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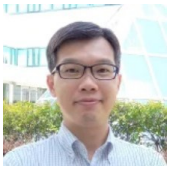
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- Section A- Citizenship Rights and Responsibilities: Citizenship Rights, Governances and practices, Urban and Social Identities, Walkable cities, Participatory projects, Urban ecology. Urban and social Identities, Well-Being, Acoustics, Smellscape, Authenticity, Quality of urban life, Public Health, Human behaviour and cities, Multiculturality: Inequalities and diversities, Social distress, Psychology.
- Section B-Territorial dynamics: Urban Landscapes, Human urban geography studies, Spatial analysis: GIS and remote sensing, Spatial divergences, Interregional migrations, Urban Competitiveness, Globalization, Territorial planning, Conflict and Divided Territories, Urban Sprawl, Wadi territories, Regional Planning, Gated communities, Housing,
- Section C- Urban Transformations: Urban Regeneration, Housing Studies, Urban renewal, Heritage Studies, Housing Economics, Urban Sociology, Urban Morphologies, Socio-spatial Practice, African regionalism in Architecture, Pre-colonial cities, Landscape Architecture, Heritage Preservation. Urban Renewal, Gated Communities, Rapid Urbanization, Rehabilitation, Tourism and economical sustainability. Slums, Globalization, Community development, Political economy. Mediterranean Architecture and Urbanism, Emerging Cities, Smart Cities, Sustainable Urban Development.

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All research articles in this journal undergo a rigorous double-blind peer review process, starting with an initial evaluation by the editor, followed by double-blind reviews conducted by at least two expert referees. The purpose of peer review is to assist the editor in making editorial decisions, while also helping authors improve their manuscripts through feedback. In the double-blind process, neither reviewers nor authors are aware of each other's identities. The typical review period is 4 weeks.

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- Reviewers who feel unqualified to review a manuscript or cannot complete the review in a timely manner should notify the editor immediately.

- Reviews must be conducted objectively, avoiding personal criticism, and reviewers should clearly express their opinions with reasoned arguments.
- Manuscripts under review should be treated as confidential.

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Authors submit manuscripts via the online submission system, and they receive confirmation of receipt from the editorial office. The Chief Editor first reviews the manuscript, often with the help of Section Editors (or Co-/Associate Editors). A Section Editor oversees the manuscript through the entire review process and provides a recommendation or decision.

Initially, the manuscript is assessed for its alignment with the journal's scope and its adherence to formal requirements. If found unsuitable, it is directly rejected, and a rejection letter is sent to the author explaining the reasons. If the manuscript meets the journal's scope and guidelines, it is sent for peer review. Reviewers evaluate the manuscript and submit their reports to the Editor-in-Chief, who then makes one of the following decisions based on the feedback:

- Accept without revisions
- Accept with revisions
- Request a resubmission
- Reject

In case of acceptance, the final manuscript is sent to production. Authors may also be asked to revise their manuscript based on reviewers' comments and resubmit it for further evaluation. Review times vary between 4 to 8 weeks, depending on the discipline and additional information required. If rejected, the manuscript is archived, and a rejection letter is sent to the authors. Reviewers may be informed of the final decision.

Once the review process is completed, the manuscript is passed to the Copy Editor, who ensures that it adheres to the correct referencing style and journal formatting. The Layout Editor then prepares the manuscript, including figures and tables, for publication in formats such as PDF and HTML. Finally, the Proof Editor confirms that the manuscript is ready for publication after completing all the necessary stages.

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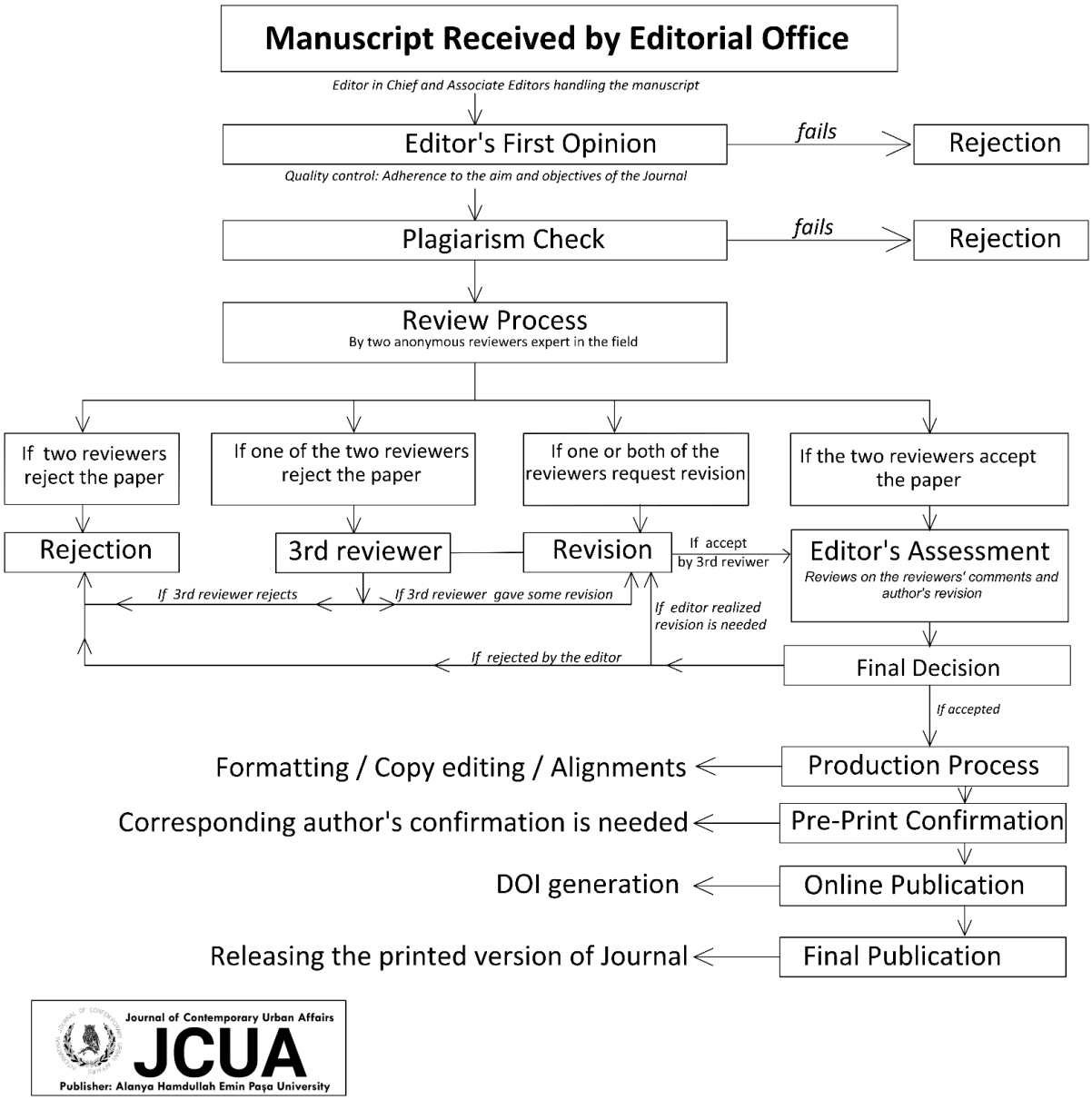


Figure 1. Peer Review Process.

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Adapted from: Bella H. Plagiarism. Saudi J Med Sci 2014; 2:127

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Credit Author Statement

In mid-2012, the Wellcome Trust and Harvard University co-hosted a workshop that brought together members of the academic, publishing, and funding communities to explore alternative models for contributorship and attribution. Following this workshop—and initially collaborating with a group of primarily biomedical journal editors and members of the International Committee of Medical Journal Editors (ICMJE)—a pilot project was initiated to develop a controlled vocabulary of contributor roles, known as a taxonomy.

The goal was to create a taxonomy that is practical, easy to understand, and minimizes the potential for misuse. CRediT (Contributor Roles Taxonomy) provides authors with the opportunity to share a precise and detailed description of their diverse contributions to published work. It is a high-level taxonomy comprising 14 roles that represent the typical contributions to scientific scholarly output. These roles help in clearly identifying each contributor's specific input to the research and publication process.

Role	Definition
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- **Formal Analysis**: M.W., J.F., S.M., R.B.
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- **Methodology**: J.F., S.M., R.B., M.W.
- **Project Administration**: S.M., J.F.
- **Writing—Original Draft**: S.M., J.F.
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All authors have read and agreed to the published version of the manuscript.

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Sources:

1. The presentation of the 14 roles has been adapted from the Consortia Advancing Standards in Research Administration (**CASRAI**) website.

2. https://onlinelibrary.wiley.com/doi/full/10.1002/leap.1210
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In an era marked by increasing socio-economic disparities and rapid urbanization, the journal acknowledges the urgent need to address the widening socio-economic gaps that profoundly impact contemporary urban societies. The complex challenge of balancing socioeconomic development with resilience in the built environment necessitates a platform for innovative and interdisciplinary dialogue. To this end, the journal aims to advance original, cross-disciplinary academic contributions that not only analyze these socio-economic divides but also propose actionable solutions to bridge them. By strengthening research in three core areas—Citizenship Rights and Responsibilities, Territorial Dynamics, and Urban Transformations—the journal seeks to illuminate the underlying factors contributing to socio-economic inequalities and to explore the emerging social and economic challenges that shape modern urban landscapes. Through this focused approach, the journal aspires to contribute meaningfully to the discourse on equitable urban development and to foster academic scholarship that can inform policy and practice, ultimately helping to create more inclusive, resilient, and sustainable cities.

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Original scientific paper

Psychological Effects of Walking and Relaxed Sitting in Urban Greenspaces During Post-pandemic: A Case Study in Bogor City, Indonesia

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ABSTRACT

The COVID-19 pandemic disrupted the world order from the beginning of 2020 to the end of 2022. The COVID-19 pandemic has had a significant impact on changes in healthy living practices, such as decreased physical exercise and increased stress, compromising psychological well-being. The psychological impacts of walking and relaxing in urban green spaces on IPB University students are investigated in this study. Bogor City Alun-Alun, Sempur Park, and Heulang Park were used for the experiment. Participants completed 15 minutes of walking and relaxed sitting before and after the experiment, and the psychological impacts were assessed using Profiles of Mood States (POMS), State-Trait Anxiety Inventory (STAI), and WHO Quality of Life (WHOQOL-BREF) before and after the experiment. The results indicate that physical activity improves psychological wellness. These findings give scientific evidence for the psychologically relaxing effects of walking and relaxed sitting, as well as recommendations to support the development and construction of therapeutic urban green spaces.

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Highlights	Contribution to the field statement
- This paper provides evidence for the effect of walking and relaxed sitting on psychological effects. - Improving psychological health is urgently needed for young adult students in the aftermath of the COVID-19 pandemic. - The positive effect of walking and sitting relaxed activities can improve psychological health in park users (IPB University students).	This paper suggests further studies to improve quality of life, stressing that further research could focus more on regular physical activity, walking and sitting. In addition, these findings suggest a series of recommendations that can assist in designing urban greenspaces that can enhance the psychological effects of their users.

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1. Introduction

The COVID-19 pandemic has posed unprecedented challenges for citizens all around the world. The pandemic has a direct impact on economic, social, and other elements of life, such as health (Chaplyuk et al., 2021). The COVID-19 pandemic has had a substantial impact on the psychological health of young adults, such as depression, stress, and anxiety (Taha et al., 2014), as well as post-traumatic stress disorder (Shultz et al., 2015). Adolescent mental health can be impacted by social and physical restrictions, as well as school closures for young adults. According to the godataipb.org data source: 44.5% of students experienced fatigue and 55.2% lost interest in the survey 'Career Awareness and Mental Health of IPB University Students in the Pandemic Period with 299 respondents, active undergraduate and vocational students of IPB University on 24-30 July 2020. A walk, according to 165 people, is an effective way to improve one's mood. Young people can have an impact on the development and promotion of mental health and well-being (MHWB) programs (Raviola et al., 2019). Lower rates of depression are connected with increased access to green open spaces, physical activity, and mental health. Green open spaces improve mental health by increasing physical exercise, providing a social space for residents, fostering social relationships, and relieving stress and mental fatigue (Cohen-Cline et al., 2015). To establish a therapeutic landscape, physical, social, symbolic, and experiential spaces must be developed (Völker & Kistemann, 2015). Previous studies have shown that exposure to natural stimuli in green spaces through physical activity or relaxation may have a psychological impact on daily routines (Li, 2010). Forest bathing is one method of natural therapy that can be used. Forest bathing is a way to enjoy the forest by walking around and enjoying everything it has to offer. This natural and low-cost activity is believed to relieve stress-related disorders by allowing plants to relax physiologically (Tsunetsugu et al., 2009).

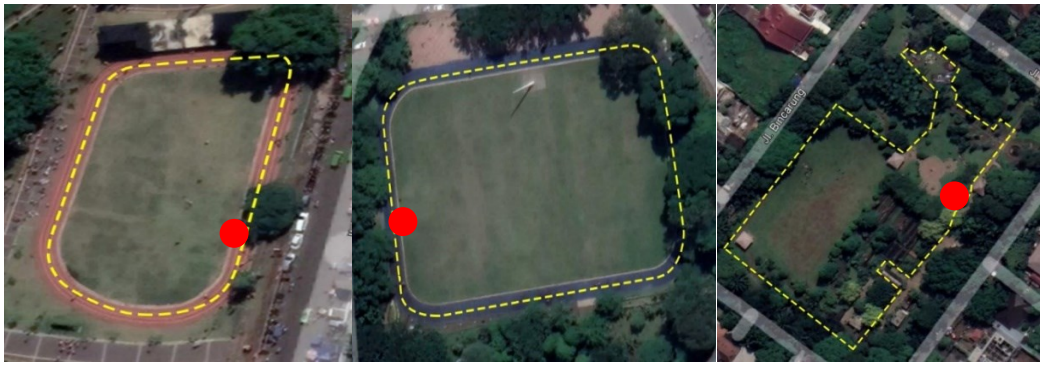
Several studies on the physiological and psychological relaxing effects of walking and exploring urban parks and forests on young adults have been conducted. Physiological studies have shown that park and forest environments reduce heart rate and blood pressure while enhancing parasympathetic nervous activity (Park et al., 2009). Furthermore, psychological studies have shown benefits in increasing subjective evaluations of feeling comfortable, natural, relaxed, strong, serene, and rejuvenated (Park et al., 2009), reducing negative moods (e.g., tension, anger, fatigue, depression, confusion), and anxiety states (Tsunetsugu et al., 2013). Yu et al. (2017) reported that a brief two-hour walk in the forest reduced pulse rate, systolic and diastolic blood pressure, and negative emotions (e.g., anger, confusion, depression, tension, fatigue), anxiety, and raised emotion positively.

