and are consistent across all retail units in the shopping center.

Following the classification of criteria for measuring retail unit perfor-

Table 1. *Performance factors categorized via literature review.*

Performance Factors	References
Retail unit interior design; Shopwindow design	Nebati and Ekmekçi (2019), Çakmak and Yilmaz (2018), Kusumovidagdo et al. (2012), Weber et al. (2018)
Lighting design of retail unit	Nebati and Ekmekçi (2019), Çakmak and Yilmaz (2018), Kusumovidagdo et al. (2012)
Retail unit dimensions; Retail unit floor height	Kusumovidagdo et al. (2012)
Location of the retail unit in shopping center	Nebati and Ekmekçi (2019), Weber et al. (2018)
Visibility of retail unit	Weber et al. (2018)
Closeness of retail unit to main cores of the shopping center, to event area	Köksal and Tığlı (2018), Lee (2010)
Closeness of retail unit to supermarket, to kids playground, to event area	Köksal and Tığlı (2018)
Closeness of retail unit to food court	John et al. (2016), Köksal and Tığlı (2018), Kusumovidagdo et al. (2012)
Closeness of retail unit to delivery yard	Kusumovidagdo et al. (2012)
Closeness of retail unit to customer wet cores	Abdullah and Jian (2019), Köksal and Tığlı (2018), Kusumovidagdo et al. (2012)
Closeness of retail unit to main entrances	Abdullah and Jian (2019), Köksal and Tığlı (2018), Kusumovidagdo et al. (2012)
Smart building technologies used in shopping center; Efficient use of water and energy; Open-air vs enclosed center concept; Floor level of retail unit	Nebati and Ekmekçi (2019)
Architectural design of the shopping center	Abdullah and Jian (2019), Nebati and Ekmekçi (2019), Weber et al. (2018), Bakhshizadeh et al. (2017)
Number of floor levels of the shopping center	John et al. (2016), Kusumovidagdo et al. (2012)
Shopping center corridor width	Abdullah and Jian (2019)
Shopping center common area floor cladding material	Abdullah and Jian (2019), Nebati and Ekmekçi (2019), Kusumovidagdo et al. (2012), Weber et al. (2018)
Building materials used in the shopping center; Shopping center floor height	Kusumovidagdo et al. (2012)
Physical comfort in the shopping center; HVAC comfort in the shopping center	Abdullah and Jian (2019), Nebati and Ekmekçi (2019), Köksal and Tığlı (2018), Kusumovidagdo et al. (2012)
Lighting design concept of the shopping center	Kusumovidagdo et al. (2012), Weber et al. (2018)
Noise level in the shopping center	Köksal and Tığlı (2018), Weber et al. (2018)
Accessibility of the shopping center by handicapped people; Physical comfort of resting areas	Abdullah and Jian (2019), Köksal and Tığlı (2018)
Closeness of the retail unit to the vertical circulation	Abdullah and Jian (2019), Köksal and Tığlı (2018), Kusumovidagdo et al. (2012)
Effectiveness of the fire escape scenario	Kısa (2015), Chotipanich and Issarasak (2017)
Closeness of the retail unit to the fire exit passageways	Kısa (2015)
Existence of carpark	Kısa (2015), Köksal and Tığlı (2018), Kusumovidagdo et al. (2012), Chotipanich and Issarasak (2017)
Closeness of the retail unit to the carpark	Köksal and Tığlı (2018), Kusumovidagdo et al. (2012), Chotipanich and Issarasak (2017)
Whether the carpark is free of charge or not	Kusumovidagdo et al. (2012), Chotipanich and Issarasak (2017)
Daylight perception in the shopping center	Solovyev (2018), Çakmak and Yilmaz (2018), Nebati and Ekmekçi (2019), Wessau et al. (2018)
Effectiveness of the guidance signboards	Abdullah and Jian (2019), Kusumovidagdo et al. (2012), Weber et al. (2018)
Range of management services	Nebati and Ekmekçi (2019), Köksal and Tığlı (2018)
Existence of ATM machines	Abdullah and Jian (2019)
Existence of info desk	Abdullah and Jian (2019), Köksal and Tığlı (2018)
Effectiveness of sanitation services	Köksal and Tığlı (2018), Chotipanich and Issarasak (2017)
Brand range	Nebati and Ekmekçi (2019), Köksal and Tığlı (2018), Kusumovidagdo et al. (2012), Burnaz and Topçu (2011)
Branch mix in the shopping center; Existence of kiosques	Kusumovidagdo et al. (2012)
Existence of an entertainment center; Closeness of the retail unit to the entertainement center	Nebati and Ekmekçi (2019), Köksal and Tığlı (2018)
Existence of x-ray machines and security guards	Kısa (2015), Köksal and Tığlı (2018), Abdullah and Jian (2019), Chotipanich and Issarasak (2017)
Existence of a cultural center; Closeness of the retail unit to the cultural center	Köksal and Tığlı (2018)
Marketing activities	Kusumovidagdo et al. (2012), Bakhshizadeh et al. (2017)

mance, researchers converted these factors into declarations aiming at assessing the significance of every factor. These declarations designed for examining the domains reflect the significance of the dependent variables. In total, the final list includes three dependent variables with fifty-two factors.

To verify the validity of content for "retail unit sales performance," researchers employed the expert judgment method by conducting interviews with a panel of experts. This expert group comprised professionals with more than a decade of experience in different facets of the retail industry. The expert group initially involved seven individuals such as one distinguished architect, one shopping center manager, one shopping center operations director, one deputy general manager serving as leasing director and three retail store managers. In addition to the professionals, three shopping center customers also took part in this expert group to provide insights from a customer perspective. These participants assessed the retail unit sales performance measurement factors by utilizing a Five-Point Likert scale, where 5 represented "strongly agree," and 1 represented "strongly disagree." The responses to each factor were assigned a factor loading, indicating the influence degree for every factor. In this expert judgement, the retail unit design performance dependent variable is assessed using twenty-one factors; the building design performance dependent variable measured by using nineteen factors; finally, the building services performance dependent variable measured by using twelve factors. Towards the conclusion of the questionnaire, researchers also included four open-ended questions, allowing respondents to offer new performance measurement factors based on their valuable insights and experiences.

Following ten experts' interviews, researchers computed the importance rankings for each dependent variable and each factor through the calculation of the arithmetic mean. Subsequently, they assessed the new performance measurement factors proposed by the participants through the open-ended questions and incorporated them into the existing list. Meanwhile they eliminated less important factors. As a result, a refined and comprehensive list of instruments for measuring retail store sales performance was established, demonstrating content validity.

After the content validation of retail unit sales performance factors via expert group judgement method and the evaluation of the expert group judgement, as shown in Figure 1, the studies for the main study initiated in August 2020. The main study aimed to test and consolidate the results of the expert judgement and to enhance the list of factors influencing the retail store's sales performance. The main study group consisted of sixteen retail store managers from the shopping center in Gaziantep, Turkey. The sixteen retail stores belong to diverse retail branch mix such as textile, prêt-à-porter, cosmetics, food & beverage, personal care, electronics. This diversity of retail branch mix enriches the evaluation of the answers and the findings of the main study.

Following the expert judgement results, researchers made some adjustments in the performance factors' list for the main study questionnaire. In the retail store design performance dependent variable group, they subtracted the lowest ranked four factors. Contrarily to the retail unit design performance factors, in the building services performance variable they added two more factors suggested by the expert judgement committee. For building design performance dependent variable, the expert group suggested three more factors and the researchers added these three factors into the factors group. Finally, the questionnaire comprised of seventeen retail store design performance factors, fourteen building services performance factors and twenty-two building design performance factors.

Subsequently, researchers created a questionnaire. In the questionnaire, they revised and improved the statements consolidated by the expert judgement and measuring the rank of significance of the factors influencing the three dependent variables: retail unit design performance, building

services performance, building design performance. Following these three sections, they created a new section for measuring the retail unit sales performance factors because the expert group emphasized the necessity of a separate section consisting of retail unit sales performance factors. Consequently, researchers sorted out from the literature the key performance indicators for retail stores, and they inserted them into the questionnaire in the section of the retail unit sales performance.

Additionally, an expert panel of five experts (with +15 years' experience) evaluated the list of performance factors and the whole questionnaire, and they suggested some new questions to further develop the questionnaire. The new questions comprised of four following topics:

- The effect of the sociological background in the city to the retail store performance,
- Online sales versus traditional sales,
- The customer habits which have been changed after the Covid-19 pandemic,
- The retail sector/shopping center trends which attract customers most.

After the addition of these four questions, the final questionnaire of the main study consisted of seventy-three statements/questions. Seventeen statement/questions belong to retail store design performance factors, fourteen to building services performance factors, twenty-two to building design performance factors, eighteen to retail store sales performance factors. Finally, the last two questions are general open-ended questions which are not categorized under a specific dependent variable group. The whole final questionnaire is presented via a questionnaire link. Every factor received a loading score, indicating influence extent, by utilizing the Five-Point Likert scale (with 5 representing "strongly agree" and 1 representing "strongly disagree"). The final questionnaire was sent to sixteen retail store managers with over 15 years of experience in the shopping center in Gaziantep City, followed by the sequences explained in Figure 1 (see Figure 1).

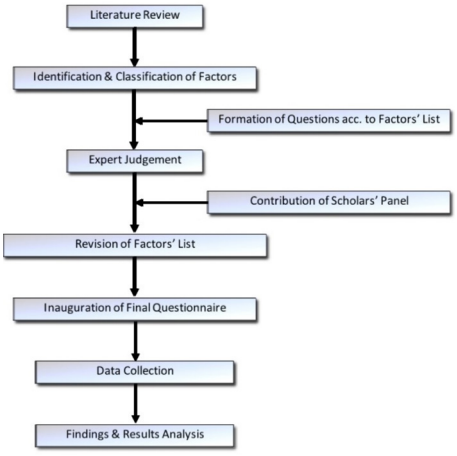

Figure 1. *Methodology flow chart of the study.*

4. Findings

Numerous factors, classified into three primary domains – retail unit design, building design, and building services, have an impact on the retail unit's sales performance. In the expert judgement among the 52 factors measuring the performance, 21 factors measured the retail store design performance dependent variable, 19 factors measured the building design performance dependent variable, and 12 factors measured building services performance dependent variable. The findings of the study will be presented according to these three categories. First, the importance level of factors will be evaluated within their own categories, then they will be compared in the overall factors' list.

In the retail store design performance dependent variable, the expert committee identified 'shop visibility' and 'retail unit interior design' as two most crucial factors influencing retail unit sales performance. Regarding the standard deviation values, respondents are mostly consolidated around these two factors' importance rank. However, respondents have diversified views on 16 factors out 21 retail store design performance factors as these factors have standard deviation values higher than 1 ($\sigma > 1$). Among the 5 statistically significant factors, respondents ranked the 'floor height of the shop' at the bottom line.

Within the realm of building de-

sign performance, survey respondents pinpointed 'the existence of a car park' as the most critical factor influencing retail store sales performance. Respondents' views are totally consolidated around this factor. On the other hand, 7 out of 19 building design performance factors are not statistically significant as their standard deviation values are greater than 1. Among the statistically significant factors, 'the floor height of shopping center' and 'the construction materials used' received the lowest score.

In the context of building services performance, the expert group unanimously designated 'the variety of brands in the shopping center' as the most significant factor impacting retail unit sales performance, with complete consensus among the experts ($\sigma = 0$). Amidst the 12 factors assessing the building services performance dependent variable, 5 factors' standard deviation values show that the respondents' views are diversified. 'The presence of security guards and x-ray machines' got the lowest importance rank.

Irrespective of the category of dependent variables, the expert group consistently identified the pinnacle as follows: 'existence of carpark' and 'range of brands' (both with mean scores: 5.00). Additionally, they considered 'retail store visibility' (mean score: 4.90), 'shop interior design' (mean score: 4.90) 'marketing activities conducted in the shopping center' (mean score: 4.80), 'retail store lighting design' (mean score: 4.80), and 'the effectiveness of sanitation services' (mean score: 4.80) as the most significant contributors to the retail unit sales performance. The ranking of all the three category performance factors (retail unit design performance, building design performance, building services performance) by the expert judgement are listed in Table 2. Researchers did not take into consideration the factors with standard deviation values greater than 1 (marked as bold), as respondents have diversified views about these factors (see Table 2).

Following the expert judgement results, researchers made some adjustments in the performance factors' list (as explained in the methodology section) for the main study questionnaire. According to the revision made after the expert judgement method, 17 factors measure the retail store design performance dependent variable, 14 factors measure the building services performance dependent variable, and 22 factors measure the building design performance dependent variable.

In the main study results, among the retail store design performance dependent variable group, respondents rank the following factors as the most important ones with mean scores of 4.80 each: 'the retail unit's lighting design', 'the shop window design' and 'the location of the retail unit in the shopping center'. Respondents have mostly consolidated views on these factors. However, respondents have diversified views on 7 factors (out of 17) with standard deviation values greater than 1.

The main study reveals the most significant factors' ranking of the building design performance dependent variable as following: 'the presence of carpark', 'the HVAC comfort' and 'the shopping center's lighting design concept' with 4.90 mean score each. Respondents consolidated their views around these factors with standard deviations $\sigma = 0{,}34$ and 0,25 successively.

Among the building services perfor-

Table 2. *Expert judgement results of dependent variables.*

Shop Design Performance			Building Design Performance			Building Services Performance		
Factors	Mean	SD	Factors	Mean	SD	Factors	Mean	SD
Visibility of the retail unit	4,9	0,32	Existence of carpark	5	0,00	Brand range	5	0,00
Shop interior design	4,9	0,32	HVAC comfort in the shopping center	4,6	0,70	Effectiveness of sanitation services	4,8	0,42
Lighting design of the retail unit	4,8	0,63	Architectural design of the shopping center	4,6	0,52	Marketing activities	4,8	0,42
Shop window design of the retail unit	4,7	0,95	Shopping center corridor width	4,4	0,70	Whether the carpark is free of charge or not	4,6	0,52
Location of the retail unit in the shopping center	**4,4**	**1,26**	Physical comfort in the shopping center	4,4	0,70	**Branch mix in the shopping center**	**4,4**	**1,07**
Closeness of the retail unit to the vertical circulation	**4,3**	**1,06**	Noise level in the shopping center	4,4	0,70	**Existence of ATM machines**	**4,4**	**1,26**
Retail unit dimensions	**4,2**	**1,03**	Physical comfort of resting areas	4,3	0,82	Existence of info desk	4,3	0,67
Floor level of the retail unit	**4,1**	**1,45**	Lighting design concept of the shopping center	4,2	0,92	Range of management services	4,2	0,92
Closeness of the retail unit to the entrances	**4**	**1,05**	Effectiveness of the guidance signboards	4,1	0,99	Existence of x-ray machines and security guards	4,1	0,99
Closeness of the retail unit to the main cores	**3,9**	**1,20**	Open-air vs enclosed center concept	4	0,94	**Existence of a cultural center**	**4**	**1,25**
Closeness of the retail unit to the carpark	**3,8**	**1,14**	Shopping center floor height	3,9	0,99	**Existence of an entertainment center**	**3,9**	**1,29**
Floor height of the retail unit	3,6	0,70	**Number of floor levels of the shopping center**	**3,9**	**1,37**	**Existence of kiosques**	**3,8**	**1,14**
Closeness of the retail unit to the entertainment center	**3,3**	**1,64**	Building materials used in the shopping center	3,9	0,88	-----	-----	-----
Closeness of the retail unit to the supermarket	**3,1**	**1,52**	**Accessibility of the shopping center by handicapped people**	**3,9**	**1,29**	-----	-----	-----
Closeness of the retail unit to the cultural center	**3,1**	**1,45**	**Smart building technologies used in the shopping center**	**3,7**	**1,34**	-----	-----	-----
Closeness of the retail unit to the kids playground	**3**	**1,25**	**Shopping center common area floor cladding material**	**3,6**	**1,17**	-----	-----	-----
Closeness of the retail unit to the fire exit passageways	**3**	**1,63**	**Efficient use of water and energy**	**3,1**	**1,20**	-----	-----	-----
Closeness of the retail unit to the event area	**2,7**	**1,16**	**Daylight perception in the shopping center**	**3,1**	**1,20**	-----	-----	-----
Closeness of the retail unit to the delivery yard	**2,7**	**1,25**	**Effectiveness of the fire escape scenario**	**3**	**1,63**	-----	-----	-----
Closeness of the retail unit to the food court	**2,5**	**1,43**	-----	-----	-----	-----	-----	-----
Closeness of the retail unit to the customer wet cores	**2,5**	**1,35**	-----	-----	-----	-----	-----	-----

mance dependent variable's factors, the respondents in the main study regard 'the brand range in the shopping center' as the most critical factor influencing retail unit sales performance, assigning it a mean score of 5.00. Also, this factor reflects a total consolidation of respondents' views (σ=0). 'The effectiveness of sanitation services' (mean score: 4.80) and 'the branch mix in the shopping center' (mean score: 4.70) come as the 2nd and the 3rd most important factors. None of the building services performance factors reflect diversified views, all these factors have standard deviation values below 1 (σ <1).

As per the main study, the rankings of factors across all three performance categories (shop design performance, building design performance, and building services performance) can be found in Table 3. The factors marked as bold reflect the factors where respondents have diversified views with (σ >1) (see Table 3).

Table 3. *Main study results of dependent variables.*

Shop Design Performance			Building Design Performance			Building Services Performance		
Factors	**Mean**	**SD**	**Factors**	**Mean**	**SD**	**Factors**	**Mean**	**SD**
Lighting design of the retail unit	4,8	0,45	Existence of carpark	4,9	0,34	Brand range	5	0,00
Shop window design of the retail unit	4,8	0,58	HVAC comfort in the shopping center	4,9	0,25	Effectiveness of sanitation services	4,8	0,58
Location of the retail unit in the shopping center	4,8	0,58	Lighting design concept of the shopping center	4,9	0,25	Branch mix in the shopping center	4,7	0,48
Floor level of the retail unit	4,7	0,48	Accessibility of the shopping center by handicapped people	4,8	0,40	Whether the carpark is free of charge or not	4,6	0,81
Visibility of the retail unit	4,6	0,62	Physical comfort in the shopping center	4,6	0,63	Range of management services	4,6	0,63
Closeness of the retail unit to the main cores	4,6	0,50	Physical comfort of resting areas	4,6	0,50	Existence of an entertainment center	4,6	0,50
Retail unit interior design	4,4	0,51	Shopping center corridor width	4,5	0,63	Existence of ATM machines	4,4	0,62
Closeness of the retail unit to the vertical circulation	4	0,97	Noise level in the shopping center	4,5	0,89	Existence of info desk	4,4	0,63
Floor height of the retail unit	4	0,73	Shopping center floor height	4,5	0,63	Existence of x-ray machines and security guards	4,4	0,89
Closeness of the retail unit to the entrances	**3,8**	**1,05**	Effectiveness of the guidance signboards	4,4	0,63	Existence of a cultural center	4,4	0,89
Retail unit dimensions	**3,7**	**1,20**	Building materials used in the shopping center	4,4	0,81	Marketing activities	4,3	0,60
Closeness of the retail unit to the entertainment center	**3,6**	**1,02**	Smart building technologies used in the shopping center	4,4	0,81	Marketing billboards in the center	4,3	0,93
Closeness of the retail unit to the carpark	**3,4**	**1,45**	Shopping center common area floor cladding material	4,4	0,72	Existence of kiosques	4	0,97
Closeness of the retail unit to the kids playground	**3,3**	**1,18**	Effectiveness of the fire escape scenario	4,4	0,73	Social responsibility projects, social activities	3,9	0,72
Closeness of the retail unit to the cultural center	**2,9**	**1,12**	Flexible architectural design acc.to weather conditions	4,4	0,62	-----	-----	-----
Closeness of the retail unit to the supermarket	2,7	0,87	Direct relationship of the center with the public spaces	4,4	0,73	-----	-----	-----
Closeness of the retail unit to the fire exit passageways	**2,7**	**1,01**	Architectural design of the shopping center	4,3	0,77	-----	-----	-----
-----	-----	-----	Abundant use of landscape in the shopping center	4,3	0,86	-----	-----	-----
-----	-----	-----	**Open-air vs enclosed center concept**	**4,1**	**1,09**	-----	-----	-----
-----	-----	-----	**Daylight perception in the shopping center**	**4,1**	**1,36**	-----	-----	-----
-----	-----	-----	Efficient use of water and energy	4	0,82	-----	-----	-----
-----	-----	-----	**Number of floor levels of the shopping center**	**3,9**	**1,18**	-----	-----	-----

5. Discussion

The purpose of this study is to pinpoint the design-related factors that influence the sales performance of retail units and to determine the significance of these factors via expert judgement and main study questionnaire. The expert judgement measured the retail store design performance dependent variable by 21 factors. However, the results showed that four factors received scores under 3.00. Therefore, researchers subtracted these four factors from the list, leaving 17 factors for retail store design performance for the main study questionnaire. The experts eliminated the factors below:

- retail store's closeness to the event area
- retail store's closeness to the delivery yard
- retail store's closeness to the food court
- retail store's closeness to customer restrooms

Findings indicate that eliminated factors are related to the placement of the retail unit in the shopping center. This implies that the customer circulation through event space, delivery yard, food hall and customer restrooms do not have an important effect on the sales performance of the retail unit.

The expert judgement measured the building design performance dependent variable by 19 factors. However, the expert group added 3 more factors according to their experience in the retail sector. These factors are listed below as:

- flexible architectural design according to weather conditions
- direct relationship of the center with the public spaces
- extensive utilization of landscaping within the shopping center

Similarly, the initial expert judgement measured the building services performance dependent variable factors by 12 factors. Moreover, the expert group suggested the following factors to the questionnaire, summing up to 14 factors:

- marketing billboards in the center
- social responsibility projects and social activities

Regarding the deep experience and knowledge of the expert group in the diverse sections of the retail sector, researchers took these additional factors into consideration, and they added them into the final questionnaire of the main study.

Before examining in detail each performance factor's ranking in the dependent variables' groups, researchers focused on how the ranking positions of the dependent variables in the expert judgement and in the main study have changed. Therefore, they analyzed the mean score of each dependent variable both in the expert judgement and in the main study. It should be noted that some factors have been added or subtracted after the expert judgement to be able to create a more accurate list of factors as explained in previous paragraphs (see Table 4).

According to the expert judgement results, the mean score, averaged across 12 factors of the building services dependent variable is 4.36, which is the highest average among the 3 dependent variable groups (building service dependent variable, building design dependent variable and retail store design dependent variable). The 2nd highest score belongs to the average of 19 factors of the building design dependent variable with 4.01 mean score. The shop design dependent variable's 17 factors received the lowest average mean score as 3.95. For an adequate comparison of the average mean scores between the expert judgement and the main study these four factors are left aside as explained above.

The main study measured the building services performance dependent variable by 14 factors listed in Table 3. The building services performance dependent variable received the highest average mean score among the 3 dependent variables in the main study as 4,52 (whereas 4,36 in the expert judgement). Similarly, the second highest score belongs to the building design performance factors with an average score of 4.01 in the expert judgement and 4,45 in the main study. The third importance rank shows the retail store design performance dependent variable's 17 factors with average score 3,95 in the expert judgement and 3,93 in the main study. Table 4 shows these results clearly. Researchers made the reliability t-test for the results in Table 4 and got p-value α =0,44, which means that the results are not statistically significant (α<0,05: statistically significant). Therefore, there is no significant difference between the dependent variables results' means in expert judgement versus the main study.

Table 4. *Comparison of the results for dependent variables.*

Dependent Variables	Expert Judgement Mean	Main Study Mean
Shop design performance	3,95	3,93
Building design performance	4,01	4,45
Building services performance	4,36	4,52

Findings from the main study clearly point out that the building services and the building design dependent variables' performance factors, which are factors belonging to the shopping center itself and which are stable for all the retail stores, are more important than the retail store design performance factors for the sales performance of the retail units in the shopping center. This fact implies that customers care more about the shopping center building itself and the shopping center services they encounter in this building and this behavior impacts on the retail unit sales performance directly. The retail store design performance factors which are variable on each retail store have less impact on the sales performance of the retail unit.

According to the expert judgement results, the highest-ranking factors are ' carpark existence' and 'brand variety', both of which received a full score of 5.00. Also, respondents are consolidated on the importance of these factors (σ=0). Both factors influencing the sales performance of a retail unit are not directly related to the retail unit; instead, they seem contingent on dependent variables of building services and building design. The most significant influences on retail unit sales performance are rooted in the shopping center's environment and the retail store's location within the center. Furthermore, the 'existence of a car park' factor underscores that easy car accessibility serves as a significant incentive for customers to visit the shopping center, aligning with findings in the research by İpekçi (2014) and Kusumowidagdo et al. (2011). In the main study results, 'the existence of car park' factor has received 4.90 mean score, and the standard deviation is σ=0.34, which shows that respondents have consoli-

dated views on this major factor.

Regarding the results of this study, taking into consideration the relevant importance level of the 'existence of carpark' in the shopping centers would be very beneficial to the building design architectural layouts in the sense of the retail units present in the shopping center. A good example of an effective design of shopping center integrated with the carparks is Primemall Gaziantep (designed by Erginoğlu & Çalışlar Architects), the plans of which are shared in Figure 2. As presented in the schematic plans and sections below (see Figure 2 and Figure 3), the carparks of the shopping center are truly integrated into the building design from 3 levels, with the support of topographic features. The shopping center presents 3 levels of carparks to its customers such as the underground carpark (as usual), the ground floor open carpark and the roof carpark (as less usual). The 3 levels of carparks (on the basement, second and fourth floors) enhance the customer circulation into all shopping floors, thus beneficial for the retail units' sales performance. As a result of this customer circulation enhancement, the retail units close to these entrances and the ones situated at these levels are more demanded by successful brands/anchors and their rental unit price is higher (see Figure 2 and 3).

A factor in 'the building services' dependent variable group, top-ranked both in the expert judgement and in the main study, the 'brand range in the shopping center' generates a combined effect and draws people through the shopping center, thereby significantly impacting the sales performance of retail units. The results of this research, in line with the research conducted by Burnaz and Topçu (2011), demonstrate that the concept of offering a diverse range of products in one location has a strong appeal to customers.

In the expert judgment results, the second-highest ranking is shared by two retail store design-related dependent variables, namely 'the shop interior design' and 'the shop visibility' both achieving a mean score of 4.90. The shop interior design plays a dual role: it serves to draw in customers to the shop

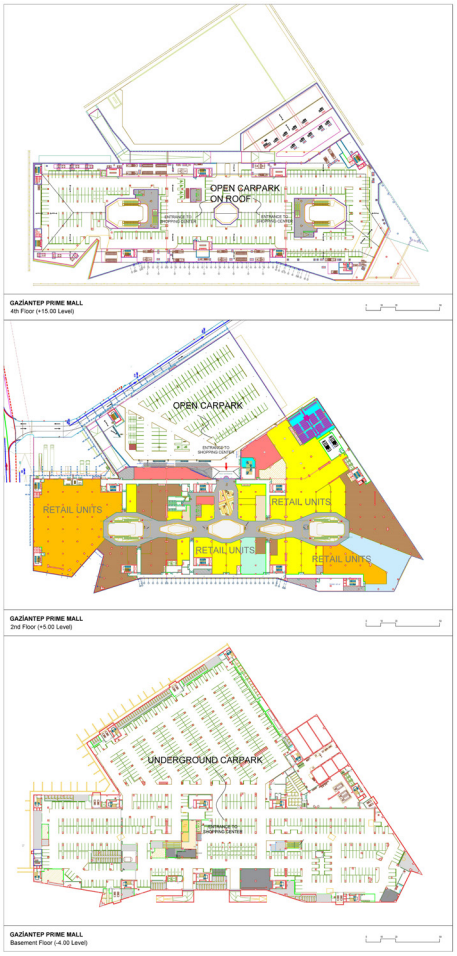

Figure 2. *Plan layouts of primemall Gaziantep (Basement, Second, Fourth Floors)*

and encourages them to spend additional time there. Both aspects have a direct impact on the sales performance of the retail unit, which aligns with the findings mentioned in Webber et al.'s study (2018). Considering the principle that individuals are guided by their visual perception, the factor of "shop visibility" is deemed one of the most significant factors influencing a store's sales performance, aligning with findings from a study carried out by Webber et al. in 2018. Nevertheless, the results indicate that "shop window design" is a relatively less important factor, with a mean score of 4.70, ranking

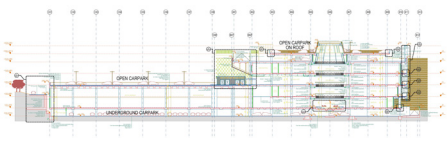

Figure 3. *Architectural section of primemall Gaziantep*

it 4th in importance.

Unlike the expert judgement, in the main study the top 2nd rank consists of three factors with 4.90 mean score each, which are 'the presence of carpark', 'the shopping center's heating/ventilation/air conditioning (HVAC) comfort' and 'the shopping center's lighting design concept'. These factors all belong to the building design dependent variable group. The top two rankings are quite different in the expert judgement and in the main study. Although in the expert judgement, the first two top ranks are evenly distributed between three dependent variable groups, in the main study 'the building services' dependent variable and 'the building design' dependent variable fully cover these ranks and leave the retail store design dependent variable to the 3rd rank. This implies that respondents of the main study considered 'the retail design performance' dependent variable as less important and this finding is parallel to the mean score finding, which states the shop design performance dependent variable as the least important among all the dependent variables, as explained in the previous paragraphs.

The top 3rd rank score is 4.80 in the expert judgement, and it is shared by three performance factors such as 'marketing activities', 'effectiveness of sanitation services' and 'retail store's lighting design'. The first two factors belong to the building services dependent variable and the last one belongs to 'the shop design' dependent variable. At this degree of ranking, "building services" factors outrank the "shop design" factors. The shopping center's management, through its periodic marketing activities and the effectiveness of its sanitation services, draws customers and thereby positively impacts the sales performance of retail stores. Additionally, the shop lighting design, including factors like efficacy, light intensity, and light color, significantly influences shoppers' behavior, as aligned with the study by Nebati and Ekmekçi in 2019. Likewise, the participants in the main study ranked "the shop lighting design" as third most significant factor influencing the retail unit's sales performance. Also, within main study, the 'lighting design concept of the shopping center' score has 4.90 score (2nd top rank). Correspondingly, Chebat et al. (2014) and Prakash et al. (2021) emphasize the importance of the lighting design concept of the shopping center factor. Following the results of this study and the literature, one must state clearly that a well-designed shopping center lighting concept with divers lighting fixtures in specific areas (see Figure 4), will contribute very positively to the turnover performance of retail stores (see Figure 4).

In the main study, the 3rd position is jointly occupied by 4 factors: 'shop lighting design', 'shop front design', 'placement of retail store within shopping center,' and 'the effectiveness of sanitation services.'. It is clearly observable that the top 3rd rank mostly consists of 'the shop design performance' factors.

The factor about the carpark payment system (free vs. payable) within the building service performance variable obtained a mean score of 4.60 in both the expert judgment and the main study. Thus, respondents, mostly consolidated with σ=0.52, consider this factor as a factor more significant one. This factor clearly shows that free carpark service affects positively the shopping behaviors of customers.

The expert judgement results place 'the shopping center architecture' and 'the climate control systems' comfort' as the fifth most significant factors influencing sales performance of retail stores. Customers are inclined to shop and linger in environments that are both well-designed and well-climatized, a finding that aligns with the study conducted by Costa Webber et

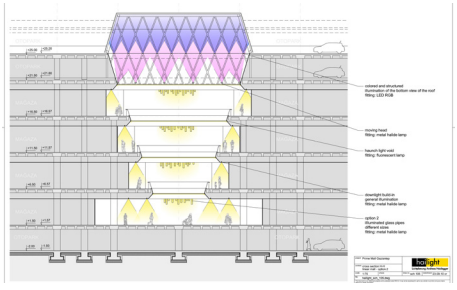

Figure 4. *Effective shopping center lighting design in primemall Gaziantep*

al. in 2018. Moreover, this outcome reinforces the notion that shopping center design should encompass a well-integrated approach that combines architectural design efficiency and electromechanical systems as a whole. The study by Ferreira et al. (2023) consolidates this finding. However, in the main study, the 'the shopping center's architectural design' factor's score decreased to 4.30, although 'the shopping center's HVAC comfort' factor gained points to 4.90 score. This implies that the significance of the building design is still consistent in the main study, but the respondents gave more importance to the detailed scopes rather than the general idea of design.

In the expert judgment, the factors that occupy the 6th position, with a mean score of 4.40, encompass three distinct factors: 'the shopping center's physical comfort', 'sound intensity inside retail center,' and 'retail center's aisle span'. Notably, the first two factors have been identified as significant for the prosperity of a shopping center in numerous previous research, such as those by Bakhshizadeh et al. (2017), Yılmaz Çakmak and Yılmaz (2018), and Köksal and Tığlı (2018). However, the 3rd factor, 'the shopping center corridor width,' offers unique insights into the significance hierarchy of factors influencing the sales performance of retail units. The expert judgement and the main study find out that the proper center corridor width plays a significant role for 'the building design performance' variable. The effective mall corridor width for good customer circulation is shown in Figure 5 below. The effective mall corridor width is driven from the idea that the corridor should be wide enough to let customers circulate easily but narrow enough to enable customers to see the shopwindows closely enough. The study by Büyükşahin, S. (2023) consolidates this result. Another point sorted out from the main study results compared to the expert judgement results is that 'the physical comfort of the center' gained more importance and was ranked in 5th line with 4.60 score. This result aligns with the study of Kusumowidagdo et al. (2011). Therefore, these results are consolidated by both studies (see Figure 5).

In a manner consistent with the conclusions drawn from the expert judgement, participants in the main study placed 'the existence of cultural performance hall' as 7th factor influencing sales performance of retail units among the building services variable. It received a mean score of 4.40. This ranking level comprises of three other factors of building services dependent variable such as existence of 'info desk', 'ATM machines', 'x-ray machines and security personnel'.

In the main study, the factor related to the center's accessibility for individuals with disabilities garnered a mean score of 4.80 and secured the 5th position among factors of all the dependent variables. This clearly states that this factor affects 'the retail store sales performance' as much as 'the retail store's lighting design,' 'the shopwindow design' or 'the sanitation services' efficiency'. This shows that the consciousness of universal design and the spatial justice for all customers are upraising concepts as similarly indicated in the study by Can and Kılıç Delice (2018).

Among 'the building design performance' factors, the following ones received the same 4.40 mean score in the main study, and they got the 22nd rank out of 53 factors: 'the efficiency of the guidance signboards', 'the building materials used', 'the smart building technologies used' and 'the common area floor cladding material', 'the fire escape scenario effectiveness', 'flexible architectural design' and 'direct relationship of the center with public spaces'. These building design-related factors, which are uniform across all retail stores, have a moderate impact on the sales performance of the retail unit. In

Figure 5. *Effective mall corridor width*

the expert judgement these factors received less points and their scores were not identical. 'The common area floor cladding material' factor had only 3.60 mean score, while 'the smart building technologies used' received 3.70 mean score. 'The effectiveness of the guidance signboards' and 'the building materials used' factors slightly ranked higher with 4.10 and 3.90 mean scores consecutively.

Numerous research (Nebati & Ekmekçi, 2019; Yılmaz Çakmak & Yılmaz, 2018) have highlighted the positive influence of daylight on customer shopping behaviors. Nevertheless, the factor concerning 'daylight perception in the shopping center' obtained the 17th position out of 19 ranks in both the expert judgment study and the main study. Moreover, the respondents have diversified views on this issue (σ=1.20 in expert judgement, σ=1.36 in main study).

The fire escape regulation stands out as one of the most crucial regulations that shopping center designs must adhere to. Consequently, shopping center building designs consistently adhere to fire escape regulations to obtain the necessary building permits. That being stated, in the main study, the factor relating to the 'closeness of the retail store to the fire exit passageways' remains at the lowest rank, with a mean score of 2.70. However, 'the effectiveness of the fire escape scenario' attains a higher level of importance in the main study, with a mean score of 4.40.

Although 'the location of the retail unit' factor stands at the 1st top level among the retail store design dependent variable's factors in the main study, respondents do not attribute importance to 'the closeness of the retail unit to the major interest areas' factor when it comes to its impact on retail unit sales performance. Factors like 'closeness to supermarket, service yard, playground, leisure event center, food hall, and customer restrooms' are rated between sixteenth and nineteenth positions out of 19. These are regarded as per the least influential factors influencing retail unit's sales performance. Thus, researchers considered leaving these factors out of the questionnaire in the main study.

6. Conclusion

In this paper, a comprehensive examination of the literature revealed the key design factors that impact the sales performance of retail units inside a retail center. This study's primary objective was to ascertain the essential design factors for creating an efficient shopping center design and to establish their respective levels of importance. Researchers categorized these factors into three distinct dependent variables: 'building design performance', 'shop design performance', 'building services performance'. At the outset, the expert judgment method involved a panel consisting of seven retail industry experts and three retail customers who assessed a list of 52 assessment parameters with a Five-Point Likert scale, accompanied by open-ended questions. Researchers subsequently deliberated on the evaluation scores assigned to each factor in terms of their impact on the sales performance of retail units. Following this, the study considered additional factors proposed by participants through unrestrictive questions, as well as removed factors with mean scores falling below 3.00 points. This process resulted in a refined list of assessment parameters that demonstrated substantive validity. Finally, the research determined the rating of fifty-two factors influencing sales performance of shop units. Moreover, this study discussed the ranks between the dependent variables.

Following the expert judgement, researchers prepared the main study for the consolidation of the expert judgement. The main study group consisted of sixteen retail store managers with more than 15 years' experience from the shopping center in Gaziantep, Türkiye. The sixteen retail stores belong to diverse retail branch mix such as textile, prêt-à-porter, food & beverage, cosmetics, personal care, electronics. The main study used the same methodology such as the Five-Point Likert scale for evaluation. Researchers discussed the statistically significant findings of the main study in detail, and they compared these results to the findings of the expert judgement. This paper only takes into consideration and compares the common factors in both the

expert judgement and the main study via accurate statistical methods. The researchers provided a comprehensive and detailed explanation of the measurement grade for each factor.

'The brand variety' and 'the presence of carpark' factors are the only two factors that received full score 5.00 with standard deviation value (σ=0). The respondents are consolidated around the utmost importance of these two factors for an effective and successful shopping center design. 'The presence of carpark' factor is presented via effective shopping center design layouts and discussed as an important issue. Following these two factors, 'the HVAC comfort' and 'the shopping center's lighting design concept' come as most significant factors influencing sales performance of shop units. Effective examples of shopping center design layouts are presented to highlight the importance of these factors. An unexpected discovery is that none of these factors are related to the performance of shop design. According to the findings, building design and building services performance factors come over the shop design performance factors. Notably, the average score of the building service performance factors is the highest among the average score of the three dependent variables (building design performance, shop design performance and building service performance). Researchers found this as a surprising result because the general tendency in the literature (as cited in the previous sections) is that the primary performance factors that significantly influence the sales performance of the retail unit are those related to both building design and retail store design. Moreover, 'the lighting design concept' appears to be particularly important both in the building design and in the retail store design performance. Respondents ranked both lighting design factors with high scores. This is a particularly important finding in the sense that it leaves behind the architectural design factors such as building materials, space dimensions or interior design.

This research focused on a special shopping center and its experienced professionals with a limited number of respondents. In future research studies, there is potential to broaden the sample size and apply the proposed measurement scale to shop managers in various shopping centers, both at local and international levels. This could facilitate a comparison of differences in shop performance indicators, considering both local and global perspectives. More detailed data analysis and evaluation may be accomplished. Future studies could explore a comparative analysis across different shopping centers in various locations. Identifying both the similarities and differences in these results could prove invaluable in developing a data model for shopping center design management in the retail industry. Such a model would offer practical insights for retail investors, aiding them in realizing and enhancing retail investments with greater viability and competitiveness.

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Robotic technology and artificial intelligence in the process of creating artworks from waste materials: The role of circular design

Mehmet Onur SENEM[1]*, İmdat AS[2]
[1] senem19@itu.edu.tr • Applied Informatics, Informatics Institute, Istanbul Technical University, Istanbul, Türkiye.
[2] ias@itu.edu.tr • Architecture, Faculty of Architecture, Istanbul Technical University, Istanbul, Türkiye

**Corresponding author*
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Abstract
In recent years, the application areas and techniques of robotic mechanisms have been gaining significance within design disciplines and various branches of art. This study aims to investigate the hardware and software development of a robotic model that assembles portrait images out of waste material. The primary objective of this research is to demonstrate the feasibility of using robotics to create works of art made out of recycled materials. This research method discovered that it is possible to carry out a production process in which artificial intelligence and robots manage all stages—from generating portrait images, to detecting waste materials to assembling the final artwork. By exploring the possibility of converting waste materials into art objects, this study aims to investigate the potential of technological advancements in robotics to establish a new realm of possibilities in the field of art, design, and waste management. This study will explore the intersections of technology, environmental sustainability and artistic expression and add a new perspective to the existing literature of robotic assemblages.

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Keywords
Computer vision, Diffusion model, Machine learning, Robotics, Waste art.

1. Introduction

During the construction of the Hagia Sophia in the sixth century, Emperor Justinian acquired spolia from all corners of the Roman Empire to compose his masterpiece in Istanbul. Spolia were architectural components taken from older unused structures repurposed for new construction or decoration. This method was quite common even for ordinary buildings. It was easier and cheaper, but it also built on the circularity of building materials, in which materials from unused structures in the vicinity were repurposed for new housing projects, city walls and churches. Even today, some architects are finding creative ways to reuse materials from old structures, such as turning old steel shipping containers into homes, (Clark, 2023) or using pieces of old infrastructure to build unique and vibrant houses (Cala, 2010). While these are inspiring examples, they are outliers in the overall scheme of architectural production. They are not scalable enough to exhaust the immense amount of building waste continuously accumulating around the globe. The scale of the waste problem is immense: According to the United States (US) Environmental Protection Agency (EPA), the US alone produced more than 600 million tons of construction and demolition waste in one year (Demetriou et al., 2023). And, only 25% of that waste underwent reuse or recycling, while the rest ended up in ever-growing landfills (EPA, 2017) and caused severe environmental harm (Duan et al., 2011).

Finding new ways to reuse materials has become crucial to the building industry today. Studies show that 95% of non-hazardous waste could be reused or recycled (Ma et al., 2020). Instead of throwing away materials, we could reuse them to make new buildings or other artifacts. In circular economies (CEs) waste is recaptured as a resource to manufacture new materials and products (Demetriou et al., 2023), i.e., material resources are reused over and over as much as possible to limit the amount of waste. This reuse helps reduce waste and gives materials a longer lifespan, which aligns with the United Nation`s (UN) sustainability development goals on responsible consumption and production (Biermann et al., 2017; Senem & As, 2022).

There has been ongoing research on the role artificial intelligence (AI) and robotics can play in supporting CEs in architecture. For example, recent studies focus on 'Buildings as Material Banks (BAMB)' (BAMB, 2016). One such study investigates using AI to identify the material stock of entire cities in order to predict the amount of stone, brick, metal and glass stocks in existing building inventory via Google Street Views (Raghu et al., 2022). Others investigate how robots can automate construction processes with as-found materials to create walls and various landscape formations (Gramazio Kohler Research, 2023). Yet, these studies do little to address the immense potential of innovative technologies to automate and compose waste into new and multi-layered designs. Indeed, the genuine capacity of waste repurposing resides within the intersection of artistic creativity, new technologies and sustainability. Through the use of AI for the conception and development of designs, combined with the precision of robotic engineering for waste sorting and assembly, we offer a particular answer towards *artistic sustainability* (Scalera et al., 2019a; 2019b).

Our literature review does not include fully automated art generation and production by AI and robots, or related works; this study aims to address that gap. . This paper will showcase a multi-faceted project that repurposes and assembles household waste into two-dimensional artwork. It involves AI-generated visuals, machine learning-driven color spectrum adjustments, object detection, preparation of waste materials, and the assembly of material pieces into artwork with the help of a robotic arm. However, our approach may extend past the confines of two-dimensional space. At the end of the paper, we will discuss a home remodeling project for Deniz Sagdic, a contemporary artist who creates ready-made art with waste materials (Figure 1). Through this architecture project we will elaborate on how some of our ideas can be transferred

to three-dimensional space. With new technologies, robots and creativity we can transform waste into something new, acting as a testbed for bigger and more impactful projects in the future.

2. Background

In an era where artistic innovation and technological advancement overlap, we can create a synergy at the intersection of art, architecture, AI-driven robotics, and waste repurposing. The convergence of artistic vision, automation, and responsible resource utilization offers a glimpse into a future where waste is transformed into habitable structures, paving the way for a more sustainable world running on CEs. Through the lens of manual and automated assembly, the utilization of AI, and the symbiosis of creative artistry and technological advancement, we start exploring how these elements shape the landscape of architecture, sustainability, and artistic expression.

2.1. Manual assembly

Today, several artists repurpose materials for their artwork. For example, Sagdic is using household waste as a medium in her work to explore the social and environmental significance of recycling. She repurposed over two tons of waste for her expressive portraits, using 13,000 buttons, 34,000 plastic clamp bands, jeans, and expired medical tablets (Oru, 2021; Figure 1).

Like Sagdic, other artists make ready-made art from old clothing material, sculptures from plastic forks and spoons, furniture and buildings from scrap foam, reused cross-laminated timber, scrap windows, salvaged building elements, recycled and other repurposed building materials (Figure 2).

These projects prove that remarkable outcomes can come from simple assembly operations. Nonetheless, new technologies can help automate such manual operations. In the following section we will give an overview of the state-of-the-art uses of robotics and AI in architecture, and discuss their use in our research.

2.2. Automated assembly

Robots have been widely used in many architectural applications, such as pick-and-place operations (Gawel et al., 2019; Gharbia et al., 2020; Vähä et al., 2013), drilling, welding, laser cutting, and 3D printing (Evans, 2012; Tay et al. 2017; Zhang et al., 2019). Robots are versatile and have been known for their ability to adapt to different tasks and environments, from laying brick walls to 3D printing entire homes to fabricating smaller-scale objects, such as urban furniture or product designs (Bonwetsch, 2012; Abdalla et al., 2021; Sakin & Kiroglu, 2017; Oberti & Plantamura, 2015). For example, in the 'Circularity Park' project researchers used robots to construct a retaining wall and terraced landscape. They worked on autonomous construction processes, using recycled building materials, and investigated the design, control and computational tools needed for on-site construction with as-found building materials and local excavations (Gramazio Kohler Research, 2023).

Figure 1. *Ready-made art from waste materials by Deniz Sagdic, left: blow-up view, right: entire canvas 140cm x 140cm (Sagdic, 2022).*

Figure 2. *1- Jane Perkins' Girl with a Pearl Earring (after Vermeer), made from clothing buttons (Perkins, 2024); 2- Sayaka Ganz's sculptures of horses made from plastic forks and spoons (Liarostathi, 2012); 3- Douglas & Company's furniture made from scrap foam and reused cross-laminated timber (Douglas, 2021); 4- Hirushi Nakamura's Zero-Waste Center assembled from 700 scrap windows (Iype, 2022); 5- S+PS Architects' Collage House upcycled salvaged building elements into its façade (Grozdanic, 2016.); 6- Lundberg Design's Breuer Cabin made from leftover materials of their earlier projects (Lisa, 2014); 7- James & Mau's Manifesto House made from recycled and repurposed building materials (James & Mau, 2023).*

2.3. Use of AI

Within the realm of architecture, AI has been extensively explored for a range of purposes including design generation, analysis, optimization, and as a wellspring of inspiration. It has shown promise in generating basic design concepts, predicting energy efficiency, maintenance needs, and risk assessment (Theis et al., 2015; Goodfellow et al., 2020; Dhariwal & Nichol, 2021; Yang et al., 2023), and developing optimized topologies for structural systems (Bernhard et al., 2021). A noteworthy illustration of AI's ingenuity in CE studies can be found in the Building As Material Bank's (BAMB) project. This project adeptly utilizes AI to predict material stock within urban settings and explores the feasibility of repurposing components from existing structures. Employing Google Street View, BAMB discerns facade materials and reusable elements such as windows, doors, and shutters, to produce classification maps and protocols facilitating urban mining, i.e., the extraction of urban materials for potential reuse in new building projects (Raghu et al., 2022). The landscape of AI-driven design generation is equally vibrant, consisting of various generative models including variational autoencoders, generative adversarial networks (GANs), normalizing flows, autoregressive, energy-based, and diffusion models. Exemples such as Midjourney (Borji, 2022), DALL-E (Kapelyukh et al., 2023), DeepDreamGenerator (Lyu et al., 2022), DreamStudio (Zhou & Shimada, 2023), as well as platforms like FreewayML, NightCafe, and DeepAI, stand out for their capacity to automate design concepts and ideas through text-to-image or image-to-image AI protocols.

2.4. Synergy of AI and robots

AI-driven robotics spans a spectrum of tasks, including autonomous navigation, precise object recognition, and collaborative undertakings (Wright et al., 2010; Klette, 2014). These technologies extend to diverse activities, such as trash sorting and recycling (Zhou et al., 2022; Ingle & Phute, 2016), the transformation of plastic waste into functional tiles, and the creation of 3D-printed metal structures using recycled materials (Tobi et al., 2017; Oberti & Plantamura, 2015; Abdalla et al., 2021). While research converging AI and robotics within the architectural realm remains relatively sparse, there are a few notable examples, such as machine learning's role in forecasting adjustments for robot toolpaths (Nicholas, 2021) or the implementation of reinforcement

learning to orchestrate the assembly of discrete components through action, reward, and observation protocols (Wibranek & Tessmann, 2021). However, research on the integrated use of robots and AI to assemble and repurpose waste into habitable structures is a relatively new area of investigation.

The remarkable journeys of artists, like Sagdic, who sculpt their visions from discarded materials, stand as living testaments to the potential that emerges from such synergy, i.e., robotics and AI in architecture is built on innovation, from robots skillfully constructing retaining walls and terraced landscapes with recycled materials to AI algorithms mapping the urban landscape to salvage and repurpose architectural components. The intersection of robots, AI, and visionary art has the potential to transform waste into habitable structures and can open a path for a more sustainable and circular future in the building industry.

3. Methods and tools

Our work makes use of a. AI diffusion models for generating expressive portrait images; b. the application of unsupervised machine learning to distill and organize color spectrums; c. the preparation of repurposed materials; and, d. the careful setup of a robotic arm to detect, sort, pick and place waste materials (Figure 3). We used open-source resources and created customized solutions to develop a prototype. The exploration of AI diffusion models, particularly the effectiveness of Midjourney, underscores the potential of crafting AI artwork tailored for robotic assembly. We used K-means clustering, spatial adjustments in image preparation, and computer vision for object detection and sorting (Dhanachandra et al., 2015). We also undertook precise coordination of the robot arm's intricate pick-and-place operations. Integrating a six-axis robotic arm within a modified control cabinet represents a practical approach to assembly. In this synthesis of technology and artistry, we present a pathway toward a fusion of AI, robotics, and sustainability within artistic architectural expression.

3.1. AI diffusion models

Since its emergence in late 2022, AI diffusion models have profoundly impacted architecture, prompting architects and designers to delve into potential applications (Epstein et al., 2023; Leach, 2022; Fernberg & Chamberlain, 2023). We surveyed Dream ML, Deep Dream Generator, Dall-E, and Midjourney for our research. The latter produced the best results for our research, i.e., generating AI artwork that a robot arm can effectively assemble. AI diffusion models provide stability and high-resolution results, which make them particularly apt for art and graphic design. They are also increasingly integrated into architectural practice with plugins that work with common software tools in the industry. AI diffusion models are built on a two-step process: a forward and a reverse diffusion process. Their neural network is trained to apply conditional distribution probabilities via text or image prompts, and to reverse the noise diffusion into discernable imagery (Dhariwal & Nichol, 2021).

3.2. Image preparation

After generating an image with Midjourney, we used computer vision for both K-means clustering to reduce the image's color spectrum and object

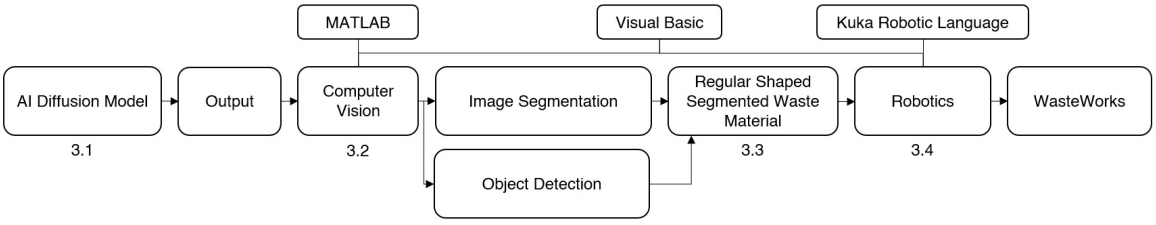

Figure 3. *Workflow of WasteWorks: AI-generated image (3.1) is segmented into color shades (3.2) through K-means clustering and material waste is identified with computer vision. Waste material is then prepared and assembled (3.3) into artwork with a robot arm (3.4).*

detection to sort and identify materials. These colors are linked to a particular material slot on the robot cabinet. While the image has red, green, and blue color channels (RGB), we set the robot arm to recognize a single greyscale channel, and converted the color images into grayscale shades. In addition, we adjusted the spatial and radiometric resolution of the source image, which is an important step in the segmentation process (Schabenberger & Gotway, 2017). The system is then able to produce an image with precise coordinates for the pick-and-place operations of the robot arm.

The use of computer vision for object detection has become indispensable in numerous fields, including remote sensing (Fritsch, 2023; Nurkarim & Wijayanto, 2023; Büyükkanber et al., 2023), autonomous vehicles (Prakash et al., 2023; Gharge et al., 2023), and even healthcare (Liu et al., 2023; Kesana et al., 2023). In the field of architecture and robotics, research on image processing and object detection is increasingly becoming more popular (Demetriou et al., 2023; Figure 3).

Within the scope of this research, we used computer vision for extracting data from the physical world. The data obtained in the image segmentation stage and the color values encoded have been used in the object detection task. Our setup achieved an accuracy rate of 90% in picking and placing materials at the desired points. With an inbuilt camera, an '8-megapixel iSight camera with 1.5µ pixels' the robot arm was able to detect and identify waste materials as target objects and perform pick-and-place operation. We mounted a plane service area, equivalent to an A2 paper, to the robot arm cage to provide a space for object detection, as shown in Figure 4.

3.3. Waste material preparation

The waste material for our project came from a printing facility. They were cut into 1.2" x 1.2" (3cm x 3cm) pieces, which took 3 hours of preparation. The production of a 4'7"x4'7" (140cm x 140cm) canvas took 38 hours of runtime. However, we had to reduce the speed of the robot arm by half for security reasons. At full speed, the robot arm would have been able to assemble all the pieces onto the canvas in only 12 hours.

3.4. Robot-arm setup

We used a six-axis robotic arm housed in a custom-made control cabinet (Figure 4). The robot arm has a maximum reach of 3' (90cm), which limits the size of the canvas to a maximum of 4'7" x 4'7" (140cm x 140cm). We placed the robot arm

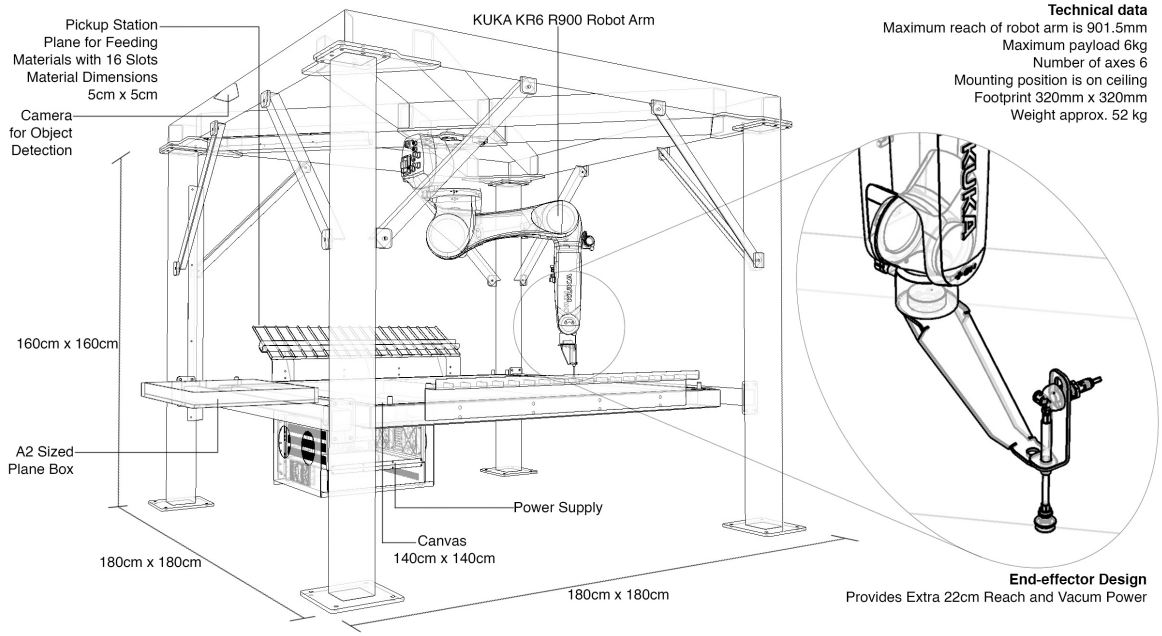

Figure 4. *Diagram of the robot-arm cabinet, camera location, pickup station, cage dimensions, design of the end-effector, robot-arm specs and cabinet components.*

upside down onto the ceiling of the cage so it has maximum flexibility to reach every point on the canvas. The head nozzle uses vacuum suction to collect waste material from the slots and transfers them to specific locations on the canvas. With the help of a local coordinate system, the robot arm picks up materials from the physical slots and places them onto the canvas.

The project workflow consists of the following steps: applying AI diffusion models, preparing images through K-means clustering, detecting and sorting material with computer vision, arranging waste materials, and setting up the robot arm to create a prototype. The utilization of AI diffusion models underscores the potential for generating AI artwork fit for robotic assembly. The image preparation phase's employment of K-means clustering and resolution adjustments, coupled with object detection capabilities provides the robot arm with precise coordinates. It enables the proper execution of pick-and-place operations.

4. Case study: The canvas

We fused AI, robotics, and sustainability to turn discarded household items into captivating art forms. Our project transforms waste, e.g., paper cards, glass, and textiles, by harnessing AI's creative potential and robotics' precision, into intricate artworks, aligning with the CE ethos. The project's core lies in computer vision, where RGB colors are translated into 4-bit grayscale compositions and stitched together via a robot arm. The pixel tapestry takes shape through careful hardware and software orchestration - a new way of fusing art, technology, and sustainability.

4.1. K-Means clustering

For the prototype, we generated a portrait image using Midjourney. We used various machine learning operations, such as pixelization, segmentation, and reduction of RGB colors to a single grayscale band in MATLAB. The resulting 4-bit grayscale data comprising 16 segments was fed to the robot arm's native software environment (Figure 5).

4.2. Object detection

We developed a customized camera setup to use computer vision to detect and sort waste material, i.e., we assembled a mainboard, graphics card, data storage, and camera system to process image data in real-time. We trained a neural network and created an efficient model to predict material type, color, shape and size, i.e., 'WasteMaterialType, R, G, B, Shape, Size' (Figure 6). The robot arm then automatically picks a material piece closest to the grey-scale shade set in the

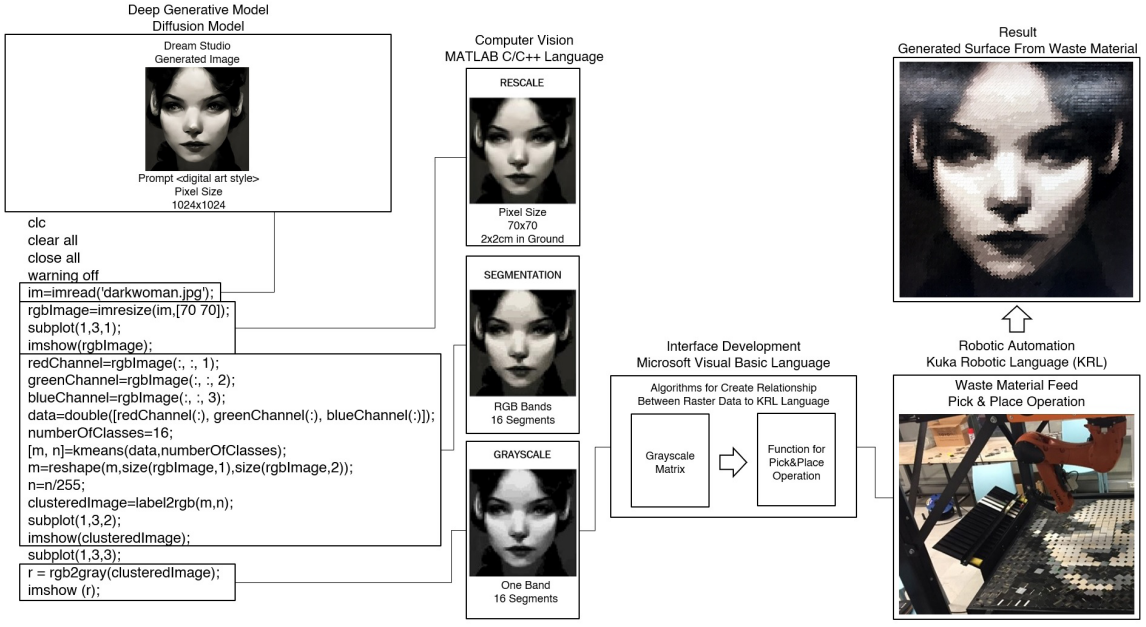

Figure 5. *Image preparation – script with corresponding image translations to turn an AI generated image into ready-made artwork.*

previous step, in 4.1, and places it onto the proper coordinates on the canvas.

4.3. Resolution and scale

We first conducted a test sample with larger pieces measuring 2”x2” (5cm x 5cm) to evaluate the software and hardware architecture. We limited them to only five color segments - as shown at the bottom right in Figure 5. The results showed that the system can effectively handle various materials and surfaces across various spatial resolutions. We subsequently increased the spatial and radiometric resolution of the image. Ultimately, the system functioned best at a ¾” x ¾” (2cm x 2cm) pixel resolution with 1 1/8” x 1 1/8” (3cm x 3cm) material pieces, allowing for a 3/16” (0.5cm) overlap on each side. We employed a 4-bit radiometric resolution, enabling the robot arm to detect 16 distinct color shades.

4.4. Material selection

Figure 7 shows the application-plan based on material types, shapes, overlapping ratios, and surface qualities. The robot arm utilizes

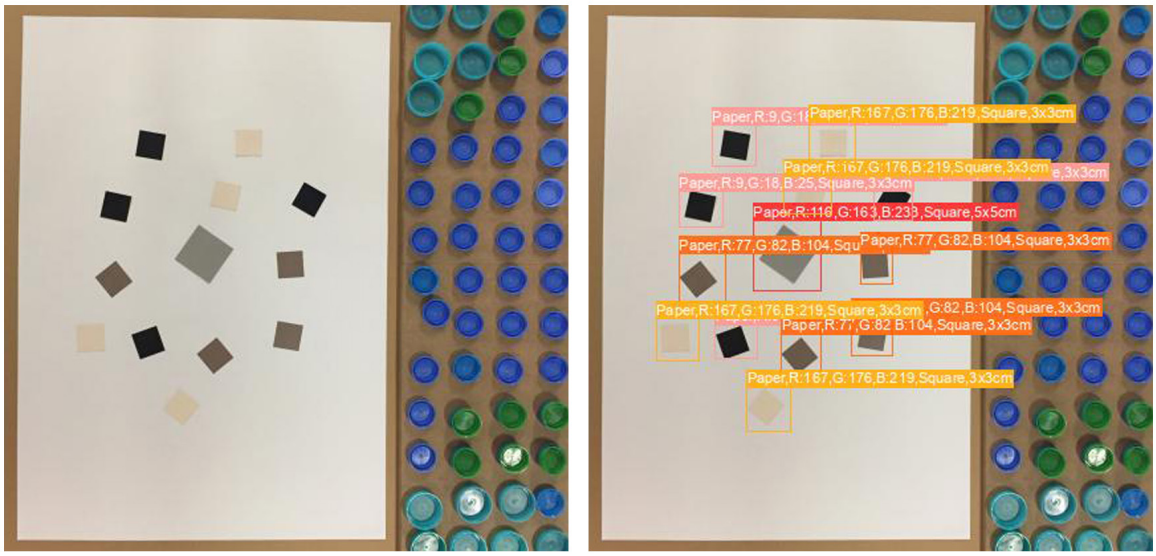

Figure 6. *Object Detection Process for Waste Material Detection, top left: randomly placed waste material pieces, top right: predicting material types, colors, shapes and scale.*

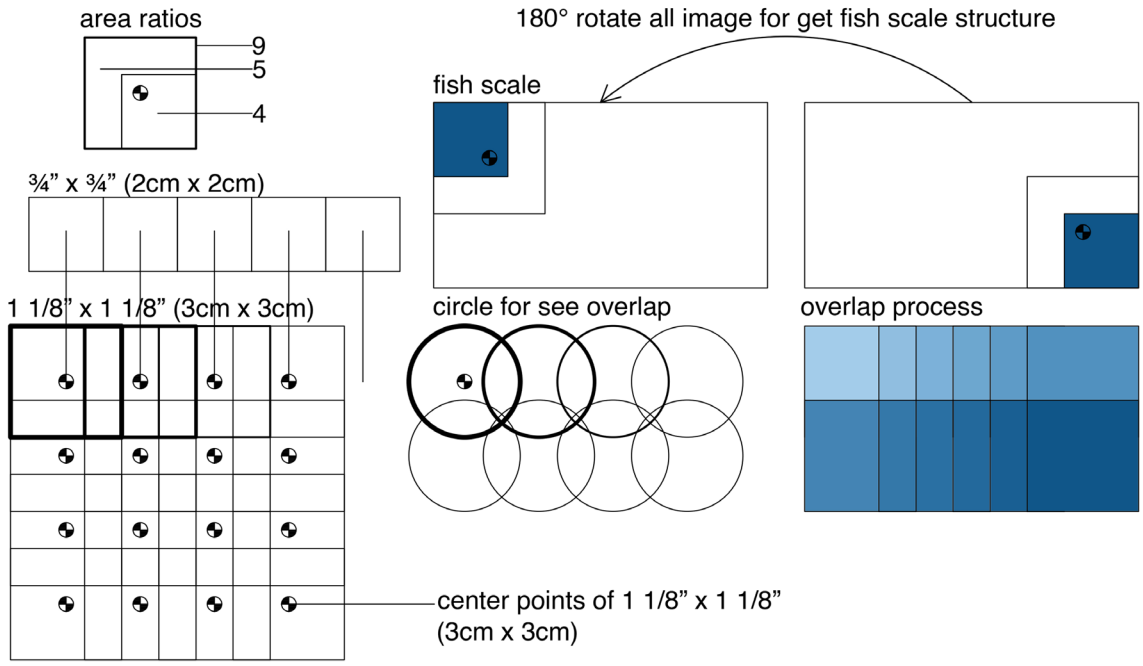

Figure 7. *Application plan for a 4’7”x4’7” (140cm x 140cm) canvas.*

vacuum suction to pick and place waste materials; therefore, choosing the proper material was critical. The materials we used had to possess specific properties, such as rigidity, to ensure successful handling by the robot arm. While we used waste paper cards, the robot arm can also work function with various other rigid materials, including glass, plastics, and metals. To ensure that the pieces remained fixed in place at the specified coordinates, we used a two-sided adhesive tape mounted on a 10mm-thick photo-block canvas. Figure 8 shows our first ready-made artwork - an automated assembly of waste material illustrating a striking synthetic image.

To test the set-up's performance and replicability, we produced additional examples with different paper-based materials, as seen in Figure 9.

4.5. Limitations

During the production of the initial few portraits, we experienced some limitations regarding material selection, resolution, and scale of the artwork.

First, the use of vacuum suction limits the type of material that can be handled. For instance, cotton, fine fabric, thin paper, and cardboard could not withstand the power of the vacuum nozzle. We found that stiff, impermeable paper, thicker cardboard, plastic-coated waste, and various plastics worked better with the robot arm's end-effector. Thus, further work with different types of nozzles is needed. For example, three-finger grippers or manipulators may allow exploring other softer materials, like plastic bags and delicate fabrics.

Second, reducing the size of material pieces would result in more pixels, thus increasing the spatial resolution from 70x70 to 140x140 or 280x280 pixels, producing finer and more detailed results. This, however, would, in turn, require more time for the robot arm to complete the tasks of object detection, sorting and placing material onto the canvas.

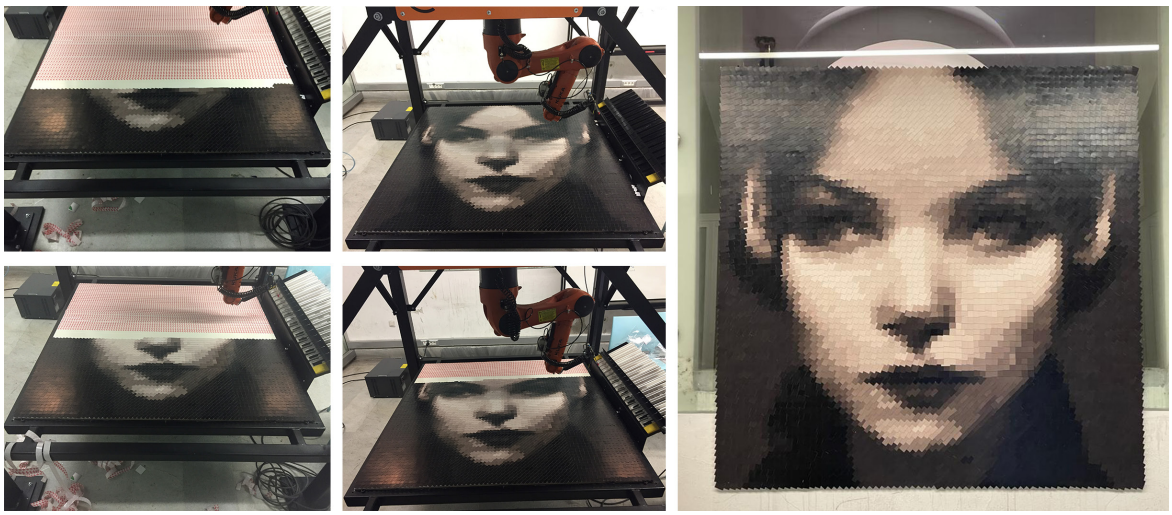

Figure 8. *WasteWorks – Assembling AI-generated art with a robot arm using waste material, e.g., old paper cards received from a printing manufacturer.*

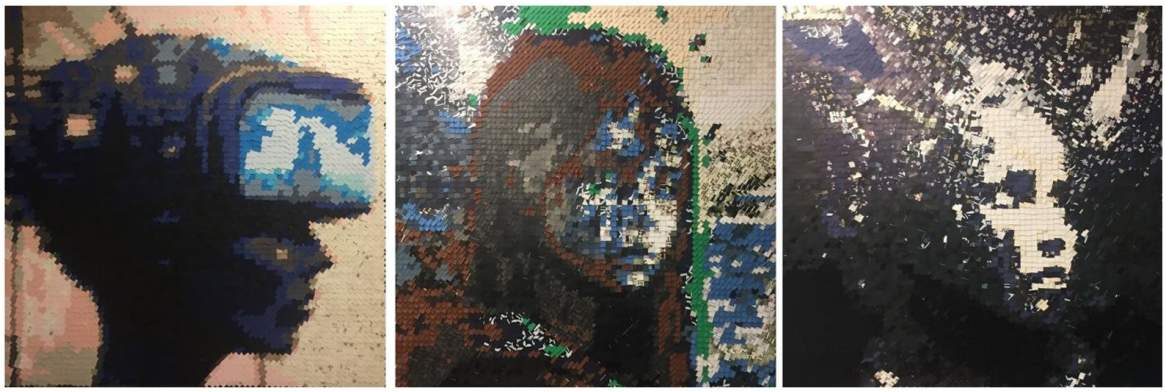

Figure 9. *Various AI-generated portraits assembled with waste materials on 140cmx140cm canvases.*

Third, the robot cabinet setup was limited to work on a two-dimensional surface – the canvas. Extending our methodology to three-dimensional space may not be feasible without adjustments. There are physical size limitations, and it may not work for the design of objects beyond the physical reach of the robot arm. This may be overcome by developing a trial system for the robot arm, using robots with wider reach, and/or multiple robots working in tandem.

In sum, this case study is an example of repurposing waste at the intersection of artistic vision, cutting-edge technology, and environmental stewardship. By converging AI's creative capacities with the precision of robotics, the project repurposes discarded household items, infusing them with new uses in captivating art forms. From the inception of generating portrait images through Midjourney to the detailed orchestration of machine learning processes for image segmentation and material detection, the project achieves a synthesis of form and function. While material selection, resolution, and scale limitations posed various challenges, the interplay of hardware and software produced pixel artistry, symbolizing the fusion of art, technology, and sustainability.

5. Discussion

The concept of *artistic sustainability* offers a creative response to the challenges of waste accumulation and environmental impact. We outlined an exploration of this concept, spanning historical precedents, contemporary artistic endeavors, technological advancements, and practical implementations. The following discussion section will delve into the broader implications, potential future developments, and the significance of the research findings.

5.1. Advancing circular design and resource management

Integrating robotics and AI into waste repurposing projects presents a paradigm shift in how we perceive and manage resources. By leveraging the principles of CEs, where waste becomes a valuable resource, this research highlights the potential to reduce the environmental burden of construction and artistic production. The examples above, such as the use of old shipping containers and repurposed infrastructure elements in creating new artifacts, underscore that creative solutions exist. However, we argue that the true scalability and impact lie in the interplay of AI, robotics, and artistic creativity.

5.2. Transforming artistic expression

The convergence of technology and artistry has the power to redefine artistic expression. Our work demonstrates how AI-generated visuals, machine learning-driven color adjustments, and robotic sorting and assembly can collaboratively produce captivating art forms. This transcends traditional artistic processes, blurring the lines between human creativity and technological innovation. The result is a fusion of human intentionality and precision, pushing the boundaries of what can be achieved through artistic endeavors.

Ethical issues and questions of authorship are critical concerns, e.g., privacy of data. Also who is the author, the person who chooses the dataset, the developer of the generative AI model, the end user who creates the output, or the AI model itself. Potentially no one can claim authorship, as such the generative result may stay anonymous (Avrahami & Tamir, 2021). The use of cultural objects, styles, and the styles of significant figures further complicates the ethical debate. Some solutions, such as assigning specific weights to these components, have been proposed, but ethical discussions around Generative AI are likely to continue.

5.3. Overcoming challenges and future directions

The paper acknowledges the challenges and limitations of the work, such as material selection, resolution considerations, and the confinement to two-dimensional canvases. These challenges, however, open the door for future exploration and refinement, such as extending the methodology to three-dimensional applications. There is a potential to translate our modus operandi to the built environment and

to augment existing workflows, i.e, to incorporate circular design principles in architectural practice that may prove a helpful step towards achieving Turkey's ambitious zero-carbon emission goals by 2053. Undoubtedly, more rigorous and comprehensive research in this area is much needed.

5.4. Impact on sustainability goals

The research aligns with the UN's global sustainability development goals, particularly those related to responsible consumption and production. By reimagining waste as a resource and leveraging AI-driven robotics potentially at scale, the study has the potential to highlight the need for resource efficiency and environmental protection. These outcomes have far-reaching implications beyond artistic expression, resonating with broader efforts to address climate change, reduce pollution, and create a more sustainable future.

In short, *artistic sustainability* can offer a particular response, albeit minute, to the challenges posed by waste accumulation and environmental degradation. We show a creative example of waste repurposing and challenge us to reimagine how art, architecture, and technology intersect to shape a future where waste is transformed into an opportunity. By starting a dialogue around innovative solutions, we want to pave a way for further exploration, collaboration, and a broader shift towards circular design and responsible waste management.

6. Conclusion

This paper illustrates waste as a valuable resource in creating automated artwork - through the convergence of robotics, AI, and creative ingenuity. Our exploration is driven by the urgency of addressing the escalating environmental impact of waste accumulation and the imperative to transition towards CEs.

The fusion of robotics and AI in architecture has presented us with remarkable opportunities. From the use of spolia in constructing the Hagia Sophia to the intricate assembly of modern structures, technology has consistently advanced the boundaries of what is possible. However, the true potential of waste repurposing lies in the intersection of artistic creativity, new technologies and sustainability. We have forged a path towards artistic sustainability by utilizing computer vision to detect and sort waste material and robotic precision to assemble striking arty compositions. The project's multidimensional workflow, encompassing AI-generated images, machine learning-based color spectrum reduction, waste material detection and preparation, and robotic arm assembly, illustrates a new era of waste transformation.

The project was not without its challenges and limitations. The selection of appropriate waste materials, the intricacies of resolution and scale, and the confinement to two-dimensional canvases underscore the evolving nature of our work. As the robot's vacuum suction determined the materials that could be used in our study, our search for diverse materials and more delicate substances has opened new opportunities for recycling waste material. Resolution and scale, intricately linked to physical constraints, serve as an impetus for future improvements. The prospect of extending our methodology to three-dimensional space, introduces opportunities for innovation, collaboration, and pioneering solutions.