Therapeutic garden planning and design must focus on meeting the physical, psychological, social, and spiritual needs of human users. In gardening, selection and meticulous arrangement of garden elements are required so that a park can reach functional and aesthetic value. Therapy rooms in open settings in Indonesia typically simply feature a contemplation walk; a therapeutic garden that meets the criteria would be more beneficial. The function of therapeutic parks should be evaluated in city parks that have been established so that parks can become public health therapy areas. Therapeutic gardens have unique aesthetic and functional values that must be considered when designing them. Existing facilities in Indonesian urban parks should be evaluated because planning is still inadequate, such as a lack of aromatic plants that stimulate the sense of smell, a lack of noise-reducing plants to reduce disturbance, and a lack of infrastructure with track widths and lengths that meet the needs of visitors of all ages (Massie et al., 2020). The purpose of this study is to offer such evidence for use in landscape planning guidelines to assist therapeutic urban greenspaces in Indonesia. This study investigates the effects of walking and relaxed sitting on psychological wellness. Our study hypothesizes that walking and relaxed sitting in urban greenspaces can improve psychological impacts.

2. Materials and Methods

2.1 Experiment Sites

The experiment was conducted from August to September 2022 in Bogor City, Indonesia, at Bogor City Alun-Alun, Sempur Park, and Heulang Park (Figure 1). The three parks were chosen because (1) they are public urban greenspaces that anyone can access without paying an entry fee; (2) they are located in the city centre; (3) there is a walking and relaxation therapy area such as a shady area, and there is a jogging track area; and (4) the tree growth rate is mature enough to provide shade (Pratiwi et al., 2022). This study used Bogor City as a case study since the extent of urban greenspaces in Bogor City already surpasses the standards stated by Law no. 26 of 2007 concerning spatial planning, with the area of green open space in Bogor City exceeding the minimum figure of 30% of the city's area. Despite having enough green open spaces in Bogor City, many Bogor City citizens suffer from psychological health issues. Bogor City Alun-Alun is 1.7 hectares in size, featuring a 500 m jogging track. Sempur Park includes a 973-meter-long running track with an average width of 1.5 meters, whereas Heulang Park has a 2.8-hectare space. Alun-Alun is Indonesia's one-of-a-kind historic open space (Kohori et al., 2019). The following criteria are applied to identify pedestrian paths: (1) a minimum length of 400 m one way; (2) a level slope; and (3) the presence of trees along the path. While the factors for selecting seats include (1) security; (2) a flat slope; and (3) the presence of shade, such as a big tree, which leads to a nice view (Pratiwi et al., 2020).



A B C

Figure 1. Experiment location. (A) Bogor City Alun-Alun. (B) Sempur Park. (C) Heulang Park
Note: The yellow line is the walking track, and the red circle is the relaxed sitting point.

The three parks have distinct vegetation cover characteristics, such as low vegetation cover in Bogor City Alun-Alun due to its recent revitalization in 2021 and high vegetation cover in Heulang Park and Sempur Park (Figure 2). There are differences in terms of climatic components (Table 1).



Figure 2. Experiment location. (A) Bogor City Alun-Alun. (B) Sempur Park. (C) Heulang Park.

Table 1. Climate Components Average in Bogor City Alun-Alun, Sempur Park, and Heulang Park.

Walking				**Relaxed Sitting**			
Climate Components	Bogor City Alun-Alun	Sempur Park	Heulang Park	Climate Components	Bogor City Alun-Alun	Sempur Park	Heulang Park
Temperature (°C)	31.4	32.5	31.6	Temperature (°C)	30.8	31.2	30.9
Humidity (%)	52.2	46.2	52.4	Humidity (%)	54.1	51.8	52.6
Wind speed (m/s)	0.2	0.3	0.5	Wind speed (m/s)	0.2	0.4	0.7
Noise (dB)	56.4	54.9	59.2	Noise (dB)	56.7	54.5	61.8
Light intensity (Klux)	22.8	27.3	25.5	Light intensity (Klux)	19.2	14.9	11.6

2.2 Participants

In this study, the snowball sampling method was employed to choose participant (Pratiwi et al., 2020) through 11 key informants spread across nine faculties and two schools at IPB University. Posters and Google forms were used to recruit participants, which were then circulated on social media and WhatsApp. Following that, participants will be given information about the research objectives, trial processes, trial dates, and a comprehensive study protocol. The research protocol was reviewed by the doctor in charge of the study at IPB University Polyclinic. Participants had to meet the following criteria: (1) be IPB students aged 19-26 years old, (2) reside in Bogor or its vicinity, (3) not be presently

being treated for cardiovascular disease or hypertension, and (4) be physically fit enough to run for 20 minutes or longer. This qualifying criterion is based on previous research conducted at IPB University (Pratiwi et al., 2022). The city and regency of Bogor are home to up to 30 student participants. Previous research with sample sizes ranging from 9 to 19 individuals showed significant results (Pratiwi et al., 2019, 2020). Thus, 30 subjects are sufficient to provide statistically significant findings in the experiment. The park therapy experiment included six males and twenty-four females (mean age, 21.1 ± 0.2 years). The experimental procedure adheres to the norms of the IPB University's Research Ethics Commission involving Human Subjects (Number: 735/IT3.KEPSM-IPB/SK/2022).

2.3 Experimental Design

In one day, thirty participants were separated into two groups. Bogor City Alun-Alun, Sempur Park, and Heulang Park are in Group 1; Heulang Park, Bogor City Alun-Alun, and Sempur Park are in Group 2. 09.00 - 12.00 was the experimental period for park therapy with walking and relaxed sitting activities. Each group has two participants. Each participant may only take part in the experiment once. Participants were required to undergo a medical examination by the polyclinic's medical team before the trial. The participants were then required to bring a health certificate on the day of the trial. All participants assembled in the conference room, and then all staff conducted a screening that included 1) measuring body temperature (no fever of 38˚C) and 2) checking general health conditions (no cough, runny nose, or shortness of breath). Following that, participants completed and signed the consent form. Before the experiment, participants were explained to and asked to complete a questionnaire to assess their mood, anxiety, and quality of life (Pratiwi et al., 2020, 2022). For 15 minutes, each participant walks or sits at a predetermined location. The participants then returned to the break room to complete the questionnaire. A minimum washout duration of 30 minutes was considered sufficient in this experiment to eradicate the treatments used in previous studies (Pratiwi et al., 2020; Pratiwi & Furuya, 2019). During the experiment, participants were obliged to 1) wear a mask, 2) keep their distance, 3) not smoke, 4) not eat, and 5) not consume caffeinated drinks, under the health protocol to prevent COVID-19 transmission (walking or relaxing sitting and filling out a questionnaire) (Pratiwi et al., 2022).

2.4 Research and Tools Materials

Before and after the experiment, participants were asked to complete a Profile of Mood States (POMS) and a State-Trait Anxiety Inventory (STAI). POMS was employed to assess mood conditions, which comprised 35 questions covering six subscales: tension, depression, anger, fatigue, confusion, and vigour. The five-point Likert scale spans from 0 (not at all) to 4. (very). They calculated the total score of mood disorders (TMD) using the following formula: [TEN+DEP+ANG+FAT+CON] – [VIG]. The current state of anxiety was assessed using the STAI state's Anxiety scale following exposure to a green area, which consisted of 20 questions. The scales used are four Likert scales with values ranging from 1 (not at all) to 4. (very) (Fernández-Blázquez et al., 2015; Julian, 2011). The WHO Quality of Life (WHOQOL-BREF) questionnaire was then administered before and after the study. The 26-question quality of life questionnaire covers four areas: physical health, psychological health, social interactions, and environmental situations. The ratings used are five Likert scales ranging from 1 (extremely poor) to 5 (excellent) (very good).

2.5 Analysis Methods

The Friedman test for data with an abnormal distribution and the Repeated Measures ANOVA test for data with a normal distribution were used to assess the Profile of Mood States (POMS) and State-Trait Anxiety Inventory (STAI) questionnaires. The Friedman and Repeated Measures ANOVA tests were also employed to analyze the differences in the findings of the POMS and STAI subscales obtained from individuals walking and relaxed sitting in three different locations. Because the data acquired from the WHO Quality of Life questionnaire (WHOQOL-BREF) is normally distributed, the Paired T-test was used to examine it. For data with an abnormal distribution, Spearman's correlation was used,

while for data with a normal distribution, Pearson's correlation was used. Actual data are presented as averages, and statistical differences were considered significant at $p < 0.05$. All statistical analyzes were performed using SPSS-22. The research flow is presented in Figure 3.

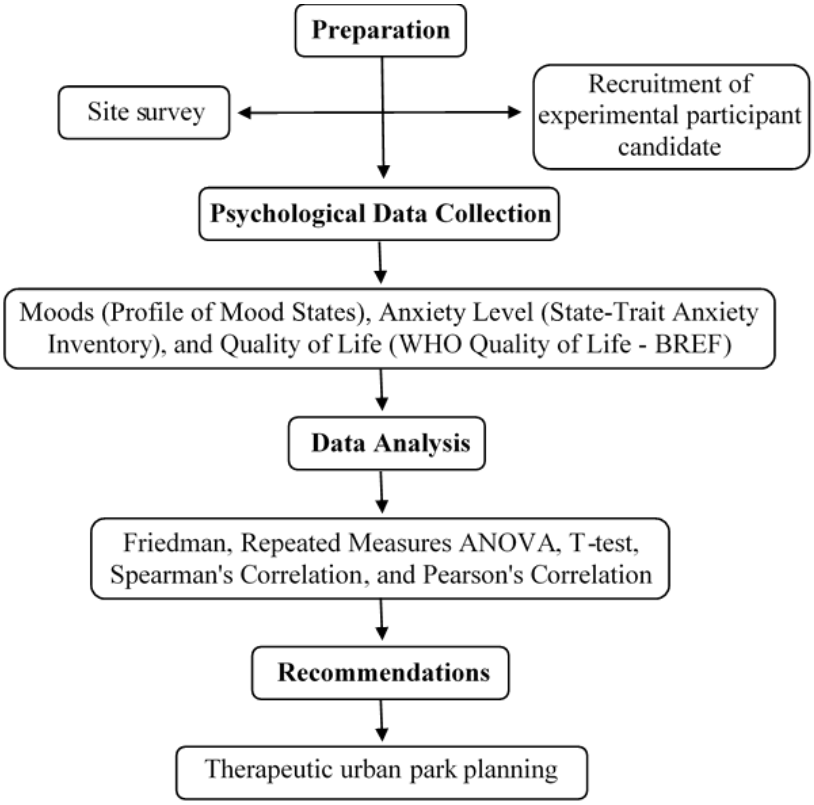


Figure 3. Research flow.

3. Result

3.1 The Characteristics of Sociodemographic

Park treatment involved 30 persons in all. According to the table, the average age of the experimental subjects was 21.1 ± 0.2 years, with 25% male (n = 6) and 75% female (n = 24). The individuals' average height was 158.7 ± 1.3 cm, and their body weight was 52.6 ± 1.7 kg. Most 90% of the participants were studying at the undergraduate program level (n = 27), and 10% were taking the graduate program level (n = 3). Then, when it came to knowledge about forest bathing, 67% of the individuals (n=20) did not know about it, whereas 33% (n = 10) did. On weekends, 35% (n = 13) of the participants preferred the full-day forest bathing program. 27% (n = 10) of subjects preferred the weekend half-day program; 11% (n = 4) preferred the two days and one-night program using a tent; 5% (n = 2) preferred the two days one-night program using a cottage; and as many as 22% (n = 8) preferred a vacation lasting a few days to a week (for the forest bathing program they were interested in, the subjects could choose more than one option). Walking activity programs were preferred by 21% (n = 10) of participants. Relaxed sitting programs were preferred by 33% (n = 16) of the individuals. 21% (n = 10) of the individuals preferred the activity program in the hammock, whereas 6% (n = 3) preferred the activity program on forest land. 11% (n=5) of the individuals preferred the water immersion program; 6% (n = 3) preferred the sensory experience activity program; and 2% (n = 1) preferred the breathing exercise program (for program activities of interest, subjects may choose more than one option) (Table 2).

Table 2. Characteristics of subjects who took part in the forest bathing program at urban greenspaces in Bogor City.

Parameter	**Average (N=30)**
Age (years)	21.2 ± 0.2
Height (cm)	158.7 ± 1.3
Body weight (kg)	52.6 ± 1.7
BMI	20.8 ± 0.6
Gender	
Man	6 (80%)
Woman	24 (20%)
Educational stage	
Bachelor	27 (90%)
Master	3 (10%)
Forest bathing knowledge	
Knowing	10 (33%)
Don't know	20 (67%)
Forest bathing programs	
Weekend full-day programs	13 (35%)
Half-day program weekend	10 (27%)
2 days 1 night using tent	4 (11%)
2 days 1 night using cottages	2 (5%)
Holidays for several days to a week	8 (22%)
Activity program	
Walking	10 (21%)
Relaxed-sitting	16 (33%)
Lying on the hammock	10 (21%)
Lying on the ground of the forest	3 (6%)
Soaking in the water	5 (11%)
Sensory experience	3 (6%)
Breathing exercises	1 (2%)

3.2 Questionnaire Results from Profile of Mood States (POMS)

The average POMS subscale scores obtained from 30 subjects before and after walking in three different Bogor urban greenspaces (Bogor City Alun-Alun, Sempur Park, and Heulang Park) revealed significant differences in the subscales of anger (p = 0.023), confusion (p = 0.001), depression (p = 0.000), tension (p = 0.000), and vigour (p = 0.028) due to a decrease in negative emotions and an increase in positive emotions There was no significant difference in negative emotions, fatigue (p = 0.228) since negative emotions rose while the subject was in Bogor City Alun-Alun and Sempur Park (Figure 4).