In conclusion, this paper represents a creative step towards waste repurposing. Using technology imaginatively, we explored sustainable artistic expression, circular resource utilization, and environmental stewardship. The limitations we encounter will guide us towards continuous refinement and evolution. As we stand at the crossroads of tradition and innovation, we aim to contribute to a world where waste is transformed into new designs, and innovation reshapes the built environment. Through the synergy of robotics, AI, and human ingenuity, we discussed redefining waste as an opportunity to create works of art. The examples we have discussed stand as proof that creativity, new technologies and recycled resources hold the potential to catalyze real change. We hope that our work ignites inspiration, and prompts a wider discussion of CEs - paving the way towards a future of *artistic sustainability*.

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Impacts of land cover change in a cultural landscape: Vulnerability assessment of the archaeological landscape of Alaca Höyük, Türkiye

Arzu TÜRK[1*], Bülent ARIKAN[2], Sam TURNER[3]
[1] turka@itu.edu.tr • Department of Landscape Architecture, Faculty of Architecture, Istanbul Technical University, Istanbul, Türkiye
[2] bulent.arikan@gmail.com • Department of Ecology and Evolution, Eurasia Institute of Earth Sciences, Istanbul Technical University, Istanbul, Türkiye
[3] sam.turner@newcastle.ac.uk • School of History, Classics and Archaeology, McCord Centre for Landscape, Newcastle University, Newcastle Upon Tyne, UK

** Corresponding author*
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Abstract
Whether caused by human or natural drivers, land use and land cover change (LULCc, hereafter) affect the landscape's vulnerability and brings environmental consequences. Landscape change also affects cultural heritage. LULCc and vulnerability studies around archaeological landscapes become more critical with climate change. We aim to assess changes in land cover types in the last 30 years and to create a vulnerability map concerning areas with different landscape characteristics around Alaca Höyük. We use a mixed-method approach; (i) a quantitative method for the LULCc assessment, (ii) the Landscape Character Assessment (LCA) and evaluation of expert opinion surveys, and (iii) a qualitative method to assess climate change impacts on land cover types with expert opinions. The study has important implications for revealing how archaeological landscapes around Alaca Höyük have become vulnerable in the context of climate change through land cover transformation over the last 30 years. The study demonstrates that the extent of agricultural land in and around Alaca Höyük has been increasing over time, while the area of uncultivated natural lands has been decreasing. This transition has resulted in an increase in the vulnerability of land uses and cover types. Thus, the unique historic landscapes of the area are under pressure and that policies for landscape management are needed. The vulnerability map underlines the immediate need for more holistic future studies to inform the management of cultural landscapes, in this case with an explicit focus on the archaeological site at Alaca Höyük and the gardens near Gölpınar Hittite Reservoir.

Keywords
Climate change, Cultural landscapes, Expert opinion, Landscape character assessment, Land cover change.

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1. Introduction

Landscapes are dynamic and change constantly as a result of natural and human factors. Many landscape changes that accelerated from the 18th century can be attributed to anthropogenic factors including population growth, urbanization, disruption of the urban-rural equilibrium, and increased mobility facilitating the spread of technological innovations (Antrop 2005).

LULCc is generally caused by human activities that alter the physical components of landscapes. Coupled with the impacts of climate change (e.g., changes in precipitation patterns and drought), it may lead to various negative impacts on the environment, for example fragmentation in landscape patterns, loss of biodiversity, and soil erosion. Pressure from population growth, urbanisation, industrial development, mineral extraction, energy infrastructure, and agriculture often cause ecologically diverse landscapes to shrink, disappear or change land cover types. For instance, the world's forests shrank from 32.5% to 31.2% of land area between 1990 and 2020 (The World Bank, 2020b); on a longer timescale, much pasture was converted to intensely cultivated agricultural land between the 1700s to the 1990s (Goldewijk, 2001).

The environmental impacts of LULCc may be accelerating due to the consequences of climate change. Such changes also put pressure on cultural heritage in threatened landscapes. One notable impact includes potential harm to buildings or structures at heritage sites, as they may experience deterioration of building materials, increased humidity, corrosion, salt crystallization, frost damage, and black crusts on stone (Carroll & Aarrevaara, 2018). According to IPCC (Intergovernmental Panel on Climate Change), the increasing pace of climate change exacerbates the effects of land cover change and increases the vulnerability of landscapes and their constituent elements (2018). The United Nations Educational, Scientific and Cultural Organization (UNESCO) has recognized the threats of climate change and its destructive impacts on World Heritage sites since 2006 (UNESCO, 2007). Increasing desertification and severe weather events such as flooding caused by climate change present substantial risks for cultural heritage sites (Gruber, 2008). As Plieninger et al. (2006) has noted, the abandonment of cultural landscapes, which may be partly or wholly driven by climate change, can lead to succession and an increase in the woodlands. While progress has been made in recognizing climate change as a threat to World Heritage properties, its integration into the monitoring system is still insufficient (Guzman et al., 2020). Such changes can directly endanger the distinctive character of landscapes and cultural elements including archaeological sites, with negative impacts on cultural values such as sense of place (De Noronha Vaz et al., 2012). Consequently, researchers studying climate change and cultural heritage sites have argued that site-specific approaches are essential, with each heritage site requiring evaluation and conservation actions tailored to its unique characteristics (Cartalis et al., 2022). This approach can also be extended to the historic landscapes around archaeological sites.

In this context, monitoring LULCc in cultural landscapes and understanding their vulnerabilities to climate change becomes crucial in protecting the natural and cultural environment. This research focuses on the archaeological site of Alaca Höyük in Çorum (Türkiye) over the last 30 years and the fragility of its landscape. Shaped by different societies in various periods, Alaca Höyük and its surroundings have a unique archaeological landscape character that has been evolving for at least 3500 years. The main research questions of the study are to examine: (i) which land cover types have changed in and around Alaca Höyük, (ii) to what extent fragility has increased, and (iii) whether the sensitive areas that have emerged affect the local landscape character of the region. Studies that focus on measuring the vulnerability to climate change generally employ one method, but rarely integrate multiple methods in physical and social sciences (Orr et al., 2021). This study uses a combination of vari-

ous approaches: 1) a period-based land cover analysis by using CORINE land cover data to map landscape change, 2) expert opinion surveys to understand the climate change impacts on land cover types of Alaca Höyük, and 3) a landscape character assessment (LCA) both to identify individual landscape character areas and to present vulnerability in landscape character areas. Aerial photographs taken from the Republic of Türkiye-Ministry of National Defense General Directorate of Mapping (HGM) show that, as of 1990, there has been a significant increase in the agricultural lands in and around Alaca Höyük. In addition to the intensification of agricultural production, there may have been changes in other land use types. The CORINE maps examined within the scope of the study also support this change. In this sense, the time limit of the CORINE maps was sufficient for the study.

2. Materials and methods

2.1. The site and historical background

Alaca Höyük is located in Alaca district, 45 km southwest of the city of Çorum, Türkiye (Figure 1). The site was a key Hittite settlement, lying 36 km to the northeast of the capital of the Hittite Empire at Hattusa (Boğazköy). The mound at Alaca Höyük formed an essential node in the settlement network of Central Anatolia for millennia. Archaeologists have identified four principal epochs of activity from the Chalcolithic Period (ca. 4000 BC), Early Bronze Age (ca. 2500 BC-2000BC), Late Bronze Age/ Hittite Empire (ca. 1500 BC-1200 BC), and from the Hellenistic Period onwards (ca. 300 BC).

During the Hittite Empire (ca. 1400 BC), an ancient reservoir at Gölpınar, supplied water for arable land (Apaydın et al., 2020). At this time, dams were constructed by creating a triangular section on a surface to take advantage of the groundwater (Schachner, 2019; Wittenberg & Schachner, 2013). Landscape change is evidently not specific to modern times; indeed, progressive aridity in north-central Anatolia during the Bronze Age (ca. 3000-1200 BC; Arıkan & Yılmaz, 2018) may have contributed to the collapse of the Hittite Empire by causing long-term drought and food shortages (Manning et al., 2023). Coupled with changing precipitation regimes and intensive anthropogenic impacts on the landscape during the Hittite period, the rate of erosion-deposition increased and badlands developed (Arıkan & Yılmaz, 2018). Such events were exacerbated by intensive deforestation for a variety of purposes. Consequently, the climate and related ecological (e.g., surface processes and biodiversity) changes were influential factors in the fate of the Hittite Empire. Until the first archaeological excavations started in 1935, the village of Alaca Höyük was located on the mound itself. Since then, the village has been moved to the north and east of the mound. Excavations at the site continue to the present day. Alaca Höyük includes the archaeological site (Figure 2) and a museum, both open to the public. The modern village is surrounded by fields, orchards, and gardens (*bağ-bahçe* in Turkish). Following the excavation and restoration of Gölpınar in the early 2000s, the reservoir operates once again. Despite a modern irrigation dam built close to Alaca Höyük, farmers continue to use

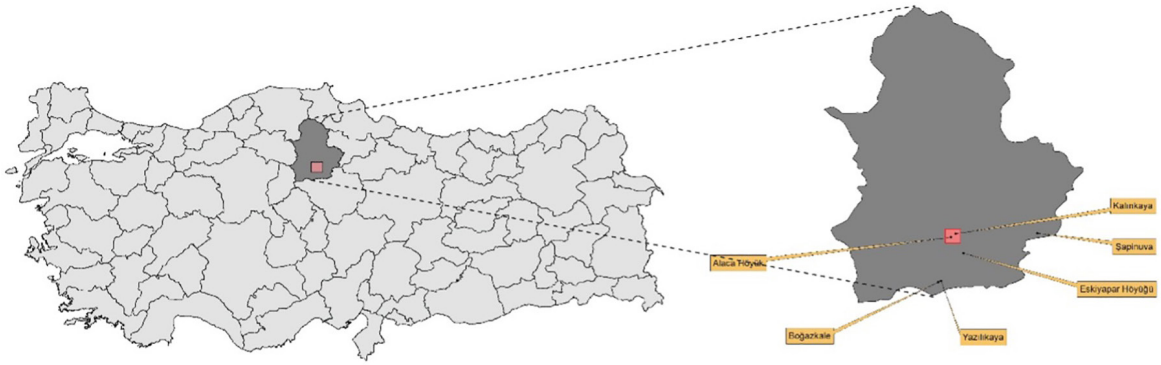

Figure 1. *Study area.*

the ancient dam during the dry summer days. Agricultural production in the region is based on wheat, rice, chickpeas, barley, and walnuts.

Figure 2. *Alaca Höyük archaeological area (by Arzu Türk, October 2022).*

2.2. Materials

The methodological flow chart (Figure 3) shows the systematic processes applied in this study. The research adopted a mixed-method approach: a quantitative method for the LULCc assessment with CORINE maps, a qualitative evaluation of experts in adapting climate change impacts to the field, a quantitative evaluation of the survey of expert opinion, and a quantitative method using LCA to assess climate change impacts on land cover types in the light of expert opinions. The graph outlines the approaches used, as well as the inputs and outputs of each technique.

2.2.1. Method 1: LULCc analysis

LULCc refers to a transition between land use/cover types and spatial alterations in specific cover types. It is widely acknowledged that LULCc can result from a combination of anthropogenic and non-anthropogenic factors (Kleemann et al., 2017). The CORINE land use/land cover data set (CLC, hereafter) is essential in providing quantitative and accessible data for researchers studying landscape change. CLC, produced in 1985, presents data relating to biodiversity, water resources, land cover, and soil structure and to create a platform to monitor the changes in the landscape within a period (Ljuša et al., 2013). Today, data are available for 1990, 2000, 2006, 2012, and 2018. CLC products are frequently used for landscape character

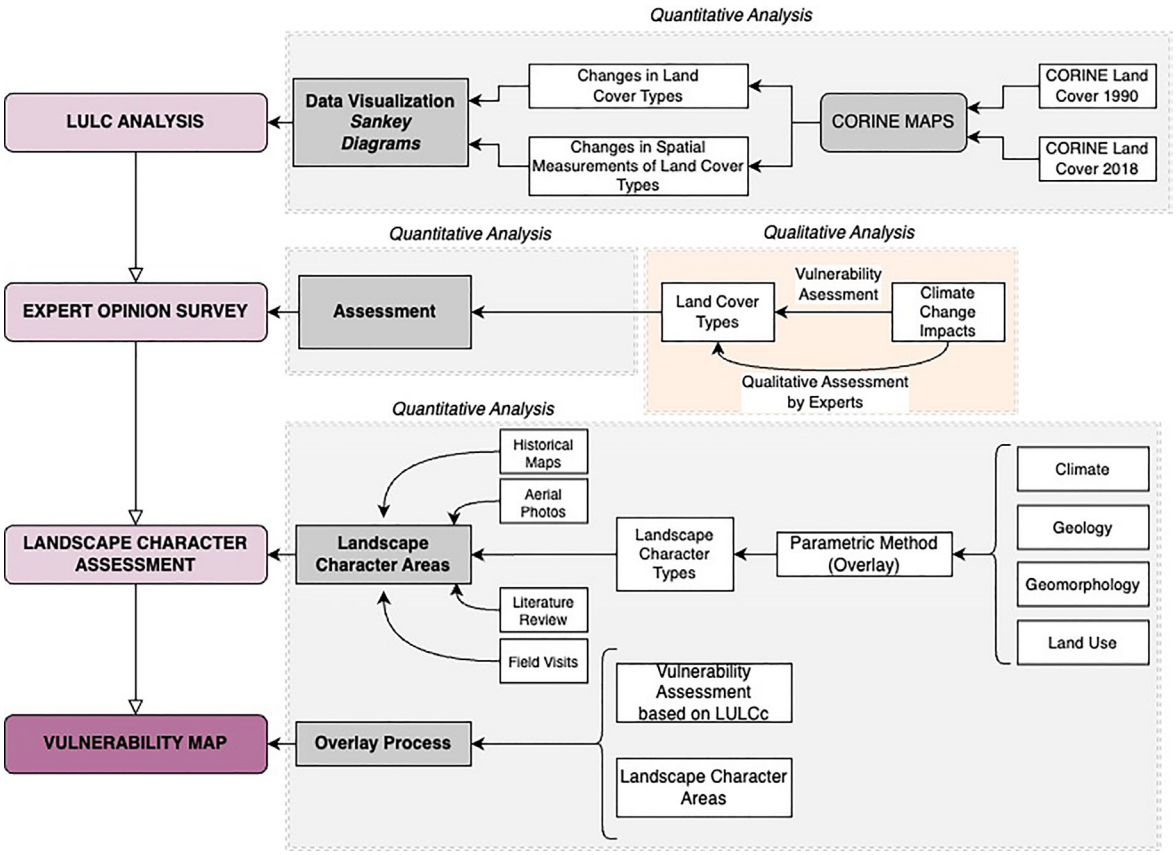

Figure 3. *Methodological flow chart.*

analysis (Uzun et al., 2015; Van Eetvelde & Antrop, 2009; Wascher, 2005), as well as to monitor change and urbanisation around archaeological sites (Agapiou, 2021; De Noronha Vaz et al., 2012; Florea, 2015) and to reconstruct past landscapes by combining land cover change and archaeological data such as pollen analysis (Abraham et al., 2014). On the other hand, current maps of CORINE can provide essential data for climate change-based LULCc studies. Cook and others (2021) advocate for the importance of near-future climate projections derived from current data in shaping archaeological heritage management decisions, highlighting their relevance over historical climate information.

The relatively low resolution of CORINE data (100 m) may prompt concern about its accuracy and usability. Nevertheless, examining aerial photos of the study area yielded results comparable to those of the CORINE data. For this reason, CORINE maps were preferred as land cover / use base within the scope of the study.

In this study, 1990 and 2018 CORINE land cover data was obtained from the Copernicus Land Monitoring Service for 5644 hectares (Figure 4).

To make the graphical representation more understandable, the explanation of code 243 has been altered to "mosaic landscapes" in the figures and tables below. Additionally, codes 332 and 333 have been combined into one and re-named "Sparsely vegetated bare rocks" since they have a similar landscape character.

Landscape change between 1990 and 2018 was assessed in two ways. First, the area of all land cover types was measured. Second, the flow of land cover types was visualized using the Sankey diagram method. Sankey diagrams display energy, material, and cost flows and major shifts in a system more efficiently, with arrows representing the power of the transfer. They may also be used to visualize the changes in land cover over time (Cuba, 2015; Zhang et al., 2017), for example, the conversion of forest to arable land or urbanization. Sankey diagrams are beneficial for communicating the impacts of land use change to stakeholders and decision-makers.

2.2.2. Method 2: Expert opinion survey to assess vulnerability to climate change

Expert-based surveys are important as participants possess comprehensive knowledge about the research subject derived from their expertise or professional background. They may be used in different ways to obtain perspectives on landscape change, for example by drawing on locally-produced oral histories (Bürgi et al., 2017), by asking experts to assess causes of change (Jacobs et al., 2015), or by generating models of possible future scenarios (Herring et al., 2022). Studies based on expert opinion are critical in forming consensus, as in the case of climate change (Anderegg et al., 2010). On the other hand, some structured expert opinion studies reveal the diversity of judgments on climate systems and factors (Morgan & Keith, 1995). It is of particular significance to consider the role of expert opinion studies in research on climate change. Studies indicate that surveys based on the opinions of experts create a positive opinion and motivation especially among policy makers and decision makers on climate change (Javeline et al., 2013). Such multiple exchanges can especially broaden communication networks between different actors and increase attention to the issue. Information gathered from different actors can be a driving force for future climate change agendas and strategies in different areas. In this context, expert opinion survey approach has been also used in cultural heritage sites and archaeological areas to assess national adaptation plans. The studies demonstrated how such methodologies can uncover innovative sources of data not readily available in the literature (Daly et al., 2022).

Our study implements a participatory expert opinion survey designed to assess the vulnerability of each land cover type at Alaca Höyük and its surroundings likely to be affected by climate change impacts, for example temperature rise, drought, floods, biodiversity, soils, and inland water. Direct impacts on coastal areas, such as sea level rise, were excluded. The survey was implemented using Google

Forms (online) and shared in English, after receiving the approval of the Ethics Committee at Istanbul Technical University.

In the study, experts working exclusively on climate change were not solely relied upon; instead, preference was given to researchers conducting work across a broad range of disciplines. The goal was to build consensus, enhance the reliability of results, and inspire decision-makers by incorporating diverse perspectives from various fields of study. In this sense, there are examples where experts are selected from different fields of study and thus a consensus is achieved in studies on climate change that use expert opinion in their research (Myers et al., 2021; Nordhaus, 1994). Our survey was conducted among thirty-three experts researching landscape ecology, landscape change, climate change, and vulnerability. Two survey results were excluded from the evaluation because of unrelated research areas. Out of the

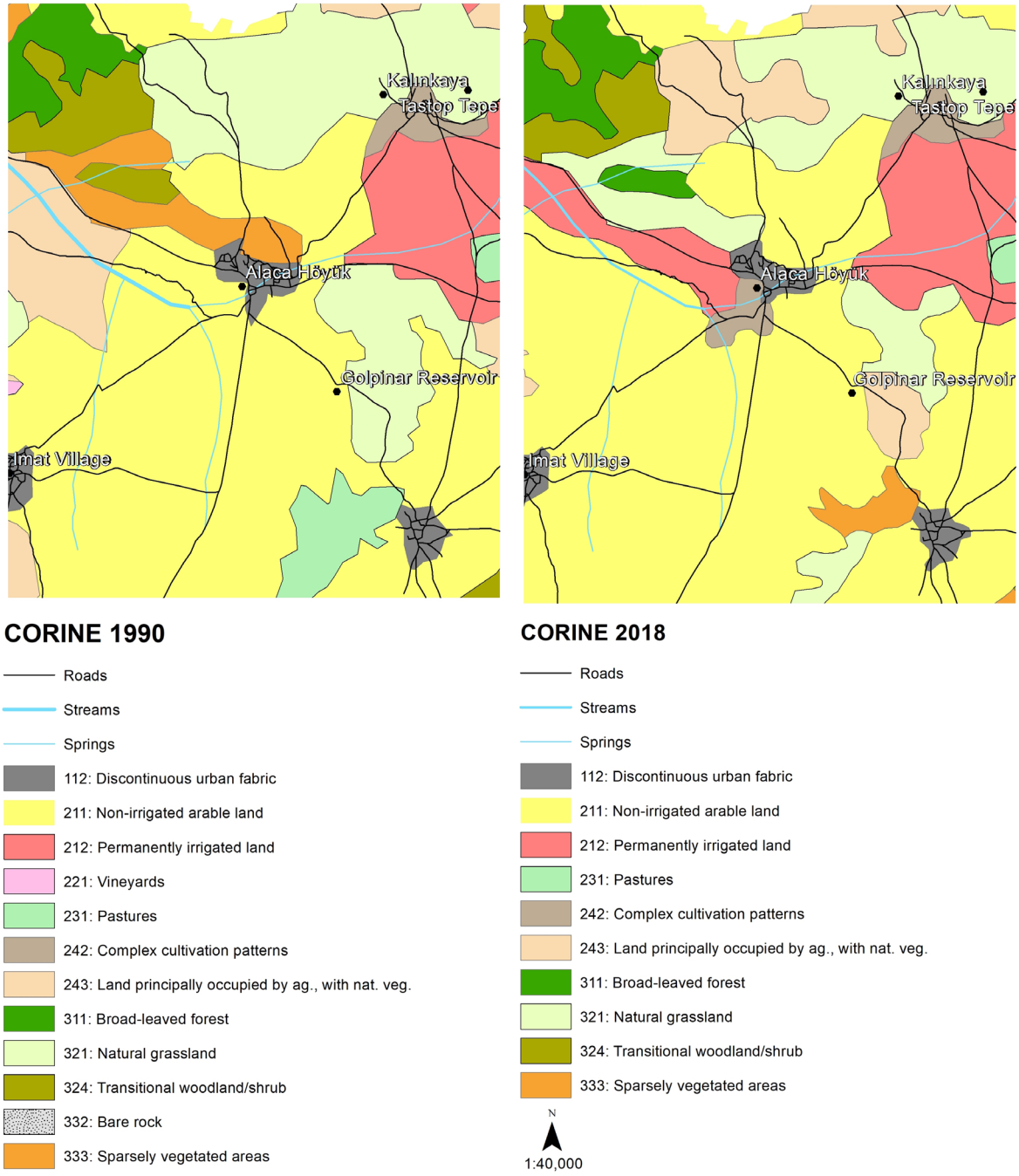

Figure 4. *CORINE land cover change between 1990 and 2018 (© European Union, Copernicus Land Monitoring Service 1990 and 2018, European Environment Agency (EEA)).*

Table 1. *Classification of the vulnerability scores and their assessments.*

Vulnerability Score (VS)	Vulnerability Assessment of Climate Change Impacts on Each Land Use Type
1-5	Minimum Vulnerability
5-10	Low Vulnerability
10-20	Medium
20-25	High Vulnerability
25-30	Highest Vulnerability

33 survey participants, 25 belong to university institutions, five are affiliated with the private sector, and three are associated with public institutions. Nonetheless, all survey participants have either completed their doctorates or are currently doctoral candidates.

In the first phase of the expert survey, participants were asked how each possible impact of climate change would affect the vulnerability of each land cover type. Responses were given based on the Likert Scale, ranging from 1 (low) to 5 (high) that desginate the vulnerability score. For example, a score of 1-5 is given for how biodiversity reduction affects transitional woodland-shrub areas. Expert opinions were averaged for each of the six climate change impacts: temperature rise, drought, floods, biodiversity, soils, and inland water. Each answer has a maximum of 5 points on the Likert scale and there are six climate change parameters, so the vulnerability score of a land cover type may be a maximum of 30 points. Table 1 shows how the vulnerability assessment was made for all land types based on the total points.

In the second step, the area covered by each land type in 1990 and 2018 was measured in hectares, and the ratio of each area to the total land size was used as a coefficient. The coefficient of each terrain type was multiplied by 100 to obtain a meaningful value in the first step and multiplied by the vulnerability score obtained. With the help of the equation given below (1), vulnerabilities of land cover types may be calculated for the years 1990 and 2018. In this equation, x and y express the area of land covers (in hectares) in 1990 and 2018, and VS represents the sum of the vulnerability scores given by experts for each land cover type. The Z value indicates the total area of each land cover type.

$$\left(\frac{x}{z} \times 100\right) x\, VS = V_{1990}$$

$$\left(\frac{y}{z} \times 100\right) x\, VS = V_{2018} \quad (1)$$

Equation 1. *Classification of the vulnerability scores and their assessments.*

The spatial fragility measurement was then classified with a maximum value of 3000, the highest vulnerability between 2500-3000, high vulnerability between 2000-2500, medium vulnerability between 1000-2000, low vulnerability between 500-1000, and most minor vulnerability between 100-500 in both 1990 and 2018. As a final step, the spatial fragility was assessed and compared for 1990 and 2018.

2.2.3. Method 3: Landscape character assessment

The visible consequences of landscape change, especially in historic landscapes, suggest that the LCA initiatives have become increasingly necessary.

These studies are essential for identifying the characteristics that make a landscape unique, for mapping landscape character areas, for informing planning, design, and management with reference to the characteristics of place as well as monitoring the changes in the landscape. LCA was initially used in the UK and subsequently in Estonia, Germany, Hungary, and the Czech Republic (Tudor, 2014); with

the signing of the European Landscape Convention in Turkey, it has become a necessity to classify, determine types, and assess landscapes on a national scale. Research in Turkey has facilitated the expansion of LCA studies to encompass basin-scale and wide-ranging readings (Uzun et al., 2015). Such initiatives are crucial in revealing the landscape characteristics of the natural, historical, and built environment (Atik et al., 2015) and underpinning sustainable management of natural and cultural resources through the identification of landscape character areas (Koç & Yılmaz, 2020).

The LCA used here consists of data collection, identification of landscape character types, and mapping of landscape character areas with the help of field visits. LCA is a structured process that determines how each element contributes to landscape character (Sarlöv Herlin, 2016) using the 'parametric method' (Van Eetvelde & Antrop, 2009). First, data relating to geology, climate, and geomorphology of the research were collated and a land-use map was prepared at a 1/10.000 scale. Following data integration, the parametric method was followed with the help of Intersect Analysis in ArcGIS. Four main spatial datasets were used for Climate, Geology, Geomorphology, and Land Use. Fifty-seven different landscape character types were identified through this method. Each type has common micro-climatic, geological, geomorphological, and land use aspects. In the GIS, each character type was given a name that contains codes for specific types of data. For instance, the Landscape Character Type (LCT) of Alaca Höyük was coded "s_as_SDSH_FA," (Sedimentary, defined as an Archaeological Site, Semi-Dry Low Humidity 1st Degree Mesothermal climate, and fill area); the LCT of Gölpınar Reservoir was defined as "s_as_SDSH_PVB" (Sedimentary, defined as Archaeological area, Semi-Dry Low Humidity 1st Degree Mesothermal climate and plain and valley base). Finally, the character types were used alongside additional information from historical maps and aerial photos, literature reviews, and field visits to identify and tag character areas based on their unique characteristics.

Twenty-four landscape character areas were determined around Alaca Höyük, including 'Alaca Höyük Fields', 'Gölpınar Gardens', 'İmat Village Woodlands and Vineyards', 'Kalınkaya Grassland and Archaeological Area' (Figure 5). The majority of the landscape is arable with fields, orchards, and small areas of vineyards. The other examples of the character areas include historic vineyards and ancient quarries, as well as the archaeological sites of Alaca Höyük itself and the ancient Hittite reservoir.

The final step is to identify areas vulnerable to climate change impacts by mapping the landscape character areas against vulnerable land cover types that emerged in 1990 and 2018 based on data gathered in each previous research stage.

3. Results

3.1. LULCc analysis

CORINE maps, which were given in the second part, produced in 1990 and 2018 were used in the research, and these production dates played a significant role in establishing their temporal scope. The analysis of field patterns in aerial photos from 1957 revealed a notable increase in new fields by 1990, indicative of expanded agricultural land and field division. However, parallel with these changes, Alaca Höyük, like other rural settlements in Central Anatolia, witnessed a substantial decline in population (Yılmaz, 2015). Our diagram (Figure 6) displays the quantitative transition of classification results and the observed land cover change dynamics between 1990 and 2018. The graph additionally provides the quantitative alterations in land cover sizes measured in hectares. For instance, it is evident that "non-irrigated arable land" comprised of 2,267 hectares in 1990 and it increased to 2,961 by 2018.

Based on our results, it is clear that in 1990, non-irrigated arable lands, natural grasslands, and mosaic landscapes had covered the largest area in the region. By 2018, natural grasslands and mosaic landscapes decreased,

while non-irrigated arable lands and permanently irrigated lands increased. It is also clear that less intensively used land was transformed into arable land. Finally, vineyards were almost entirely replaced by mosaic landscapes. However, viticulture and grape consumption have been influential in Anatolia for millennia. Endemic grape species supported wine production during the Hittite Empire and the production of table grapes during the Ottoman period, and historical descriptions by travelers indicate that there were extensive vineyards in the research area.

3.2. Expert opinion survey to assess vulnerability to climate change

The vulnerability assessment based on expert opinion is given in Figure 7, depending on each climate change parameter. Expert opinion indicates that sparsely vegetated lands have a medium vulnerability, while other land cover types are interpreted to be highly vulnerable. Thus, an increase or decrease in the latter land cover types will inevitably affect the vulnerability of the landscapes around Alaca Höyük. When land-cover changes between 1990-2018 were analyzed, the spatial

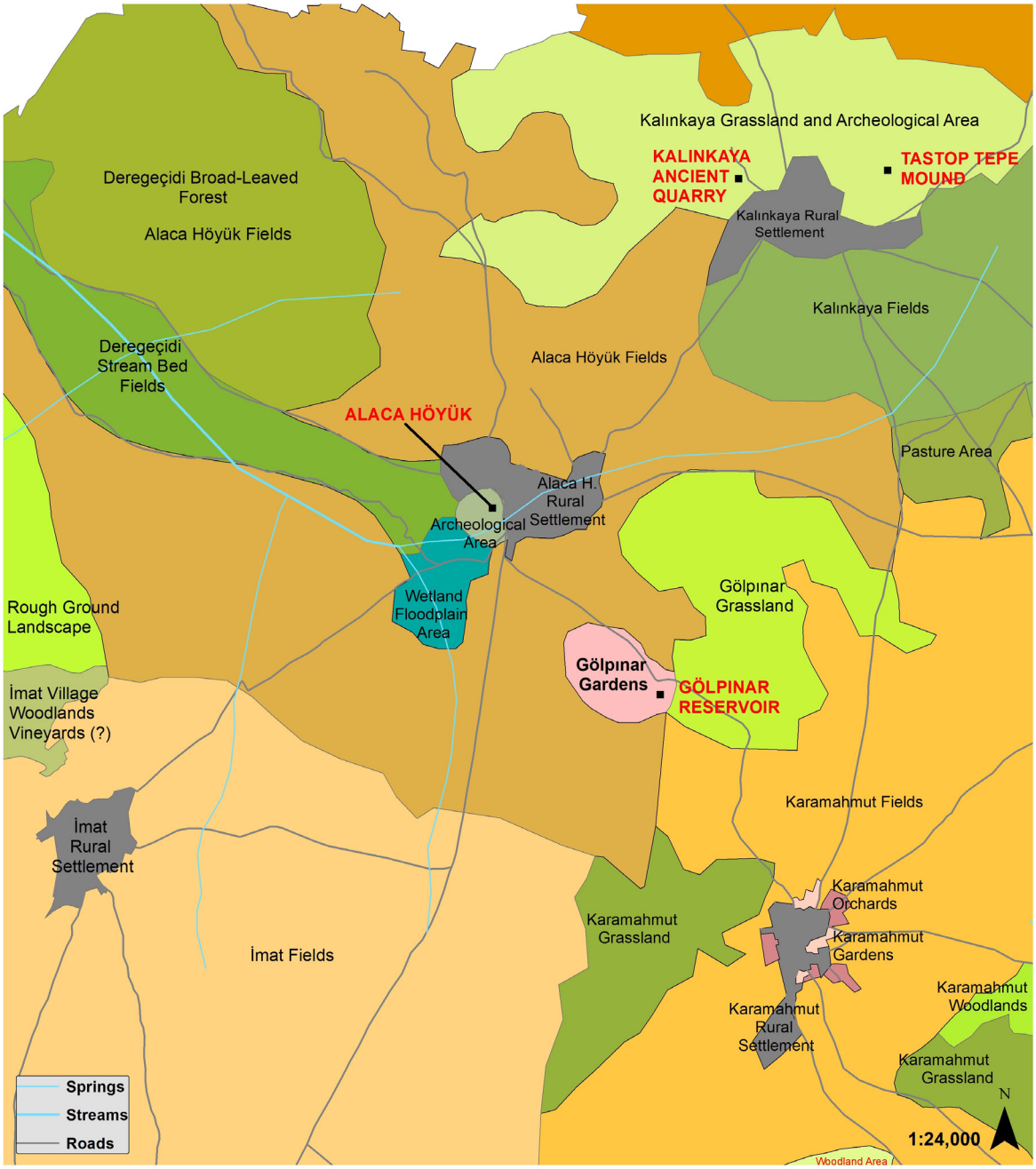

Figure 5. *Landscape character assessment of Alaca Höyük.*

vulnerability of non-irrigated arable lands appeared to increase, that of natural grasslands decreased, and the other areas seemed stable.

Alaca Höyük and its surroundings are suitable for dry farming with precipitation values varying between 400-500 mm/year: in response to economic drivers, the area of non-irrigated agricultural land increased substantially between 1990 and 2018. However, precipitation became more irregular in the same period, especially after 2000. The increase in non-irrigated lands is consequently becoming more vulnerable to climate change impacts under drought (Lu et al., 2020). Even though the region is suitable for dry farming, permanently irrigated arable lands are also increasing. This indicates that changes in the rainfall regime are likely visible and perceivable among local people and landowners. It suggests that rainwater has become insufficient, and water management strategies have become increasingly crucial for agriculture around Alaca Höyük. In the future, there may be a shift from non-irrigated arable land to more permanently irrigated land. Indeed, a similar shift has already been identified at the national level (The World Bank, 2020a). Water management for arable agriculture is likely to become increasingly crucial on both the regional and national scales.

Other fundamental changes are seen in mosaic landscapes and natural grasslands. The mosaic landscapes of the area include woodland-shrub, mixed with small fields. Between 1990 and 2018 much natural grassland and pasture land was converted into permanently irrigated land, with a consequent reduction in the carbon-hold capability of the soil (IPCC, 2003).

An area with small intermixed parcels for various crops and pastures identified as 'complex cultivation patterns' forms part of a small floodplain, which retains rainwater and therefore provides a valuable resource during drought seasons (Ebert et al., 2019). While the total area may be relatively small, replacing such complex ecosystems with agricultural land may create areas that are more vulnerable to climate change. Whilst it was used mainly for grazing in the past, the area has been used increasingly as agricultural

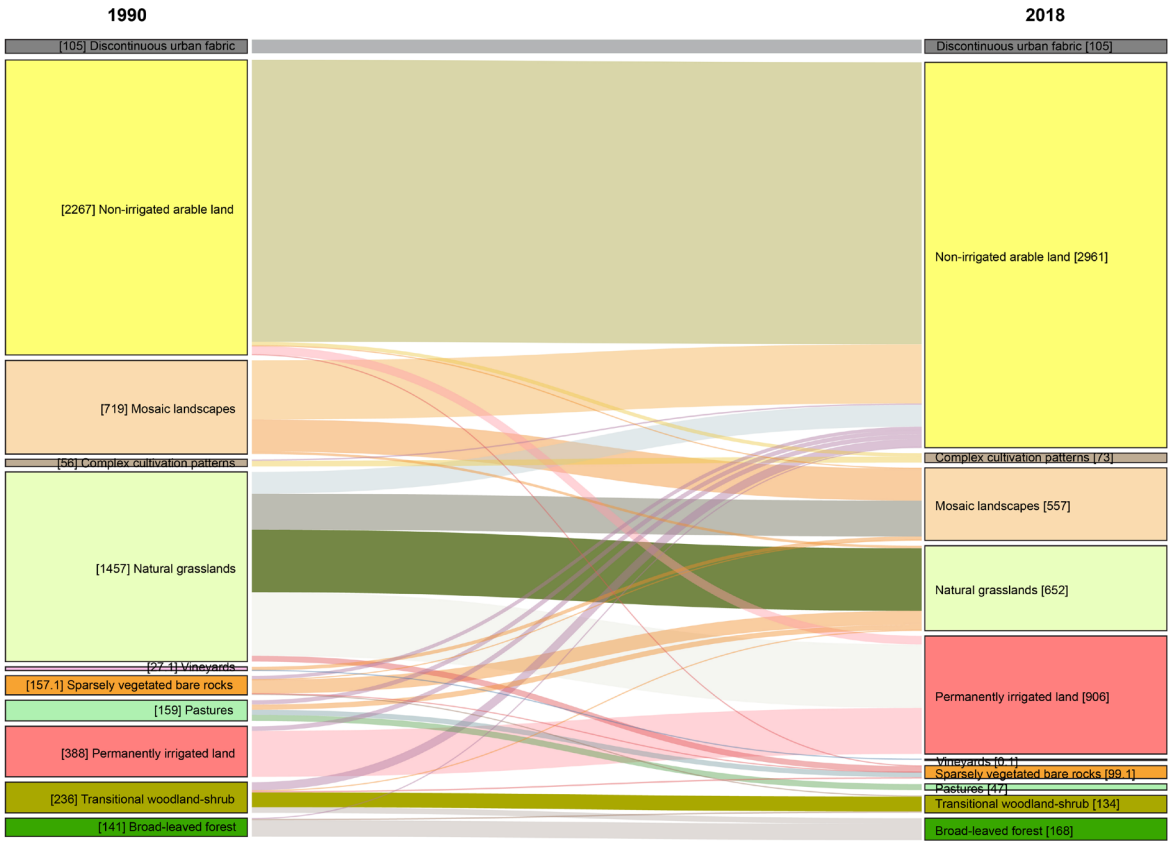

Figure 6. *Transition among different land cover types, between 1990 and 2018.*

land in the last 20 years. This change in landscape character is therefore likely to increase sensitivity to drought.