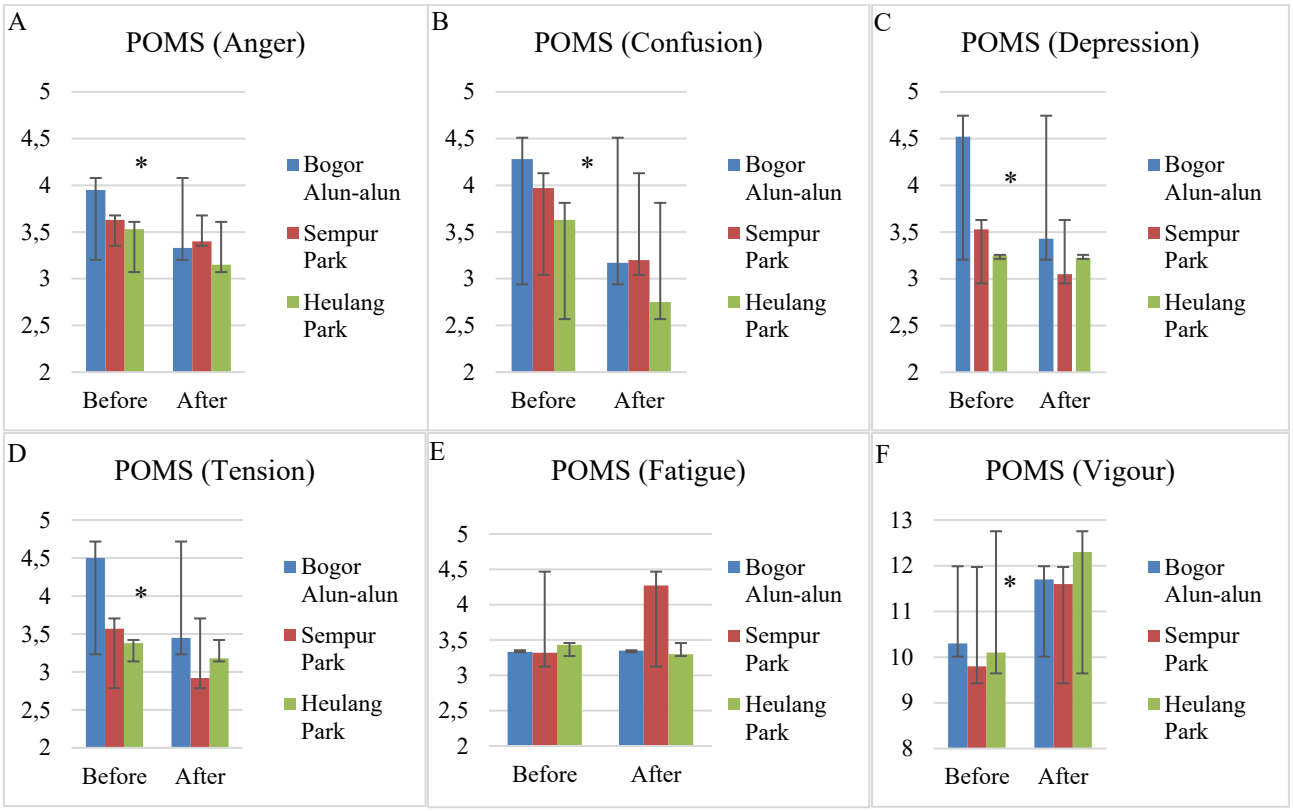


Figure 4. Comparison of the results of the POMS subscale and before and after walking experiment in the three locations. (A) Anger. (B) Confusion. (C) Depression. (D) Tension. (E) Fatigue. (F) Vigour.
Note: (*) *p*-value ≤0.05

Significant differences in fatigue (p = 0.001), confusion (p = 0.000), depression (p = 0.004), tension (p = 0.000), and vigour (p = 0.004) were observed when subjects performed the relaxed sitting experiment. There was no significant difference in negative anger feelings (p = 0.103) because negative emotions increased while the participant was at Heulang Park (Figure 5).

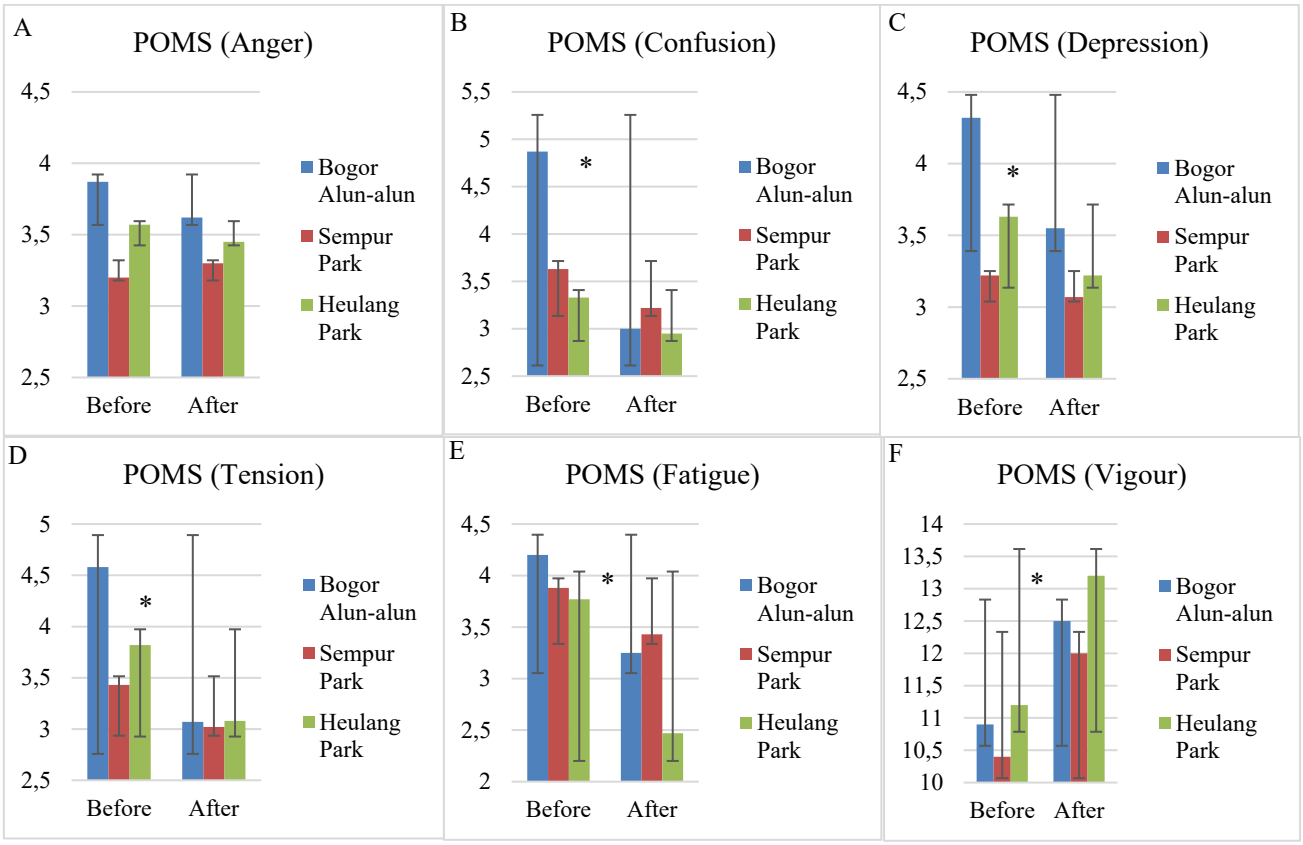


Figure 5. Comparison of the POMS subscale results before and after relaxed sitting experiment in the three locations. (A) Anger. (B) Confusion. (C) Depression. (D) Tension. (E) Fatigue. (F) Vigour.
Note: (*) *p*-value ≤0.05

The results of Total Mood Disturbance (TMD) comparing walking and relaxed sitting activities in urban greenspaces revealed the most significant difference when the subject completed the relaxed sitting activity (p = 0.000) against the walking activity (p = 0.083). Scores were obtained before and after walking in Bogor City Alun-Alun (4.05; 2.90), Sempur Park (3.85; 3.40), and Heulang Park (3.78; 3.02). While the scores obtained before and after the subject sat relaxed in Bogor City Alun-Alun (4.75; 3.12), Sempur Park (3.93; 3.08), and Heulang Park (4.75; 3.12), respectively (3.88; 2.23). The resulting score demonstrates the best emotion decrease while the subject is in Heulang Park. The Japanese POMS questionnaire categorizes POMS scores as "low" (-20 - 19), "moderate" (20 - 59), and "high" (60 - 100). Total Mood Disturbance (TMD) findings show that the subject's negative mood dropped while his positive mood grew; scores before and after walking/relaxed sitting varied from 4.75 to 2.90, which is considered "low" (Figure 6).

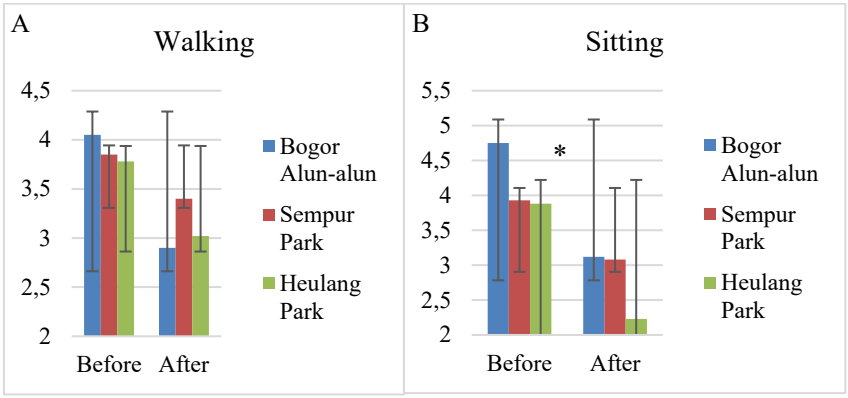


Figure 6. Comparison of the POMS (TMD) results in subscale walking and relaxed sitting before and after an experiment in the three locations. (A) Walking. (B) Relaxed sitting.
Note: (*) *p*-value ≤0.05

3.3 Questionnaire Results from State-Trait Anxiety Inventory (STAI)

The average STAI score indicated significant differences for walking (p = 0.000) and relaxed sitting (p = 0.000) for the three sites. The STAI was measured before and after walking at Bogor City's Alun-Alun (36.2; 32.3), Sempur Park (34.5; 32.1), and Heulang Park (34.5; 32.1). (34.3; 30.1). STAI was also evaluated before and after a relaxed sitting at Bogor City Alun-Alun (37.4; 34.2), Sempur Park (35.1; 32.1), and Heulang Park (35.1; 32.1). (35.2; 28.8). These findings show that anxiety levels in Heulang Park have greatly decreased. The score also demonstrates that relaxed sitting has more substantial effects than walking. STAI scores are often divided into three categories: "absent or low anxiety" (20-37), "moderate anxiety" (38-44), and "high anxiety" (45-80) (Kayikcioglu et al., 2017). These findings suggest that the subject's anxiety level before and after walking/relaxed sitting is 31.5 - 35.9, indicating "none or low anxiety."(Figure 7).

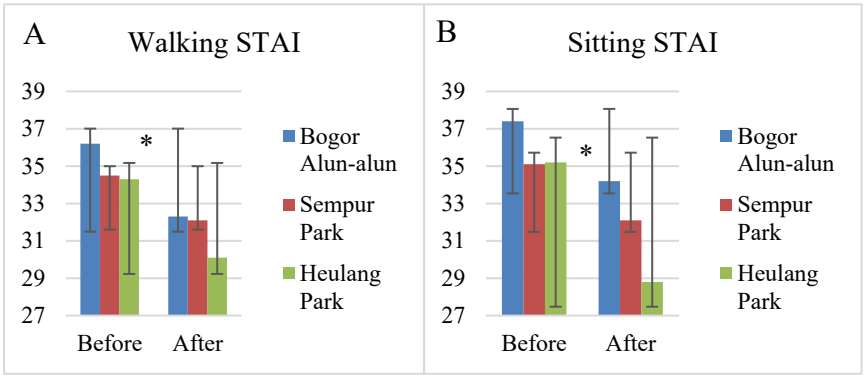


Figure 7. Comparison of the STAI subscale results before and after walking/relaxed sitting at the three locations. (A) Walking. (B) Relaxed sitting.
Note: (*) *p*-value ≤0.05

3.4 Comparison of Walking and Relaxed Sitting Activities

Walking and relaxed sitting exhibited significant outcomes from the Total Mood Disorder (TMD) and Anxiety-State Inventory (STAI), specifically walking (p = 0.000) and relaxed sitting (p = 0.000), with an average score of relaxed sitting (155.4) and walking (p = 0.000). (99.8). The difference in TMD at the Bogor City Alun-Alun site for walking (1.15) and relaxed sitting (1.63); Sempur Park for walking (0.45) and relaxed sitting (0.85); and Heulang Park for walking (0.76) and relaxed sitting (0.85). (1.65). The STAI difference in Bogor Alun-Alun for walking (3.9) and relaxed sitting (3.2); Sempur Park for walking (2.4) and relaxed sitting (3.0); and Heulang Park for walking (4.2) and relaxed sitting (3.0).

(6.4). Bogor Alun-Alun (p = 0.170), Sempur Park (p = 0.031), and Heulang Park (p = 0.017) were the analytical results. When compared to walking, relaxed sitting activity is more significant. Based on the sociodemographic characteristics questionnaire, 33% (n = 16) of the individuals prefer seated-viewing programs. These findings also suggest that Heulang Park has the biggest improvement in psychological health, as measured by the difference between TMD and STAI scores (Table 3).

Table 3. The results of the difference between total mood disturbance and state anxiety before-after walking and relaxed sitting at the three locations.

Parks	**Activity**	**Total Mood Disturbance**		**Difference between before and after**	**State-Trait Anxiety Inventory**		**Difference between before and after**
		Before	**After**		**Before**	**After**	
Bogor Alun-Alun (N=30)	Walking* (99.8)	4.05	2.90	1.15	36.2	32.3	3.9
	Relaxed Sitting* (155.4)	4.75	3.12	1.63	37.4	34.2	3.2
Sempur Park* (N= 30)	Walking* (99.8)	3.85	3.40	0.45	34.5	32.1	2.4
	Relaxed Sitting* (155.4)	3.93	3.08	0.85	35.1	32.1	3.0
Heulang Park* (N= 30)	Walking* (99.8)	3.78	3.02	0.76	34.3	30.1	4.2
	Relaxed Sitting* (155.4)	3.88	2.23	1.65	35.2	28.8	6.4

Note: (*) p-value ≤0.05

3.5 WHO Quality of Life (WHOQOL-BREF)

The WHOQOL-BREF score before and after the experiment did not substantially improve (90.27; 92.13). The results of the subscale scores before and after the experiment show that domain 1 "physical health" (23.9; 25), domain 2 "mental health" (20.5; 20.9), domain 4 "environment" (27.8; 28), and domain 3 "social relations" (10.5; 10.4) increased, while domain 3 "social relations" (10.5; 10.4) decreased. As a result, walking and relaxed sitting in urban greenspaces do not affect the subject's quality of life (p = 0.156) (Figure 8).

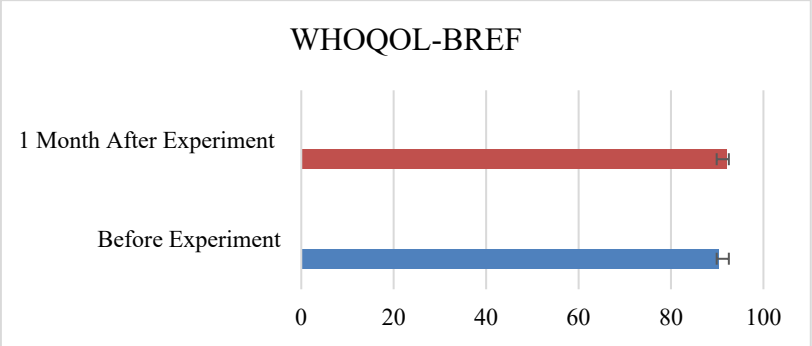


Figure 8. Comparison of the results of the WHOQO-BREF subscale before the experiment and one month after the experiment.

4. Discussion

4.1 The Benefits of Physical Activity to Psychological Health

Based on the results of the POMS and STAI questionnaires, therapy in parks, such as walking and resting, can enhance psychological health. According to Sakip et al. (2015), A park is a place that encourages and facilitates physical activity and plays an important role in the connection between humans and the environment. Parks may serve as a gathering area for individuals of various backgrounds and personalities. Physical health has an impact on psychological well-being. Individuals have psychological health when they are free of all symptoms of psychological disorders and can go about their daily lives (Adisty et al., 2015). These findings are consistent with previous research, which found that physical activity in natural settings is related to better psychological health than physical activity in other settings. Previous research has found that physical activity and interaction with nature in parks are strongly linked to various psychological health benefits (Li et al., 2016). According to Frances (2006), one of the biopsychosocial advantages of outdoor recreation include improved mood, a distraction from mental health illnesses, improved coping mechanisms, increased capacity to cope with challenges, increased emotional maturity, and increased self-acceptance. Relaxed sitting activities considerably enhance psychological health over walking activities, and Heulang Park greatly improves psychological health compared to Sempur Park and Bogor City Alun-Alun. It is also stated in this situation that the physiological impacts of the environment have a substantial impact on the results of psychological stress alleviation. Greenery can alleviate stress, physical discomfort, anxiety, and depression symptoms while also improving attention, mood, and cognitive performance (Dijkstra 2009).

4.2 The Benefits of Physical Activity with Quality of Life

The activities of walking and relaxed sitting in the urban green space in Bogor City did not affect the subject's quality of life; this may be attributed to the fact that the experiment, particularly the walking and relaxed sitting experiment, was only performed twice a month. Experiments should be carried out at least once a week to increase the subject's quality of life. Based on studies conducted by Lok et al. (2017) for ten weeks, regular physical exercise has a significant impact on depression and quality of life. The subject's highest subscale result is domain 4 (environment), indicating that the environment in Bogor City greenspaces has a significant impact on the subject's quality of life. Physical aspects of the environment are prominent features of urban parks. Bogor City Green Space contains trees and a variety of plants, creating the impression of natural nuances. Shady trees provide shade and support for leisure activities by providing clean air. A pleasant park with an enhanced environmental function is an ideal park for supporting recreational activities.

4.3 The effects of Park Characteristics on Psychological Health

Each of the three parks chosen has distinct characteristics. Bogor City Alun-Alun is adjacent to the highway, thus the park conditions are rather loud, and the vegetation around the jogging track is limited. Because Bogor City Alun-Alun was only revitalized in 2021, the mood is less relaxed. Sempur Park is located beneath the highway, thus the park is noisy, and the vegetation is plentiful and shady, but only around the running track. Meanwhile, because Heulang Park is located in a housing complex, the park is serene. Furthermore, the state of the vegetation, which has been numerous and shady, makes the park feel pleasant and relaxed. The variances in these three parks' qualities can have an impact on the psychological health outcomes of the subjects.

The results obtained by Heulang Park are the best among all parks. It might be due to the park's state, which contains a lot of vegetation, making it comfortable and relaxed, producing the most important value among the other two parks. Temperature fluctuations in urban greenspace can have an impact on human comfort. Tree shade may reduce solar radiation and obstruct sunlight dispersion from the sky and the surrounding surface, altering the heat exchange between the structure and the surrounding environment (Shahidan et al., 2010). Forest bathing requires several conditions, including ecosystem space that gives body comfort, attractiveness, and coolness, vegetation density, air temperature and

humidity, forest surface shape, and many more. Heulang Park provides adequate amenities, shade, comfortable living circumstances, and water element visualization. Heulang Park is located in a residential area rather than near a highway. According to research, public open areas with a lot of shade, decent pedestrians, seating, children's playgrounds, food sales locations, and well-maintained park conditions bring comfort to users. The socioeconomic profiles of users are also impacted by the placement of public space. Users will visit park locations in residential areas with adequate park support facilities 2-3 times per week. Unlike the park's commercial position and surrounding tourist attractions, the average visitor comes 1-2 times per month (Amalia et al., 2021)

According to one viewpoint, older trees can influence comfort and health. Heulang Park gives the most comfort since its vegetation has a longer lifespan. Because there are more annual plants in Bogor City Alun-Alun and Sempur Park than vegetation, Heulang Park can have a greater health benefit than other parks.

The more plants there are in the park, the more biodiversity there is, which contributes to a sense of connectedness with the rest of nature (White et al., 2019). Furthermore, the more plants in the park, the more oxygen is available, which relaxes a person's psychology. Then there are water elements like fountains at Heulang Park, albeit the conditions need to improve. In terms of the existence of water features, previous studies have shown that the presence of water bodies (particularly those that are incredibly natural) has a positive impact on psychological problems such as mental health. It happens even when socioeconomic factors are taken into account. Furthermore, listening to the sound of water (along with visuals) considerably reduces tension and improves psychological conditions (Dwiputra & Ardiani, 2017).

4.4 Recommendation

Walking and relaxed sitting in urban greenspaces can improve subjects' psychological well-being after being evaluated. Some recommendations for urban green areas in Bogor City include highlighting the element of water since it may help relax the body and mind (Pouso et al., 2021; White et al., 2019; Zhang et al., 2021); dividing the zone into public and private spaces since zones can provide varied healing qualities depending on the activities they allow (Grahn & Stigsdotter, 2010); can include decorative plants or aromatherapy plants with a variety of colours and soothing fragrances so that visitors can relax while walking around the park (Fujita et al., 2010; Zhang et al., 2021); City parks can be made accessible so that persons with disabilities can access and enjoy the park with less assistance; and benches can be added since they can be utilized to sit and rest, improving psychological health (de Bell et al., 2017).

The design principles are as follows: 1) provide spatial variation; 2) supply an even green material; and 3) facilitate the user's motor activities (walking, reflection, and relaxation). 4) Include positive diversions such as plants and water elements. 5) Reduce distractions by adjusting the level of light and noise in the surrounding space. 6) Consider minimizing uncertainty in healing garden planning and design. Individual physiological and psychological responses might change depending on leaf colour (Marcus & Barnes, 1999).

Moreover, plant colours can assist people in releasing stress and improving their state of mind (Todorova et al., 2004). Green and purple plants are more effective than red, yellow, and white plants for relaxing the body, reducing anxiety, and improving mood. As a result, the plant's colour can aid people in relieving stress and enhancing their emotional condition (Jang et al., 2014). In line with these findings, Xie et al. (2021) also proposed that seeing flowers bloom can have physiological and psychological advantages such as reduced stress and increased well-being. The colour of the flower also has a favourable influence on the individual's physiology and psychology. Jo et al. (2013) stated that aromatic plants have psychological and physiological advantages. Plant aromas may lift one's spirits, alleviate depression, and create a positive and stimulating image. Aromatic plants have been shown to improve the mood and emotions of persons who inhale them. Then, for the design of park benches to encourage relaxed sitting activities, a book called Anatomy of a Park suggests that a suitable park bench design is multi-jogs (Molnar & Rutledge, 1992). The design of multi jogs park seats can

accommodate a wide range of visitors to city parks, including individuals, couples, and groups. This park's bench shape will be even better if built with seating arrangements, particularly clusters. Hinoki cypress wood (uncoated wood, oil-finished wood, vitreous-finished wood) was used in the park bench design to improve psychological wellness because hinoki fir wood has a psychologically relaxing impact (Ikei et al., 2017, 2018). Based on the recommendations and design plans presented, this research provides a new perspective for urban studies, particularly developing cities and their greenspaces by offering therapeutic urban parks to improve people's psychological health.

5. Conclusions

The COVID-19 pandemic has raised the prevalence of psychological health issues among young adults. Many studies have shown that green open spaces can have an impact on both physiological and psychological wellness. However, studies on the advantages of physical exercise such as walking and relaxed sitting in improving psychological health and quality of life are still lacking, particularly in Indonesia. Physical activity in urban greenspaces increased mood and relieved anxiety. Urban greenspaces with proper planning and design can help people overcome psychological disorders. As a consequence, presenting a suitable park design and relaxation amenities is required to achieve maximum psychological relaxation effects and promote park therapy activities (walking and relaxed sitting). Because the young adult participants in this study fall into the low-stress category, future research must explore subject criteria based on all stress levels to supplement existing design plans. Physical activity should then be repeated regularly to assess its impact on quality of life. that it can help users of urban greenspaces restore their overall health.

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Conflicts of Interest

The Author(s) declares(s) that there is no conflict of interest.

Data availability statement

The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding author/s.

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Original scientific paper

Fear and Architecture: Learning from Mega-Projects and Canal Istanbul as a Case

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ABSTRACT

Fear has been a fundamental aspect of human existence throughout history, and its connection with architecture has evolved as cities and the built environment have changed. Mega-projects, such as Canal Istanbul, play a significant role in shaping urban fear. Considering this fact, this study explores the relationship between fear and architecture in the context of mega-projects, with a focus on the case of Canal Istanbul, to define fear, identify its different types (environmental, socio-economic, technological), and examine their common underlying factor: generating a situation of uncertainty. The research investigates the Canal Istanbul project as a case study, presenting arguments supported by theoretical sources to explore the relationship between fear, architecture, and uncertainty. In this regard, this study adopts a qualitative and interpretive research approach. It provides insights into the potential consequences of the Canal Istanbul project concerning fear and architecture by emphasizing the importance of transparency and public participation in mega-projects, highlighting the need for detailed analysis and scientific references. Overall, the research contributes to understanding the interplay between fear, architecture, and mega-projects, offering valuable insights for future urban planning and development.

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Highlights	Contribution to the field statement
- The relationship between fear and architecture is explained through the mega projects. - The reasons why mega-projects and their relationship with the concept of fear are to be discussed from today's urban life with different perspectives. - The argument develops from the discussions of urban fear types and concludes with an assumption of generating a situation of uncertainty for the cities. - As a mega project, Canal Istanbul Project has created various types of fear in the society	The originality of this article is grounded on the analysis of the relationship between fear and architecture and concludes with a unique discourse of generating a situation of uncertainty for the cities. The article examines the concepts of fear and architecture, explains mega-projects and presents their relationship with fear and illustrates Canal Istanbul Project as a case.

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1. Introduction

Fear has existed since early human history; therefore, the concepts of fear and architecture have been related. However, as cities and the built environment change, the meanings of fear and architecture in cities also change. Power has used architecture as a tool from the past to the present to be talked about for many years and to leave a mark on cities. Today, mega-projects are the most important representatives of this concern to leave a trace. The Palm Deira Project was designed and built in Dubai; the Line Project was designed in Saudi Arabia; and the Mega-China Projects are mega-projects planned to be built in the 21st century. In recent years, Istanbul has witnessed the government's policy of rapid urbanization through urban regeneration and mega-projects. Istanbul is an emerging global city and an attraction point for real estate investors, which make their lion's share from the capital invested in urban mega-projects (Dogan & Stupar, 2016).

Canal Istanbul, one of the mega-projects of Istanbul, is an extremely large-scale urban project that was announced as a "Crazy Project" in 2011 by the government. However, since the project was announced, it has been widely discussed in public, political, and scientific publications and caused serious concerns. Therefore, since the beginning of the project's announcement, the whole process has caused fear and has a strong relationship with architecture. Similar to other mega-projects of the 21st century, where fear drives architecture and architecture drives fear, resulting from their existence.

Since the Canal Istanbul project did not have a transparent process, limited information about the project could only be obtained from Canal Istanbul's website. In addition, it is seen that the information on the official website is still not transparent and is not supported by scientific references. The decisions and explanations regarding the route, scale, budget, and the project's environmental impacts were announced to the public between 2011 and 2022 and have changed several times. They do not contain scientific information or general uncertainty regarding the project. This uncertainty is related to the unpredictability of mega-projects, a common feature of mega-projects, and is an important fact of the Canal Istanbul Project. It directly creates an atmosphere of fear through Canal Istanbul and its architectural existence.