The replacement of woodland/shrub areas, which are important for local flora with arable land, is also likely to increase vulnerability to climate change. On the other hand, natural or human-induced ecological succession has increased in other parts of the study area, notably areas characterised by sparsely vegetated bare rocks which have tended to move towards transitional woodland/shrub. This change

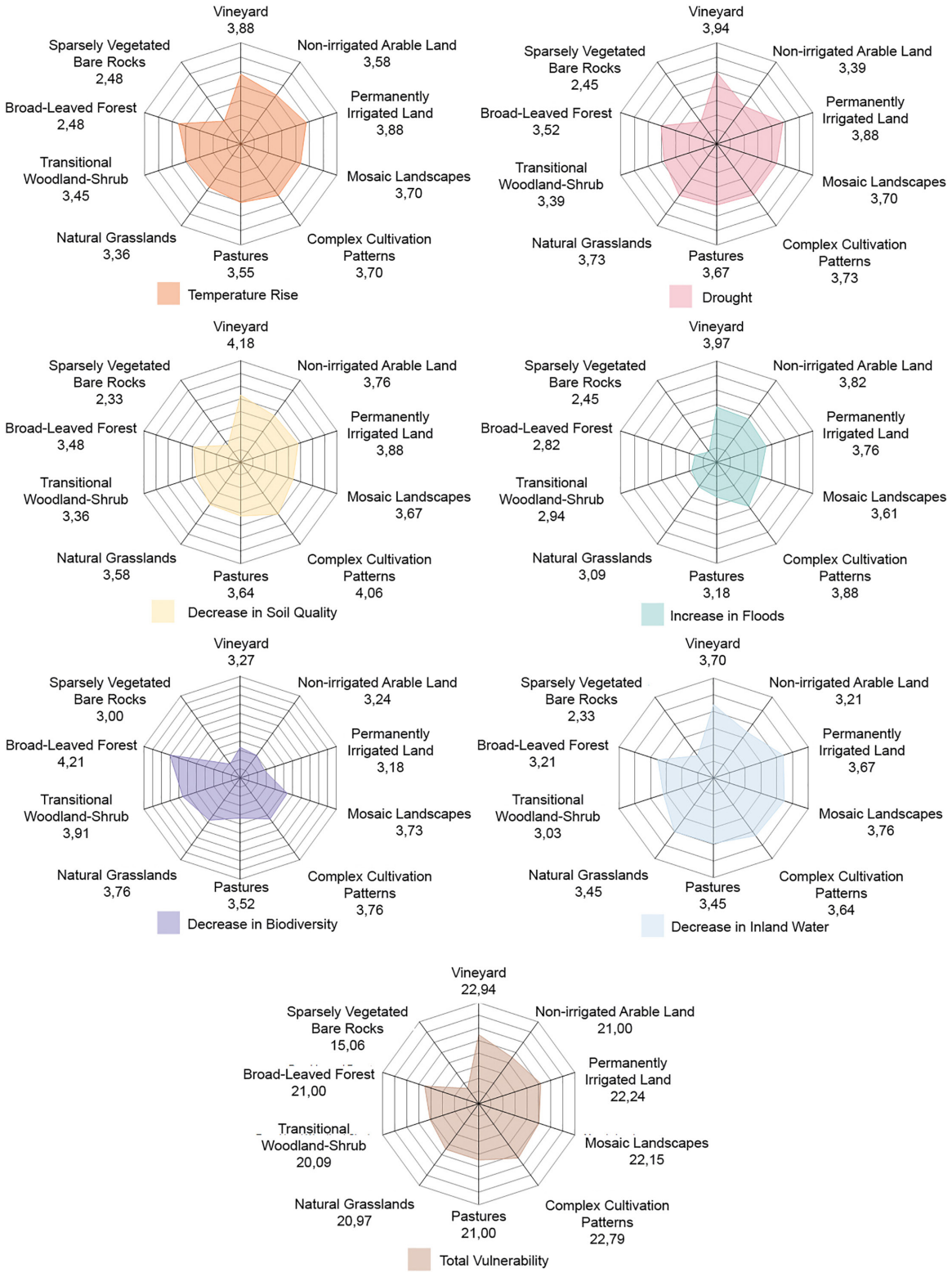

Figure 7. *Radar (or web) chart of expert opinion survey about the vulnerability assessment of different LULC types and climate change parameters.*

may be beneficial to prevent erosion resulting from weak soil medium and temperature changes and to create resistance patches in the vegetational layer. Some natural grasslands have also changed into coniferous forests, with benefits for carbon capture, preventing erosion, increasing soil quality, and enriching biodiversity.

The descriptions of land cover types, the direction of land cover change and its causes, and an assessment of vulnerability are given in Table 2. LULCc is affected by economic drivers, as shown by the demand for arable land, as well as climate change, extreme grazing, and ecological succession. However, the lack of management strategies for landscapes in and around Alaca Höyük will inevitably create ecological impacts in the coming years since temperatures are rising, precipitation patterns are changing, and extreme weather events are happening more frequently (IPCC, 2018). Indeed, rainfall data in Çorum show significant increases and decreases in various years. Changing rainfall patterns also make cultivation more difficult; besides the adverse effects of droughts, unstable precipitation patterns can cause crop damage in fields and orchards (Çevre Yönetimi ve Denetimi Şube Müdürlüğü, 2023). Significant drops in water levels have been observed in local dams over recent years, and research indicates that drought also played a pivotal role in the decline of the Hittite Empire (Manning et al., 2023). Fluctuations in rainfall patterns and drought are likely to have been experienced by past inhabitants of the region.

Between 1990-2021 the average temperature in Çorum has already increased by as much as 2 degrees. Climate change in agricultural areas will negatively affect soil quality and crops. According to the latest report by the IPCC, although crop productivity and quality have increased with the help of agricultural techniques on a global scale, the development speed has slowed down due to climate change in the last 50 years (IPCC, 2023). Given projected population growth and the need for food, climate change is therefore likely to create further instability in terms of food security.

3.3. Landscape character assesment

LCA of Alaca Höyük and its environs demonstrate that the existing landscape exhibits a heterogeneous structure in terms of both modern and historic landscape patterns. The study area has unique microclimate structures and topographic characteristics. Moreover, the region displays notable variations in geology and land cover, which have given rise to a diverse range of land uses. While the monotonous of the brownish color steppe landscape is disrupted by diverse modern and ancient settlement and structures, the region also builds a landscape seasonally blossomed.

As noted in relation to individual land cover types above, LULCc is likely to create landscapes that are more vulnerable to climate change (Riebsame et al., 1994). Monitoring changes in land cover is therefore essential to provide a basis for future planning and management. From this perspective, Figure 8 presents the relationship between vulnerable areas and landscape character areas, identifying areas that were sensitive in and before 1990, and new sensitive areas identified in 2018.

Based on the vulnerability assessment, vineyards, non-irrigated arable lands, and permanently irrigated lands exhibit a high score. The major factor influencing these assessments is the reduction in ‘inland water’ surfaces for vineyards and permanently irrigated lands. Unlike non-irrigated arable lands that rely on rainfall, vineyards, and permanently irrigated arable lands depend heavily on inland water and irrigation systems for sustainability.

Mosaic landscapes and complex plantations also have a high vulnerability. These areas are diverse landscapes comprising wetlands, water resources, corridor areas, and agricultural areas. Such diverse landscapes are affected by a wide range of climate change events at different rates. Additionally, pastures, natural grasslands, transitional woodland shrubs, and broad-leaved forests also demonstrate a high level of vulnerability. The cover type that is the least vulnerable to climate change is “sparsely vegetated bare rocks”.

In Figure 8, dotted areas represent fragile land use areas in 1990, and hatched areas represent fragile land use

in 2018. The map is the result of two CORINE maps (1990 and 2018, Figure 4) and vulnerability assessment of expert opinions and shows the land use types with vulnerability values greater than 21 are shown. As a consequence, İmat Village woodlands and vineyards, Alaca Höyük, İmat and Kalınkaya Fields, Alaca Höyük site and wetland, Gölpınar Hittite Reservoir Gardens, Dere Geçidi Stream and fields have strong vulnerability, especially coming from the land use types from and before 1990. On the other hand, new land use changes starting from 2018 created new vulnerable areas. Thus, Gölpınar Grassland, Deregeçidi Broad-Leaved Forests, and Kalınkaya Grassland and Archaeological Area are facing pressure. Future studies should consider how to protect these areas from this new pressure.

4. Discussion

In this research, we assess the LULCc and vulnerabilities that these changes bring in and around Alaca Höyük in relation to climate change. The results suggest that the most significant change in Alaca Höyük and its surroundings is in agricultural areas (i.e., non-irrigated arable land and permanently irrigated land categories in Tables 2). Both land character types tend to increase,

Table 2. *Changes in land cover, reasons, and expert opinion results on their vulnerability.*

CLC Types	Description	LULCc	Driver(s)	Vulnerability Assessment
Vineyard	Vineyard for viticulture	Decrease	Economic Reasons, Climate	22,93
Non-irrigated Arable Land	Cereals, legumes, fodder crops, root crops, fruit trees, and flowers	Increase	Demand for arable land	21,03
Permanently Irrigated Land	Crops irrigated with irrigation channels, drainage networks	Increase	Demand for arable land	22,24
Mosaic Areas	Land Occupied by Significant Areas of Agriculture, Natural Vegetation, Water Bodies	Decrease	Demand for arable land	22,15
Complex Cultivation Patterns	Small parcels of diverse annual crops, pasture, or permanent crops	Increase	Demand for arable land	22,78
Pastures	Dense grass cover	Decrease	Extreme Grazing, Demand for arable land	21,00
Natural Grasslands	Low productivity grassland	Decrease	Demand for arable land	20,96
Transitional Woodland-Shrub	Bush vegetation with scattered trees	Decrease	Ecological succession	20,09
Broad-leaved forest	Vegetation formation composed with trees	Increase	Ecological succession	21,00
Sparsely Vegetated Bare Rocks	Cliffs sparsely vegetated lands where rocks cover %75 of the land	Decrease	Ecological succession	15.06

this agriculture-driven change has resulted in a return to areas with more natural character. This pattern fits Plieninger's (2006) statement that land use, particularly agriculture, is the fundamental motivation to shape the rural landscape. According to Antrop (2005) agricultural intensification may destroy the landscape characteristics and spirit of traditional landscapes. Indeed, the landscape, which has gradually become an agricultural area in Alaca Höyük, has begun to lose its unique parts. The vulnerability assessment reveals that agricultural areas are generally more sensitive to climate change. Therefore, transforming natural areas into agricultural areas has led to the increase of fragile areas in Alaca Höyük and its surroundings. Kurukulasuriya and Rosenthal (2013) underscore the vulnerability of agricultural lands (e.g., variations in temperature, rainfall, and extreme weather events) all of which bring significant repercussions on food production and security.

Our research highlights how some landscape character types risk disappearing altogether from the region.

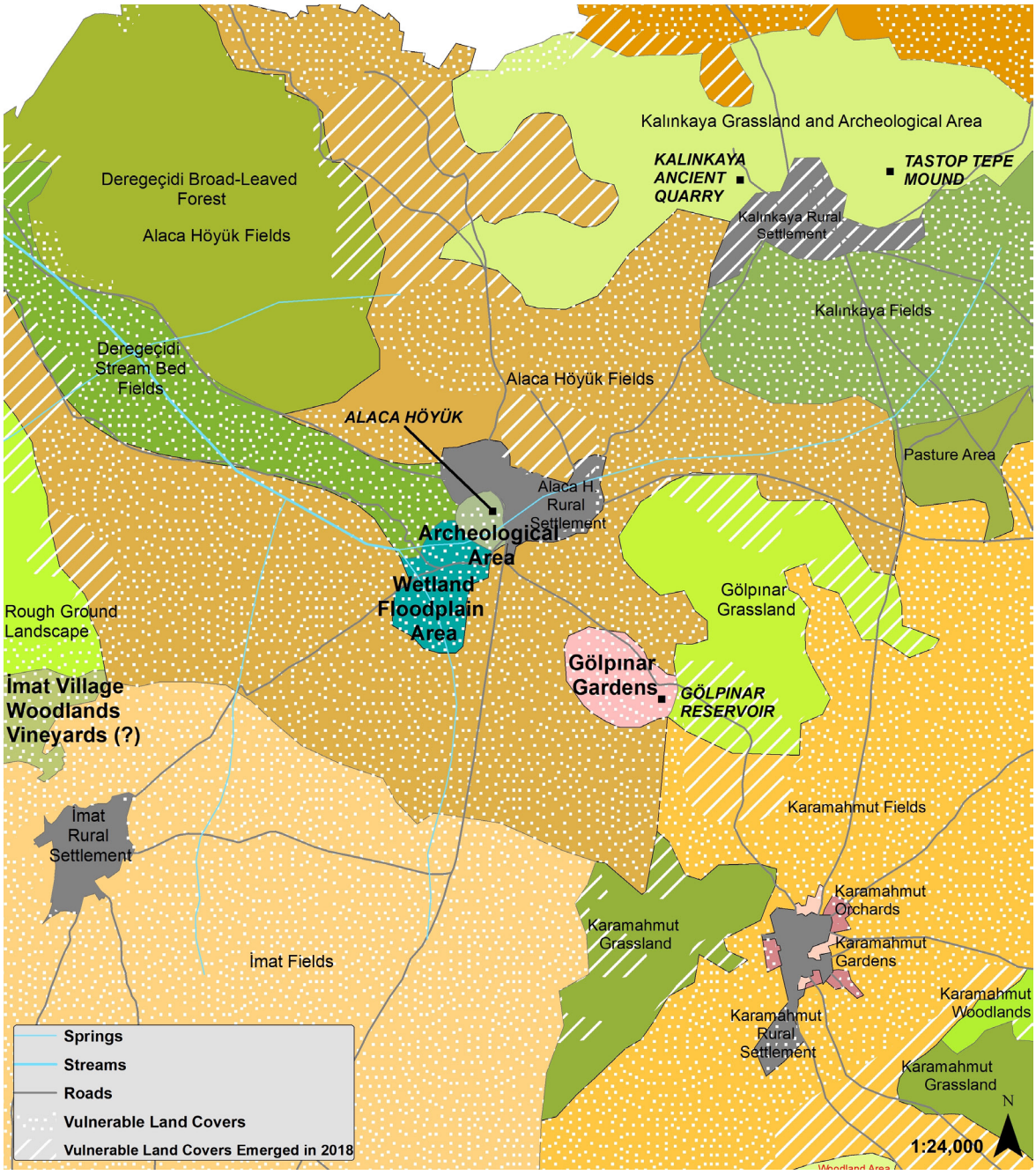

Figure 8. *Vulnerability maps and unique landscape character areas around Alaca Höyük.*

Notably, vineyards were once typical in the districts of Alaca and Boğazkale (the capital of the Hittite Empire), but today they have decreased significantly. Studies show that the effects of climate change put pressure on viticulture due to the increasing temperature and drought (Cardell et al., 2019; Webb et al., 2008). All the vineyards in the village of İmat were lost by 2018; it is possible that climate change affected crop yields and increased the vulnerability of this land cover type. Climate change brings significant challenges not only in the distribution and conservation of viticulture globally but also in the economic sense (Hannah et al., 2013). The loss of suitable land for this commercially important produce means a significant economic loss for the rural population.

The disappearance of vineyards that distinguish Alaca Höyük's steppe landscape from others marks a shift in the rural landscape's identity. Although changing agricultural farmlands to natural areas may sound ideal, this change may cause problems. For instance, the traditional cultural landscapes of Europe were cultivated by moderate human intervention, and if the land were abandoned, ecological succession would ensue, resulting in the loss of cultural landscapes (Plieninger et al., 2006).

Moreover, the vulnerability assessment here indicates extinction in other areas as well. The final vulnerability map (Figure 7) shows that the unique character areas such as Gölpınar Gardens and the Alaca Höyük Natural Pasture area (wetland/floodplain) are under tremendous pressure today. The character of both these pastures and the vineyards and gardens of Gölpınar result from their historical development; they are likely to represent surviving elements of the historic character of past landscapes. In this context, decision-makers need to have a concrete planning and management strategy in order to preserve their cultural characteristics. Moreover, the vulnerability of land-use types in 1990 continued in 2018; new fragile areas were added in 2018, which means there is a lack of management strategies in Alaca Höyük. In this context, robust landscape management strategies are needed in and around Alaca Höyük so that other unique landscape areas will not be destroyed, as in the case of the historic vineyards of İmat. Alaca Höyük and its surroundings have a land use strategy under the Master Plan covering Samsun-Çorum-Tokat provinces. However, this 1/100.000 scale plan does not reflect the unique and site-specific characteristics of the landscapes in the region due to its scale. Therefore, in such historic landscapes, it is important to identify small-scale approaches and strategies that work with the whole.

Planning and management policies may help protect cultural landscapes and local identity. After the European Landscape Convention, which was put forward for the protection, management and planning of landscapes, the Council of Europe carried out a new study –Landscape Mosaics– to ensure the applicability of these objectives, to understand the landscapes and to make the strategies put forward more tangible (Council of Europe, 2023). The ratification of the European Landscape Convention in Turkey supports efforts to monitor and record landscape changes, while government agencies have initiated planning and management strategies (Uzun et al., 2018).

In this context, it is essential for planners to work across scales and collaborate with various stakeholders. A network of actors—including agricultural engineers and botanists to understand site-specific cultural and natural landscapes, archaeologists to emphasize cultural heritage and archaeological value, and climate experts to address climatic vulnerability—is of great significance. However, it is crucial that landscape architects, as well as urban and regional planners, play an active role in ensuring a strong link between these experts and decision-makers. The engagement of local communities and administrative units should also be considered to facilitate the transfer of knowledge and strategies between local and broader scales (or vice versa). Thus, the significance of multi-actor, site-specific studies in such archaeological landscapes becomes evident. As the LCA reveals, even in Alaca Höyük

and its immediate surroundings alone, different landscape characters have been identified, and more localized solutions are needed to protect the vulnerability of these areas, especially against to climate change. This is also important for the protection of cultural fragility. This is why a multi-spectral action scheme comprising experts, public officials, cultural and ecological conservation actors and local communities is crucial for such historic sites.

Employing mixed-method approaches in a case like this may facilitate the implementation of site-specific strategies for landscape planning and management. These methods go beyond purely quantitative research and enable the inclusion of different actors (in this case, experts) in the research. The study also has the potential to draw multi-disciplinary attention to the landscape of Alaca Höyük and its vulnerability. In this sense, it can potentially attract the attention of a broader audience to the research subject, method, and location. Although countries currently have risk prevention strategies against natural disasters such as climate change, these strategies and plans fail because stakeholder participation is interrupted or not considered at all (Shirvani Dastgerdi & Kheyroddin, 2022). Future approaches may expand the scope of research on the socio-ecological resilience of historical landscapes in response to the challenges posed by climate change. Future studies with the local community are of especially great importance. Many solutions to global problems in local regions are likely to be hidden at the local scale with local actors (Vos & Meekes, 1999). In this sense, it will be essential to include locals and local decision-makers in the planning, strategy, and management stages.

5. Conclusion

Landscapes are constantly changing due to anthropogenic and natural drivers. The critical distinction between traditional/historical and contemporary landscapes lies in their dynamic nature, characterized by rapid and extensive changes driven by shifting perceptions, which, although accompanied by an exceptional volume of data, often exceed the capacity for data documentation and study (Antrop, 2005). However, managing and monitoring these changes and preserving diversity in landscape patterns is necessary for effective adaptation to global changes. In our study, CORINE land cover maps helped us to understand the changes in Alaca Höyük in the last 30 years. The interpretive score-based approach contributed to assessing the multi-variables of climate change effects on different land cover types and revealing the vulnerability of each land cover type. These different approaches were synthesized into a final vulnerability assessment map based on the unique landscape character areas in and around Alaca Höyük. In this context, the superposed map provides a valuable synthesis with the potential to underpin landscape management strategies for the Alaca Höyük landscape.

The study has two kinds of limitations. The first is that the oldest CORINE data for land cover change is from 1990. In a future similar study with a longer time span, a manual land cover classification method using historical satellite imagery could be chosen, which would also reveal changes in the landscape, especially before the mechanization of agriculture. However, since the study involves a methodological approach based on CORINE maps, a manual classification was not used. Moreover, it is a fact that high-resolution satellite images are needed for such manual classification. Another limitation was the inability to interview local people due to time constraints and transportation problems. As mentioned in the results section in the meaning of landscape management, an open-ended interview and workshop bringing together different actors would be important to adopt a common ground approach.

The study reveals that the agricultural areas in and around Alaca Höyük have been gradually increasing whilst uncultivated areas have been shrinking, with the result that more vulnerable land uses and land cover types have become more widespread. The disappearance of vineyards, the grad-

ual shrinkage of wetland areas and their transformation into agricultural areas, and the decrease in natural pastures negatively impact rural character. Moreover, LULCc puts pressure on characteristics that underpin the sense of place in Alaca Höyük, for example the historic Gölpınar Gardens. In this context, the study highlights the need to increase awareness regarding the preservation of this unique landscape character around the archaeological site of Alaca Höyük. Preparing holistic planning and management strategies that include both local people and experts will be an essential step toward addressing this issue.

This article synthesizes qualitative and quantitative approaches to assessing land cover changes in cultural landscapes and measures their vulnerability to climate change. The research provides valuable insights into the vulnerability of Alaca Höyük and its surroundings to climate change, shedding light on the specific factors and land cover types most susceptible to climate impacts. Mixed method approaches can enable the development of site-specific landscape planning and management approaches, which are especially valuable for cultural landscapes with a strong sense of place identity. Future studies could also extend the research to understand the socio-ecological resilience of such historic landscapes to climate change. In this context, the views of local people could be integrated into the study to better understand the social, economic, and cultural impacts of climate and land cover changes on them. In this way, more inclusive and location-specific planning and management strategies could be designed that involve local people, decision-makers and planners. Such actions will be vital in raising awareness of the risks that climate change poses to the natural and cultural heritage of landscapes.

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Conservation of the Khakhuli Monastery: An architectural overview and future scenarios

Mustafa Tahir OCAK[1]*, Gülsün TANYELİ[2]
[1] ocakm@itu.edu.tr • Department of Architecture, Faculty of Architecture, Istanbul Technical University, Istanbul, Türkiye
[2] gtanyeli@itu.edu.tr • Department of Architecture, Faculty of Architecture, Istanbul Technical University, Istanbul, Türkiye

*Corresponding author
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Abstract
Monastic churches in the Tao-Klarjeti region have many unique features arising from construction techniques, use of materials, and land settlement. The fate of these medieval churches, located in an area close to Türkiye's border with Georgia, depends on political negotiations between those two countries. While those negotiations continue, the churches should be documented and a basis for future conservation work should be prepared. This study examines the Khakhuli Monastery, a monastic settlement that began with a cross-planned church in the 10th century, as the historical structure surviving in the best condition in the region. An understanding of the formation of the annexes that expanded the settlement over the centuries is only possible with detailed documentation of the building. Archival evidence showed that the settlement was used as a monastery longer than previously believed. This study documents the construction techniques of the Khakhuli Monastery in detail, examines the causes of ongoing damage to the monastic church, and provides suggestions for conservation work. It primarily focuses on the holistic conservation of the Khakhuli Monastery, integrating structural analysis and social dynamics to preserve its cultural significance considering the international cooperation between Türkiye and Georgia.

Keywords
Church, Conservation, Medieval, Monastery, Tao-Klarjeti.

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1. Introduction

The Khakhuli Monastery is located in the Bağbaşı village of the Tortum district of Erzurum province, in the northeastern region of Türkiye. The monastic settlement is situated on the northern bank of the Bağbaşı Creek, which is a branch of the Tortum Stream extending along the southeast-northwest axis (Figure 1). Thus, the monastery is strategically located close to water and productive agricultural land. The village of Bağbaşı differs from the surrounding villages in terms of its mild climate and the variety of agricultural crops grown there.

Tao and Klarjeti are the historic names of two important regions within the Çoruh Valley. From the 9th century until the beginning of the 11th century, when the Georgian principalities were united into a single kingdom, Tao-Klarjeti [1] was the name of a medieval principality ruled by the Bagratid dynasty, under which the region experienced its golden age. Small monasteries were established in Klarjeti (Artvin, Türkiye) in the 9th century, while larger monastic churches were built in Tao (Uzundere-Tortum, Erzurum, Türkiye; Yusufeli, Artvin, Türkiye) towards the end of the 10th century. The monasteries of Oshki, Ishkhani, Otkhta Eklesia, and Parkhali were established in Tao in the 10th century. Oshki (Uzundere) and Ishkhani (Yusufeli) are the closest monasteries to Khakhuli. They were constructed as domed cruciform churches, similar to Khakhuli, while Otkhta Eklesia and Parkhali were both built with a basilica plan (Khoshtaria, 2023). The Khakhuli Monastery was the westernmost of the monasteries of the Tao-Klarjeti region. Both during and after the reign of the Tao-Klarjeti principality, Khakhuli maintained relations with its western neighbor, the Byzantine Empire (Figure 2). This monastery was a pioneer in education and crafts, and many Georgian clergy members were educated at Khakhuli, an important monastery of the Middle Ages [2].

Figure 1. *The south façade of the monastic church and the south chapel (photograph by the authors, 2021).*

Figure 2. *Tao-Klarjeti monasteries and World Heritage Sites (Google Earth, 2021).*

1.1. Aim and scope

This study aims to convey the environmental value of cultural heritage by considering historical and geographical interactions to address it from a holistic perspective. Within that framework, the study provides a comprehensive overview of the Khakhuli Monastery, detailing its historical significance, architectural features, conservation status, and current challenges. Furthermore, the importance of conserving such cultural heritage sites is highlighted, emphasizing the need for urgent intervention to ensure their preservation for future generations. This study also addresses broader implications for the conservation of similar medieval churches in the region, foregrounding the importance of collaborative efforts between Türkiye and Georgia as the legal custodians of Tao-Klarjeti's cultural heritage. The international cooperation between and cross-border serial heritage potential of Türkiye and Georgia are explored with the aim of understanding how such collaboration can mitigate political and bureaucratic obstacles in cultural conservation. Thus, the present study provides a holistic approach to the conservation of the Khakhuli Monastery together with other monastic churches of the Tao-Klarjeti region, integrating structural analysis, social dynamics, and international cooperation to facilitate the effective conservation of these culturally important monuments.

1.2. Methodology

The research presented here involved a thorough examination of various sources including historical documents, architectural surveys, archival records, and previous research studies. On-site research and documentation were carried out using modern techniques such as 3D scanning and drone photography to collect detailed information about the physical condition and architectural features of the monastery. By synthesizing the information obtained from these sources, a detailed narrative was constructed to explain the monastery's history, architecture, and conservation issues. Furthermore, this study proposes future scenarios and suggestions for conservation efforts in light of current regulations in the field of cultural heritage protection. Since there are limited studies in the literature addressing this topic and those sources are generally not well known, a brief review of the literature is presented in the next section.

1.3. Selected works in the literature

Works addressing the conservation status of the Khakhuli Monastery were primarily conducted in the 19th and early 20th centuries. As the first visual document of the Khakhuli Monastery, an engraving was produced by Théophile Deyrolle in 1869. Deyrolle noted that the building had been converted to a mosque [3]. The first known photographs of the Khakhuli Monastery were taken by Dimitri Ermakov, who was appointed by the Russian Empire as a military photographer in the region during the Russo-Turkish War of 1877-1878. Ermakov shared details of his second trip in his correspondence with Praskovya Sergeevna Uvarova, president of the Archaeological Society of Moscow (Nadimashvili, 2018), in 1908. He mentioned accompanying Ekvtime Takaishvili, a Georgian historian and archaeologist who conducted an expedition to other towns in the region in 1907, such as Göle, Oltu, and Çengilli, but not Tortum, and he described taking 300 photographs of the monasteries of Ishkhani, Oshki, and Khakhuli during the trip [4]. From the documents in the Ottoman Archives [5], it appears that Ermakov came to Tortum in 1908. However, his surviving photographs of the region are far fewer than the numbers specified in his correspondence.

The most comprehensive research on Tao-Klarjeti was conducted by Ekvtime Takaishvili, commissioned by the Society of History and Ethnography of Georgia. The fieldwork, which started on 8 August 1917, brought together Takaishvili and architect-engineer Anatoly Nikolayevich Kalgin; painters Ilya Zdanevich, Dimitri Shevardnadze, Lado Gudiashvili, and Mikheil Chiaureli; photographer Eduard Karlovich Liozen; and Ipolite, the

head priest of the Vardzia Monastery [6]. The team began its work at the Khakhuli monastic church. After the fieldwork ended, B. Ryabov completed the drawings based on measurements taken by Anatoly Kalgin (Berdzenishvili & Nioradze, 2020). While he measured the church, plaster copies of the stone reliefs were made by Mikheil Chiaureli and the wall paintings were copied by Lado Gudiashvili and Ilya Zdanevich (Kalandia, 2017). Gudiashvili and Zdanevich, who participated in this expedition in their twenties, later became well-known painters of Georgia.

Wachtang Djobadze, a Georgian-American art historian, conducted seven surveys in Tao-Klarjeti between 1965 and 1983. In 1992, he published the results of those surveys as a book (Djobadze, 1992). Mine Kadiroğlu was the first Turkish art historian to study Tao-Klarjeti, and she conducted research on the Khakhuli Monastery during surveys in the region in 1996 and 2003 (Kadiroğlu et al., 1998, 2005). In 2016, together with new measurements and drawings, a detailed examination of the Khakhuli Monastery was undertaken for the first time using 3D scanning methods. With that detailed documentation study, many previously unknown aspects of the building's construction techniques and materials were illuminated [7].

2. Architectural overview

Although few architectural structures other than the monastic church at Khakhuli have survived to the present day from among the monasteries of Tao-Klarjeti, monastic settlements were widespread in the region in the Middle Ages.

2.1. The Khakhuli Monastery settlement and its surroundings

In the monasteries of Tao-Klarjeti, as self-contained architectural complexes, monastic life was practiced in seclusion from society. Thus, a monastic church, chapel, refectory, kitchen, scriptorium, workshop, cellar, and winery were deemed necessary for a monastery's self-sufficiency. The designs of the Armenian and Georgian monasteries in Northeast Anatolia were not dependent on any specific scheme (Ahunbay, 1997). In the case of Khakhuli, the monastery complex has lost its integrity as most parts, except for the church, have been destroyed over the centuries. However, the monastic church and its immediate surroundings have survived to the present day in good condition. Some other structures, such as inner and outer fortifications of the settlement, probably from the same period, remain near the monastic church [8] (Figure 3).

At Khakhuli, the monastic church, the north church, and the south chapel

Figure 3. *Drone photograph showing Khakhuli Monastery and its surroundings (photograph by the authors, 2021).*

are located within inner walls that enclose an area of 2242 m². This area, surrounded by a wall approximately 3 m tall, is entered via an arched opening in the south. The ruined bell tower is accessed by stairs adjacent to the entrance gate (Takaishvili, 1952). Eighty meters west of the monastic church, there is an outer wall that is thicker than the inner wall, extending on the north-south axis. As this outer wall approaches the Khakhuli (Bağbaşı) Creek, it turns towards the east and continues in parallel to the creek. Between the inner and outer walls, there are remains of buildings thought to have belonged to the monastery (Figure 3).

One kilometer west of the monastery, a chapel stands on a high hill from which both ends of the valley can viewed. Five additional chapels are located throughout the village. The remains of three chapels, one adjacent to the south of the church, one at the southeast corner, and one adjacent to the south of the inner wall, were documented in 1917 (Takaishvili, 1952). The quarry from which the stones used in the monastery buildings were obtained is located approximately 50 m northeast of the monastic church. The natural slope of the quarry is such that stones could be transported to the construction site quickly after being cut (Figure 3).

2.2. Monastic church

The main entrance of the domed cruciform church is located on the south side. Both the main wall and the south façade of the entrance hall are rich in bas-reliefs and figures of animals. The eastern arm of the structure consists of apsed pastophories and a wide apse positioned 73 cm above floor level, accessible by steps. There is a niche in the middle of the apse, and on both sides of this niche, there are four equal arched niches with heights of 5.50 m. Djobadze (1992) noted that the niche in the middle could have held a bishop's throne. The annexes were entered from the cross arm of the church in the original plan. Today, however, the annexes can be entered only through destroyed sections of the wall and their

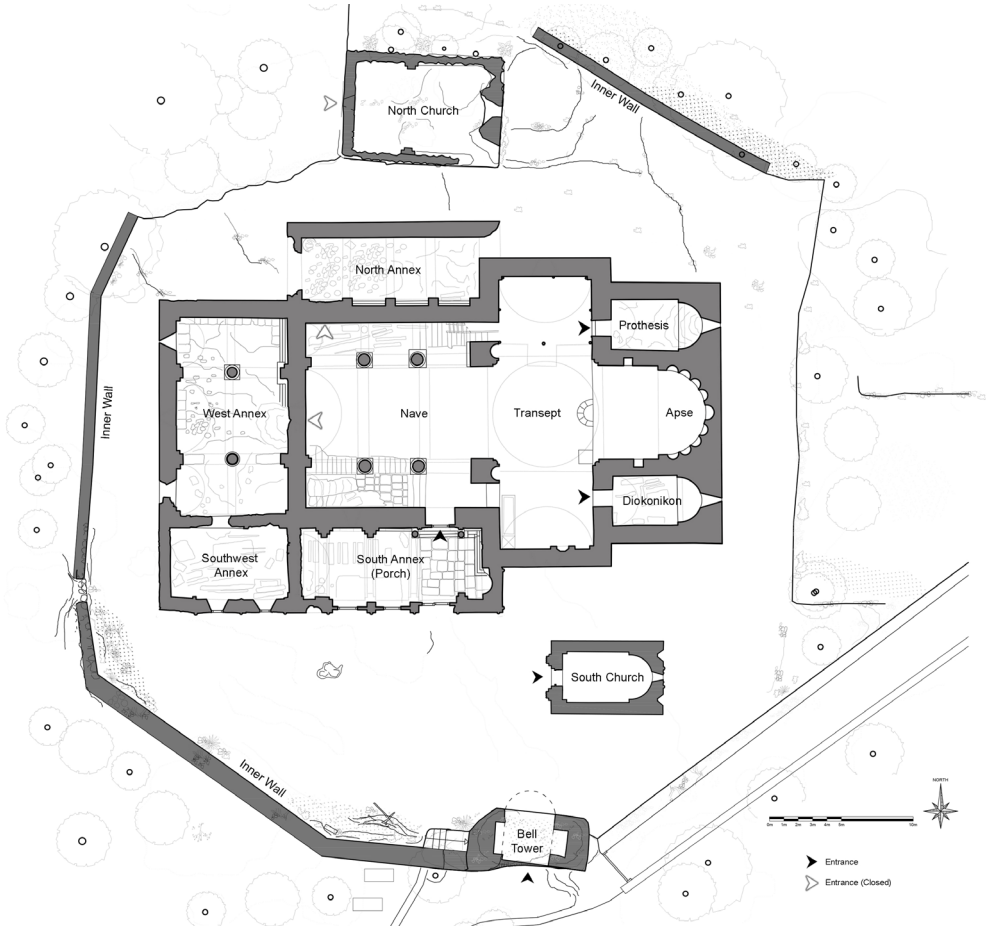

Figure 4. *Elevation plan (+1.50 m) of Khakhuli Monastery (drawing by the authors, 2016).*

doors have been filled or closed from inside the church (Figure 4).

One of the best-preserved examples of a conical dome on a high drum, a characteristic feature of monasteries in the region, survives at the Khakhuli Monastery. The frescoes in the dome and apse have survived only in part but their essential details remain visible. Close observation of the existing fragments of frescoes on the inner wall surfaces reveals that the frescoes were not planned in the initial construction phase and were added later.

2.3. Construction technique

The monastic church was built on a raised foundation composed of smoothly finished blocks forming three steps of 20 cm in height. The walls were composed of two façades and the space between them was filled with rubblestone mixed with lime mortar. Finely cut stone of approximately 2-3 cm in depth faced the surfaces of the walls throughout the interior. The interior surface of this stone facing was roughly shaped to ensure optimal adhesion. The finely cut stones, unique to Armenian and Georgian architecture, were tapered towards the inside of the wall and the stones barely touch each other along the vertical axis.

Andesite was used for the stone of the walls and the vaults of the building. Stone was extracted from the quarry located immediately to the northeast of the church. Within the church, only the stone used for the drum differed from that used in the construction of the main wall. The stone used in the drum was yellowish in contrast to the gray andesite stone used in the lower walls of the building. Tuff [9] was applied for the upper parts of the windows in the drum and façades. This stone was also used as filling for the walls of other churches in the region. The use of tuff as a decorative element is only seen on the façade of Khakhuli.

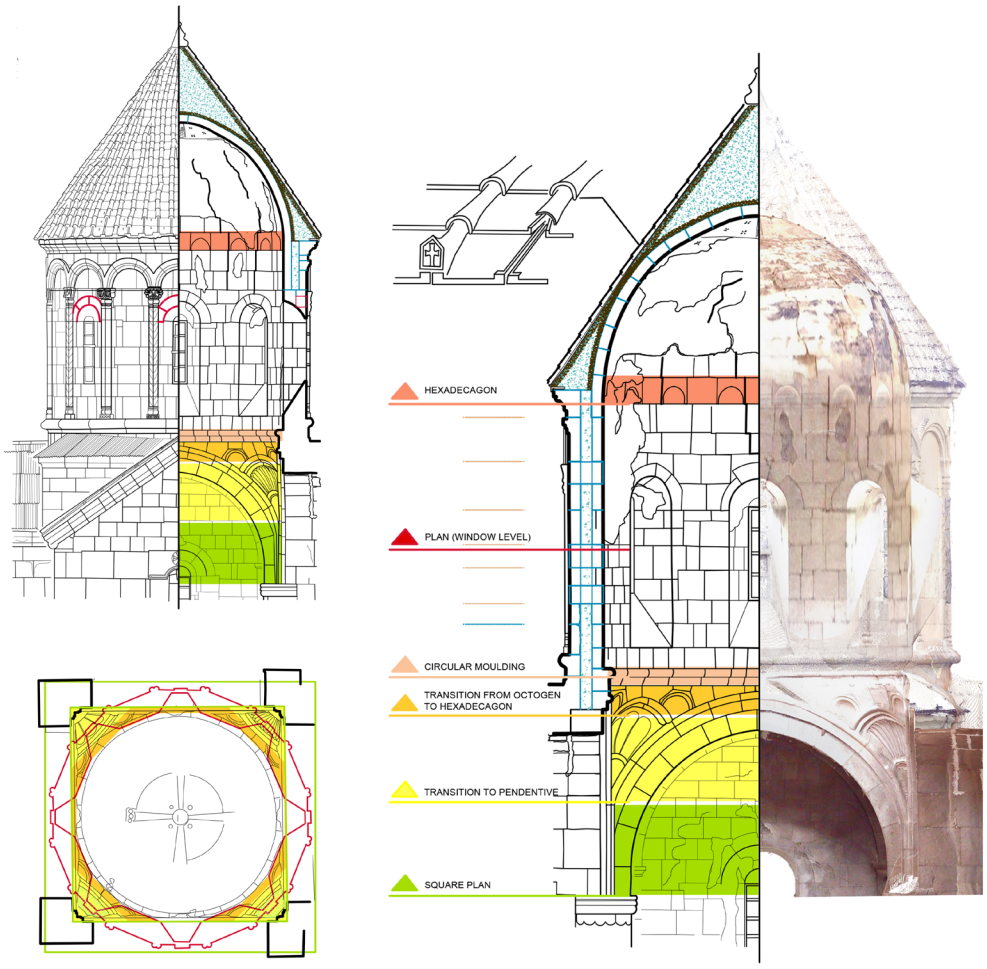

Figure 5. *Analysis of the construction technique used for the dome and drum (drawing by the authors, 2016).*

The dome was supported by the apse walls in the east and by two piers in the west. The vaults covering the cross arms of the church were designed to form a square base under the dome's drum. The transition from this lower base to the circular base of the hexadecagonal drum was achieved using pendentives (Figure 5).