Within the scope of this article, we examined the inconsistencies mentioned above and the contradictions. We presented the possible relations between fear architecture and mega-projects through the example of the Canal Istanbul Project and disclosed the types of fear in this project. Therefore, this study first examines the relationships between fear and architecture. Secondly, the emergence and characteristics of mega-projects from the past to the present are introduced, and the relationships between fear and architecture are explained. Lastly, it is aimed at examining the Canal Istanbul Project as a case study and as a mega-project to reveal its technical features, literature review, and visible and invisible reasons. As outputs, the types of fear created by the project are presented. In the conclusion section, the possible consequences of the Canal Istanbul project are evaluated concerning fear and architecture, and outputs are presented on whether the project should be built.

The article’s research method is based on qualitative and interpretive theoretical and emancipatory approaches, and evaluations are presented through Canal Istanbul as a case study. The idea of mega-projects generating uncertainty within the relational architecture of fear is unique. This statement can be evaluated as a possible contribution to the area.

2. Fear and Architecture

2.1. Definition of Fear

According to the Oxford English Dictionary, "anxiety" is "a feeling of pain or discomfort caused by a sense of impending danger and a state of concern for the safety of someone or something." Fear is a personal reaction that manifests as apprehension in the face of danger. (Tanyeli, 2022). Wurff, Staalduinen, and Stringer define fear as a sense of threat to one's well-being and a sense of being unable to overcome its existence (van der Wurff et al., 1989). Bauman likens fear and evil to Siamese twins. "You cannot meet one without meeting the other." "What we fear is bad; we fear what is bad."

Fears describe what people find bad (Bauman, 2006). The idea of "fear of fear" lies at the root of agoraphobia. This thought can be explained as the fear of excessive body reactions resulting from fear

and the consequences they will cause (Goldstein & Chambless, 1978). Fear of fear is a common feature not only for agoraphobia but also for different types of anxiety disorders, such as panic disorder, general anxiety disorder, social phobia, and obsessive-compulsive disorder (Chambless & Gracely, 1989). We unavoidably develop fear-inducing thoughts due to what we hear, hear, and see on television, in movies, in theatres, and in everyday conversations.

For this reason, in the development of the fear reaction, in addition to the natural occurrence of a negative event, the information we obtain from our environment may also cause the same kind of reaction (Gençöz, 1998). At this point, we see that observing an event can be a source of fear in addition to experiencing it directly. This condition is called fear of crime. Fear of crime can be described as "an emotional fear or anxiety reaction against a crime or symbols associated with crime" (Ferraro, 1995). In addition, according to studies, it can be said that fear of crime is a more common problem than the crime itself (Ditton et al., 1999). People can experience a variety of emotions about crime. These emotions are changeable. These feelings about crime are hidden in the answers to the survey questions about 'fear' (Farrall et al., 1997). Three cases are mentioned in the crime victimization surveys on fear of crime. Fear is the product of victimization, that is, it is experienced by the person who was exposed to the crime; it is the product of deterioration in social control; it is the product of the urban environment; it is the product of how people experience and interpret the urban space (Ditton et al., 1999). Fear is a distinct, primitive, and basic emotion (Izard, 1992). This primitive emotion brings with it a defensive response. Defence, a behavioural action, is a tightly organized component of the human motivation system. Fear is associated with intense neurobiological and cognitive features. It is revealed when dangers directly and imminently threaten us. The action tendency that this emotion elicits is the 'fight or flight' response (Lang, 1995). That is the 'emergency response' or the 'alarm response.' Strong fears lead to strong avoidance behaviour. Theorists consider this response to be an evolutionarily favoured, ancient response. The response is characterized by an urge to escape. This impulse reflects fear's basic propensity for action and flight (Cannon, 1929).

The clinical manifestation of fear is most evident in panic attacks. People experiencing panic show a behavioural urge to 'get out of there' in extreme fear. These impulses have important social consequences (Tangney et al., 1996). For example, these people avoid getting into situations where their urge to escape can be blocked. When a person begins to avoid a situation that causes fear, he restricts his freedom of movement. This restriction blocks the emotions we can experience in everyday life. Avoiding the possibility of experiencing the thought of 'what if something negative happens?' is the product of 'fear of fear' (Gençöz, 1998). Fear increases personal resentment and decreases the desire to participate in social encounters (Ferraro & Grange, 1987). Based on the concept of fear defined by Bauman, characterizing the thing feared as "evil" involuntarily necessitates an action plan, as it describes the elimination of the "evil" on which the fear is based (Bauman, 2006). All these dynamics of fear and eliminating evil are welcomed in space. Uğur Tanyeli likens the fear of socializing to swimming in the sea on the shore. There is uncertainty in the sea, and one fears uncertainty, but such behaviour destroys the possibility of experience (Tanyeli, 2022).

Since the beginning of time, fear has been one of humanity's most pressing concerns. Since cities have evolved, the fear concept has also evolved. The concept of fear has also influenced and shaped architecture. In the prehistoric period of medieval cities, people used vast walls or fences to fortify their cities and protect them from their enemies (Ellin, 1997). Then, with capitalism, new insecurities arose. These insecurities created new construction methods. It attempted to resolve the fearful atmosphere created by the use of architecture. More controllable spaces began to be created. By using architecture in an overly controlled way, more controllable spaces are created, which is expected to make people feel safe. However, this triggers fear and anxiety in people's lives.

2.2. Architecture of Fear / Fear of Architecture

The city's diversity provides people with opportunities to experience and learn. However, due to practices based on the fear factor, the city has become a stray, restless, and disorderly place (Bannister & Fyfe, 2011) reflected in the city's walls and gates aimed at creating sheltered areas. With the development of technology, boundaries have been crossed. Taking precautions against danger by drawing borders also creates fear in people because they will not think they are safe anywhere except in the areas where the borders are drawn. Furthermore, implementing high-security measures, such as secure sites, shutters, alarms, bulletproof windows, and so on, has increased public distrust.

Along with the modern period, the elements in the city became a cause for danger. Social and geographical mobility gained momentum with increased railways, factories, etc. In the modern era, the difference is now seen as an element of danger, and fear has arisen against the difference (Bannister & Fyfe, 2001). They separated functions by comparing cities to machines. This approach is isolating. As a result, social awareness has decreased, the city's fabric has deteriorated, and the environment has been damaged. The class differences that emerged with capitalism gave birth to colonial culture. Capitalism has caused a lack of foresight and uneasiness among the people around it. These insecurities created spaces that could be controlled, observed, and controlled, courthouses, police stations, and prisons are examples. The Panopticon prison model can be given as a striking example of a prison. This architectural concept was developed by Jeremy Bentham in the late 18th century and included a circular prison design where a central watchtower allowed guards to observe the inmates unseen. The design was intended to create a constant sense of surveillance and control that would instil fear in the prisoners and prevent them from rebelling. Another example of these practices is the Pruitt-Igoe residential project in St. Louis, Built in the 1950s, which aimed to provide affordable housing for low-income families. However, the project was poorly designed, with buildings that were difficult to maintain and lacked adequate lighting and other amenities. The result was a sense of decay and neglect that created a breeding ground for crime and other social problems. The project was eventually demolished in 1972 after being in operation for less than 20 years.

With all these developments, the transition from the architecture of fear to the fear of architecture began. After Baron Haussmann's reconstruction and the new urban design of Paris, the bourgeoisie segregated itself from the low-income and working classes by constructing arcade buildings (Frisby, 2004). Furthermore, it sampled factory workers, where workers did not have enough time to complete mass production (Ellin, 2001). With the rebuilding, everything was to be made uniform. However, it was not possible to eliminate the differences. The idea of defining a single ideal for the needs and wants of all people is not possible. Efforts to create safe areas have fed the feeling of insecurity because anxiety and fear, especially fear of crime, have emerged everywhere, including in areas defined as safe.

At the beginning of the early modern era, modernist architects and designers criticized the Iron Age's understanding of urban design and building decoration styles. They used functionalism as a methodology and the discourse that 'form follows function.' However, from the 1950s to the 1960s, post-modern architects accused modernist architects of orienting people like machines and alienating them from everything, as discussed in the book 'All That Is Solid Melts into Air' (Berman, 1982). Some ecological and post-modern movements, such as escapism, nostalgia, and detribalization, sought to return to pre-industrial period movements, such as new urbanization against isolation, segregated master plans, and zoning (Ellin, 2001), which evidenced fear from the early modern period. In the book "The Death and Life of Great American Cities," Jacobs (1961) argued that modernist planning principles, such as zoning and separation of uses, led to destruction. He said it causes the loss of urban communities and social diversity. Instead, he advocated a more organic and mixed-use approach to urban design that values human scale, pedestrian activity, and social interaction. Many safety solutions were developed in cities to protect urban economic development (Bannister & Fyfe, 2001). For example, using lockable cars, monitored CCTV surveillance systems, and security guards reflected some security concerns (Ellin, 2001). Paranoid typologies explained this situation when various low-income communities took precautions against crime. Luxury camps with high-security monitor

surveillance systems, where wealthy people live, pocket ghetto communities surrounded by police barricades (Flusty, 1994), where low-income people live, and gated communities are examples of the architecture of fear. All this insecurity continues today. Integral urbanism and good urbanism are solutions to the isolation and fear of separate functions caused by the separate cities created with the master plan. The concept of integral urbanism indicates that the new urban movement model focuses on solving urban problems through participatory design. Develop cities that are best maintained through organic interventions rather than master planning and social engineering. Five qualities are displayed to achieve this. Hybridity, connectivity, porosity, authenticity, and vulnerability (Ellin, 2006). Some examples are Vauban, Germany: This neighborhood in Freiburg is designed to be car-free and incorporates a range of sustainable technologies, such as solar power and rainwater harvesting. Barcelona, Spain: This city has implemented innovative urban planning strategies, including pedestrian-friendly streets and a network of public squares and green spaces.

In his book Good Urbanism, Nan Ellin's approach to the city is also subtle. Good urbanism respects the past by preserving historical textures and reusing existing structures, preserving their value while improving the low-performing ones. We can also see potential in what we call problems. The High Line project in New York is one of the strongest examples of this perspective. The High Line was the former elevated rail line. It has been transformed into a public park with green spaces, seating, and other amenities. The project was designed to create a warm, inclusive public space to unite people and develop a sense of community (Ellin, 2013). Interventions in cities with fear and security concerns have been discriminatory and destructive. Setting up borders or creating safe havens did not reduce fear but increased it.

In conclusion, fear will always be in our lives. Today, we are confronted with mega-projects proposed by governments concerned about leaving no trace. The great intervention of these projects in the city also creates various fears (environmental, technological, economic, etc.) for society.

3. Mega-projects and Their Possible Relations with Fear and Architecture

Mega-projects are not phenomena that belong to the 21st century; their historical roots go back to the times of hunting and gathering, even to sedentary life if Göbeklitepe is taken into account. Monuments and temples built in the names of gods, pharaohs, and kings are the beginning of mega-projects. God-kings and emperors wanted to go down in history through these gigantic monuments that they thought would stand for centuries (Uzunçarşılı Baysal, 2017). In this context, mega-projects have resulted from the authorities' desire to leave a mark. When politicians stay in power for a long time, they want their names to go down in history, and they use architecture and mega-projects as tools for this purpose (Tezer, 2013). The authorities desire to leave a trace can undoubtedly be considered a policy of demonstrating power. From the past to the present, it can be seen that in every interval, the authorities have somehow left their traces. The desire to leave a trace is related to the fear of being unable to leave something of themselves when they look back. This sense of fear may result from producing 'mega-projects' today. Actors' relative power and interests in an epistemic community may change over time. Still, apart from ideological orientation, we find certain constants in their culture—assumptions about their roles that favor action even at the risk of certain displacement. First, within any particular historical moment, members tend to believe that they ‘‘know’’ how best to do projects and to assume that, once conceived, a mega-project is inevitable, i.e., ‘‘if we didn’t do it, someone else would’’. In other words, while progressing, experts within the epistemic community see themselves as being in a better position than others to minimize risks (Gellert & Lynch, 2003).

In the age of technology and information, it is possible to say that the number of mega-projects worldwide has been increasing in recent years. Particularly in developing countries, mega-projects are a part of neo-liberal policy. It is a fact that, in order to have a place in the global world as a city, mega-projects are the most effective tool to increase the authorities’ desire to generate mega-projects. In the globalized world, cities compete with one another for financial capital while experiencing construction booms to promote mega-projects. In a certain context, mega-projects help support the fear released

through architecture. In some cases, uncertainty and complexity accompany the fear. From this perspective, fear can establish a strong association with uncertainty and complexity.

On the other hand, a power expression through architecture could be the result of this competition. At least from the perspective of many urban planners, legislators, and corporations, strategic and large-scale mega-projects are becoming more associated with the perception of a city. (Bornstein, 2010). On the other hand, community responses to mega-projects. Mega-projects adhere to an urban development model that many governments prefer: high-profile strategic projects with the potential to achieve short-term objectives, attract outside capital, and redefine a neighborhood or the city. Mega-projects respond to the fierce struggle between cities worldwide for capital, knowledge workers, visitors, and prestige (Dicken et al., 2002; Brenner, 2004).

Technology now controls a sizable portion of society thanks to modernity. In this society, due to scientific knowledge and technological development, some things that could not have been done in the past are now possible (Tezer, 2013). As technology becomes a tool for development, societies' and governments' desire to show themselves with new projects, i.e., mega-projects, emerges. Technological development pressures us to create mega-projects (Özbekhan, 1972). Such mega-projects will seek to implement something on a scale that has never been done before in the place where they are being built, often relying on new knowledge and technology. Mega-projects are handed down from one era to the next, but the difference in our time is their number and scale, which are growing incredibly. Massive infrastructure investments are at their peak, especially in the transportation, energy, water, and agriculture sectors. Today, with technology, because mega-projects are considered large-scale projects with large capital, supported only by visuals and without any feasibility studies, no clear information is provided to the public. However, it is obvious that the larger the scale of mega-projects, the greater the risk. It should be emphasized that the right to the city and the right to nature should speak against mega-projects. It should be considered that natural assets can renew and produce themselves. After the right to the city, the right to nature should also be discussed (Harvey, 2007). Calculations for mega-projects are often unpredictable. Mega-projects frequently cost far more than expected, opening them up to allegations of corruption (Tezer, 2013). Mega-projects are sometimes not explained to the public fully and can often lead to questionable situations, one of which can be related to the budget; sometimes, the unforeseen budget issue can be an issue not understood by the public over time. Some see an uncertain future for mega-projects; they would argue that their declining numbers, whether due to globalization's emphasis on flexible production, social protest, or the exhaustion of potential sites, indicate that the bias toward scale may be a thing of the past (Gellert & Lynch, 2003).

Projects are never completed at the predicted cost and on time. From energy transportation to agricultural projects to water, in 9 out of 10 projects across all sectors, costs are exceeded and borne by governments, taxpayers, and consumers (Uzunçarşılı Baysal, 2017). The magnitude of mega-projects and their power to influence society mean that democratic decision-making processes based on majority voting are often at the expense of the people living in the areas where the projects are located (Tezer, 2013). Another problem is the need for transparency in the decision-making and democratic deliberation processes of the projects and to maintain confidence in the functioning of the oversight mechanism for their implementation.

Since the late 1970s, a new stage of capitalism has been emerging. In a world in which all the rights and gains provided by the social welfare state are destroyed, states are run like corporations. Even under the guidance of global corporations, citizens are turned into consumers; basic social rights such as housing, education, and health are transformed into commodities that can be bought and sold, the commons are privatized and offered to capital; the city, the countryside, nature, history, and cultural assets are commodified and put into accumulation processes; moreover, rights and freedoms and the norms of the rule of law are violated; the public interest is transformed into the interest of capital... In this new phase, which puts capital/profit, not people or life, at its center, we are at the turning point where democracy is moribund. Therefore, it is necessary to look at mega-projects differently without ignoring those mentioned above (Uzunçarşılı Baysal, 2017). According to David Harvey, one of the

world's leading social theorists, the reproduction of urban space gains importance in neoliberalism, which cannot generate significant profits since most profits are derived from the speculation of assets and the creation of new assets to be invested in. That is to say, the crisis of over-accumulation in industrial production, the first cycle of capital, is solved in the second cycle by investing this accumulation in urban space and commodifying urban space. Mega-projects can solve the accumulation crisis, which is the most extreme point that urban transformation in this second cycle can reach.

According to David Harvey, in neoliberalism, which cannot be a significant producer of profit, most of the profit is derived from the speculation of assets and the creation of new assets to invest in. In this context, the reproduction of urban space also gains importance, as the problem of over-accumulation in the first cycle of capital, industrial production, is solved by investing this accumulation in urban space. Mega-projects are reconfigured and reterritorialized environments where the participation of local, regional, and national elites and the function of national and occasionally transnational capital are typically prominent, as will be made plain in the contributions to this volume. Increased urban competitiveness and global visibility are seen as essential outcomes in the development of these projects. Still, mega-project design and implementation also frequently address the need to bring together and harmonize several scales of power because, in various socio-political contexts, the configuration of political power exhibits different and distinct relationships between the local, regional, national, and global domains of social action (Del Cerro Santamaría, 2020).

Thus, the city, which was the place where commodities were produced in this second cycle, now produces land to be transformed for the needs of capital as a mega commodity. Mega-projects, which are considered urban projects, are evaluated as so absurd that they can be considered urban; they are the lifeblood of revitalizing the global economy without realizing the countryside (Uzunçarşılı Baysal, 2017). Flyvbjerg characterizes mega-projects as related to uncertainty because of their understated risks and outsized returns. Disasters destroy the environment, destroy the habitats of entire communities of living beings, trigger displacement, plunge states into financial crises, or shake their budgets. In this context, the risk is broad, including environmental, social, financial, health, and safety risks (Uzunçarşılı Baysal, 2017).

Mega-projects can also be considered 'mega decisions' in another sense. It is possible to consider that these 'mega-decisions' are not only a change on the urban scale but also a change on the emotional level. At the same time, urban paranoia caused by mega-projects can lead to disconnections from the city in people's daily lives. It can cause a person to gradually disconnect from the city, reduce his/her relationship with the city, and reduce 'porosity.' These disconnections may cause fear and insecurity in society. Mega-urban projects can cause damage to society; these large urban projects do not benefit all residents and serve a minority of the population (Cugurollo, 2013). Mega-projects envision an ideal, non-existent space with unquestioning environmental, political, and economic rules. However, this vision belongs to a local ruler aiming to express power (Cugurollo, 2013). The Canal Istanbul project will shape the future of Istanbul and its surroundings. Still, this hugely significant project has not been open for discussion at a public inquiry and has been conducted in a non-transparent manner. Although almost nine years have passed since it was announced, no official document has been released publicly (Ceylan Baba, 2020). This continuous state of ambiguity creates an everlasting unease, that turns into fear. From this comes a society that lives in fear and a social order that operates by mechanisms contingent on this fear (Ceylan Baba, 2020). This non-transparent, ever-changing sea of information creates an atmosphere of unease and insecurity in society.

4. Canal Istanbul Project as a Case

Canal Istanbul is a mega-project that aims to build in the European part of Istanbul and is announced on April 27, 2011, as a 'Crazy Project' by the Turkish Republic Government (Ceylan Baba, 2018). The project aims to create a parallel artificial canal to the Bosporus in Istanbul. According to the former president of the Chamber of Architects, Mücella Yapıcı, the project is not only the mega-project of Istanbul but also the mega-project of Turkey (Köksal & Öztürk, 2017). Moreover, the Canal Istanbul

project continues the New Istanbul Project, including the Istanbul 3rd Bridge, the New Istanbul Airport, and other existing construction projects (Logie & Morvan, 2018). In addition to referring to the prospective shores of Canal Istanbul, the project is also planned as an enclave around the New Airport (Mutman Uluengin et al., 2022; Logie & Morvan, 2018).

Furthermore, it is stated that, in addition to hotels, cookhouses will be located along the canal and numerous mosques in each neighborhood. The official aim of the Canal Istanbul is; to decrease busy ship traffic on the Bosporus and rotate the cargo ships to the Canal Istanbul, thereby avoiding ship accidents and creating safe routes for these ships (Ceylan Baba, 2020). In addition, the Ministry mentioned that the new canal aims to protect and preserve the historical and cultural heritage (Ceylan Baba, 2020). On the other hand, according to critics, the implicit aim of the Canal Istanbul Project is related to economic gains, which are linked to the New Istanbul Project, which is a round of mega-projects in Istanbul (Ceylan Baba, 2020; Kılıç, 2020). As far as the official website of the project shows, scientific studies and analyses have not yet been shared with the public, and the canal route and measurement distance vary yearly and remain uncertain.

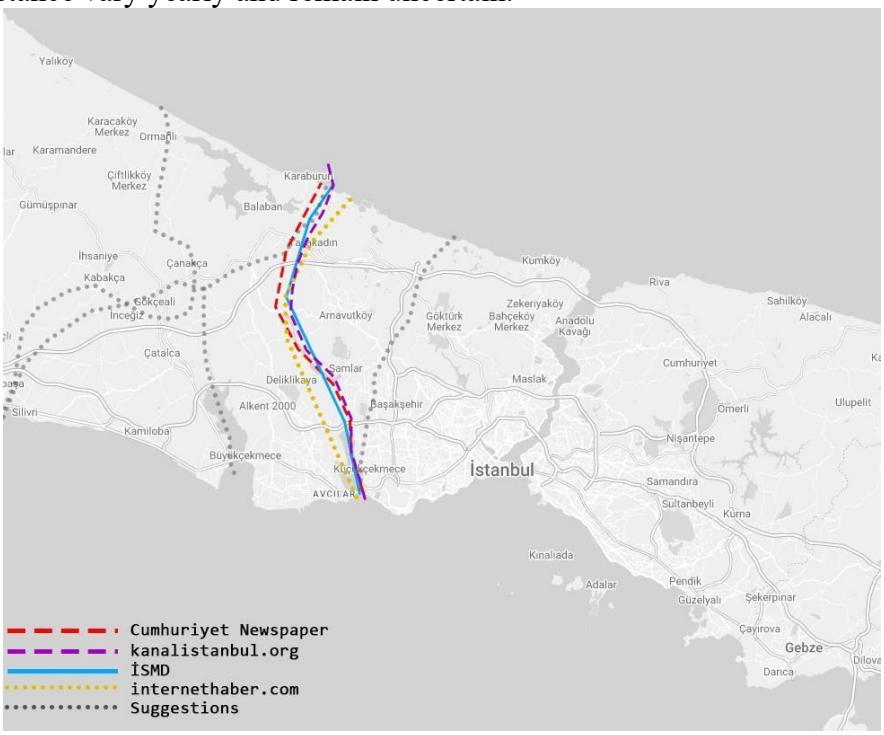


Figure 1. Alternatives routes of Canal Istanbul.

4.1. An Overview of the Canal Istanbul Project

The physical features of the Canal Istanbul Project have many controversial issues. The project has multiple alternative routes and remains uncertain. The Canal Istanbul Alternatives Route Diagram depicts the canal's planned alternative routes. The last approved canal route is on the Küçükçekmece-Sazlıdere-Durusu axles (see Fig. 1). On the official website of the project, the technical features of Canal Istanbul were published; the length of the route is 45 km the minimum width is 275 m, and the depth is 21 m. On the other hand, environmental experts criticize this amount of excavated soil, who say it can create air pollution and noise (Ceylan Baba, 2020). In addition, several sources have different costs for the Canal Istanbul Project. According to the Ministry of Transportation and Infrastructure, the project budget is 75 billion Turkish Lira (Ceylan Baba, 2018). However, since the exchange value of the Turkish Lira currency has been decreed, the project's cost is increasing daily.

On the other hand, it is mentioned in the 'Workshop Report of Canal Istanbul' in 2020 – the project cost does not reflect reality. As it is a mega-project, the project's cost could be very different from the calculated cost, and new cost inputs may appear during the project's construction stages (Kılıç, 2020). As mentioned in this study's "Mega-Projects" chapter, mega-projects are never completed at the predicted cost. In addition, the project cost could be increased during the construction process

(Uzunçarşılı Baysal, 2017). On the one hand, mega-project decision-making processes based on majority voting are often at the expense of the people living in the areas where the projects are located (Tezer, 2013). The Canal Istanbul Project is also an important factor for the Istanbul population. The 1/100.000 scale zoning plan of the project states that five hundred thousand people will live in the project area. On the other hand, the population of the Canal Istanbul Project estimates that if all the announced 800,000 housing units are built, a population of 2.4 million can be expected in the area (Mutman Uluengin et al., 2020; see Fig. 2).

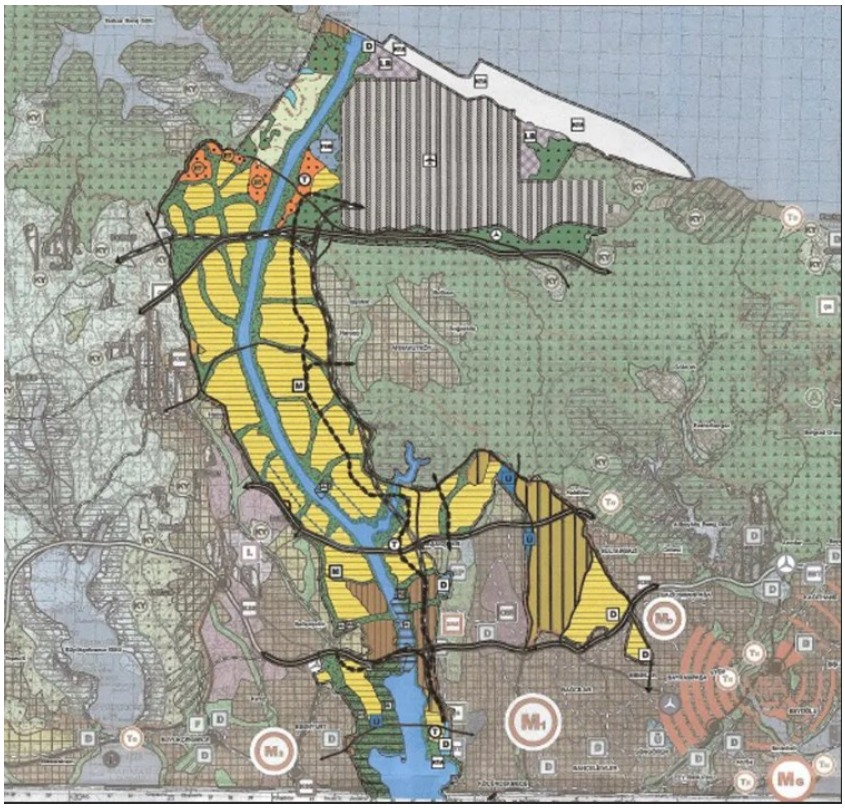


Figure 2. 1/100.000 Canal Istanbul Project Plan (Kılıç, 2020).



Figure 3. Canal Istanbul Project Initial 3D Renders (Ceylan Baba, 2018).

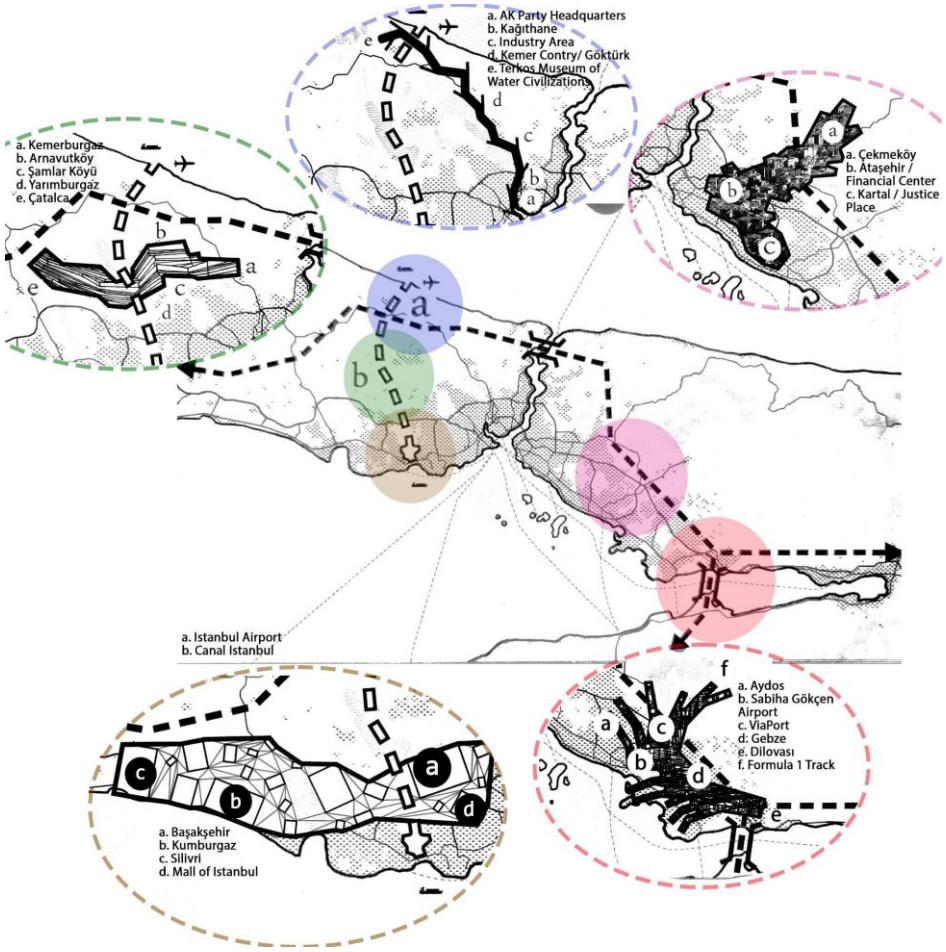


Figure 4. Canal Istanbul Project continues, and the New Istanbul Project.