Eight names written in the Asomtavruli script of Georgian appear on the lower parts of the dome's drum: Gursi, Aderk, Mikel, Javakh, Tvalshav, George, Tvalis, and Mhss (Mukhutsis). These were most likely the names of the master stonemasons who built the structure (Takaishvili, 1952).

Ceramic tiles were used for the roofing material of the dome and vaults. The first row of tiles was placed on the eaves of the vaults and the dome. For the eaves, rectangular tiles were arranged in rows. The first three rectangular tile rows were fixed with metal nails and the exposed edges of the tiles in those rectangular rows were covered with semi-cylindrical tiles (Figure 6).

The wooden floor is carpeted today but the original paving stones below the carpet are in good condition, as is apparent in the western naves of the structure.

3. Historical overview: Construction stages and functions

The monastic church of the Khakhuli Monastery was initially designed with a cruciform plan. It changed with additions over time, as can be understood from its elevated foundation. However, there is a lack of consensus about the timeframe in which the monastic church was originally built due to a dearth of inscriptions. The only inscription found in the church to date appears on a later column added next to the entrance door in the southern annex. This poorly written inscription was probably placed there during the construction or repair of the southern annex. According to Takaishvili (1952), the inscription states that "Saba Saghiridze donated to the church and set a commemoration day for himself" [10]. However, Sargisian (1864) stated that the inscription includes expressions such as "I ... founded ... David" and suggested that the mentioned David was David I, who ruled between 876 and 881. He also noted that he saw Armenian letters in an inscription on the east wall of the apse and was able to read the date inscribed there as 868. Brosset (1864) disagreed with Sargisian, stating that the date is controversial and difficult to defend. Takaishvili (1952) observed that the inscription in the southern annex is located in a section that was added later; thus, it cannot be an inscription associated with the original construction.

Although it is accepted that Georgians built the monastic complex, the years in which the church forming the core of the monastery was built is a matter of debate. Based on the date proposed by Sargisian, some Armenian researchers have argued that the church was initially built in the 860s (Maranci, 2003). However, there is no firm evidence indicating that the church was built before the 10th century. In contrast, among Georgian sources, the church was referred to as "Kha-

Figure 6. *a) Dome cover of Khakhuli's monastic church; b) Detail of the tile cover of the dome (photographs by the authors, 2021).*

khuli" in the 11th-century "Georgian Chronicles" manuscript describing events that occurred between 786 and 1072. The church is attributed there to David Kuropalat III, a donor of other churches in the area.

Archival sources are not able to clarify this issue and there are also gaps in our knowledge regarding the exact construction dates of the annexes. The periodization proposed in the present study is intended to contribute to the subject with newly obtained data rather than repeating or comparing previous discussions.

The annexes are referred to as "north," "west," "south," and "southwest" according to their directions as additions to the western arm of the church (Figure 7). Precise measurements and detailed examinations of the junctions of the monastic church and its annexes have revealed new findings. The construction details obtained by tracking the moldings under the eaves and examining the junction points provided new information about the order of the annexes' construction: the north annex was added shortly after the construction of the church, and then the south annex was added with the south chapel, the west annex was subsequently added, and, finally, the southwest annex was added during the repair of the south annex.

In this periodization, the south annex is particularly important. The region's seismicity and soil characteristics must have necessitated repairs and other interventions, particularly in the south annex. As a result, structural and spatial changes occurred in the building. The portico section on the south façade of the church was built before the vault and supporting arches, together with the exterior wall. In the following period, the portico piers were jacketed and existing vaults were supported with arches sitting on other parts of the piers. The junction points of the layers in the vault and the piers and the decoration scheme are clear evidence of the southern annex having been repaired many times (Figure 7).

The primary sources associated with the Khakhuli Monastery are Georgian manuscripts written in the monastery itself. The latest manuscript in the archives that was written in the Khakhuli Monastery dates to 1556 [11]. Based

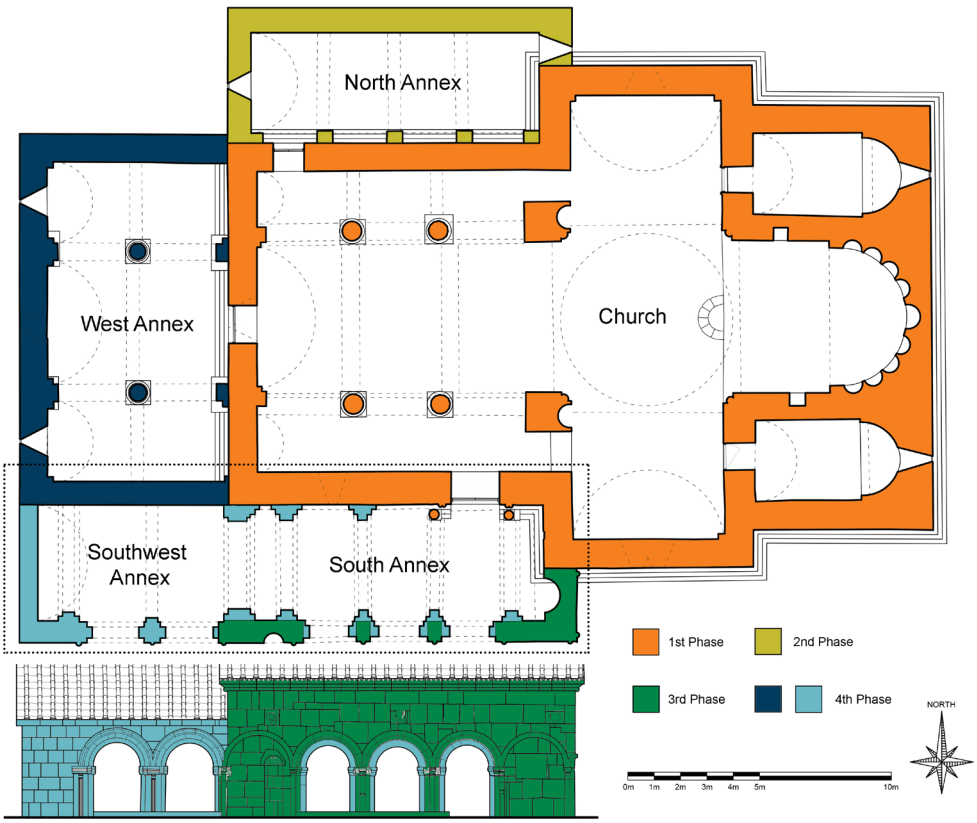

Figure 7. *Period analysis of the monastic church of Khakhuli and its annexes (drawing by the authors, 2023).*

on that manuscript, Djobadze (1992) asserted that the monastery was active until the middle of the 16th century. The Khakhuli Monastery and its surroundings came under Ottoman rule in 1549, but that did not bring an end to its activities. In the Detailed Tax Registers of Erzurum Province (*Erzurum Eyâleti Mufassal Avârız Defteri*) from 1642, it is evident that four of the 23 non-Muslim homes in the village of Khakhuli belonged to monks. Furthermore, half of the Muslim households in the village were registered as *veled-i Abdullah*, meaning that they had converted to Islam (İnbaşı et al., 2014, p. 186). In light of this information, it is apparent that non-Muslims lived in the village and the monastery continued its activities until the middle of the 17th century.

There is no evidence of the monastery being used from the 17th to the 19th century. The conversion of the monastic church to a mosque dates to the second half of the 19th century. A mihrab niche was carved into the south wall of the southern cross arm of the building but no major interventions were applied when the church was turned into a mosque.

At the beginning of the 20th century, the building was opened again as a church and its condition and use were monitored by Colonel N. Shugurov, a Russian officer who served in Khakhuli between 1915 and 1917, during the region's occupation by the Russians (Shugurov, 1916). Upon reconversion to a church, a wooden iconostasis was added to the apse and a wooden cross was added to the dome (Takaishvili, 1952). The building then functioned as a church for two years (1916-1918). According to Shugurov, the building, known as the Church of the Virgin Mary, was considered a holy place in the village and women who wanted to have children would go there to pray (Takaishvili, 1952). The monastic church was converted to a mosque once again after the Russians withdrew from the region in 1918 (Figure 8). During the Ottoman period, it was known as *Taş Cami* or "Stone Mosque." The Khakhuli Monastery gave its name to the village in that period, coming to be known as "Haho." The building is still respected as a sacred place today.

4. Conservation issues

The churches of Oshki, Ishkhani, and Otkhta Eklesia have reached the 21st century in structurally poor condition. Local residents used them for some time but eventually abandoned them. The monastic churches of Parkhali and Khakhuli have continued to

Figure 8. *A wooden iconostasis was added to the church's apse in 1916 (Takaishvili, 1952); view from inside the church (photograph by the authors, 2021).*

function as mosques to the present day, and thanks to locally funded repairs, they have survived in good structural condition. In the 2010s, the restoration of the monastic churches of Ishkhani and Parkhali was completed. However, failure to implement a signed protocol between Türkiye and Georgia suspended the restoration of the Oshki monastic church after it began in 2018. The monastic church of Oshki has remained closed since 2020, with no restoration activities taking place.

The monastic church of Khakhuli has survived in good condition to the present day. In the 1980s, the Khakhuli Monastery was registered as a historic structure together with other monastic churches in the region and conservation projects were planned. However, for various reasons, those projects were postponed for many years. While evaluations conducted in terms of the conservation of the Khakhuli monastic church are conceptually addressed together with other Tao-Klarjeti monasteries in the following sections, a structural evaluation is proposed specifically for the Khakhuli monastic church.

4.1. Conceptual approach

The heritage sites of Tao-Klarjeti are managed differently than other cultural assets in Türkiye as international protocols come into action here. Türkiye and Georgia are both legally responsible for the Tao-Klarjeti monastic churches. In Türkiye, under Law No. 2863 of 1983, Türkiye is obligated to protect these cultural monuments within its borders. In Georgia, Article 2 of Law No. 4708, which entered force in 2007, imposes responsibility on the Georgian state for the protection of Georgian cultural heritage abroad. The restoration of these buildings also entered the agenda within the scope of a cultural protocol in force between 2017 and 2021, in which the responsibilities that both states should undertake were defined (Republic of Türkiye Ministry of Foreign Affairs, 2017). The protocol was renewed at the beginning of 2024 with similar regulations; however, there has been no progress on restoration practices since the implementation of the new protocol. While the majority of the legal framework has been established, challenges remain in the planning and implementation phase of the conservation work. Many of these buildings require urgent intervention but bureaucratic hurdles are causing delays, leading to wasted time and exacerbating the risk of architectural loss. Unless these obstacles are overcome, there will be no progress in preserving the buildings and the extent of the architectural loss will increase.

The modern function of the monastic churches in the region is one of the most controversial points in the context of conservation. It is also a sensitive matter within the framework of the relationship between Türkiye and Georgia. Restorations of the Ishkhani and Parkhali churches have been completed, but the physical condition of the buildings cannot be maintained due to their lack of function. As the buildings have not been in use since the restorations were completed, deterioration processes are still continuing. There is no Christian population left among the inhabits of the region to ensure that these churches are used according to their original function; thus, the cultural agreements between Türkiye and Georgia do not include plans for the buildings to be used as churches. Keeping in mind that the sustainability of cultural assets must be prioritized, decisions should be made to re-function these buildings for socially or culturally useful purposes.

Although it was converted to a mosque in the early 20th century, the church of the Khakhuli Monastery was still recognized by local residents as a holy place dedicated to the Virgin Mary. However, since the early 20th century, the population mobility in the region has completely changed that perception. Reintroducing the churches in the area to local residents by highlighting their cultural value will raise local awareness and facilitate the acceptance and integration of this cultural heritage.

The monastic church of Khakhuli has survived better than other churches in the Tao-Klarjeti region due to its long years of use. A holy place of pilgrimage for Georgian tourists, the Khakhuli Monastery welcomes foreign

tourist groups for most of the year. However, in its current state, the monastery does not have the necessary infrastructure for meeting the demands of that tourism. While the monastery continues to serve its current touristic function, conservation works should ensure improvements in infrastructure that will enhance the experiences of visitors for religious or historic purposes. At the same time, the tourism planning and activities should respect and accommodate the religious beliefs and practices of the local population. The activities should be planned to sustain rather than erode heritage and traditions. Interpretations of and conservation plans for this heritage site should entail a multi-participatory approach in coordination with the local community (ICOMOS, 2022).

4.2. Damage assessment and intervention approach

To understand the material properties of the Khakhuli Monastery and the damages experienced by the monastic church, comprehensive architectural documentation was first carried out. Detailed drawings of the Khakhuli monastic church and its annexes were created using the up-to-date methods of 3D scanning and drone photography. With this documentation work, many unique details of the building's original construction were revealed. The sets of drawings for the survey, the analysis results, and the proposed conservation strategies were sent to relevant institutions in Türkiye. Documentation work is significant not only for this church but also for other monastic churches constructed with the same technique. The buildings in the region were not repaired over the years; therefore, they have largely preserved their original characteristics. Documentation of those original characteristics, from joint details to masonry and from the materials used to the workmanship, is important to prevent the loss of data preserved in these structures for centuries.

The Khakhuli Monastery is located between a rocky area and the streambed. A general examination of the monastic church revealed ground settlement, especially in the southern part, due to ground differences between the northern and southern parts of the structure. Due to the ground settlement, a crack extending upwards from the ground has formed in the apse wall. The settling of the building has also caused the portico of the south annex to shift, creating an opening in the vault. In addition, the immediate environs of the building have been filled with earth as a result of landslides of the northern slope.

Another structurally problematic part of the building is the dome: there are cracks on the inner and outer walls from the drum to the dome (Figure 9). The south annex is also structurally problematic. The fact that it has been repaired many times shows that its structural problems have existed since the early times of the church.

Before beginning any structural repairs to the building, the different cracks should be monitored for at least a year. This monitoring phase will reveal how active the cracks are, allowing proposals for repair to be developed accordingly.

As a result of the cracking of the tiles over time, the mortar underneath has been exposed to external weather conditions, losing its binding properties over time and becoming fragmented. In the 1970s, the roof of the monastic church was covered with metal trapezoidal sheets. This temporary measure partially prevented water from further damaging the building, but many destructive weeds have grown in parts of the dome that are not covered with metal trapezoidal sheets. The weeds with longer roots have damaged the structural stability of the vaults. Weeds are also evident in the empty joint gaps on walls exposed to water (Figure 10).

Until conservation work begins, the exposed sections of the roof should be covered with metal trapezoidal sheets and the existing sheets should be renewed. From the beginning of the 20th century, temporary roofing has similarly been used in several historic churches in Georgia. During this preliminary phase of conservation, it is imperative to research and document the original roof cover.

Reconstructing original roof coverings is a costly process that requires ex-

tensive research on restitution. For this reason, temporary but well-planned solutions will prevent exorbitant restoration costs for these churches, which already face challenges in acquiring adequate funding. At the same time, such reversible interventions will ensure the preservation of original data (ICOMOS, 2003, Article 3.9).

From drawings and photographs taken in 1917, it can be understood that there were previously more frescoes in the building, some of which have been lost. The images depicted in the frescoes, particularly in the dome and apse, can be understood, albeit in a fragmented way, but if deterioration processes continue at the current rate, the frescoes will be completely lost in the near future. One of the most important interventions to be made in the monastic church of Khakhuli is the elimination of the water exposure that has caused losses in the frescoes. The surviving frescoes urgently need to be consolidated.

Human factors have been influential in the deterioration of some parts of the monastery. Local residents have recounted several instances of illegal excavations at the monastery, resulting in the destruction of the floors and walls of the monastery that are not used as part of the mosque's prayer space.

Figure 9. *Dome of the Khakhuli monastic church (photograph by the authors, 2021).*

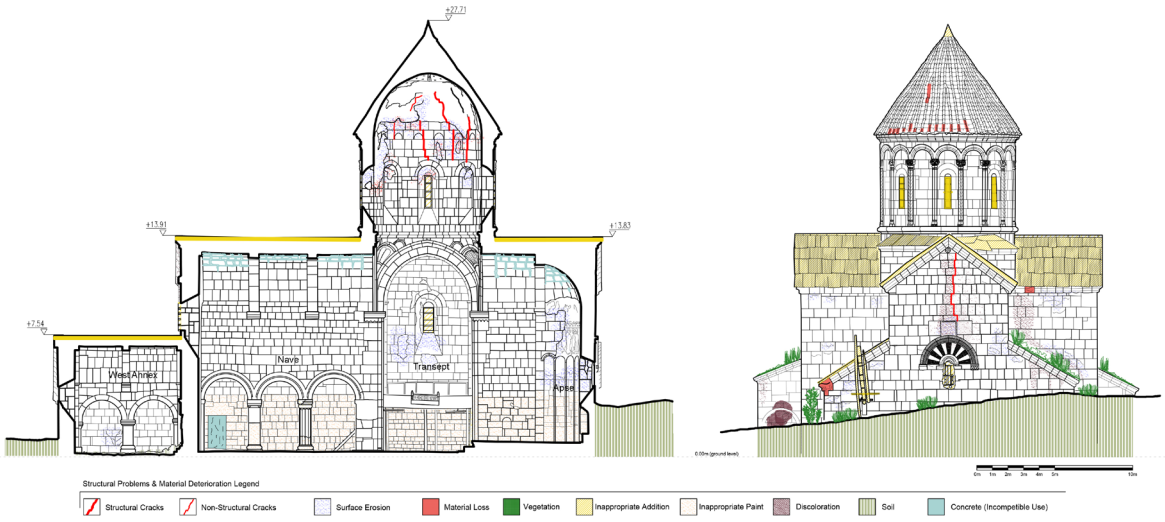

Figure 10. *Damage mapping of the Khakhuli monastic church (drawing by the authors, 2016).*

Stoves have also been used to heat the section of the monastery where the mosque exists. A suitable non-destructive solution should be found for heating the building.

Along with the structural reinforcement of the monastic church and its annexes, archaeological excavations should be conducted at the monastery. The foundations identified during the surveys and excavations should be conserved as a priority.

Since the gaps in the walls of the north, west, and south annexes of the church weaken the building structurally, these openings should be closed. The openings of the original entrances to these spaces should be used in the western arm of the church, as in its original state. Structural integration should be the primary goal for monumental buildings in rural areas. Small and effective interventions should be undertaken. Integrations leading to reconstruction and cleaning practices that completely remove the patina of the surface should be avoided.

In 2016, comprehensive documentation of the Khakhuli monastic church was completed. Subsequently, the structure underwent recurring on-site surveys. During expeditions conducted in 2020, 2021, and 2022, observations indicated that misuse continued in and around the church. Because of the moisture within the structure, fresco deterioration persisted. In the western annex of the structure, water-induced damage has progressed to an advanced stage.

5. Future scenarios as a conclusion

The structural problems identified in the monastic churches in the Tao-Klarjeti region can be prevented from causing larger problems by taking urgent measures. The structural problems of the buildings can be resolved with planned restorations. However, for these interventions to be sustainable, all monastic churches in the region should be managed with a specific program and priorities should be determined. Taking into account the political and sociological aspects of conservation, the interventions should be discussed and decisions should be made by multiple types of participants. International platforms such as UNESCO (The United Nations Educational, Scientific and Cultural Organization) that prioritize the protection of cultural heritage are suitable mediators for overcoming political deadlock. In the following scenarios, the transboundary heritage potential of the monastic churches is emphasized and it is suggested that conservation efforts be carried out with this perspective.

5.1. Transboundary serial heritage

Transboundary serial heritage entails a set of cultural heritage sites that cross the borders of countries, representing a shared history, culture, or natural heritage. Transboundary serial heritage reflects the shared values of nations linked by geographical, cultural, or historical ties. It is an important tool for strengthening intercultural understanding and cooperation in a globalizing world. When the architectural heritage of the Tao-Klarjeti region is analyzed within the framework of transboundary serial heritage, it is seen to have potential in many ways.

Although the Tao-Klarjeti region today refers to an area within the borders of Türkiye, in the Middle Ages the borders of the region included some of the territory of today's Georgia. Similar monastic churches can also be seen across the border in Georgia as architectural examples of the same culture.

UNESCO's Guidance for Transnational or Transboundary Nominations states that nominations should be prepared and submitted jointly by States Parties (UNESCO, 2013). Such joint applications are encouraged by UNESCO and are excluded from application quotas. A description of transboundary serial heritage could be added to the cultural cooperation protocol signed between Türkiye and Georgia, thus expanding the possibilities for inter-country cooperation. The restorations completed in the region to date have required specialists and skilled stonemasons. The adaptation of the protocol between the two countries to the nomination process would ensure that the conservation activities are carried out on an international basis.

5.2. Social dynamics and function

The sociological characteristics of the settlement are among the issues that should be taken into consideration while re-functioning any religious cultural heritage site. The village where the Khakhuli Monastery is located, like other villages in the area, was inhabited by a certain proportion of Georgian Christians until the 17th century. Over time, they migrated or converted to Islam. However, as Shugurov and Takaishvili described, villagers still came to the church in the 19th century to make wishes and offer sacrifices. Today, villagers use part of the building as a mosque and maintain it with local resources. The Khakhuli Monastery never lost its prestige and recognition among local residents and the monastic church has survived to the present day in good condition thanks to its re-functioning as a mosque. Considering this point in conservation proposals, the continuation of the mosque function, even partially, will positively affect the villagers' perspective of the building and should be evaluated in terms of functional sustainability. At the same time, for the buildings to be accepted and protected by society, it is important to introduce the cultural assets located in the countryside to local people and to convey their importance.

5.3. Structural recommendations for restoration works

Located at the crossroads of the Caucasus and Anatolia, Georgian and Armenian monastic churches stand out as early examples of building techniques in Anatolia. The Khakhuli monastic church and other churches in the Tao-Klarjeti region have preserved their original features from the Middle Ages to the present day. They are therefore valuable for the information we can gain from them about historic construction techniques; this will help guide future conservation efforts.

The Khakhuli Monastery is one of the best-preserved examples of churches in the Tao-Klarjeti region. Considered together with its landscape, surrounding walls, outer walls, and chapels, it is not merely a monumental structure that stands isolated in a rural area. On the contrary, the scope of its conservation should include both the monument and the larger landscape in which it is situated.

The Khakhuli Monastery has long since lost the structures necessary for it to be defined as a monastery. The refectory and library, for example, have not survived to the present day. As a result of surveys conducted in Bağbaşı village, it was determined that the surrounding walls of the monastery were originally wider. The use of the area between those walls and the monastic church as a cemetery allowed the remains of buildings in the area to survive to the present day under the soil. To locate and identify these remains, ground-penetrating radar measurements and controlled research excavations should be carried out in the area. Further research aligned with the discoveries presented in this study has the potential to provide more accurate data on the historical development of the monastery.

Despite its appearance in archival sources and other literature, the Khakhuli Monastery still has many undiscovered characteristics. Understanding its past interventions and changes provides valuable insights for future restoration strategies. It is important to shift the focus to the structure's historical interventions and concentrate on their reasons. Focusing on the causes of interventions rather than their symptoms is essential for understanding why interventions were needed in the past. As evidenced by the changes that have occurred in the southern annex, constant intervention is needed due to the instability of the ground upon which the building is located. Therefore, monitoring and ground surveys should be carried out before any comprehensive conservation efforts are initiated. Considering other monasteries in the region that are abandoned and derelict, it might be argued that the Khakhuli Monastery has fared relatively better because it has been in use for a longer duration of time. In general, making historical buildings usable is a recommended strategy for conservation.

To ensure the preservation of the original qualities of the building, irreversible integrations up to reconstruc-

tion should be avoided. Any actions taken to alter or restore a historical building should be carefully considered to prevent permanent changes that might compromise its historical value (ICOMOS, 2003, Article 3.9). Consequently, integrations should only be performed for the Khakhuli monastic church in the event of structural requirements. The needs of the church are currently simple but urgent; it must be transferred to the future with carefully planned conservation solutions. The restoration of the Bagrati Cathedral in Georgia started in the 1950s with minimal integrations, but with a decision made in the 2010s, the cathedral was reconstructed. Due to those irreversible restoration practices, the building was removed from the World Heritage Site list. Such an outcome should be avoided at Khakhuli.

One of the most crucial requirements of a scientific conservation project is documentation as an integral part of the whole process of conservation. During any future conservation campaigns, every aspect of the monastery, including parts revealed during restoration and archaeological excavations that possess original details from the 10th century, should be documented, analyzed, and inventoried (ICOMOS, 1990). Creating a database that includes all such information will help guide future interventions for the Khakhuli Monastery and other cultural properties in the region that were built with similar construction techniques.

The fate of these medieval churches, many of which currently lack a function, depends on negotiations between Türkiye and Georgia. The conservation of this heritage is a race against time, but the progress has been halted by bureaucracy and policy. This vulnerable heritage requires urgent conservation measures. The fact that the Khakhuli Monastery has survived to the present day does not guarantee that it will continue to survive in the future. For this reason, conservation work should be undertaken as soon as possible before irreversible problems arise.

Endnotes

[1] In Armenian sources, the name of the region is given as Tayk and Kharjk.

[2] Some of the famous clergymen educated at the Khakhuli Monastery include Basil of Khakhuli, Iovane Khakhulili, Davit Tbileli, Grigol Khakhulili, and Giorgi Athonite (Djobadze, 1992). The Virgin Mary icon produced in the Khakhuli Monastery is a noteworthy specimen of Georgia's medieval handicrafts. It was taken to the Gelati Monastery, near Kutaisi, in the 12th century and a triptych was prepared there (Kadiroğlu, 2009). It is now exhibited at the Georgian Fine Arts Museum of Shalva Amiranashvili in Tbilisi.

[3] T. Deyrolle made his trip to Trabzon and the Tortum region in 1869-1870, commissioned by the Geography Society of France (Deyrolle, 1876). His report and drawings are available in the French National Archives with archive number F/17/2955/B.

[4] The Oshki, Ishkhani, Otkhta Eklesia, and Parkhali monasteries were established in Tao. Oshki (Uzundere, Erzurum, Türkiye) and Ishkhani (Yusufeli, Artvin, Türkiye) are the closest monasteries to Khakhuli.

[5] According to documents in the Ottoman Archives, Ermakov was under suspicion and not allowed to prepare maps for military purposes (Republic of Türkiye Presidential State Archive. BOA, BEO/3326/249409 (Hijri: 03.05.1326) 03.06.1908)

[6] In Takaishvili's publication, this date was incorrectly given as July 8 (Arabidze, 2010).

[7] This article was prepared by the corresponding author from his master's thesis completed at Istanbul Technical University. The data obtained for the master's thesis were expanded within the scope of a doctoral thesis and compared with data from other monasteries. The surveys for each thesis were carried out with the permission of the Ministry of Culture and Tourism of the Republic of Türkiye (M. T. Ocak, 2016).

[8] The monastic church at Khakhuli was also referred to as a cathedral because the bishop's seat was there and the bishop was appointed there. This fact emphasizes its importance as a religious center.

[9] The experiments to identify the material characteristics of the tuff stone were conducted by Ayşegül Ağan

at the ITU Architectural Conservation Laboratory.

[10] Thanks to Irene Giviashvili and Zaza Skhirtladze for their guidance in the translation of the inscription.

[11] Manuscript No. S-252, Korneli Kekelidze Georgian National Centre of Manuscripts.

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A systematic evaluation approach for integrating smart sustainable buildings and cities

Fatma Handan SARIGUL[1*], Husnu Murat GUNAYDIN[2]
[1] sarigul18@itu.edu.tr • Department of Architecture, Faculty of Architecture, Istanbul Technical University, Istanbul, Türkiye
[2] gunaydinh@itu.edu.tr • Department of Architecture, Faculty of Architecture, Istanbul Technical University, Istanbul, Türkiye

* *Corresponding author*
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Abstract
A smart sustainable building uses advanced technologies and sustainable practices to boost energy efficiency, reduce environmental impact, and increase occupant comfort; a smart sustainable city uses technology to improve residents' quality of life and promote sustainability. This research aims to a systematic approach to the "Smart Sustainable Building-City Integration Evaluation Model (SSB-CIEM)" for integrating smart sustainable buildings and cities. The methodology begins with a qualitative literature review on smart and sustainable buildings, cities, and SSB-CIEM. Then it continues with the bibliometric analysis of articles obtained from Scopus. The comprehensive content analysis of selected articles reveals trends, strengths, and weaknesses. The findings highlight six main areas for a holistic SSB-CIEM: Resilience, environment, governance, aesthetics, mobility, and welfare and well-being. The systematic approach to SSB-CIEM, which offers a holistic perspective by completing the shortcomings of existing evaluation approaches, encourages practitioners to strengthen the necessary technology infrastructure in six areas determined for integrated building-city in architecture, engineering, and urban planning projects. The model presents the preliminary areas that practitioners can consider when integrating building-city projects and supports government decision-makers in reviewing national smart city action plans and local government infrastructure projects. Such a systematic evaluation approach is one way of considering the socio-economic and cultural benefits of cross-scale communication between buildings and cities, implemented with state-of-the-art technologies at local and central scales.

Keywords
Integration evaluation, Smart sustainable building, Smart sustainable city, Systematic approach, Systematic literature review.

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1. Introduction

In the last few decades, some notions, such as smart, sustainable, inclusive, sustainable just (Nederhand et al., 2023), and resilient, have emerged as popular solutions to rapid population growth problems in cities (Nederhand et al., 2023). One of these notions, smart cities, stands out significantly because of the use of digital technologies to solve urbanization problems (Xia et al., 2022). Smart homes, smart grids, and smart meters, which constitute smart city components, work harmoniously in a smart environment for better living conditions (Al Dakheel et al., 2020). This cooperation, which works through a systematic network based on ubiquitous ICTs (Information and Communication Technologies) and integrates all smart services by involving citizens in this structure, helps raise the standards of building and city services (Sladoljev et al., 2019). For this reason, it is necessary to establish coexistence between the smart systems of both smart cities and smart buildings (Sladoljev et al., 2019). This coexistence means establishing a building-city relationship through the Internet of Things (IoT) by connecting household appliances to a network and equipping the buildings with sensors (ITU, 2021; Sladoljev et al., 2019).

The development of smart building technologies encourages the transition to a new era in building-city related services. Integrating smart building systems into smart city digital platforms can increase cities' smartness levels. At this point, the role of smart buildings is to increase the city's capacity to use all the functions offered by smart areas and to be designed to enable smart building services, smart materials, and smart construction features to serve city systems (Apanaviciene et al. 2020a). With smart sustainable building and city integration, buildings can harmoniously use their smart and sustainable functions through ICT with the city's capacities. Buildings, one of the most critical components of the city, have a vast integration potential with the city's digital and physical infrastructure in the areas, such as resilience, environment, management, aesthetics, mobility, and welfare and well-being. Matching buildings and cities capacities in these areas with ICT infrastructures can ensure sustainable city goals are achieved in terms of citizens' welfare and minimizing the global climate crisis. For example, city-integrated smart buildings are connected microgrids that can produce energy while consuming it and feed the grid, while utilities are responsible for managing energy-producing resources and organizing their distribution (Stieninger, 2016). For this reason, not only the micro (building) scale resource production-consumption data becomes vital in evaluating interoperability data at the macro (city) scale. Although many building evaluation tools have been produced to establish sustainability, there is a need for cross-scale treatment. Conte & Monno (2012) propose a cross-scale model that includes the building and the associated environment, but again, the evaluation includes the overall building and its sustainability.

Essentially, there is a massive leap in the number of smart city projects, so the speed of academic and industrial studies is growing to evaluate cities' performance with the smartness criteria (Caird et al., 2016; X. Li et al., 2019). The idea of what smart buildings should be like is taking place with increasing interest in academic, popular, and industrial literature (Buckman et al., 2014; Froufe et al., 2020). However, smart sustainable building-city integration evaluation is a relatively new discourse. An effort to integrate a smart building with a city by interacting with the components of the smart city has raised the issue of evaluating the levels of these efforts. Nevertheless, Apanaviciene et al. (2020a) investigated the potential of buildings to benefit from city's capacities with the ICT infrastructures and to become smarter in the fields of smart energy, smart mobility, smart life, and smart environment. On the other hand, since existing evaluation tools evaluate building and city smartness and sustainability separately, there is a need for a systematic evaluation approach for integrated smart sustainable building-city. This research aims to analyze smart and sustainable building evaluation studies

to identify key features and weaknesses to achieve holistic SSB-CIEM. For this purpose, the research is structured as follows: Literature background in section 2; Methods in section 3; Results in section 4; Bibliometric analysis in section 4.1.; Discussion in section 5, Content analysis (Research trends) in section 5.1.; Strenghts and weaknesses in section 5.2., Systematic approach proposal in section 5.3.; Maturity and data management in SSB-CIEM in section 5.4; Conclusion in section 6. The findings contribute to the literature by analyzing existing building-city evaluation tools to identify smart sustainable building-city intersection areas over strengths and weaknesses. Such a systematic study will provide the necessary information for conceptualizing holistic SSB-CIEM. Suggested SSB-CIEM can assist architects, urban planners, and engineers throughout the project's lifecycle.

2. Literature background

This section explains the sustainability approach, reveals the importance of a smart, sustainable building-city and the latest related digital technologies, and current knowledge of smart and sustainable building-city evaluation approaches. Afterward, the dark points of the Smart Sustainable Building-City Integration (SSB-CI) concept come to light. The review is useful for providing an in-depth look at the need for SSB-CI and digital technology-aided application areas.

2.1. Sustainability

While cities are places where 55% of the world's population lives, the expectation for this figure is to increase to 68% by 2050 to find better opportunities in fields such as work and education (UN-Habitat, 2022; UN Habitat, 2020). A considerable increase in the rate of urbanization required international policies. In the 1970s, policymakers started to talk about the concept of sustainable development. Since then, many international meetings have occurred, including the assembly where the Paris Agreement, which included critical decisions, was signed. The United Nations organized "The twenty-eighth session of the Conference of the Parties (COP 28)" about climate in December 2023. COP 28 includes a 'global review' of climate change mitigation targets in the Paris Agreement (2016). Countries revealed that efforts to reduce greenhouse gas emissions, resilience to climate change, and support (financial and technological) to vulnerable nations are slow while placing particular emphasis on the choice of renewable energy sources instead of fossil fuels (United Nations, 2023). In light of those mentioned above, it is clear that international policies and research have supported smart and/or sustainable building-city practices for a more livable world by reducing the effects of climate change. However, the potential benefits to sustainability of systematically addressing the integrated smart sustainable building-city concept are ignored.".

The sustainability as a concept, risks, and triggers of environmental crises, social and economic factors, and dominant urban development paradigm (housing crisis, unplanned urbanization); is the basis of the awareness that future life will endanger as a result of ecological and social deprivation (resource scarcity) under the influence of increasing social disruptions (globalized market, lack of skilled labor) (Bibri & Krogstie, 2017). The fact that cities consume 70-80% of the resources while occupying 2% of the world (Bibri, 2018; Hong et al., 2017) strikingly reveals the importance of sustainable cities. Ensuring sustainable life routines of citizens can be possible by constructing adaptable, resilience and high-quality infrastructure that provides livable, accessible and safe urban areas (Sala Benites et al., 2022).

On the other hand, buildings which are the essential components of the city responsible for 40% of world energy consumption and 36% of energy-related greenhouse gas emissions (European Commission, 2021) because of the buildings' heating, cooling, ventilation, and lighting needs (Engelsgaard et al., 2020). The importance of resource optimization, planning, and control became a sine-qua-non especially in high-density parts of the cities (Akcin et al., 2016; Calvillo & Villar, 2016). Moreover, the high use of water and

materials in buildings compared to other sectors shows the seriousness of the adverse environmental effects of buildings (Franco et al., 2021) and the inevitable necessity to design smart sustainable buildings. Smart sustainable building is a relatively new approach that combines the characteristics of ecological (sustainable, green, passive) buildings with the features of smart buildings in a single building (Radziejowska & Sobotka, 2021). This approach avoids conceptual confusion with smart buildings that ignore sustainability and sustainable buildings ignore ICT. "Smart" and "sustainable" concepts for "building" and "city" are inseparable parts like two sides of a coin, and the "smartness" provides effectiveness in achieving "sustainable goals" with methods and technologies.

2.2. Smart sustainable buildings

While the impact of buildings on environmental sustainability is obvious, the impact of buildings on human health and work efficiency is of considerable importance, as people spend 90% of their time in buildings (Stieninger, 2016). Installing smart systems for user comfort is the first step of a human-centered approach (Markoska et al., 2019). The parameters of various devices are collected by sensors with the help of the IoT, and the data are stored in real-time in the corresponding database (Yang et al., 2022). A smart building approach using control algorithms and IoT, one of the ICTs, can constantly monitor environmental data, offer a management approach to achieve minimum energy consumption and optimum interior comfort (Lin et al., 2020); manage various tasks such as surveillance, access and fire detection (Lam et al., 2023).

The potential for ICT to facilitate the design, construction, and operation of smart buildings has required a re-evaluate of the technologies used in current building production approaches (Apanaviciene et al. 2020a; Chiesa, 2020). The construction industry's cutting-edge technologies can facilitate real-time data collection, monitoring, and control, optimizing processes and adding economic value through online platforms (Piras et al., 2024): Data acquisition (IoTs, UAV (Unmanned Aerial Vehicles)/drones, Geographical Information Systems (GIS), Laser Imaging Detection and Ranging (LİDAR), Global Positioning Systems (GPS), Sensors, Radio-frequency identification (RFID), data analytics (Big data, artificial intelligence/machine learning), data visualization (BIM, 3D printing, Robotics, DFab (Digital fabrication)), sensing and digital technologies ((BIM), (GIS), (GPS), laser, satellite, light detection and ranging (LIDAR) (Sepasgozar et al., 2019). Gonçalves et al. (2020) developed a model for smart building energy management based on machine learning using smart control predictive control; Lin et al. (2020) developed a sun-powered smart window blind system with automatic control; Louis & Dunston (2018) simulated the preparation of a process model with IoT-enabled control and sensor information at the construction site for real-time and automatic decision-making in construction.