4.2 Literature Review on Canal Istanbul Project

Since its announcement, the Canal Istanbul project has been the subject of interest in the local and international press and academic articles. The main topics discussed in the articles are environmental, infrastructural, economic, political, security, and international law. The environmental topics include ecological effects, earthquakes, sea animals, and the habitation of natural life. According to the Ministry of Communication, project effects on ecology and the environment have been considered by scientific works, and the project will not damage natural areas or archaeological sites. However, the scientific works mentioned by project supporters and the government are still unavailable. On the other side, the critics pointed out that the project will destroy the Marmara Sea (Saydam, 2015) and the Dead Sea animals (Ceylan Baba, 2020). Furthermore, in the EIA (CED) report, salt water from the canal of the groundwater source could adversely affect states (Kılıç, 2020). Also, due to its current route, the project will destroy the Terkos and Sazlıdere natural water sources, which are important drinking water sources for residents of Istanbul (Baba, 2020). According to academicians, the project will also affect Istanbul's archaeological sites (Kılıç, 2020). Another topic discussed in the articles is related to the economic effect of the Canal Istanbul Project. From the perspective of critics, it is pointed out that; according to the non-official aim of the project, it aims to become an attractive center for investors (Ceylan Baba, 2020). Conversely, it is evaluated as a logistical gain for Istanbul (Karataş, 2021). According to the critics, the Turkish Bosporus, recognized as a UNESCO cultural heritage site connecting two continents, must be protected (Öğüt, 2014). On the other hand, it is stated that; Turkey has the right to unilaterally determine the legal regime of the canal due to the existence of an independent political authority (Çınar, 2017). The figure below shows the timeline of research on the Canal Istanbul Project as a literature review summary.

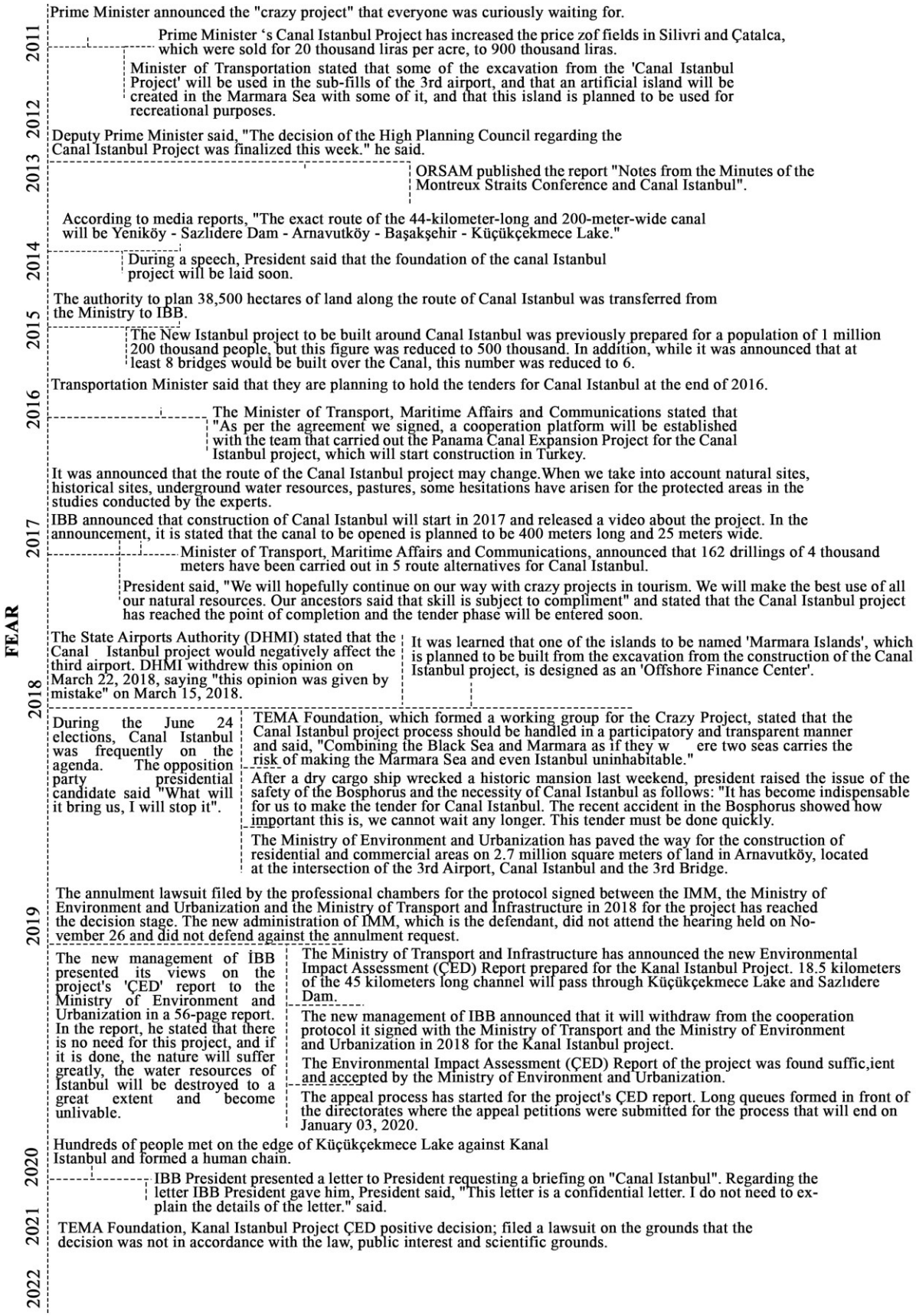


Figure 5. Timeline of the research on Canal Istanbul Project.

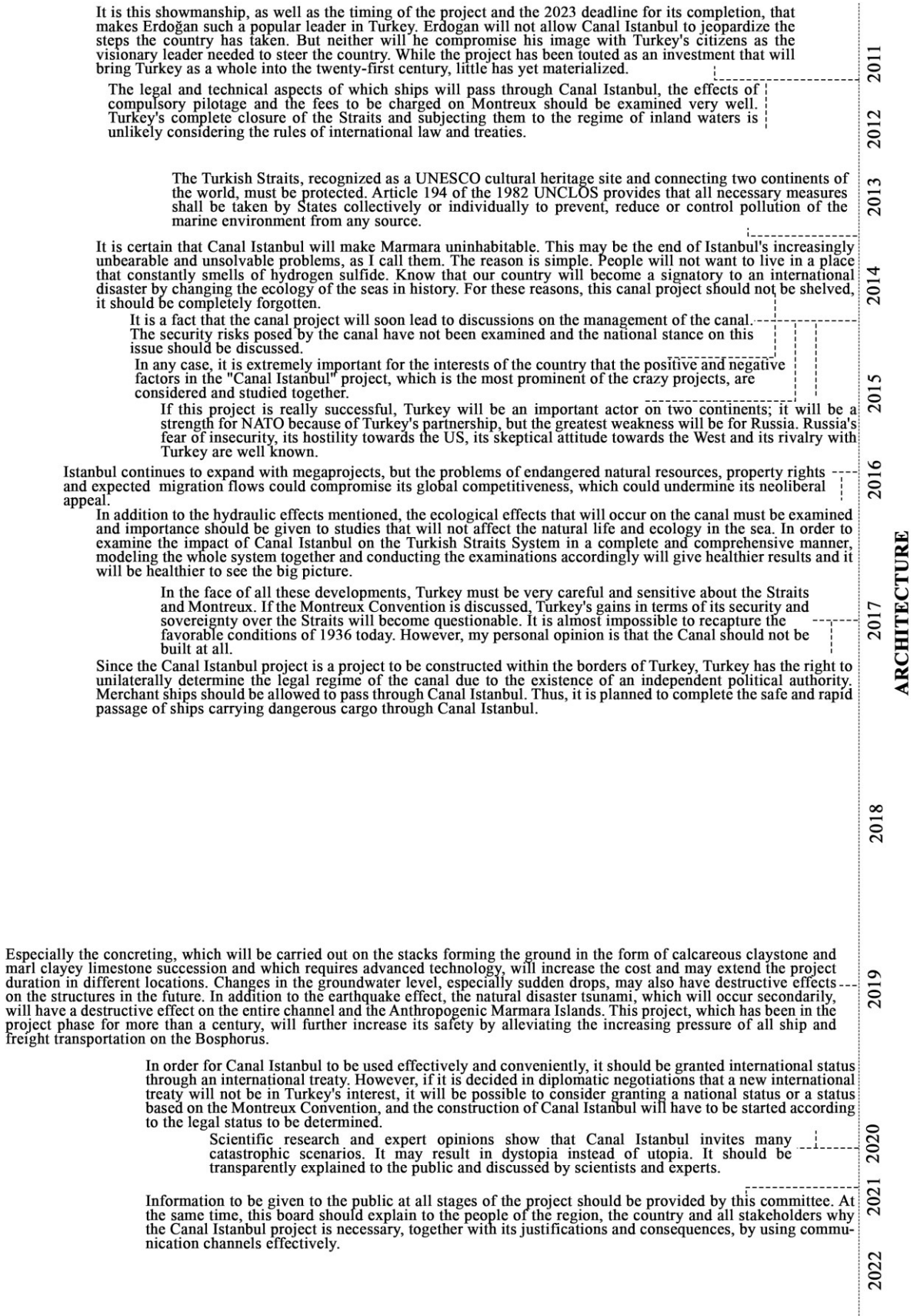


Figure 6. Timeline of the research on Canal Istanbul Project.

The Timeline of the research on the Canal Istanbul Project is categorized into two parts. One lists “news” about the project, and the other lists “scientific articles.” In the news part, it is mentioned that project

alternative routes news, the negative comments of opposition politicians about the project, and the environmental damages of the Canal Istanbul project in some news reports are included. Also, one of the criticisms of the project is its economic effects. The number of news and statements about the project by the supporters has increased, especially during the election period. Also, the scientific article listed the project's international law and security issues, economic topics, and environmental-technological topics. The project remains uncertain because the details of the project regarding cost, routes, construction periods, technique details, construction techniques, and other topics remain uncertain. This uncertainty concerns a relationship with fear of society.

4.3. Possible Relations of the Canal Istanbul Project with Fear

The Canal Istanbul project has many possible relationships with fear regarding the environment, technology, economy, politics, sociology, security, and *uncertainty*. From this point, there is fear of uncertainty both on the governmental side and public concerns. According to scientific research on Canal Istanbul Project, the project should be presented to the public with all circumstances, evaluations, and possible effects on Istanbul (Ceylan Baba, 2020; Mutman Uluengin et al., 2022; Öğüt, 2014). Fear typologies such as economic fear, political fear, fear of safety and security, environmental fear, and technological fear occur with an examination of the project (Ceylan Baba, 2020; Mutman Uluengin et al., 2022; Öğüt, 2014; Saydam, 2015). Also, fear of power and political and economic fear is the main fear of the project supporters.

The most prominent aspects of the project are environmental fear and technological fear. Therefore, excavation works, transportation of excavated soil, and construction equipment in Figure 6 - illustrated by the Istanbul Planning Agency (IPA) - show the effect of fears on Istanbul.

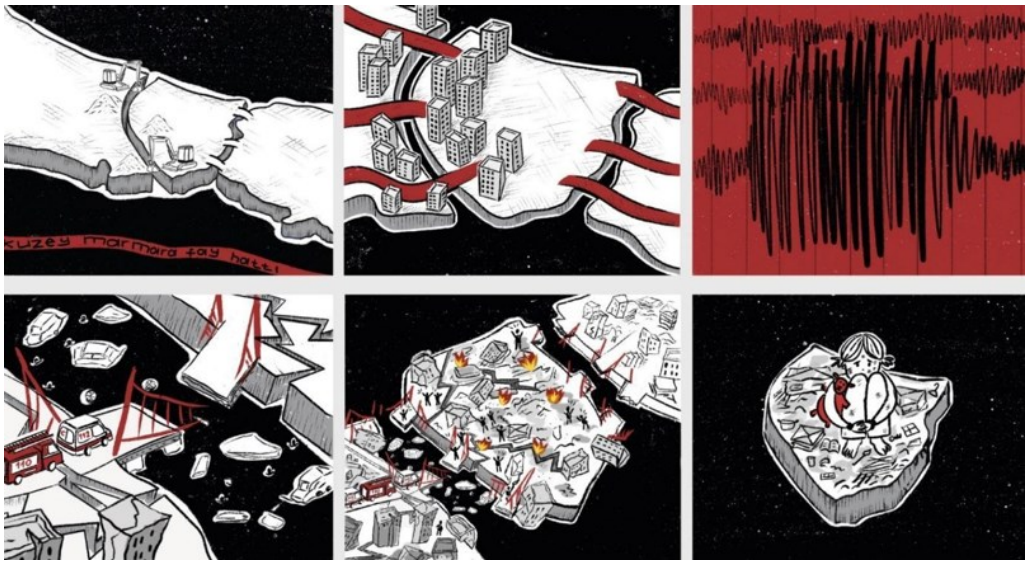


Figure 7. Technological Fear (Yıldırım, 2021).