"Integrating digital technologies in construction facilitates urban planning and land cover management while supporting sustainable development efforts. Barrile et al. (2023) integrate BIM and GIS to combine physical-geographical (urban) information of the building (microscale) to the urban power systems (macro-scale) to offer an advanced methodology for building energy management in the Municipality of Reggio Calabria (Italy). On the other hand, Qian & Leng (2021) propose "Community intelligent modeling," which is a three-dimensional simulation platform that could act as a bridge between buildings and digital environment analysis software, collects data from BIM, GIS, IoT, and cutting-edge technologies to solve low comfort level, poor safety, and significant energy consumption problems. These and similar efforts point to smart sustainable cities, where buildings supported by digital technologies are integrated with city components for environmental sustainability and human comfort.

2.3. Smart sustainable cities

The idea of a sustainable city emerged in the late 1990s and does not have a single descriptive expression in the literature (Janik & Ryszko, 2020). "The city approach that can meet the needs of the present without compromising the needs of future generations." (Kaltenegger &Fink, 2016) is the most accepted description. On the other hand, the concept of "smart" is one of the components of the sustainability movement (Arditi et al., 2015). Re-evaluate how we build and manage our cities (Höjer, M. and Wangel, 2015) and introducing additional requirements to cities that are constrained to operate with limited resources to ensure that their citizens can live without compromising their level of well-being has revealed smart cities (Austin et al., 2020; Azevedo et al., 2018; Sladoljev et al., 2019) in the 1990s (Albino et al., 2015). However, the concept's origin goes even back; based on the Cybernetically Planned Cities of the 1960s, it had in urban development plans with a new name as Networked or Computable Cities since the 1980s (Gabrys, 2014). There is no universal and inclusive smart city definition yet (X. Li et al., 2019; Lima et al., 2020). However, a smart city is an approach that adopts modern ICTs in city planning, construction, operation, and management (Xia et al., 2022). In summary, the smart city is an interconnected system that focuses on people and the environment, aims for quality life, monitors and optimizes resources, management, security, mobility, and technology, and makes decisions by prioritizing smart ICT, data, and rationality. This view also supports the argument that smart city studies facilitate achieving sustainable city goals regarding method and technology.

Although the smart city aims for sustainability, the absence of sustainability in all smart city applications has revealed the concept of a smart sustainable city (Ahvenniemi et al., 2017; Bibri & Krogstie, 2017). Smart sustainable city is a new phenomenon that spread in the mid-2010s and is relatively less studied (Janik & Ryszko, 2020; Taveres-Cachat et al., 2019) means that cities should be sustainable (flexible and inclusive) and digitally competent (ITU, 2021), increasing the quality of life of city residents (Kutty et al., 2023).

Global examples show that integrated 3D geographical information of the ground and underground of Chongqing (China) facilitates urban planning, public facilities management, simulation technology in construction, emergency response, etc. (GIM International, 2017). On the other hand, Denmark's relatively easy access to open data facilitates cooperation between municipalities and the private sector, supporting decision-makers in smart city solutions (Snow et al., 2016). The top three smart sustainable city indicators showing Smart sustainable city rankings for Copenhagen (Denmark) are wastewater treatment, E-commerce, patent applications, and, for other European cities: Berlin; Bicycle network, Wastewater treatment, E-commerce, Paris; Wastewater treatment, Unemployment, GHG emissions; Rome; GHG emissions, Protected terrestrial area, PM10 concentration."

The lens of the state of the art technologies, while IoT-based sensor technology enables cost-effective approaches for continuous monitoring of city components (Tripathi et al., 2023); artificial intelligence and machine learning are effective in providing the necessary infrastructure to digitalize the daily operations of local governments (Siokas et al., 2021). While Ford et al. (2020) developed a conceptual smart city digital twin that facilitates disaster management, Austin et al. (2020) proposed a city digital twin architecture combined with a semantic model and machine learning approach and applied it to buildings in Chicago. Revelo Cáceres et al. (2023) integrated BIM, GIS, and LCA (Life Cycle Assessment) to analyze the urban densification of high-rise blocks in the city of Quito (Ecuador), highlighting that operational energy causes the most impact. These studies show that an integrated building-city approach is essential when equipping city infrastructure with the latest digital technologies to better serve building occupants.

2.4. The lens of smart sustainable building-city integration (SSB-CI)

Every new building design in cities must be compatible with existing development plans and urban texture. If a new energy-efficient building design causes the existing urban landscape to change radically, it may reduce the energy efficiency of the neighborhood (Futcher et al., 2017). In other words, the energy efficiency of the urban form may be less than the sum of the energy efficiency of isolated buildings (Futcher et al., 2017). Designing and operating smart sustainable physical and digital building systems, considering the cities' infrastructures, can potentially increase resource efficiency in areas where other environmental resources and city services are carried out, just like in the energy field. A more detailed look at the scope of a smart building's relationship with the city is as follows (Stieninger, 2016):

"Technically, a designed building is an island disconnected from people, environmental systems, and nature; it can have solar panels on top of the roof. Moreover, it can reuse gray water, black water, rainwater, and organic waste in the landscape, producing more energy than it consumes. It can be called "green" and "smart" if it includes all the technology and tools imaginable while meeting all the computational requirements; even though it is a fancy, net-zero-energy, repeatable building, nothing can go in or out except rainwater and solar radiation, it is a closed circuit. It is a fact that such a building cannot be smart because its functioning does not end at the entrance door. A smart building should interact with other sustainable city components while supporting reuse and recycling; it should use its inputs and outputs (what it takes from nature and what it can give back to nature) in a balanced exchange of giving and receiving. A smart city can operate in a healthy and environmentally friendly manner only if it benefits from constant change while providing feedback loops about all inputs and outputs".

With this approach, Stieninger (2016) argues that a building, even with smart systems with the latest technologies, cannot be called smart if designed separately from all sub-components of the urban system. This discourse emphasizes that integration is essential. The task of smart buildings in the functioning of the urban system is to establish a harmonious and environmentally friendly relationship with other connected buildings and infrastructures surrounding it. The delivery of resources required for the functioning of the building to the building, the management of building waste, the connection between the inside and outside of the building, and the entry and exit of people into the building Stieninger (2016) constitute the integration relationship of the building with the natural and built environment.

Through the latest digital construction technologies, smart buildings and smart cities can connect to physical, digital, and theoretical (Kim et al., 2021). Gao et al. (2024) integrated BIM, GIS, and LCA and used a Multi-information integration-based life cycle analysis technique to calculate the spatial distribution of GHG emissions during the production, transportation, and construction stages in Shenzhen (China). Mair et al. (2023) proposed a framework and the categorization system for recycling construction material through BIM, GIS, and LCA Technologies. Cinquepalmi et al. (2023) proposed a tool based on the systematization of various digital technologies for rapid automatic pre-evaluation of the potential conversion of an existing building stock into a residential space through integrated BIM and GIS technologies. Costantino et al. (2022) combined BIM, 3D GIS, LIDAR, and Grasshopper (Rhino), collected numerical cartography and geodata from Open Street Map and point clouds generated by airborne LIDAR sensors; analyzed and simulated to visualize projects from illustrations to photorealistic renderings for 3D Modelling of Buildings and Cities. The smart city data platform receives and shares all data from smart city components in the network (Apanaviciene et al., 2020a). In a smart city, some dynamic and self-learning control systems in which components interact and optimize their energy use ensure that buildings are integrated while powerfully operating the

in-building energy management and the city's energy system (De Groote et al., 2017). The building can help manage local stormwater, and the microgrid provides drinking water to the building and treats and reuses wastewater from the building (Stieninger, 2016). However, not every city has the highest level of smart-ready environment in every area, so if the building has a higher ICT capacity, this functionality may remain underutilized for a while until the city uses it, or vice versa (Apanaviciene et al., 2020a) . Therefore, the first step is to evaluate the current level of building-city integration in order to identify potential smart sustainable intersection areas.

2.5. Smart sustainable building-city evaluation and integration evaluation approach

While sustainable/green buildings' certification systems such as Leadership in Energy and Environmental Design (LEED), Building Research Establishment Environmental Assessment Method (BREEAM), and WELL (performance-based evaluation system) are widely accepted, some academic research introduced new local tools (H. Kang et al., 2016). The certification systems of some countries such as Japan and Hong Kong provide smart and green building criteria together; some countries like Korea have entirely different (Amirhosein Ghaffarianhoseini et al., 2016). Since existing research generally focus on cities by using the system (Bibri & Krogstie, 2017; Janik & Ryszko, 2020; Kim et al., 2021; Palumbo et al., 2021; Pérez & Oltra-badenes, 2020) there are few publications on evaluating smart building (Buckman et al., 2014; Ghaffarianhoseini et al., 2018). Nevertheless, the Smart Readiness Indicator (SRI) (energy savings and operation, responding to users' and grids' needs) for buildings, supported by the European Commission, stands out in research (Fokaides et al., 2020; Markoska et al., 2019; Martínez et al., 2021; Ramezani et al., 2021), and the Building Intelligent Quotient (BiQ) and Honeywell Smart Building Score (HSBS) are other tools that we find traces of in the literature.

On the other hand, the issue of smart cities takes place in nations' strategies and action plans, and the number of cities equipped with smart city networks is increasing progressively. Evaluating the applications to provide a smart and sustainable quality to cities is necessary. The current literature focuses on evaluating and comparing (with the most accepted indicators) cities' sustainability and impact performance for approximately 30 years with various tools. In Giffinger's study, which is the most cited in the literature, smart city components are under six headings: smart mobility, smart living, smart environment, smart governance, smart people, and smart economy (Giffinger et al., 2007). However, the tools that evaluate smart or sustainable cities are insufficient in evaluating building-city integration with current criteria.

The latest research in the literature, propose a holistic multi-scale system-of-systems approach in which building and urban scale are considered together and there is an illustrative example of building-city integration to improve human health, comfort and reduce the energy consumption of buildings (Bi & Little, 2022). However, evaluating the integrated smart building-smart city is relatively new approach. Apanaviciene et al. (2020a) investigated the potential of buildings to benefit from the capacities of smart cities and become smarter in the fields of smart energy, smart mobility, smart living, and smart environment. This study also ensures the evaluation framework's reliability by testing the proposed indicators. Conte & Monno (2012) suggest a conceptual model by mentioning a cross-scale evaluation approach over building evaluation and they emphasize the necessity of applying the model in case studies involving stakeholders to ensure the reliability of the holistic indicators of the model. At the core of the evaluation approach of this study is building sustainability, and buildings are defined as a dynamic process, just like a living organism, within the ever-changing urban mechanism (Conte & Monno, 2012). This view is like Stieninger's (2016) idea that since a buildings operation will not end within its door thus it should

be integrated with the city in order to be a really smart building. Since buildings and cities are still considered separate entities in the research mentioned above, this research defines a holistic and systematic evaluation approach toward integration.

3. Methods

3.1. Identifying research questions

Research questions (RQs) make understanding and summarizing researched concepts easy (Kim et al., 2021). This study's systematic quantitative literature review (SQLR) searches for articles to answer five RQs. The following RQs investigate smart and sustainable building-city evaluations and SSB-CI evaluation in terms of concepts, research trends, strengths, and weaknesses till January 2023. This way, the review defines SSB-CIE intersection areas to reach a systematic evaluation approach to SSB-CI, draws a concept diagram for SSB-CIEM, and defines SSB-CI maturity.

RQ1: What do smart/sustainable building-city concepts and integrated approaches mean? (The answer is given in section 2.

RQ2: What are the smart/sustainable building-city evaluation/ integration evaluation studies? (The answer is given in section 4). Articles found from queries are examined. Bibliometric analysis and keyword co-occurrence analysis are performed to determine the prominent concepts.

RQ3: What are the strengths and weakness in smart/ sustainable building-city evaluations? (The answer is given in section 5.2.) Strengths and weakness identified by authors are highlighted through in-depth content analysis.

RQ4: What are the smart sustainable building-city intersection areas? (The answer is given in section 5.2.). As a result of the content analysis, the intersection areas are defined.

RQ5: How to set up a systematic approach to SSB-CIEM? (The answer is given in section 5.3., 5.4.).

3.2. Database selection for research

Frequently, using an SQLR database such as Scopus and Web of Science (WoS), a systematic and holistic approach identifies studies in the research area (Pickering & Byrne, 2014). In this review, we use Scopus, the most comprehensive abstract and citation database of peer-reviewed literature (Harzing & Alakangas, 2016; Jin & Ji, 2018). Scopus uses Boolean Syntax and allows the combination of keywords for a precise search. Scopus is a well-established alternative to WoS, and it has appeared in many international universities' rankings, such as the Times Higher Education rankings (Harzing & Alakangas, 2016). On the other hand, Google Scholar's quality control process is weak and remains in the background as it simply scans all kinds of information found on academic-related websites. Another motivation for choosing the Scopus database was that it covers more than 29,200 active serial titles and that content from more than 7,000 publishers has been thoroughly reviewed and independently selected (Scopus Content, 2024). Therefore, it is possible to search for published articles on smart sustainable building-city evaluation almost without missing them with advanced search processes. In addition, the Scopus database has been preferred in literature review articles on similar topics, such as the management of construction projects and city services with smart technologies (Akindele et al., 2023; Akinlolu et al., 2022; Celeste et al., 2022; Rigillo et al., 2023; Sepasgozar et al., 2021; M. Wang et al., 2020).

3.3. Systematic literature review steps

The researchers adopted a four-step method to propose a systematic approach for SSB-CIEM (Smart sustainable Building-City Integration Evaluation Model). Figure 1. shows the review steps as: 1- Qualitative literature review, 2- Visualizing and interpretation of bibliometric analysis results, 3- Critical analysis of current evaluation tools, 4- A systematic approach to SSB-CIEM. Qualitative literature review (1. Step) examines the interrelationships between current concepts (sustainability, smart and sustainable building-city), focuses on the lens of SSB-CI (Smart sustainable

Building-City Integration), and discusses how the SSB-CI lens can be applied to buildings and cities.

Visualizing and interpretation of bibliometric analysis results (2. Step) includes planning, filtering, analysis, and reporting studies. In the planning (data collection phase), researchers select words that best describe their research questions and structure queries 1, 2, and 3. The reason for choosing the sampling method is to reach the integration areas through building and city evaluation tools with a bottom-up approach. Chosen query words are the most used in research in this field in recent years, as mentioned in the literature background section. A comprehensive literature search was carried out to reduce the number of articles that would be overlooked by typing all related concepts (e.g., smart building, sustainable building, evaluat*, assessment, rank) from the existing literature into the Scopus database/search engine. Although the sample can be expanded with other normative concepts in this field, as in many disciplines, this research is limited to the determined keywords; this also defines the sample size. In the filtering (data cleaning phase), queries were searched in the articles' titles, abstracts, and keywords. At this stage, the sampling includes all articles from the oldest to the newest provided by the Scopus search engine. Articles on new and existing smart or sustainable building-city evaluation tools are included in the results. The analysis sample is limited to articles in English found with the words searched for in Scopus. There is always a risk of finding articles that are not directly relevant to the research question, and these articles were excluded for the accuracy of the results. The analyzing stage includes visualizing (science mapping) valuable data. The Bibliometrix (Biblioshiny) is an open-source software tool that works with the R Studio package (Kim et al., 2021). This software tool can visualize much data, such as co-occurrence networks of keywords. The reporting stage includes focal points in smart and sustainable building-city evaluation studies.

Critical analysis of current evaluation tools (3. Step) covers the content analysis of the bibliometrically analyzed articles. Results highlight the strengths and weaknesses in the smart, sustainable building-city evaluation tools. The identified strengths and weaknesses offer a holistic approach to the SSB-CIEM intersection areas.

A systematic approach to SSB-CIEM (4. Step) includes a systematic approach using the information obtained from the analyses of the previous sections, a concept diagram, and a graph describing maturity in SSB-CIEM. The conceptual diagram shows the areas at the intersection as integration areas as a result of the content analysis of building and city evaluation articles. The working principle of the diagram is based on Stieninger's (2016) "a smart building system changes inputs and

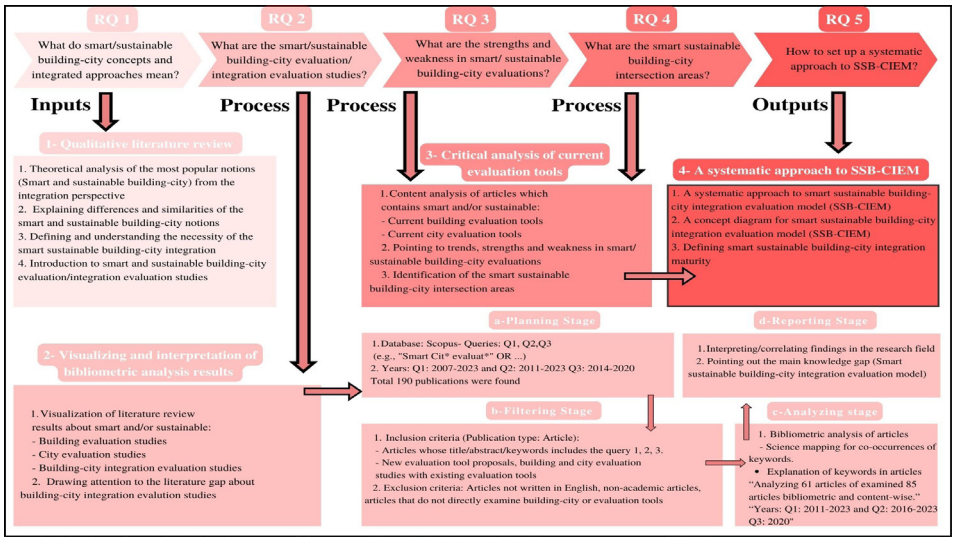

Figure 1. *Research methodology.*

outputs in balance with the city." it is based on the approach. The literature on integrating building and city data points to the latest digital technologies (BIM/GIS) in the diagram. The maturity graph expresses the potential of state-of-the-art digital technologies to increase cross-scale working levels throughout the building life cycle (see Figure 1).

4. Results

We search the concepts with detailed definitions in the previous sections through publications' titles, keywords, and abstract sections. The search results of the queries (1, 2, and 3) take place in the tables and maps (section 4. and section 5.). Queries progress from the building scale to the city scale and later to the integration scale. The total number of publications was 190 (q1:73, q2: 114, q3:3) (according to Scopus). The search engine found 85 articles (q1:47, q2:36, q3:2). 23 of these 85 articles were unrelated to the research area, so it was discarded. Finally, we selected and analyzed sixty-one relevant articles (q1: 29, q2:31, q3:2 (1 was an intersection article)) bibliometrically. The percentage distribution of the articles is as follows: 45,90% building, 50,81 city, 3,27% building-city integration area.

4.1. Query 1: Searching for publications containing smart and/or sustainable building evaluation

Query 1 searchs "Smart building* evaluat*" OR "Sustainable building* evaluat*" OR "Sustainable building* assessment" OR "Smart building* assessment" OR "Smart sustainable building* evaluat" OR "Sustainable smart building* evaluat *" query outputs (till January 2023). The search engine finds 77 publications, including articles (47) between 2007 and 2023. Others are conference papers (22), review (4), and book chapter (4). The distribution of query outputs is engineering (46), social sciences (23), energy (22), environmental science (17), computer science (14), others (less than 10). The possible reason for the overwork in engineering and energy is the realization that the building construction industry consumes the world's total energy, and the search for technical energy-efficient solutions in building projects has been effective. The fact that social sciences are second in smart city research shows the potential of smart and sustainable buildings to increase people's welfare.

4.2. Query 2: Searching for publications containing smart and/or sustainable city evaluation

Query 2 searchs "Smart Cit* evaluat*" OR " Smart cit* assessment" OR "Smart sustainable cit* evaluat" OR "Sustainable smart cit* evaluat*" (till January 2023). The search engine finds 93 publications, including articles (34) between 2016 and 2023. Others are conference papers (45), conference review (3), review (3), and book chapter (5). Publications are limited to the presence of the researched concepts in the title, abstract, and keywords sections. The distribution of query outputs is; computer science (49), engineering (42), social sciences (35), energy (20), environmental science (18), mathematics (16), business management and accounting (11), and others (less than 10). Results show that majority of the publications in the field focus on computer science. The development of ICT, which constitutes the infrastructure of smart cities, with computer science and engineering studies, and the integration of the opportunities it provides with other components of cities, makes the number of studies in these areas superior to others. Since the purpose of smart city studies is to increase citizens' welfare triggers studies in the field of social sciences.

4.3. Query 3: Searching for publications containing the concepts of sustainable and/or smart city, building, integration and evaluation

Query 3 searchs ("smart building* integration" OR "sustainable building* integration") AND ("smart cit*" OR "sustainable cit*") AND (Maturity OR "Maturity Level" OR Assessment OR Tool* OR "Assessment Tool*" OR "Assessment Model" OR Indicator* OR Standard* OR KPI* OR Certificate OR Evaluat* OR Performance OR Rank* OR Index OR Readiness OR Code*

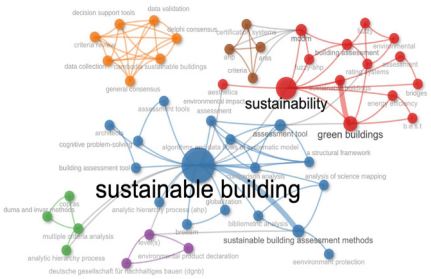

Figure 2. *Cluster distribution map for query 1.*

OR "City IQ" OR "Key Performance Indicator*" OR "Decision Support System") OR "City Analysis" OR "Reference Model". The search engine finds 3 publications (3 articles) between 2014 and 2020.

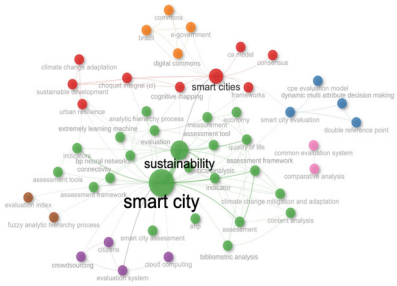

Figure 3. *Cluster distribution map for query 2.*

4.4. Keyword analysis

The co-occurrence analysis of the author's keywords obtained using Biblioshiny is presented in Figure 2. and Figure 3. A keyword and other keywords of the same color form a cluster. Lines that connect keywords represent links. The larger the node is, the more significant the usage frequency of the corresponding keyword is and the greater its relevance. The overuse of a keyword in publications shows that the topic is the focus of researchers. In Figure 2, the minimum number of co-occurrences of a keyword was set to 1. The fact is that the subject of sustainable building evaluation stands out the subject of smart building evaluation relatively. The sustainable building/s assessment concept strongly relates to assessment tools, AHP, fuzzy-ahp, rating systems, and multiple criteria analysis. Moreover, decision support systems, Delphi consensus, general consensus, data collection, and verification in determining sustainable building evaluation criteria stand out in research. Thus, widely accepted in the scientific literature, these techniques can be used to decide the sub-areas of the proposed SSB-CIEM. Finally, we see the first traces of the relationship between aesthetic criteria and sustainability for holistic SSB-CIEM (see Figure 2).

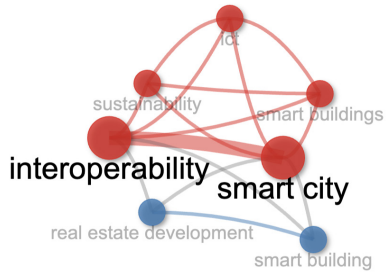

Figure 4. *Cluster distribution map for query 3.*

It is seen in Figure 3 that the concept of smart city evaluation is directly related to indicators such as economy, connectivity, and quality of life. The strong relationship between the concept of sustainability and smart city stands out. The common goals of these two concepts are improving the quality of life, urban resilience, climate change mitigation, and adaptation. The fuzzy AHP, Bp neural network, extremely learning machine, cloud computing, and frank operator are innovative approaches to preparing smart city evaluation tools (see Figure 3).

Figure 4 shows that at least 1 of the keywords in the articles were found together. According to the analysis result, smart buildings and smart city are mentioned with interoperability. ICT is the key to enabling interoperability between the building and the city. Real estate development is associated with the issue of building-city integration. Based on Figure 2, Figure 3, and Figure 4, the bibliometric analysis study shows that there are very few studies on integrating smart city with smart building, and all kinds of methods are open to exploration to ensure this integration (see Figure 4).

5. Discussion

5.1. Content analysis of current evaluation tools (Research trends)

This section contains the content analysis of the articles, which were bibliometric analyses made in the previous section. The review focuses on sixty-one articles regarding research direction, reference, research methodology, and achieved goals.

5.1.1. Content analysis of articles for query 1 (Research trends)

According to the results of Query 1, research on new sustainable building evaluation tools, dimensions of sustainability, comprehensive literature reviews, multi-criteria decision-making methods, and verification of evaluation criteria are listed in Table 1. The following article's topics fall outside the research: life cycle assessment (LCA), building energy performance models, thermal comfort methods, simulations, building envelope and facade, Ad-Hoc networks, users' perception of sustainable buildings, and sustainable buildings in higher education. So, the analysis includes twenty-nine articles (see Table 1).

Although the popularity of smart building studies is indisputable, there is still a great interest in sustainable/green building studies (Anshebo et al., 2022). Green smart building applications researched by (S. Xu & Sun, 2021) are also a relatively new approach. Alawneh et al. 2019; Díaz López et al., 2019; Efe et al., 2022) compare the most used sustainable building certificates (LEED, BREEAM, DGNB, and BEST). Del Rosario et al. (2021) compare DGNB and European framework Level(s) under the EPD criterion in the LCA title. Based on evaluation tools with a high impact on a global scale are generally used for preparing local features added tools (Mousavi, 2022; Mousavi et al., 2017).

In sustainable building evaluation, there are two types of parameters, endogenous (constants: global weights of criteria) and exogenous (variables: performance score of building for each criterion) (Bhatt & Macwan, 2016). Mostly, the survey method validates these parameters (categories and indicators) of the prepared evaluation tools through academia, construction industry experts, and sustainability experts (Al-Jebouri et al., 2017). Among the multi-criteria decision-making approaches, AHP is the most preferred sustainable building criteria selection method by researchers (Bhatt & Macwan, 2016; Gong et al., 2017; Medineckiene et al., 2015). (Díaz-López et al., 2019) analyze the indicators through eleven popular evaluation tools and find the inadequacy of the indicators representing the economic dimension while encountering comprehensive criteria for sustainability's environmental and social dimensions. (Grazuleviciute-Vileniske et al., 2021) explore the role of aesthetics through evaluation tools used in sustainable building evaluation.

5.1.2. Content analysis of articles for query 2 (Research trends)

According to query 2, articles are not about smart and sustainable city

Table 1. *Content analysis of articles related to smart and sustainable building evaluation.*

Research direction	Reference	Research Methodology
Sustainable hotel evaluation with local evaluation tool	(Mousavi, 2022; Mousavi et al., 2017)	Literature review, interviews and LEED evaluation
Local evaluation tool and ecological and socio-cultural sustainability	(Anshebo et al., 2022)	Expert panel, literature review, AHP
Selection and application of consensus methods	(Chan, 2022)	Comparison of Delphi and general consensus over case study
An exemplary criteria set of the university campus buildings evaluation	(Efe et al., 2022)	Comparison of B.E.S.T. with BREEAM and LEED over case study
Climate zone, building type, and accommodation characteristics for a new tailarmade tool	(Bahadiroğlu et al., 2022)	Case study
More life-cycle modules and more comprehensive scenarios for improving EPDs a data	(Del Rosario et al., 2021)	Comparison of certificates over case study
Green smart building	(S. Xu & Sun, 2021)	AHP-FCE over case analysis
Four theory: sustainability aesthetics, genius loci, biophilia, and a regenerative approach.	(Grazuleviciute-Vileniske et al., 2021)	Literature review, examine among the criteria of certificates
Materials & waste management, energy efficiency have highest weight in the technological aspect.	(Reddy et al., 2021)	Literature review, analysis current tools, expert panel, DELPHI
Adding technological advances in sustainable building evaluation tools	(Arukala & Pancharathi, 2020)	Literature review, expert opinion, Fuzzy-AHP
Integrated SDGs evaluation and management approach for sustainable non-residential buildings	(Alawneh et al., 2019)	Literature review, AHP, relative importance index, questionnaire, focus group discussion
A comprehensive view of the status quo and predicts the dynamic directions of future research	(Díaz-López et al., 2019)	Bibliometric analysis, systematic literature review
Sustainable building evaluation tools	(Díaz López et al., 2019)	Comparative analysis
Indicator usage in sustainable building evaluation	(Al-Qawasmi, 2019)	Context analysis
Urban planning indicators to indicate missing elements such as technology, cultural issues in local region and sustainability	(Stevanovic, 2018)	Literature review
Indoor environment quality, natural and human resources, social, and governance requirements for a local sustainable construction framework	(Al-Jebouri et al., 2017)	Literature review, analysis, survey,
Sustainable building evaluation tool and 3-layer development process framework for project decision makers	(H. Kang et al., 2016)	Mixed-method sequential design, including interviews, workshops, the Delphi survey technique, FD-AHP weight analysis, and scenario analysis
A new sustainable commercial building criteria	(Bhatt & Macwan, 2016)	Fuzzy logic and AHP
A new sustainable building assessment method: INVAR, utility degree and investment values of the projects under deliberation	(Kaklauskas, 2016)	The systems and the values and weights of the quantitative and qualitative criteria express these requirements, case studies
Credibility and applicability of evaluation tools, a new framework	(H. J. Kang, 2015)	Analysis, structural framework
Mobilising sustainable building evaluation models	(Faulconbridge, 2015; Faulconbridge & Yalciner, 2015)	Events along the way', empirical examine
Criteria selection for sustainable building evaluation	(Medineckiene et al., 2015)	AHP, Swedish certification system Miljöbyggnad, Saaty's judgement scale and new original scale, ARAS (Additive Ratio Assessment) method, MCDM, LEED
Resilience and sustainability for optimize system (e.g., civil infrastructure) considering structural design, utilized material, maintenance plans, management strategies, and impacts on the society	(Bocchini et al., 2014)	A numerical application dealing with the comparative analysis
Estonian regulations, sustainability evaluation tool indicators against LEED and BREEAM	(Seinre et al., 2014)	Comparison
Perceptions and preferences for India sustainable building evaluation tool	(Bhatt et al., 2012)	Interviews, statistical analysis
An integrated building-urban evaluation model based on the urban matrix	(Conte & Monno, 2012)	A cross-scale evaluation approach
AHP in sustainable building criteria: weights of parameters	(Bhatt & Macwan, 2011)	Thomas Saaty's rule of Consistency Ratio, comparison

Achieved Goals			
	Current sustainable building evaluation tools and criteria		
New local or universal evaluation tools	Suitable tool and method selection	Criteria selection, development of criteria, importance/weights of criteria	Current situation analysis and dynamic directions of future research
(Bhatt & Macwan, 2016; Bahadiroğlu et al., 2022; S. Xu & Sun, 2021; Arukala & Pancharathi, 2020; Alawneh et al., 2019; H. Kang et al., 2016; Kaklauskas, 2016; H. J. Kang, 2015; Mousavi, 2022; Mousavi et al., 2017; Anshebo et al., 2022; Conte & Monno, 2012)	(Mu et al., 2022; Chan, 2022; Díaz López et al., 2019a; Del Rosario et al., 2021)	(Medineckiene et al., 2015; Al-Qawasmi, 2019; Stevanovic, 2018; Reddy et al., 2021; Al-Jebouri et al., 2017; Seinre et al., 2014; Bocchini et al., 2014; Bhatt & Macwan, 2011)	(Faulconbridge, 2015; Faulconbridge & Yalcimer, 2015; Díaz-López et al., 2019; Grazuleviciute-Vileniske et al., 2021)

evaluation fall outside the scope of this research. Thus, the analysis includes thirty-one articles listed in Table 2, which include city evaluation studies, a literature review, and new model proposals for smart and sustainable city evaluation tool (see Table 2).

Researchers evaluate the cities all over the world such as in China (Fang & Shan, 2022; Hsu et al., 2021; Z. Wu et al., 2021), Brazil al., 2022), India (Govindarajan & L.S., 2021), United Kingdom (Caird, 2018) Japan (Zou et al., 2022), and Indonesia (Qonita & Giyarsih, 2022). However, the current models are still not universal (Hajek et al., 2022) due to the uncertainty of evaluation processes, complexity, and the limitations of the evaluation tools. The lack of a universal model encourages the proposition of new models with local characteristics for different geographies.

The general typology of the smart city evaluation tools occurs smartness dimensions and indicators obtained from multiple stakeholder groups consisting of experts in the fields with multi-criteria decision-making methods (Castanho et al., 2021; De Genaro Chiroli et al., 2022; Hajek et al., 2022; Y. Wu et al., 2022; Zeng et al., 2023). Experts present alternative proposals to a finite set of criteria by assigning weights and evaluating and ranking criteria (Kaklauskas, 2016). Researchers usually prefer TOPSIS, AHP, and fuzzy-AHP methods to define smart city evaluation criteria. According to Sharifi & Allam (2022), the majority of indicators are under the headings of ICTs, economy, and governance. Some studies evaluate a city with only one dimension of smartness, such as transportation (Yan et al., 2020), governance (Mainka et al., 2016; Rotta et al., 2019), social and political dynamics (Valencia-Arias et al., 2021). According to Suliman et al. (2021), smart city evaluation tools can only ensure the multifaced development of cities when they expand their scope with sustainability, resilience, and connectivity. (Correia et al., 2020) suggested a new model that has evolved to combine sustainability, innovation, and quality of life. However, in (Sharifi & Allam, 2022)'s taxonomy, the limited compatibility of the smart city models on environmental sustainability and climate change is remarkable. The common view is that one-dimensional evaluation tools are insufficient and far from standardization (C. Li et al., 2020).

An evaluation model can measure the maturity level of smart or sustainable applications of local governments/municipalities with titles such as smart governance, smart environment, or smart economy (Castanho et al., 2021; Hsu et al., 2021; Rotta et al., 2019; Suliman et al., 2021). The smart readiness level of a city infrastructure evaluated in this way can determine the direction of smart city investment decisions. However, when it is discovered that a city's smart city physical infrastructure, such as wireless network and IoT, has not been established, that is, if it needs physical infrastructure before digital infrastructure (Yan et al., 2020), it will not be possible to prioritize data shar-

Table 2. *Content analysis of articles related to smart and sustainable city evaluation.*

Research Direction	Reference	Research Methodology
Measuring smart city performance	(Sotirelis et al., 2022)	Multiple Criteria Decision Analysis
Municipal waste management	(Jonek-Kowalska, 2022)	Multi-criteria analysis
Multi context evaluation	(De Genaro Chiroli et al., 2022)	AHP to support the process of weights definition and MACBAC.
Featured research/key themes	(Hajek et al., 2022)	Bibliometric analysis, content analysis
Policy implications and investments	(Fang & Shan, 2022)	Principal component and sensitivity analysis, k-means clustering, multi-linear regression
Connectivity to sustainability/resilience	(Sharifi & Allam, 2022)	Taxonomy
Hesitant information	(Y. Wu et al., 2022)	K-medoids clustering to classify experts, DEMATEL method to determine the weights of attributes, consensus-reaching process
The fuzzy comprehensive evaluation model on sustainable development of smart city construction	(J. Xu et al., 2022)	Fuzzy set theory and neural network model for indicators, AHP
ICT, and life quality	(Zou et al., 2022)	AHP
Governance evaluation	(Hsu et al., 2021)	Literature review, expert consensus, the fuzzy AHP
Smart agglomerations, City Intelligence Quotient (City IQ)	(Z. Wu et al., 2021)	Automated information scraping in leading social media platforms, semantic analysis
Sustainability	(Valencia-Arias et al., 2021)	Qualitative descriptive methodology
Renewable energy	(Govindarajan & L.S., 2021)	Climate Smart Cities Assessment Framework (CSCAF)
Impact, performance and sustainability potential	(Kourtzanidis et al., 2021)	Three complementary evaluation axes
Sustainability, technology	(Castanho et al., 2021)	Cognitive Mapping and the Choquet Integral
Development level	(Huang et al., 2021)	A double reference point decision making method
Connectivity, sustainability, resiliency	(Suliman et al., 2021)	Literature, case study
Perception	(Orlowski, 2021)	Comparing with rankings or ISO standards
Smart building-city integration for real estate development	(R. Apanaviciene et al., 2020)	Comparative case study
Common and sherable framework	(C. Li et al., 2020)	Horizontal comparisons and benchmarks
Comprehensive system framework for smart transportation	(Yan et al., 2020)	Secondary qualitative data analyses, self-organization theory, case study
To maximize smart city capacity	(Wang et al., 2020)	Theoretical exploration, indexes and smart city relationship
Scheme (tool) selection	(Sharifi, 2020) (Sharifi, 2019)	Literature review, analyzing
Sustainability, innovation, and quality of life	(Correia et al., 2020)	Literature review
Municipal e-Gov Platform Evaluation Model	(Rotta et al., 2019)	Investigating municipal websites
Sustainable development goals (SDG 11)	(Wendling et al., 2018)	Critically analysis
Smart technologies for cities and citizens: reporting practices, challenges and recommendations	(Caird, 2018)	Case-study, evaluation and reporting
Smart city construction (model accuracy and time cost)	(Shi et al., 2018)	AHP, experts' opinions AHP, AHP-BP and AHP-ELM
Local evaluation tool	(Rocon & de Alvarez, 2017)	Literature review, European Smart Cities evaluation tool
ICT, open innovation/decision-making processes/governance	(Mainka et al., 2016)	Best-practice examples and research frameworks

Achieved Goals				
New evaluation tools		Current smart city evaluation tools		
		Suitable tool and method selection, literature review and tool comparison	City Ranking	Current advances and future research directions, improving current tools
(Sotirelis et al., 2022; De Genaro Chiroli et al., 2022; Fang & Shan, 2022; Y. Wu et al., 2022; J. Xu et al., 2022; Zou et al., 2022; Hsu et al., 2021; Valencia-Arias et al., 2021; Z. Wu et al., 2021; Castanho et al., 2021; Kourtzanidis et al., 2021)	(H. Huang et al., 2021; Suliman et al., 2021; Orlowski, 2021; Apanaviciene et al., 2020a; C. Li et al., 2020; (Yan et al., 2020; Correia et al., 2020; Rotta et al., 2019; Wendling et al., 2018; (Shi et al., 2018)	(Sharifi & Allam, 2022; Sharifi, 2020; Sharifi, 2019; Shi et al., 2018; Wendling et al., 2018)	(Caird, 2018; Jonek-Kowalska, 2022)	(Hajek et al., 2022; C. Wang et al., 2020; (Rocon & de Alvarez, 2017; (Mainka et al., 2016; (Govindarajan & L.S., 2021; (Caird, 2018; (Rocon & de Alvarez, 2017; (Mainka et al., 2016)

Table 3. *Articles on smart building-city integration.*

Title	Reference	Keywords
Smart building integration into a smart city (SBISC): Development of a new evaluation framework	(Apanaviciene et al., 2020a)	Interoperability; Smart buildings; Smart city; Sustainability
Smart Building Integration into a Smart City : Comparative Study of Real Estate Development	(Apanaviciene et al., 2020b)	Interoperability; Real estate development; Smart building; Smart city

ing (Fang & Shan, 2022). In this case, a comprehensive ICT infrastructure must be established throughout the city.

5.1.3. Content Analysis of Articles for Query 3 (Research trends)

Query 3 results refer to the three articles and one of them is nor related shown in Table 3. The literature shows that only one study focuses on smart building-city integration evaluation. This study investigated the potential of buildings to benefit from the capacities of smart cities and become smarter in the areas of smart energy, smart mobility, smart living, and smart environment (Apanaviciene et al., 2020a). The authors conducted a case study covering nine office building projects that enabled smart materials and smart building services and proposed features of smart construction to serve the surrounding systems (Apanaviciene et al., 2020a). The other article does not propose a new evaluation tool (see Table 3).

5.2. Strengths and weaknesses

At the end of the content analysis, to respond RQ3 we identify six strengths for building-city intersection area and eight major weaknesses in building-city evaluation literature.

5.2.1. Strengths

As a result of our content analyses, strength areas at the intersection of building and city evaluations constitute holistic intersection areas. Contrary to existing literature, economy and technology areas are not included as separate areas in our model because they are pre-requirement for smart revolution of all areas. Therefore, we determined the six main intersection areas of the smart sustainable building-city to respond RQ4: Resilience, environment, management, aesthetics, mobility, and welfare and well-being.

5.2.2. Weaknesses

1. Adding local city features to building evaluation criteria is a requirement. Buildings are evaluated as closed boxes, and it is necessary to consider not only universal standards but also the topographic-climatic characteristics of cities and regions.

2. Studying more aesthetics, social and economic criteria in sustainable building evaluation tools is necessary. The criteria in existing evaluation tools are more focused on environmental sustainability.

3. Discussion of the necessary criteria in smart building evaluation needs to be improved. The literature is generally about developing sustainable building evaluation criteria.

4. Few studies evaluate the ICT infrastructure maturity of cities. ICT is indispensable to smart cities' infrastructure, and evaluations often need to measure the maturity of the technologies.

5. The smart city evaluation tools prepared by the multi-criteria decision-making method need to be more reliable. The tools must be validated with additional techniques and tests.

6. The smart city evaluations should have a holistic approach to all areas (e.g., mobility, living, governance). Current evaluation approaches need to evaluate some areas of city life.

7. The smart city evaluations often ignore the indicators of resilience, connectivity, and sustainability. This emerges as a higher understanding that covers the entire smart sustainable city approach.

8. Tools for evaluating smart city infrastructure and integrating smart buildings still need to be explored. Although there have been efforts to establish relationships between scales in a few studies in the literature, a common evaluation approach has yet to be seen.

5.3. A systematic approach to smart sustainable building-city integration evaluation model (SSB-CIEM)

After a comprehensive literature review, to respond to RQ5, we propose a new systematic approach for SSB-CIEM,

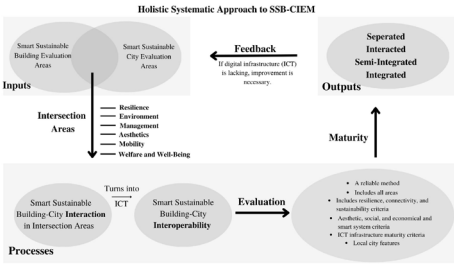

Figure 5. *A systematic approach to SSB-CIEM.*

as shown in Figure 5. SSB-CIEM is based on six main areas: resilience, environment, management, aesthetics, mobility, welfare and well-being. Some implementation examples from the literature in the six designated areas and future research recommendations are as follows:

5.3.1. Resilience

The integration of BIM and GIS can increase resilience in cities by providing information necessary for evacuation and intervention in fire situations and responding to fires in a short time (Isikdag et al., 2007) or by providing effective disaster management in assessing and monitoring the potential of flood risk to affect buildings (Lyu et al., 2016). Integrated use of digital technologies in disaster management can improve municipalities' urban services and help them achieve more resilient cities. Future research can focus on reducing possible risks of disasters (e.g., earthquake, flood, fire) with integrated BIM/GIS.

5.3.2. Environment

While GIS provides the integration of electrical data in a building system managed with BIM and data in the city management system, it enables data visualization, analysis, building performance analysis, and appropriate location selection with a bottom-up management approach with smart microgrids containing semantic information (Farooq et al., 2017). In the construction phase, practitioners can determine the nearest location to which the excavated soil will be transported through the BIM-GIS-IoT-based urban system (T. Huang et al., 2022). Recycling of construction, operation, and demolition waste of buildings to appropriate city facilities, in short, asset management throughout the building life cycle. Monitoring the data on the energy produced by buildings with PV panels and presenting the excess to the city grid; communicating with the city grid in real-time in case of an electrical malfunction and quickly carrying out the necessary maintenance and repair; and storing this data for later use could be focus points in the future research.

5.3.3. Management

BIM-GIS integration enables smart urban management practices, moving from traditional construction permit applications to fully integrated planning reviews in any municipality (automate model-based e-permitting (Shahi et al., 2019). The data required include 3D city models, BIMs, and regulations to be checked (Noardo et al., 2020). Moreover, integrated BIM-GIS enables versatile and flexible site layout planning (AlSaggaf & Jrade, 2023). Transform BIM information into a GIS map model for operation and maintenance management of mechanical, electrical, and plumbing, enabling integrated delivery (Hu et al., 2018). The interoperability of BIM-GIS technologies to integrate building and city management systems requires that future work focus primarily on resolving data format conflicts.

5.3.4. Aesthetics

The simulation of the city's and buildings' functioning in virtual environments and interactive BIMxD+BigData+Digital Twin is the new horizon (Redondo, 2023). Integrating BIM and environmental planning has only recently entered the agenda (Wilhelm et al., 2021). Recent studies show that integrating the BIM model of buildings into the GIS representing the urban scale system can facilitate design decisions in a 3D working environment, comply with zoning plans, and facilitate urban aesthetics.

5.3.5. Mobility

The proximity of public transport stops, and the frequency of travel indicate the accessibility of a building. Proximity to urban services and alternative means of transport (bicycle access and parking,

car sharing, electric charging stations) are other sub-headings that fall within the scope of smart mobility (Seinre et al., 2014). Further studies can focus on making more accurate building and landscape layout decisions by correlating proximity to urban services, building landscape, and city plans with integrated BIM/GIS.

5.3.6. Welfare and Well-being

Converting point clouds obtained by scanning into geometry objects and then integrating them with geographical data such as air quality or noise information are positive developments in protecting human health and so well-being (Ellul et al., 2017). Moreover, benefiting human health by identifying and reducing aerobiological health risks in urban environments (Fernández-Alvarado & Fernández-Rodríguez, 2022) may be possible with integrated BIM/GIS in smart sustainable cities. On the other hand, integrating socio-cultural activities planned for occupants in affordable housing areas with the city through BIM/GIS integration and physical infrastructure systems may be a focus for future research, as it has the potential to increase human well-being with its smart sustainable features.

Even if a building project alone is at a sufficient level of development, integration into smart city networks, interoperability goals, and the ability to adapt to the strategic goals developed, identify integrated smart buildings (Apanaviciene et al., 2020a). A building equipped with smart, sustainable systems will integrate with the city if it can benefit the city's capacity at intersection areas. In "separated" environments, smart, sustainable buildings and cities do not interact with each other. In "interacted" environments, a human can interact with the building and the city via smart devices. In "semi-integrated" environments, buildings and cities start to work together but cannot interact in all areas. In "integrated" environments, building potential and city capacity interact in six main areas, and the interaction level can increase with ICT. When there is a lack of integration, decision-makers should improve the infrastructure of the missing areas at the intersection by analyzing the building and city potential well (see Figure 5).

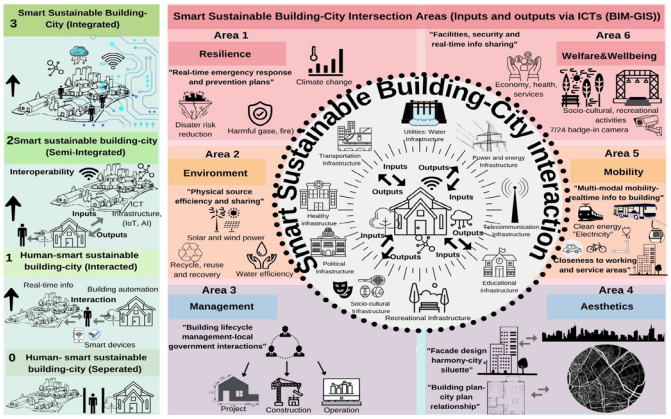

Figure 6. *Conceptual Diagram of SSB-CIEM*

The conceptual diagram of SSB-CIEM in Figure 6. demonstrates the potential use of SSB-CIEM based on intersection areas. The building and the city constantly interact with each other through inputs and outputs in the six main intersection areas. Smart sustainable buildings can manage valuable data (e.g., energy and water) on all kinds of urban resources throughout their life cycle (planning, construction, operation, demolition) through a common digital platform with the city. Thanks to the latest developments in ICTs, management platforms that can effectively monitor inputs and outputs in real-time and make high integration possible can be considered BIM for buildings and GIS for cities.

Integration evaluation areas are limited by the dominant headings in existing evaluation tools at the building, city, and integration scales, and an overlooked heading (aesthetic). Every new smart technology and sustainability approach implementing area between the building and the city's building-related infrastructure has the potential to evaluate the existence and level of data integration technologies. Therefore, we discussed implications for future research and practice. Moreover, we showed that smart, sustainable building-city integration evaluation could be evaluated through BIM-GIS integration. BIM/GIS can provide smart sustainable building-city integration by integrating data into the city's design, construction, operation, and demolition activities. Since the

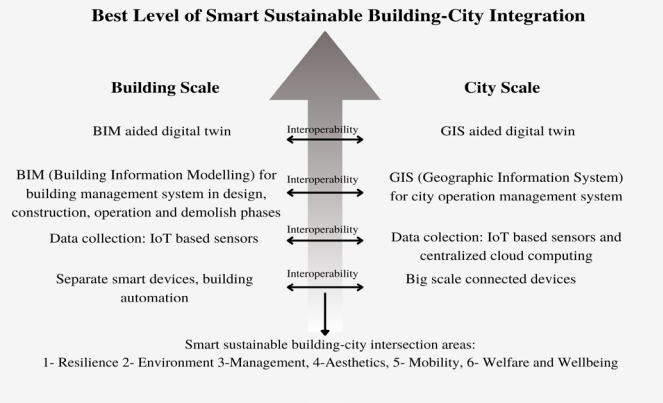

Figure 7. *SSB-CIEM maturity diagram.*

main areas included in the model cover many sub-application areas/titles, only the findings of the systematic literature review are compared with the existing literature, which is supported by some studies on BIM/GIS integration included in the articles searched in Scopus (see Figure 6).

5.4. Maturity in SSB-CIEM and Data Management

Grids, open data platforms, connected transport systems in smart cities, and the proliferation of technologies to automatically manage and monitor resources (González-vidal et al., 2019) allow smart buildings as a small-scale data management points interacting with these systems throughout their life cycle. Data management with ICT (monitoring, storage and interpretation-processing) and real-time information are critical in SSB-CI. Establishing a robust ICT infrastructure in intersection area could increase the maturity of integration. Figure 7 represents digital and physical infrastructures of building and city scales that increase the maturity level of integration.

While BIM is useful for 3D interior models with comprehensive meanings, GIS is useful for spatial analytical tools of open spaces (Jiang et al., 2022). BIM and GIS need to be combined for improving the availability and efficiency of information (Pauwels et al., 2017). Integration of BIM-GIS data in smart cities enables holistic perception of the building and its environment in the digital environment (Karan & Irizarry, 2015). In addition, the fact that data sharing is bidirectional between BIM and GIS is noteworthy in data integration as it minimizes the margin of error in analyzing systems belonging to resources in building-city management and reduces time loss (Farooq et al., 2017). Information models prepared with integrated BIM-GIS, real-time data sources, and other digital platforms can create digital twins (DTs) (Piras et al., 2024). When smart buildings and DTs of cities can work together, the level of integration increases (see Figure 7).

6. Conclusion

The literature review shows that the building's and city's smartness and sustainability evaluation efforts are prevalent. Despite this popularity, something is being overlooked: Smart sustainable building-city integration. Bibliometric analysis reveals that SSB-CI has been the subject of only a few studies, and SSB-CIEM is quite a new approach that is open to development. For this reason, this research defines the concept of SSB-CI. After conducting a bibliometric analysis of all articles obtained from Scopus, passing them through a certain filter, and making a content analysis of sixty-one, the areas of existing building-city evaluation tools were identified. The proposed SSB-CIEM includes six intersection areas: Resilience, environment, management, aesthetics, mobility, and welfare and well-being. Continuous interaction, interoperability, and information flow in the six designated intersection areas between building and city infrastructure in a smart sustainable city are prerequisites for full integration. The integration maturity is increasing with digital technological developments, namely the BIM-GIS-aided digital twin integration approach. Based on the findings, we proposed the following eight-item approach for a holistic SSB-CIEM:

1. We can evaluate integration maturity between building-scale and city-scale based on ICTs (Ubiquitous Computing, IoT, BIM, and GIS) data platforms.

2. The integration level of smart sustainable building-city physical and digital infrastructures can be increased depending on common data-sharing

(interaction turns to interoperability) levels via digital twins.

3. Taking experts' opinions for the intersection areas and sub-areas/criteria from the private and the public sector via multicriteria decision-making methods such as AHP and Delphi Technique can increase the reliability of the SSB-CIEM.

4. A holistic approach to all areas (i.e., mobility, living, governance) can increase integration and resource efficiency and improve citizens' quality of life.

5. The resilience, connectivity, and sustainability indicators should be indispensable in the intersection of sub-areas/criteria.

6. Evaluation sub-areas/criteria appropriate to the local characteristics of cities (such as geography (climate, topography) and cultural habits) can be added to SSB-CIEM.

7. SSB-CIEM criteria can be multi-dimensional if we add aesthetics, social, and economic-based criteria.

8. Among the sustainable building criteria, those that can be implemented with smart technologies should be called "smart sustainable criteria" for SSB-CIEM.

Using the SSB-CIEM can be helpful for city planners, architects, and engineers to set system integration starting from the planning stage and defining priorities in physical and digital infrastructure projects. At this point, we draw attention to expanding the use of digital tools necessary for building and city integration among practitioners. Moreover, the evaluation of building-city systematic integration in the identified areas with the proposed SSB-CIEM can be used by public authorities, especially in municipalities, in cooperation with technology developers, to improve the quality of services offered to citizens by producing new solutions based on publicly available data. Finally, the model supports that decision-makers consider the socio-economic and cultural benefits on a local and global scale of cross-scale communication established with the latest technologies from building to the city through steps such as reviewing national smart city action plans. Thus, SSB-CIEM can contribute to more than one area of sustainable development, particularly SDG11 "sustainable cities and communities." Future research could determine the sub-areas/criteria and criteria weights. Although the selected word sequences limit the study, researchers have reviewed many other articles related to the study for an in-depth literature analysis. There is always a risk that a significant article will not be noticed. The bibliometric and content analysis studies are limited to English articles in journals indexed in Scopus. Future studies may include other databases, such as the WoS, to support the outputs. Finally, the lens of integration can also be applied to other popular and normative city concepts.

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Play guide: Creating play opportunities for refugee children

Sinem AVCI KARADUMAN[1*], Melih BOZKURT[2]
[1] avci18@itu.edu.tr • Department of Landscape Architecture, Faculty of Architecture, Istanbul Technical University, Istanbul, Türkiye
[2] melihbozkurt@gmail.com • Department of Landscape Architecture, Faculty of Architecture, Istanbul Technical University, Istanbul, Türkiye

** Corresponding author*
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Abstract
In recent years, migration flows have accelerated, displacing individuals and causing lasting adverse effects. A significant portion of the migrant population consists of children. Research highlights that play is essential for refugee children's well-being, aiding their social adaptation and helping them establish routines. However, design practices must be adapted to their specific needs. As the country hosting the largest number of refugees globally and a signatory to the United Nations Convention on the Rights of the Child (UNCRC), Türkiye must ensure refugee children's right to play.
This study aims to create a comprehensive guide for local governments to provide play opportunities for refugee children. It is structured in two stages: first, identifying challenges and solutions through a literature review; and second, proposing solutions based on five criteria—disabilities, education, child development, inclusive planning, and ecology. Specific practices are also reviewed within these criteria. Key findings indicate that local authorities should prioritize inclusive design, foster collaborations, and allocate resources to develop play spaces that support the physical, emotional, and social development of refugee children.
As a result of this study, a play guide was developed, offering strategies for local governments to create new play opportunities and improve existing ones. The guide outlines methods and partnerships that local authorities can adopt to ensure inclusive, well-designed play environments for refugee children.

Keywords
Local authorities, Play guide, Play opportunities, Refugee children.

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1. Introduction

In the 21st century, migration flows have accelerated due to economic instability, health crises, climate change, wars, and internal conflicts (International Organization for Migration [IOM], 2022). These migration patterns have had a significant impact on Türkiye because of its geographical location as a key destination for refugees, migrants and displaced populations through history (İçduygu et al., 2014). Türkiye has long hosted migrants from various regions, recent waves, particularly from Syria, Afghanistan, and Ukraine. According to The United Nations Children's Fund's (UNICEF) reports, it hosts the world's largest registered refugee population (UNICEF, 2019a).

Children represent a significant portion of the migrant population. According to UNICEF, one in every eight international migrants is a child, and in Türkiye, over half of the Syrian population under temporary protection consists of children (UNICEF, 2022; Mülteciler Derneği, 2023). These numbers underscore the urgent need to address the specific challenges refugee children face, particularly their right to play—a critical yet often overlooked aspect of their development and well-being.

This study focuses on developing a comprehensive guide for local governments in Türkiye to ensure refugee children have access to play opportunities. By examining the legal framework, design principles, and case studies, this research aims to offer practical solutions for creating inclusive play spaces that meet to the unique needs of migrant children. This study is especially important in light of Türkiye's commitment to international child rights conventions and the growing number of displaced children within its borders.

In this study, "refugee" encompasses migrant children, refugees, and those under temporary protection.

2. Providing play for refugee children

2.1. Legal and psychosocial frame

The rights of refugee children are protected by the UNCRC, of which Türkiye is a signatory. According to Article 22, signatory states are responsible for ensuring that all children within their borders enjoy all the rights outlined in the convention (UNICEF, 2019b). Therefore, every signatory state of the convention must provide the right to "rest, leisure, play, recreational activities, and cultural and artistic activities," as recognized in Article 31 (UNCRC, 2013).

While these legal protections provide a foundation, they often fall short in addressing the complex psychological trauma that refugee children endure. It illustrates again that political, legal, and even psychological barriers come interlinked in providing protection to the children. This gap between legal protections and actual psychological support shows how intertwined political, legal, and psychological barriers are.

Although legal frameworks like the UNCRC aim to protect the rights of refugee children, they cannot fully mitigate the impacts of displacement, war, and social exclusion. Psychological challenges, such as post-traumatic stress disorder (PTSD), often arise from the loss of familiar places and routines, which are critical to child development (Eskiocak, 2013). Within a psychosocial framework, play helps children reestablish routines, connect with their environment, and restore a sense of normality (Ergin, 1982).

Research underscores that play can help refugee children's emotional recovery and social integration after traumatic events like war, displacement, and cultural dislocation. Studies by Betancourt and Khan (2008) and Ager et al. (2011) shows that structured play in supportive environments enhances psychological resilience, reducing symptoms of PTSD, depression, and anxiety. By providing a safe space for emotional expression, play supports children in processing trauma and fosters self-expression.

Studies also show that play promotes social bonding. Mariam (2021) reported that children in refugee camps who participated in structured play were more likely to develop empathy, trust, and a sense of belonging. Similarly, Bratton et al. (2005) revealed that play therapy helps children externalize traumatic memories, enabling gradual

emotional processing. As stated Masten and Narayan (2012), play acts as a protective factor against trauma's adverse effects and brings adaptive skills for children, which enhance their resilience.

Research by Marsh and Dieckmann (2017) and Agutter (2016) shows that group play develops essential social skills, like communication and collaboration, that foster community integration. These studies highlight how play cultivates a supportive environment where refugee children can practice social behaviors critical for adapting to new settings.

Küçükali (2015) underlines the importance of play for holistic development, impacting physical, social, emotional, cognitive, and linguistic growth—all vital for resilience and trauma recovery. Indeed, providing access to play is as essential as meeting children's basic needs for health, nutrition, and shelter.

2.2. Limitations and problems in refugee children's access to play

Refugee children encounter various barriers to accessing play in urban settings, including physical, cultural, social, political, psychological, and economic challenges. These barriers often interact with one another, increasing the difficulties refugee children face in exercising their right to play.

Physical barriers such as disabilities present significant challenges. Although data on disabled refugee children is not precise, it is known that they are at risk of injury, abuse, and violence during displacement (UNICEF, 2016; Williamson & Çetin, 2019). A study conducted in Lebanon and Jordan revealed that over 60% of refugee households had at least one disabled member, with 14.6% of girls and 19.1% of boys aged 2-17 living with disabilities (Humanity & Inclusion & IMMAP, 2018). The lack of accessible play areas and suitable activities for children with disabilities exacerbates this issue (Handicap International & HelpAge International, 2014). This situation illustrates the interaction between physical and social barriers.

Cultural barriers further isolate refugee children, as ethnic discrimination (Crush & Tawodzera, 2014) and language differences (Portes & Rivas, 2011) prevent their integration into local social networks. Environmental design can exacerbate these issues, with park signage and information systems often inaccessible to non-native speakers (Çocuk İzi, 2021). These barriers intersect with social exclusion, where communication challenges and ethnic prejudice contribute to further isolation. Cultural factors, such as exclusion from local peer groups and negative societal attitudes, also limit refugee children's opportunities for play (Yanık Özger & Kozandağı, 2021). Additionally, parental concerns about academic success or the necessity for children to assume caregiving roles further reduce time for play (Wirunrapan et al., 2018).

Political barriers also play a significant role in restricting access to play. Despite the UN Convention on the Rights of the Child (UNCRC), many countries, including signatories, lack comprehensive policies to guarantee children's right to play (Rico & Janot, 2021). Temporary or limited legal measures fail to create sustainable play environments. This highlightes the need for more political action to address and mitigate these barriers (Woolley, 2021).

Psychological barriers are also prevalent among refugee children, with conditions such as post-traumatic stress disorder, anxiety, and depression leading to social withdrawal and cognitive difficulties (Yalın Sapmaz et al., 2017). Despite the importance of psychological support, many refugee children have limited access to these services (Barghadouch et al., 2016). The neglect of psychological needs undermines the effectiveness of legal and social interventions.

Economic barriers significantly exacerbate the challenges faced by refugee children, as many are forced into child labor to support their families, leaving little time for play (Wirunrapan et al., 2018). In low-income urban neighborhoods, the lack of safe and accessible play spaces presents an additional economic barrier (Christie, 2003; Chen & Knöll, 2022). In Türkiye, for instance, research shows that eco-

nomic difficulties, particularly in slums with high concentrations of Syrian refugees, limit the supply of play spaces (Bilgili, 2019). Budget constraints in urban planning further restrict the development of green spaces and playgrounds (İstanbul Büyükşehir Belediyesi Park Bahçe ve Yeşil Alanlar Daire Başkanlığı. 2021). Moreover, factors such as traffic, noise, and pollution in low-income areas, where refugee children often reside, further impede the creation of healthy play environments (Bilgili, 2019).

In summary, refugee children face multiple, interconnected barriers—physical, cultural, social, political, psychological, and economic—that restrict their ability to engage in play. The studies focusing on the relationship play and refugee childrens provide valuable insights but most are geographically specific and based on narrow sample sizes. It is limited their ability to present a broader understanding of the factors influencing refugee children's access to play. The existing literature highlights the need to address these barriers holistically. Key gaps, such as the lack of suitable play areas for disabled children, the intersection of cultural and social exclusion, and the inadequacies of legal frameworks, guide the approach of this study in evaluating play opportunities for refugee children.

This research aims to explore not only the individual barriers but also the ways in which they interact, offering a more comprehensive understanding of refugee children's experiences in urban environments. By proposing solutions to these complex and interrelated challenges, this study seeks to contribute to the development of more effective strategies to ensure that all children, regardless of their refugee status, can exercise their fundamental right to play.

3. Methodology

This study aims to create a play guide for local authorities, offering opportunities for refugee children. The goal is to assess the challenges and requirements of refugee children in accessing play, provide a comprehensive analysis of existing play options, and present recommendations to enhance inclusivity. The research consisted of two parts as systematic review and a case study analysis.

3.1. Systematic review

A systematic review collects, evaluates, and synthesizes existing information to research a specific topic (Prince et al.,1980). It involves examining prior studies, enabling access to cumulative knowledge, and facilitating critique, reproduction, and diversification of existing knowledge (Popper, 2014; Kuhn, 1970). In this research, the choice of a systematic review as the method is based on:

- Ethical considerations in reviews involving refugee children.
- Challenges related to on-site research during the COVID-19 pandemic
- The desire to establish a broad understanding of the research field by comparing national and international studies

3.1.1. Data collection process

This study begins by establishing a theoretical framework to explore the relationship between migration, children, and play. Data collection involved a comprehensive search of academic databases of Scopus, Web of Science, and Google Scholar, using targeted keywords like "refugee children," "migrant children," "benefits of play," "right to play," and "barriers to accessing play." Specific inclusion criteria were set:

- Studies focusing on refugee children's access to play, especially in urban environments
- Articles examining the psychological, social, and developmental benefits of play for children
- Research addressing barriers to accessing play, including physical, cultural, social, or economic challenges
- Fieldwork and case studies from NGOs and international organizations working with refugee populations

Studies that did not specifically address play or focused solely on adult refugee populations were excluded.

Both quantitative and qualitative studies were reviewed to gain a comprehensive understanding of the bar-

Table 1. *Cross section about the analytical tool development process.*

identifying barriers	proposed solutions	establisment of criteria	categories
cultural barriers	Language education through play	play-based learning activities	education
	eliminating language barriers by featuring sensory-focused play equipment like memory cubes and polyphonic toys	play equipment supporting to develop different skills	child development
	group play opportunuties for enhancing interaction between communities	creative play play equipment supporting to develop different skills	child development
	workshops and events to support the integration process of communities	taking into consideration the needs of the communities managing participatory processes	inclusive and socially

riers and opportunities in this area. From this analysis, criteria were developed to evaluate existing play spaces and to guide the creation of new, inclusive play environments for refugee children. These criteria serve as an analytical tool for assessing play opportunities, offering a structured approach to improving access to play for this vulnerable group.

3.1.2. Analytical tool development

The analytical tool developed for this study was designed to systematically evaluate barriers and propose solutions for providing play opportunities to refugee children. The process involved several key steps. As illustrated in Figure 1, a schematic overview was constructed to depict the analytical tool's development.

To elucidate the relationship between barriers, solutions, and criteria categories, the cross-section focusing on cultural barriers serves as an illustrative example, simultaneously representing the development process across all criteria (Table 1).

Identification of barriers

It began with a comprehensive literature review that identified barriers to play across physical, cultural, social, political and psychological dimensions.

Formulation of proposed solutions

In response to the barriers, a variety of solutions were proposed. To facilitate the development of these solutions, specific needs for effective play opportunities were identified. Solutions to the barriers are presented below, with reference to Figure 2.

One critical aspect is creating accessible play environments with appropriate equipment for disabled refugee children (Figure 2, a). Play opportunities should respond to different needs, such as wheelchairs, speakers and xylophones for kids with sensory impairments, or a sandbox designed for those with autism. Besides, pop-up play and mobile play activities should be organized in residential environments when the playground is not accessible for children with disabilities.

Another area of focus involves developing solutions to address the challenge of limited play spaces in low socioeconomic areas where refugee children reside (Christie, 2003). The following recommendations are advised:

- Utilizing suitable structures in the surrounding area as play areas (Figure 2,m).
- Expanding the park system (Figure 2, m).
- Using schoolyards as parks after school hours (Cranz, 1989; Figure 2,m).

Figure 1. *Steps for the analytical tool development process.*

- Developing alternatives like play kits to enhance access to play (Figure 2, f).

To make play opportunities more widespread, the rehabilitation and reuse of existing structures, parks, or play equipment (Figure 2, m), using recycled and recyclable materials (Figure 2, ı) and local materials (Figure 2, n), should be promoted.

Play is a standard method for providing education and psychosocial support for refugee and disabled children in conflict areas (Kinyera, 2019). Play opportunities in disaster areas should promote self-confidence, teamwork, motor skills, muscle and coordination development, and imagination (Save the Children, 2008). For refugee children undergoing migration as a social disaster, designing play environments that incorporate educational play tools for various age groups (Figure 2; c, d, g) and emphasizing developing diverse skills is crucial.

For children lacking access to safe play spaces, particularly those without suitable home environments, indoor play kits, accompanied by play guides for children and caregivers, offer viable alternatives (Figure 2; d, f).

Overseeing play areas is crucial to tackle safety concerns such as violence and vandalism (Figure 2, k). Furthermore, collecting feedback from children and residents regarding safety issues in play areas and violations of children's play rights serves to understand community needs and facilitate a participatory design process (Figure 2, k).

Child labor, another significant economic barrier, requires urgent attention and action to protect the rights of refugee children. Preventative measures should include formulating robust policies specifically addressing the rights and welfare of refugee children, increasing inspections to monitor and enforce these policies, and offering caregiver education to raise awareness about the detrimental effects of child labor. By addressing these areas, stakeholders can work collaboratively to create safer environments that prioritize education and development over labor for these vulnerable children (Figure 2; e, k).

To minimize cultural barriers, language education through play should include also the languages of minorities (Figure 2, c); the play experience should be designed to eliminate language barriers by featuring sensory-focused play equipment like memory cubes and polyphonic toys (Figure 2, h). The play design and equipment should enhance interaction between communities and provide opportunities for group play (Figure 2; f, h); organizing workshops and events can be an excellent approach to support the integration process of communities (Figure 2; i, j).

Social barriers generally arise as caregivers ignore or violate the right to play, such as restricting access to play based on gender distinctions among children or expecting children to take on caregiving responsibilities. Therefore, there is a need to increase awareness in this context by conducting educational programs and producing printed materials on the right to play and its impact on child development for caregivers (Figure 2; d, e).

To eliminate political barriers, it is necessary to report refugee children's play and recreational activities, enhance expert capacity for monitoring children's rights locally, carry out supportive initiatives related to leisure and play activities, and formulate policies (Figure 2; i, e). Local authorities should collaborate with local partners such as Istanbul Metropolitan Municipality Parks, Gardens, and Green Areas Directorate, Turkish Red Crescent Migration and Refugee Services Directorate, Ministry of Interior Directorate General of Migration Management, Ministry of Interior Disaster and Emergency Management Authority, Ministry of Family and Social Policies, NGO's, design offices, and volunteers (Figure 2, k).

As for eliminating psychological barriers, adventure playgrounds can be created to support rehabilitation through play for refugee children with limited access to psychological support (Figure 2, f). In adventure playgrounds that emerged in the 1940s, it was observed that children reenacted their war experiences through war games (Lisul, 2004), and this controlled play experience had a healing effect on children with post-traumatic stress disorder (Kinoshita & Woolley, 2015). In such play environments, playworkers must guide the play when needed (Hurtwood, 1968) (Figure 2, b).

Play therapy is another method for providing psychological support. Offering training and creating guides for instructors and playworkers can help spread play therapy.

As mentioned earlier, it is essential to note that caregivers may also need psychological support. In this context, establishing programs for caregivers (Figure 2, i), organizing play activities and workshops in which caregivers and children participate together (j), and creating instructional materials and guides for caregivers (Figure 2; I, e) will support the psychological well-being of caregivers and the caregiver-child relationship.

Engagement with stakeholders

The needs were refined through consultations with academic experts, practitioners from NGOs and child welfare organizations experienced in working with refugee populations, ensuring their relevance and real-world applicability.

Establishment of criteria

The minimum requirements necessary for implementing the proposed solutions were established as the criteria.

Categorization of criteria

The criteria were categorized by their area of impact, such as designing for disabilities, education, child development, inclusive and socially effective planning, and ecological considerations (Figure 2). This categorization helps in clearly defining the objectives of each criterion and facilitates a structured approach to implementation.

Documentation and implementation

The analytical tool facilitates a comprehensive evaluation of existing play opportunities for refugee children, using criteria for an inclusive play environment that considers refugee children. For example, if the assessment identifies a lack of language-inclusive play equipment, the tool highlights this gap and recommends solutions, such as introducing multilingual play materials or activities that encourage group collaboration. Play guide includes practical guidelines for integrating the criteria into play programs and initiatives aimed at refugee children.

3.2. Case study analysis

3.2.1. Determination of case studies

The second section evaluated 36 applications offering play opportunities for refugee children using stated criteria. These applications were identified using the following keywords: 'refugee children,' 'right to play,' 'bringing play

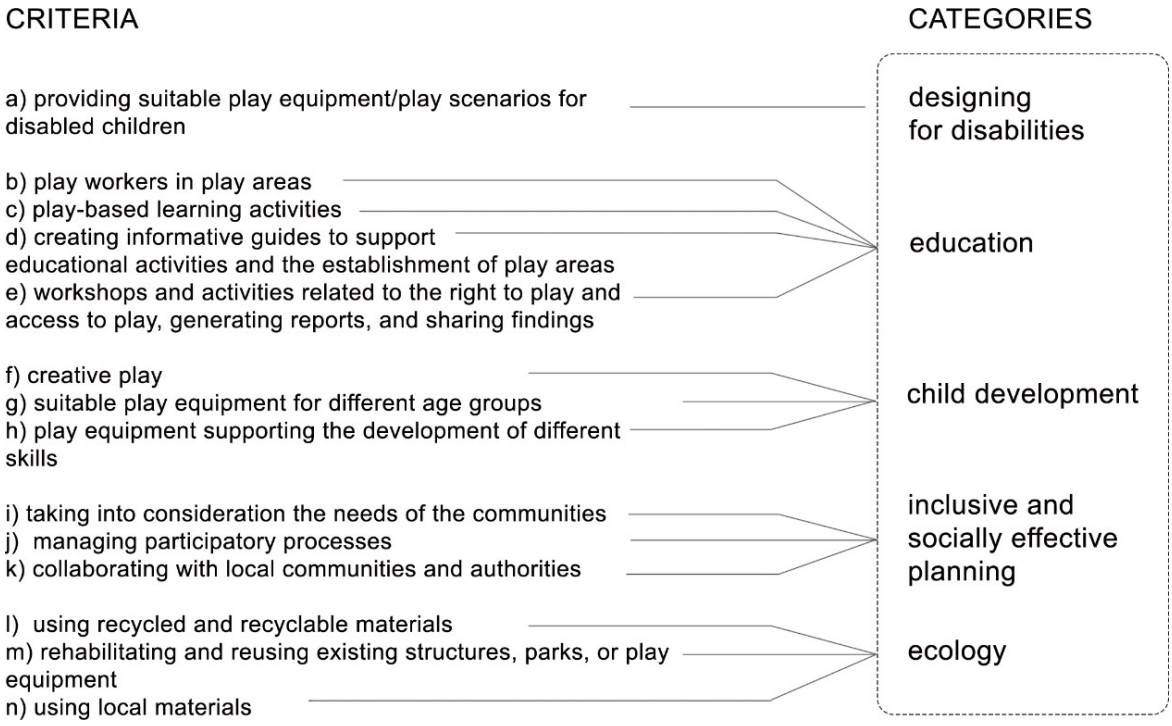


Figure 2. *Criteria to be considered in providing play opportunities for refugee children.*

to refugee children,' 'playgrounds in refugee camps,' 'play in crisis,' and 'alternative play opportunities for refugee children.' The selection of these applications was based on the following criteria:

- Providing play opportunities for refugee children or both refugee and local communities.
- Being publicly accessible (Private play areas are not included in this scope).
- Excluding digital gaming tools

3.2.2. Case study analysis

The analysis of the selected applications was evaluated in two stages:

(I) Firstly, the examples were categorized according to method, location, and sustainability. The guide includes recommendations for different methods, such as playgrounds, pop-up games, activities, and workshops. It has also developed strategies for offering play opportunities in various locations and ensuring their continuity, taking into consideration the existing play environments

(II) Secondly, the examples were evaluated according to specific criteria, including disability-friendly design, education, child development, inclusive and socially engaging planning, and ecology. This evaluation provided a comprehensive analysis of the play opportunities offered to refugee children, highlighting their potential for inclusivity and identifying challenges and needs for improvement. This analysis forms the basis for the strategies presented in the play guide

As a result of the study, a play guide has been provided for local authorities including recommendations for resolving current issues and making improvements.

4. International practices providing play opportunities for refugee children

National and international organizations, civil society groups, associations, and local authorities are dedicated to advocating for, protecting, and facilitating children's right to play and creating suitable environments for them. Notable international organizations working in this field include UNICEF, Child Watch International, the European Child-Friendly Cities Network, the International Council on Children's Play, the International Toy Library Association, Right to Play International, the World Leisure Association, the International Play Association (IPA), the LEGO Foundation, Save the Children, War Child Holland, Plan International, United Nations High Commissioner for Refugees (UNHCR), Pop-up Adventure Playground, and many others.

In the systematic review, 36 applications have been identified to provide play opportunities for refugee children (Table 2).

Two notable features distinguish these applications: the timeframe and geographical focus. Although the research did not specify a particular date range, a significant concentration over the past decade was observed. It can be attributed to the growing recognition of the benefits of play and the increasing necessity of providing play opportunities for refugee children due to the rising mass migration movements.

According to UNICEF and UNHCR, despite approximately 35 million displaced children worldwide, the play opportunities for refugee children are mainly concentrated in countries heavily affected by the Syrian crisis, such as Lebanon, Türkiye and Jordan.

4.1. Classification of existing play opportunities for refugee children

Various tools are utilized to provide play opportunities for refugee children, including physical spaces and advocacy for the right to play. These can be categorized into four groups: play parks, pop-up play, play activities, and guides.

Play parks encompass playgrounds, school sports areas, camp play tents, and child-friendly spaces in disaster-affected regions. They are advantageous due to their permanence and role as community meeting points (Ergin, 1982). However, they face challenges such as vulnerability to environmental conditions (climate, pollution, noise, security issues), difficulties in site selection, high installation costs, maintenance needs (Sülün, 2019), and susceptibility to vandalism in urban settings (Akyol, 2006).

Table 2. *Assessment matrix for evaluating play opportunities for refugee children.*

YEAR	PLAY OPPORTUNITIES	LOCATION	design for disabilities	education				child development			inclusive & socially effective planning			ecology		
			a	b	c	d	e	f	g	h	i	j	k	l	m	n
2011	P.L.A.Y.,Imagination Playgorunds	Haiti& Bangladesh						●			●		●	●		●
2013	UNICEF Early Childhood Development Kit				●	●		●	●	●	●			●		
2013	UNICEF Recreation Kit and Guidance					●		●	●	●	●		●			
2020	Observation Report Based on Children's	Türkiye	●				●				●	●	●			
2015	IBTASEM playground	Lebanon			●			●		●	●	●	●	●	●	●
2016	Karantina playground	Lebanon		●	●			●	●	●	●	●	●	●	●	●
2016	Fursa playground	Lebanon						●		●	●	●	●	●		●
2016	Ariha playground	Syria									●	●	●			
2017	Basma playground	Lebanon									●	●	●			●
2017	Atme playground	Syria									●		●			
2018	Bar Elias playground	Lebanon									●	●	●	●	●	
2018	Bouday Child Friendly Space (CFS)	Lebanon						●		●	●	●	●			●
2018	Za'atari playground	Jordan	●								●		●			
2019	Arsal playground	Lebanon	●					●	●	●	●	●	●		●	●
2019	Hermel playground	Lebanon	●					●	●	●	●	●	●		●	●
2019	Barja playground	Lebanon	●					●	●	●	●	●	●		●	●
2019	Qaroun playground	Lebanon	●					●	●	●	●	●	●		●	
2019	Tyre playground	Lebanon									●	●	●			●
2019	Chanay playground	Lebanon									●	●	●			●
2019	Chehour playground	Lebanon									●	●	●			●
2021	Karm Al Arees playground	Lebanon	●					●	●	●	●	●	●		●	●
2021	Kaskas playground	Lebanon						●	●	●	●	●	●	●		●
2017	Playscapes	Jordan									●			●	●	
2018	Maidan Tent	Greece									●		●			
2020	Al-Azraq Refugee Camp and Play Kit	Jordan					●				●	●	●			
2013	The Indigenous Play for Active Lives Kiosk	USA			●			●		●	●		●			
2019	Discover, Play Share	Türkiye		●	●			●	●	●	●	●	●			
2018	Social Circus	Türkiye		●	●			●		●	●	●	●			
2018	Çok Güzel Atölye	Türkiye		●	●			●		●	●	●	●			
2017	Intelligence Games Workshop	Türkiye		●	●			●		●	●	●	●			
2018	Children's Fest	Türkiye			●								●			
2012	Refugee Play Day for Displaced Children	Egypt		●							●		●			
2015	TeamUp	Holland		●	●				●	●	●		●			
2021	Guide to Facilitating Harmony through	Türkiye			●	●		●	●	●	●		●			
2019	"How to" Guidebook	USA										●	●			
2019	[Play]station	Sweden						●	●	●						

Pop-up play involves mobile play solutions, including portable equipment and temporary structures. It offers significant advantages over traditional parks, being easily transportable to areas lacking suitable conditions or facing economic challenges. The costs and time associated with production, transportation, and installation are lower compared to permanent parks (Gürdoğan et al., 2020). Additionally, it allows for creative use of natural and recycled materials like boxes and ropes (Leicher-Saxby & Law, 2014).

Play activities include one-off events, scheduled activities, and workshops that foster cognitive and educational development while promoting interaction between local and refugee children, aiding integration. They also raise awareness among caregivers regarding children's right to play and are generally cost-effective, primarily involving materials and instructor payments.

Play guides include play kits and guides for children, as well as resources for educators and caregivers. This study recognizes reports that recommend play opportunities and monitor the right to play, emphasizing the need for structured play implementation.

Among the 36 assessed applications, 43% are play parks, 12% are pop-up play, 22% involve play activities and workshops, and 13% are guides, with 11% incorporating a combination of methods. Additionally, 50% of applications are permanent, while 34% are temporary. Six projects, comprising 16% of applications, include workshop reports and guides that have yet to be evaluated (Table 3).

The analysis indicates that permanent play opportunities are mostly found in play parks. While this consistency can help establish familiar spaces for children, it also presents challenges related to cost, construction, and maintenance.

In terms of location, 21% of activities occurred in refugee camps, 16% in public parks, 21% in schools, 9% in NGOs, and 19% in transformed spaces like warehouses and sports centers. Notably, six projects (14%) lacked specific spatial representation. No studies documented refugee children playing at home or in their immediate vicinity, highlighting a gap for play kits and guides designed for home use.

4.2. Evaluating for inclusive play on existing play opportunities for refugee children

Applications were evaluated based on design criteria, identifying areas with less than 50% compliance as needing development (Table 4).

A key criterion is disabled-friendly design, crucial for reducing injury risks among refugee children in disaster areas. Unfortunately, only 20% of applications meet this criterion (Table 4).

Education is another essential aspect, as refugee children often lack educational opportunities. Play-based educational activities are essential, along with workshops and guides to promote awareness of the right to play and prevent rights violations related to child labor and discrimination.

Regarding child development, equal play opportunities should offer diverse play structures catering to various age groups (Table 4). Ignoring age-appropriate play can harm children's self-esteem and achievement. It's essential to support habits and self-confidence through play, especially for children facing trauma-related developmental challenges. This could include memory cubes, language cards, and group play toys that foster community and collaboration.

The assessment highlighted the most favorable results in inclusive and socially effective planning criteria (Table 4). To ensure the well-being of refugee children, collaboration among NGOs, local authorities, international organizations, and communities is necessary. Addressing the diverse needs of refugee children, acknowledging physical, ethnic, and cultural differences, is vital for overcoming barriers to play access and promoting the right to play.

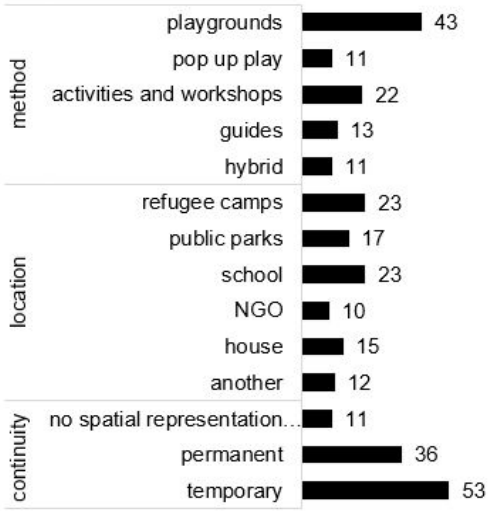
Participatory processes are crucial for fostering a sense of belonging, aiding integration, and increasing awareness of play rights, which can mitigate security and vandalism issues.

The ecological criterion is essential for creating cost-effective, portable play areas. Reusing parks and equipment through relocation, repair, and repurposing materials can reduce costs and support local economies. This is particularly important for refugee children in economically disadvantaged regions, as enhancing ecologically friendly play opportunities can lower expenses, ensure sustainability, and empower local communities to create their play environments (Table 4).

5. Play guide: A toolkit for local authorities

This study presents a play guide designed for local authorities to address barriers and establish play opportunities for refugee children. It outlines three play methods: playgrounds, pop-up play, and workshops/activities. Each method considers common factors such as location, equipment, supervision, and reporting, while addressing unique requirements like equipment design and program content. Figure 3 summarizes these methods and their components (Figure 3).

Table 3. *Classification section about the analytical tool development process.*



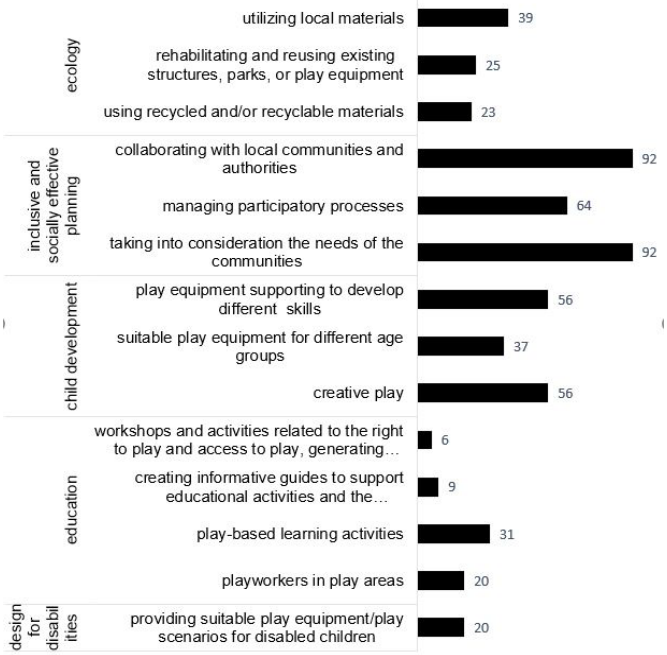
The "Playgrounds" section prioritizes areas with limited resources, focusing on inclusive adventure playgrounds and utilizing existing spaces. Collaboration with local governments and universities is encouraged. The "Pop-Up Play" method emphasizes mobile, flexible setups using recyclable materials, supported by local volunteers for sustainability and safety. "Workshops and Activities" encourage social interaction and emotional support, involving caregivers and educators to improve children's well-being. Each section includes mechanisms for regular supervision and feedback to optimize play environments. The guide is organized into three main sections: play design, management, and implementation.

5.1. Design of play

The play guide has a decision-making process shown in a flowchart (Figure 4) to choose the most suitable type of play opportunity—playground pop-up play, or workshops/activities—for an area.

The process begins with assessing existing play opportunities. If they are limited or nonexistent, the guide examines nearby buildings (indoor sports complexes, cultural centers) that could

Table 4. *The evaluation of existing play opportunities in terms of the criteria.*



be repurposed. If such spaces are available, playgrounds or indoor play areas can be established. If no spaces exist, the budget is assessed. With sufficient funding, a new playground can be created; otherwise, pop-up play solutions, being more flexible and temporary, are recommended.

The flowchart also distinguishes between temporary and permanent play areas. Temporary options like pop-up play are suited for locations available only for a limited time. Permanent spaces are prioritized when location and budget allow for long-term solutions. In cases where neither condition is met, workshops and activities are recommended as flexible, cost-effective alternatives. They are flexible and relatively cheap to organize and be held in different settings.

This systematic approach can expand and diversify the play opportunities based on specific contexts and the resources available (Figure 4).

5.1.1. Design and implementation of playgrounds

First of all key areas for new playgrounds should be identified, particularly in low income neighborhoods which often have few play spaces or places that can be transformed such as schoolyards or community centers. A network map illustrating focus areas should be created to attract funding and volunteers, and to keep the community informed.

Adventure playgrounds are particularly beneficial for supporting children who have experienced trauma, such as refugee children (Kinoshita & Woolley, 2015) (Figure 5).

If outdoor play is not feasible, indoor spaces like workshops, community centers, or vacant shops should be considered for welcoming play areas (Leicher-Saxby & Law, 2014). These settings provide safe places for children, support parents and children connect, and assist families in getting used to new areas (Vandekerckhove & Aarssen, 2020) while helping caregivers support children's right to play (UNICEF, 2022). It's important to consider the children's backgrounds and play habits. Workshops with children can be helpful to gather their input on play spaces and understand their sense of belonging (Mart et al., 2022).

Designing play spaces with accessible equipment for children with disabilities is also crucial (Dunn & Moore, 2005). Temporary play areas or mobile play events can bring play directly to neighborhoods. Utilizing 3D printing for 1:1 scale prototype can save time and resources (Knaapen, 2018), with modifications based on feedback from children during interactive sessions or surveys.

Engaging with local universities can also involve students or faculty in designing process. This can provide to create affordible play opoortunities. It will also support local talent and enrich design education by addressing community needs and diverse user requirements.

Local materials and labor can significantly reduce costs while supporting the local economy (Dabaj & Conti, 2020). Preferring modular components that are easy to assemble and disassemble simplify maintenance and allow for more playgrounds at lower costs.

For funding, local organizations, social responsibility projects, and local donors which are interested in supporting play initiatives should be connected. Raising awareness of play as a fundamental right for children is essential for building support and securing funds (Woolley, 2021).

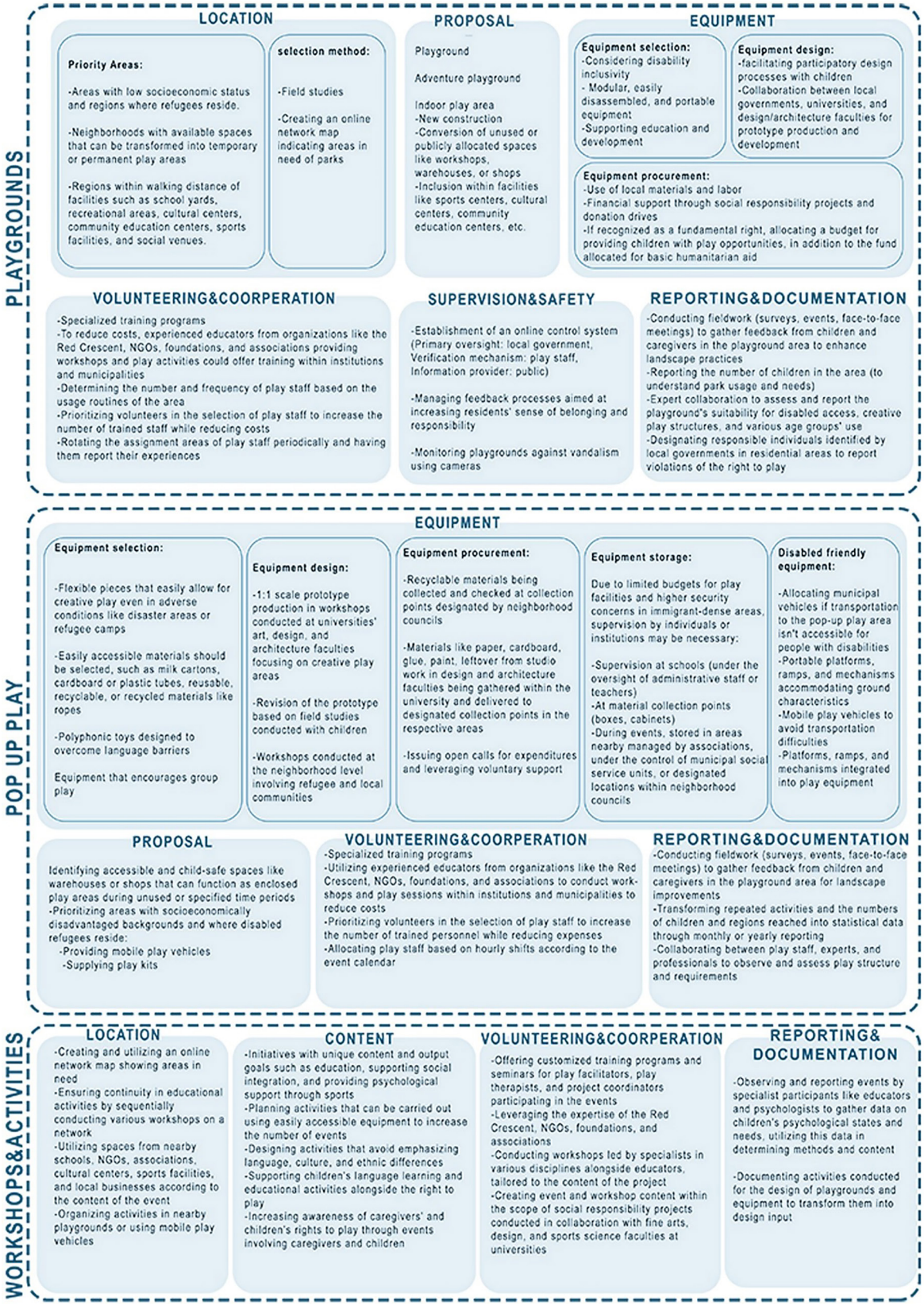


Figure 3. *Play guide scheme (Produced by the author).*

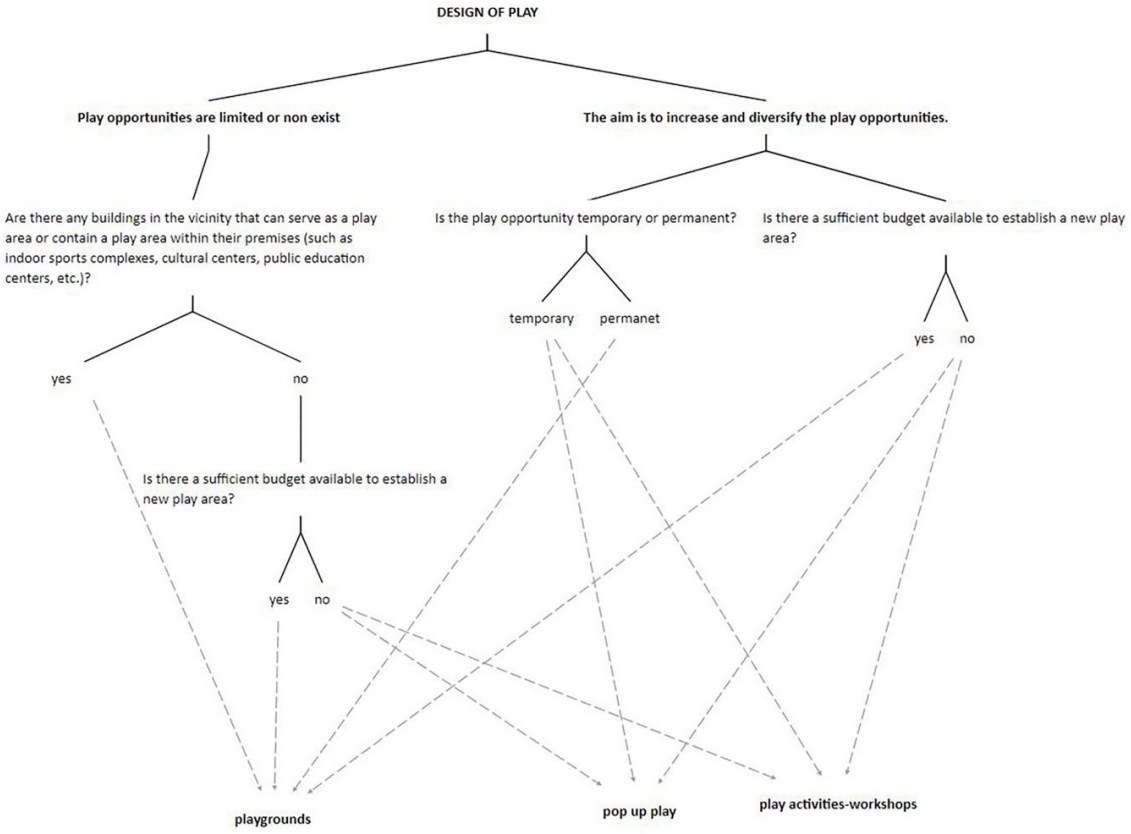


Figure 4. *Play design decision tree (Produced by the author).*

Figure 5. *Adventure playground (Conceptual collage crafted by the author).*

5.1.2. Designing and implementing pop-up play

The primary strategy for establishing pop-up play areas involves organizing time-limited outdoor activities that align with favorable weather conditions. These schedules should be communicated via bulletin boards, schools, and social media platforms to keep everyone informed (Leichter-Saxby & Law, 2014). It's crucial that pop-up play areas are accessible to children and caregivers with disabilities; municipalities can facilitate this by providing transportation and setting up portable platforms, ramps, and adaptive equipment for various terrains (Sungur Ergenoğlu & Czaplinska, 2018).

When outdoor conditions are unsuitable, indoor spaces provide an excellent alternative. Community-friendly spaces such as warehouses, stores, or other public areas can serve as indoor play zones during specific hours or when they are not in use. Local administrations may also rent private spaces to meet this need (Leichter-Saxby & Law, 2014). Indoor play areas are particularly beneficial for refugee children, as many family members work during the day due to economic constraints (Copeland et al., 2012). Activities and workshops in these spaces can enhance integration, strengthen family bonds, and ensure that all family members are involved in the adaptation process, helping caregivers recognize the significance of play (Vandekerckhove & Aarssen, 2020; UNICEF, 2022).

Play buses represent another innovative approach to bringing play to communities. Inspired by Japan's experience with play buses in post-disaster areas, these buses deliver play materials and facilitators directly to neighborhoods, setting up play areas around temporary shelters, parking lots, or community spaces (Kinoshita & Woolley, 2015). Play buses enable affordable and flexible play options on a larger scale (Bozkurt, 2016). They prioritize accessibility for children with disabilities and families in lower-income neighborhoods (Mould & Fabian, 2009). They can range from smaller vehicles equipped with toys to larger buses designed for interactive play. Municipalities can adapt buses for play and schedule regular visits to residential areas, schools, or safe spaces. These visits can be publicized through social media, bulletin boards, and local offices.

Selecting flexible, creative, and affordable play materials—such as milk cartons, cardboard, plastic pipes, and rope—facilitates easy transport and accessibility. Selecting recyclable or reusable materials especially beneficial in lower-income areas where many refugee children reside (Neill, 2013; Leichter-Saxby & Law, 2015). Local authorities, community members, and volunteers can contribute by gathering and donating materials, including surplus from university design projects (e.g., paper, cardboard, glue, and paint). Play materials need supervision due to vandalism. Therefore they can be stored at nearby schools, local offices, or community centers and transported to play sites as needed (Akyol, 2006).

Play kits are another ideal option for pop-up plays (UNICEF, 2015). These kits can be prepared in single box or in multiple boxes to accomadate varying group sizes (UNICEF, 2013). The contents of these kits should be determined in consultation with local partners and professionals, including educators, psychologists, and play specialists. Observations of caregivers about children's play habits can inform the design of kits intended for home use.

Production, packaging, and distribution of play kits require additional workforce and budget. Funding and volunteer assistance from NGOs, international funds, and socially responsible companies can significantly impact the program's success. The municipality can take the lead in establishing a distribution network to ensure kits reach local centers like schools and community warehouses. Volunteers can then deliver those kits directly to families in need.

5.1.3. Programming play activities and workshops

Activity areas should be selected from the previously mentioned network map to bring play to the locations with limited or nonexistent play opportunities. This method supports

continuity in educational play activities and promotes the integration of refugee and local children into the same programs (Ancın, 2019). Considering the challenges and inequalities refugee children face in accessing education (Aydın & Kaya, 2017), a dedicated program within educational activities can help overcome these challenges.

Activities and workshops can take place in diverse settings—schools, NGOs, cultural centers, sports facilities, or even local businesses (e.g., internet cafés when computer labs are unavailable). When possible, these activities should occur near playgrounds or be integrated into mobile play options like play buses.

Workshops and activities often have specific goals, including supporting educational objectives, fostering social integration (Chayder, 2019), and providing psychological support through sports (Whitley & Gould, 2011). They can also play a vital role in participatory design efforts for play areas and equipment, enabling children to share their ideas (Rigon et al., 2021).

Activities focusing on social integration should avoid highlighting cultural or ethnic differences, encouraging instead for shared, expressive activities. Physical activities, art, music, and dance allow children to express themselves nonverbally (Yanık Özger & Kozandağı, 2021; Chayder, 2019). Collaboration with local educators can enhance language learning support, leveraging their expertise and insights.

Workshops and activities for both children and their caregivers are essential for strengthening family bonds (Sim et al., 2018) and raising awareness about play as a fundamental right. Engaging caregivers from both local and refugee backgrounds helps address issues of discrimination and exclusion. Children can assist their parents' adapting to new environments (Agutter, 2016).

To ensure the sustainability of these activities, it's advisable to avoid high-cost, long-lead-time equipment. Essential items, such as computers and specialized software, may be funded through partnerships with national and international supporting organizations.

5.2. Managing play

5.2.1. Supporting volunteering and cooperation

Volunteering and community cooperation are essential for managing the costs of providing play opportunities, fostering new collaborations, and supporting children's social development. Volunteers enhance children's access to play while cultivating a sense of trust and support (Weinberger, 2020). Both playgrounds and pop-up play events require playworkers to supervise activities and assist when necessary (Leichter-Saxby, 2019). The number of playworkers can be adjusted based on the number of children present, their age groups, and daily routines, such as naptimes and school schedules. Scheduling playworkers by the hour can enhance flexibility for the pop-up events. In order to have more trained playworkers without increasing costs, it is crucial to concentrate on volunteer support (Bozkurt, 2019). Training should be offered for playworkers, play therapists, and project managers at playgrounds and pop-up sites. Local partnerships can facilitate in-house training programs.

Funding for the play opportunities for refugee children, can be secured through collaborative projects with national and international organizations (Bozkurt, 2016). Additionally, university departments in fields such as fine arts, design, and sports science can organize social responsibility projects to foster interdisciplinary collaboration and reduce costs.

5.2.2. Supervision and safety

Supervision is a vital component of pop-up play, playground activities, and workshops. It helps sustain a safe, engaging environment. Permanent playgrounds, however, require more supervision since the equipment, seating, and lighting may be vandalized in urban areas (Akyol, 2006). Community members and regulatory agencies must collaborate to ensure the safety of play areas. Areas with low income, where most refugees reside, tend to experience more vandalism (Park & Burgess, 1924). Therefore, playgrounds need to be equipped

with security cameras The Parks and Gardens Department should regularly monitor playgrounds and address any issues regarding their physical conditions.

A community monitoring system is essential, as it allows residents to report repairs or dangerous conditions quickly through an online mechanism. So, residents can follow issues until they are fixed (Figure 6). In neighborhoods lacking digital access, community members can report concerns directly to staff on site. By engaging residents in monitoring, the community can proactively prevent security issues and foster shared responsibility (Scott et al., 2007).

5.2.3. Reporting and documentation

Understanding the needs of children and caregivers in playgrounds is vital for developing effective solutions. Conducting needs assessments through surveys and face-to-face interviews helps identify gaps and ensures resources are used effectively (McDonald, 2011). For example, a poorly utilized park may indicate safety concerns, child labor issues or a need for relocating equipment to more frequented areas.

For pop-up play activities, documenting participation rates, repeat visits, and popular areas is beneficial. Monthly or annual reports help assessing program effectiveness (Miller & Piliavin, 1957). If attendance declines, factors such as location, transportation, and publicity should be reevaluated. Observations by educators and psychologists during activities and workshops can provide valuable insights into refugee children's mental health needs (MacMillan et al., 2015), guiding improvements in play programs.

Finally, documenting the efforts in designing play opportunities is essential for promoting inclusive play environments. The information will be useful for local reports on the right to play, advocacy for varied play equipment, and enhancement of research on play and social integration.

5.3. Implementing play

Ensuring the sustainability of accessible play opportunities is crucial. There are numerous strategies to achieve this. Materials such as guides, handbooks, and reports, holding workshops and educational programs, or creating supportive policies can effectively promote the right to play in communities. Awareness campaigns and informational resources for caregivers, experts, and the public (UNICEF, 2022) are particularly valuable. For instance, handbooks developed in partnership with play therapists and educators can provide practical guidance on age-appropriate games and possible needs or conflicts during play. Such resources can be adapted for various contexts, including public spaces, residential areas, schools, and disaster zones, ensuring children have safe play options without requiring extensive equipment.

Organizing workshops and seminars can raise awareness and publicize their outcomes. Creating a coordinating group can help monitor play opportunities for refugee children. The community can identify where play spaces may be lacking or in need of improvement. Community members from schools, local councils, and associations, can be encouraged to gather feedback from caregivers about access to play spaces.

In times of crisis, it is important to prioritize the right to play alongside essential services like health and shelter. Policies considering play opportunities for refugee children can ensure that their rights are upheld (Woolley, 2021).

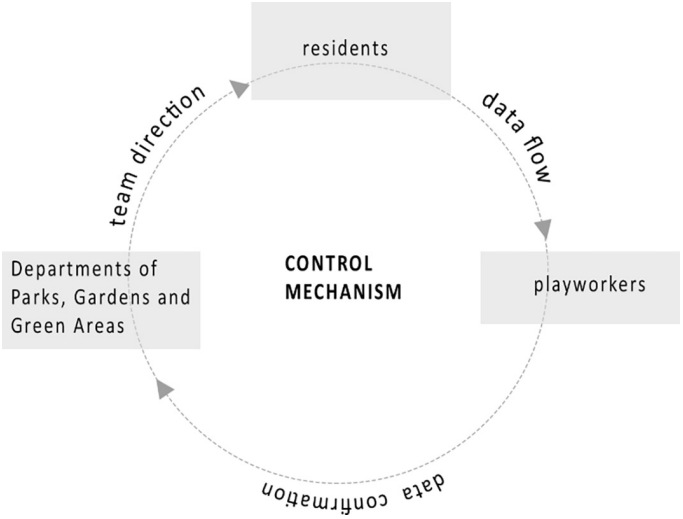


Figure 6. *Control mechanism data flow diagram (Produced by the author).*

6. Conclusion

The number of child migrants is expected to increase due to ongoing conflicts, wars, natural disasters, climate crises, and pandemics. This situation demands immediate and proactive action from states party to the UN Convention on the Rights of the Child (UNCRC) to safeguard the rights of refugee children, particularly their right to play. While current efforts are encouraging, they must be enhanced to fully address the unique needs of these vulnerable children. This study highlights the essential role of play in the well-being of refugee children, identifies barriers to accessing play opportunities, and proposes solutions to overcome these challenges.

The play guide developed in this study offers a comprehensive framework for creating inclusive play spaces that nurture the physical, psychological, and social development of refugee children. Although the findings offer valuable insights, it is vital to recognize that some existing initiatives may not meet the specific needs of these children. The focus should not be on segregating refugee children from their host communities but on understanding their play habits and fostering inclusive play environments.

This research aims to serve as a lasting resource for local authorities, NGOs, volunteers, and professionals dedicated to improving the lives of refugee children. By continuously adapting this guide, stakeholders can ensure that play remains a central aspect of these children's lives, promoting resilience, well-being, and social cohesion. The guide functions as a foundational tool for future initiatives, offering adaptable strategies to advocate for the right to play, design appropriate play environments, and strengthen collaborations that support children's growth and integration into their communities.

However, this study has limitations. It relies primarily on a systematic review due to ethical considerations and restrictions imposed by the COVID-19 pandemic, which hindered extensive on-site observations. As a result, the findings may lack the contextual understanding that fieldwork could provide. Additionally, focusing on refugee children in Türkiye may limit the applicability of the proposed play guide to other countries due to potential cultural and social differences.

To address these limitations, future research could incorporate field-based studies involving direct interactions with refugee children and local communities. Ethnographic studies or participatory action research could provide deeper insights into the lived experiences of refugee children and their interactions with play spaces. Comparative studies across various countries hosting refugee populations could also enhance the guide's adaptability to diverse contexts.

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Contributors

Bülent ARIKAN
Bülent Arıkan is an anthropological archaeologist focusing on early complex societies of southwest Asia (10,000–1,200 BC). His research addresses settlement systems, land use, and human-environment interactions through cultural ecology and landscape archaeology. He received his PhD from Arizona State University and is currently a full professor at ITU.

Imdat AS
Imdat As is faculty at ITU, Department of Architecture. He received his doctoral degree from Harvard, M.Sc. from MIT, and B.Arch. from METU. His field of research is in architectural representation and new technologies, and novel applications at the intersection of digital and physical spaces.

Sinem AVCI KARADUMAN
Sinem Avcı Karaduman is an architect practicing multi-scale design projects in diverse contexts. She is currently a Ph.D. candidate in Landscape Architecture at Istanbul Technical University. Her research interests migration-driven spatial transformations, social integration processes, community resilience, and the role of landscape in creating inclusive public environments.

Asu BEŞGEN
She works as a Professor at Karadeniz Technical University, Department of Architecture, leading the "Architectural Design", "Interior Design", "Basic Design" Studios, teaching the courses of "Theory of Architecture", "Theory of Art", "Aesthetics", "The Dialog of Art and Architecture in 20th Century", "Cinema and Architecture" and is the author of many related works.

Can BOYACIOĞLU
Can is an assistant professor at the Department of Architecture at Gebze Technical University. Received his bachelor's degree in architecture from Yeditepe University (2008) and his master's (2010) and PhD degree (2017) in architecture from İstanbul Technical University. His research interests include the theory of architecture, Anthropocene, and environmental architecture.

Melih BOZKURT
Melih Bozkurt is a lecturer at Istanbul Technical University, specializing in human experiences in urban open spaces. His recent projects explore children's use of green spaces, physical activity, health, sensory landscapes, and the integration of AI in landscape design and visual recognition for scientific observation.

Warebi Gabriel BRISIBE
Warebi Gabriel Brisibe is a Professor of Architecture at the School of Architecture, Rivers State University, Nigeria. He holds an MSc in Architecture from University of Jos, Nigeria and a PhD in Architecture from Newcastle University, United Kingdom. His research interests include architectural history and culture, building conservation, colonial and post-colonial architecture.

Vivek CUCKEMANE
Vivek Cuckemane is an Architect and research scholar at the Faculty of Architecture, Sathyabama University, Chennai, India. He holds a Master's in Architectural Conservation from SPA Vijayawada. His academic and research interests include heritage conservation, architectural history, and studio pedagogy. He has authored research papers on regional heritage and planning.

Abdullah Yasin DÜNDAR
Yasin is a PhD candidate at the Department of Architecture at TU Delft. Received his bachelor's degree from Selçuk University (2020) and his master's degree from Gebze Technical University (2022), both in architecture. His research interests are game studies, new materialism, and architectural theory.

Zeynep ELBURZ
Dr. Zeynep Elburz completed her bachelor's at Dokuz Eylul University and earned her master's in Regional Planning from Istanbul Technical University. She holds a PhD from Dokuz Eylul University and was a visiting researcher at VU University Amsterdam. Her research focuses on regional economics, industrial geography, and regional inequalities.

Hüsnü Murat GÜNAYDIN
He specializes in project and construction management. He completed his bachelor's degree in Architecture at YTU in 1991 and his master's and doctoral degrees at IIT Chicago in 1995 and 1999, respectively. He has held positions at both IZTECH and ITU. He also provides consulting services in various sectors.

Şeyma Gül KIRDI
Şeyma Gül KIRDI is a researcher with a bachelor's and master's degree in urban and regional planning. Her work focuses on rural development, smart villages, and spatial analysis. She specializes in CRM methods and GIS-supported analysis, continuing her academic research on rural policies and digital planning.

Melih BOZKURT
Melih Bozkurt is a lecturer at Istanbul Technical University, specializing in human experiences in urban open spaces. His recent projects explore children's use of green spaces, physical activity, health, sensory landscapes, and the integration of AI in landscape design and visual recognition for scientific observation.

Mustafa Tahir OCAK
Mustafa Tahir Ocak is a research assistant at Istanbul Technical University (ITU) Department of Architecture. He holds a B.Arch and Master's degrees in Architectural Conservation and History of Architecture from ITU. He completed his Ph.D. at ITU and was a visiting scholar at TSU, Georgia during his doctoral studies.

Ramota OBAGAH-STEPHEN
Ramota Obagah-Stephen is a Chartered Architect in Nigeria, a lecturer and researcher at the School of Architecture, Rivers State University. She earned her MSc in Architecture from the University of Nigeria and is currently a PhD candidate in Architecture. Her research interests are colonial and post-colonial architecture, architectural history and education.

Muhammed Ali ÖRNEK
Muhammed Ali Örnek, PhD, runs the ForestGuard startup after 17 years in academia, integrating advanced technology into teaching and research at Istanbul Technical University and Florida International University. He has received awards for his research, patent, and startup, and served as CELA Regional Director and Innovation Advisor to Istanbul Municipality.

Gozde Basak OZTURK
Dr. Gozde Basak Ozturk is an Associate Professor at Aydin Adnan Menderes University. Her research spans Digital Twins, Construction IT, Information Management, and Artificial Intelligence. She has widely published on digital transformation in the built environment, focusing on smart infrastructure, cognitive systems, and data-driven decision-making in construction and design.

Arulmalar RAMARAJ
Arulmalar Ramaraj is an Architect and Professor at the Faculty of Architecture, Sathyabama University, Chennai., India. She completed her PhD in Architecture in 2020 and has been guiding research scholars since 2021. Her academic and research interests include creativity, pedagogy, generative tasks and recycling. She has authored many research papers in Indexed national and international journals.

Fatma Handan SARIGÜL
She specializes in project and construction management, with a primary focus on smart, sustainable buildings and cities. She completed her bachelor's and master's degrees in Architecture at Gazi University in 2013 and 2018, respectively and doctoral degree at ITU in 2025. She has held a position at Ankara Metropolitan Municipality since 2013.

Sheida SHAKERI
Sheida Shakeri is an architect and Ph.D. candidate in landscape architecture, specializing in digital fabrication, knitted architecture, and biomaterials. Her research has been published in leading journals and conferences. With a background in architecture and interior design, she blends computational design with sustainable innovation in academic and design contexts.

Mehmet Onur SENEM
Mehmet Onur Senem holds a Ph.D. in Geographic Information Technologies from ITU, with a background in Landscape Architecture (B.Sc.) and Architectural Design (M.Sc.). His research explores AI, robotics, sensors, and GIS applications. He also lectures on AI-driven design and its impact on the built environment.

Sam TURNER
Sam Turner is Professor of Archaeology at Newcastle University and directs the McCord Centre for Landscape. His research explores medieval and post-Roman landscapes across Britain, Europe and the Mediterranean, focusing on cultural heritage and historic landscape characterization. He has held his position at Newcastle since 2004.

Berrin TUZCUOĞLU
Berrin Tuzcuoğlu holds a bachelor's degree in Interior Architecture from Karadeniz Technical University and a master's degree in Landscape Architecture (2021). She has been a lecturer at Avrasya University since 2018, after joining as a research assistant in 2016. She is currently pursuing a Ph.D. in Architecture.

Gülsün TANYELİ
Gülsün Tanyeli teaches restoration and conservation at the ITU Faculty of Architecture, where she completed her undergraduate and graduate studies. Her architectural and technical activities include conservation of archeological and historical monuments, and reuse projects of early modern industrial facilities. She is a member of ICOMOS National Committee of Turkey.

Arzu TÜRK
Arzu Türk is a researcher and landscape architect. Her PhD from Dept. of Landscape Architecture, ITU focused on historical landscape character transformation around Alaca Höyük, Çorum. Her current research interests include landscape change and memory, landscape archaeology and history, semantics of landscape, and Anatolian palimpsest landscapes.

Bhoomika UMASHANKAR
Bhoomika Umashankar is an Architect and Assistant Professor at Siddaganga Institute of Technology, Tumakuru. She holds a Master's in Digital Architecture from BNCA, Pune. Her research explores parametric design, agent-based modelling, and computational tools in architecture. She has presented and published in international journals and conference proceedings.

Zeynep YILMAZ
She is a PhD candidate in Project and Construction Management Program at ITU. She holds her BArch from METU and her MSc from ITU with her thesis on risk management. With +20 years' experience in international real estate development, her expertise lies in retail architectural development and project management. She currently develops RE projects in Luxembourg.

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