Other possible results of environmental effects of the project are, due to heavy excavation works and transportation of excavated soil, Istanbul will have air pollution and noise (Ceylan Baba, 2020). In addition, the new project will be a risk to ecological life and affect natural life (Saydam, 2015). Figure 7 - which is illustrated by I.P.A - explains the environmental effect of the Canal-Istanbul-Project.



Figure 8. Air pollution and Construction Works (Yıldırım, 2021).

Another type of fear is economic and political, presented by project supporters and critics. Economic and political fear strongly relates to neo-liberal politics. The scientific articles present the Canal Istanbul Project as the result of neo-liberal policies (Köksal & Öztürk, 2017; Mutman Uluengin et al., 2022). The official page of the Canal Istanbul Project states that the project will be economically gain because ships pass through the new Canal by payment of pass (Ceylan Baba, 2018). On the one hand, Canal Istanbul Project aims to become a center of attraction for foreign investors, which is mentioned as an implicit aim of the project. Moreover, it is mentioned that the Canal Istanbul Project is a Utopian Project, which can result in dystopia, which shows dystopian aspects of fear (Ceylan Baba, 2020; Mutman Uluengin et al., 2022). Therefore, the community views this approach with fear and raises concerns about displacement, population growth, and increased cost of living.

Fear of Security is one of the other aspects of the project. The new Canal to be opened with the Canal Istanbul project makes the status of the Bosporus controversial in the international community. Furthermore, it is mentioned that; the legal and technical aspects of which ships will pass through Canal Istanbul, the effects of compulsory pilotage, and the fees to be charged on Montreux should be examined in detail (Ece, 2011). Other typologies of fear coexist with the international anxiety generated by the project. Also, project problems of endangered natural resources, property rights, and expected migration flows could breach global competitiveness (Dogan and Stupar, 2017).

As mentioned in the previous chapter, fear occurs when a sense of threat to the well-being and a feeling of being unable to overcome the source of fear. Furthermore, the feeling of "bad" is related to fear (Bauman, 2006). Moreover, from a societal perspective, this fear is considered a fear of uncertainty. Canal Istanbul Project maintains the fear of uncertainty on the side of the Project supporters, critics, and society level. Furthermore, fear of architecture shows itself within all aspects of the fear of Canal Istanbul Projects.

The image below gives a concept map of this study that includes keywords in the relationship between the Canal Istanbul Project and fear. It is prepared from general to specific and includes keywords related to fear of architecture, paranoid structures, integrated urbanism, and good urbanism.

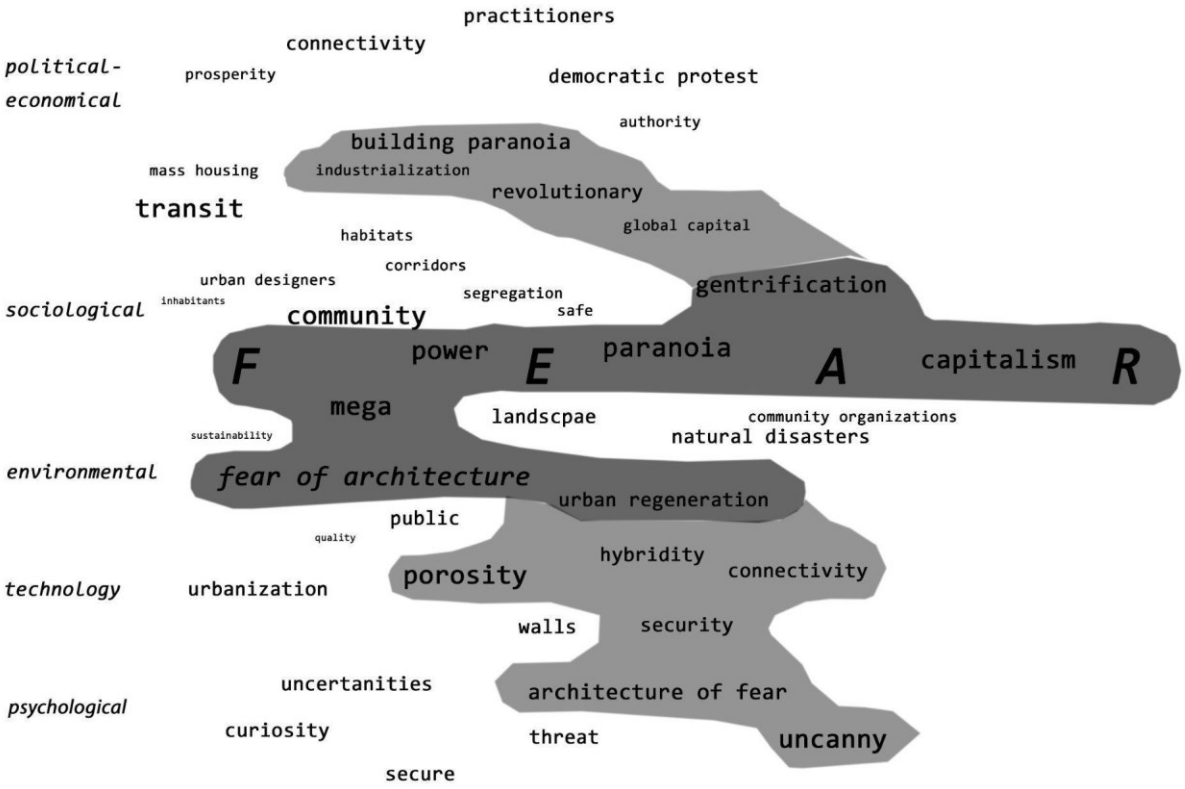


Figure 9. Concept Map of Canal Istanbul Project.

The keywords reflecting the social, political, economic and environmental, technological, and psychological impacts of the project are included in the conceptual map. The project's lack of transparency has allowed this architectural fear to generate keywords such as extraordinary, democratic protests, hybridity, sustainability, threat, security, curiosity, and connectedness on a social, psychological, environmental, and technological basis. When the political and economic aspect of the project is analyzed, it allows the words capitalism, urban renewal, gentrification, security, and protest to appear in the table. All these assumptions reveal the relationship between fear and fear and the architecture of the Canal Istanbul project, which shows that the project's relationship with the concept of fear and architecture is based on uncertainty.

5. Conclusions

The Canal Istanbul Project is a mega-project that attracts attention on national and international platforms. However, from its announcement, fear of architecture—one of the subtitles of "fear"—had a strong relationship with the 'Crazy Project.' The project includes several fear typologies: environmental-technological, economic-political-sociology, and fear of uncertainty. The new Istanbul is mainly formed by mega-projects that are representatives of neoliberal politics of the 21st century. Within this context, the Canal Istanbul Project has triggered several types of fear in the city since 2011. In addition, the project affected the main atmosphere of the city by generating the fear of uncertainty in society. Mega-projects usually have non-transparent processes, which also emerged in the Canal Istanbul Project; the fear of uncertainty persists both on the political and contracting sides.

A common conclusion in the scientific articles that evaluated the project both positively and negatively stated that it should have a detailed analysis and be transparent to the public and all its stakeholders. Mainly from the experts' and academicians' perspectives, the project has many environmental, technological, and socio-economical dimensions. Environmental fear connects with technological fear

because the projects demand many excavation works and construction techniques, which will result in noise, air pollution, and destruction of the ecological environment. While the official reason for the project is to provide logistics, transportation, and security on the Bosporus, the unseen reason for the project, which is based on economic interests, is to make this region a centre of attraction. This causes economic fear as it will burden Istanbul and Turkey financially. On the other side, the project's cost varies, and the possibility that the Canal Istanbul project will be built at a higher cost than the estimated cost, as in mega-projects, causes economic fear in the power and the public. Also, as neo-liberal politics affect the project and Istanbul, it is mentioned in some articles that the project would affect Istanbul's residents in terms of population and demography. All these fears mentioned above generate an unclear future for the realization of Canal Istanbul. This argument supports the idea of uncertainty in Istanbul. Another characteristic of mega-projects is the desire to generate interest and talk about the project. The political power desires to leave a mark on the city and mega-projects are used as a tool for this desire. Fear of the lack of this mark can be explained as another type of fear related to mega-projects. Also, the safety and security issues that arise from national and international laws, the safety of the strait, and ship accidents in the Bosporus, which are widely discussed and scientific articles have been written about, are other fear factors related to the arguments of political power.

In conclusion, the project should not be constructed for economic, transportation, or environmental reasons. However, if the power decides to do this, the process should consider public opinion and be transparent. After the literature reviews and our analysis, this project will change Istanbul's ecosystem regarding nature, air, water, animals, economic loss, international law problems, security, and others. Therefore, considering the damages of mega-projects and the fact that this research reveals that many fears are harboured over the Canal Istanbul Project, the project's construction should be removed from the agenda. Even if it is criticized for the climate crisis, mega-projects are still being carried out. Its proliferation is alarming, but mega-projects continue to be made for developing countries. This situation has changed in developed countries, and they now take a more fragmented approach instead of producing mega-projects. Developing countries continue to develop mega-projects to exist and be heard in the world.

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The Impact of Urban Home Gardens on The Mental Well-Being of Women in The Greater Jakarta Area

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ABSTRACT

Promoting positive mental health is of utmost importance, especially in today's urban context, as recognized by the World Health Organization. However, the scarcity of green spaces in urban areas presents challenges for fostering a connection with nature. To address this gap, this study investigates the distinctive contribution of urban home gardens to the mental well-being of women in the Greater Jakarta Area. Through an online survey, participant backgrounds and mental well-being were assessed using the WEMWBS scale. Validity and reliability were established using Pearson's product-moment correlation and Cronbach's alpha, respectively. The study unravels several influential factors, including garden interaction (visit frequency and duration) and size. Crucially, it advances the literature by shedding light on the original contribution of urban home gardens to mental well-being. Notably, women who visit their urban home garden more than seven times a week and spend over two hours per day in their garden report the highest levels of mental well-being. These findings highlight the unique role of urban home gardens in promoting mental well-being among urban women. Consequently, they hold implications for policymakers and practitioners aiming to enhance mental well-being and foster access to green spaces in urban areas.

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Highlights	Contribution to the field statement
- This study reveals the positive impact of urban home gardens on the mental well-being of women in Greater Jakarta Area. - Women who visited their home garden more than seven times a week and spent more than thirty minutes per day in their garden reported the highest levels of mental well-being. - Research highlights the unique role of home gardens as accessible green spaces, offering potential solutions to improve mental well-being in urban settings. - This study provides valuable insights for policy makers and practitioners aiming to promote mental health and increase access to green spaces in urban areas.	This study significantly contributes to the existing literature by examining the impact of urban home gardens on the mental well-being of women in the Greater Jakarta Area. It sheds light on the unique role of home gardens in promoting mental well-being, particularly for urban women. The findings provide valuable insights into the positive effects of frequent garden interaction. This research expands the knowledge base and offers new insights for policymakers and practitioners aiming to enhance mental well-being and improve access to green spaces in urban areas.

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1. Introduction

The field of mental health has received considerable attention in recent years, with a growing emphasis on the significance of positive mental well-being. The World Health Organization (WHO) recognizes the crucial role of positive mental health in enabling individuals to trust their abilities, effectively cope with life's challenges, perform productively, contribute meaningfully to their communities, and ultimately enhance their overall quality of life (Tennant et al., 2007). In line with this, the WHO has provided recommendations for sustaining mental health and psychosocial well-being, including engaging with nature as a healthy living practice. Notably, (Krols et al., 2022) have highlighted the numerous health benefits associated with exposure to nature, which include improved subjective well-being, enhanced quality of life, and reduced stress levels.

Furthermore, (Pouso et al., 2020) conducted a study revealing that maintaining contact with nature during stressful life events can aid in the preservation of mental health. Notably, individuals residing in greener rural areas reported fewer symptoms of mental and physical ailments compared to their urban counterparts. However, the rapid urbanization observed in densely populated regions such as the Greater Jakarta area has led to a scarcity of available land that can be utilized as green open spaces (GOS) (Budiman et al., 2014).

The situation was further exacerbated by the mobility and social restrictions implemented during the Covid-19 pandemic, making it increasingly challenging for urban communities to access green open spaces. The government's implementation of Large-Scale Social Restrictions (PSBB) meant that individuals were confined to their homes, with transportation, office activities, schools, recreational areas, parks, and places of worship all closed. This quarantine policy had significant adverse effects on society, notably contributing to a decline in psychological well-being. (Elvira et al., 2021) conducted a survey in the Jakarta Greater Area and discovered that 14% of the residents displayed moderate to severe anxiety (11.82% moderate and 2.17% severe) during the pandemic. Importantly, their findings highlighted a higher prevalence of depressive symptoms among women, suggesting that they were more vulnerable to psychological distress. Various factors, such as experiencing domestic violence, longer working hours compared to men, and the responsibility for household chores, contributed to heightened psychological stress among women during the pandemic.

In light of these circumstances, home gardens have emerged as a potential alternative to fulfill the need for interaction with nature, particularly for married women. (Pérez-Urrestarazu et al., 2021) found that homes with open areas, such as terraces or green spaces, played a supportive role during periods of isolation. Both visual and physical exposure to plants have been linked to increased positive behavior and pleasurable feelings, while also mitigating negative emotions such as anger, fear, and stress. Building upon these findings, the present study aims to further investigate the mental well-being of women in urban areas, specifically the Jakarta Greater Area, and explore their patterns of interaction with private garden houses. This exploration will include examining the frequency of visits, duration of visits, types of activities engaged in, as well as the size and positioning of the private garden houses. By delving deeper into these aspects, the study aims to contribute to the existing body of knowledge and provide valuable insights for promoting mental well-being among urban women.

2. Methods

2.1. Research Location and Time

This study was conducted from July 2021 to May 2022 in the Greater Jakarta Area, located at 6.2175° S, 106.8178° E. The Greater Jakarta Area or commonly known as Jabodetabek is an urban area in Indonesia that is integrated with Jakarta, consisting of the city of Jakarta and its surrounding areas, especially Bogor, Depok, Tangerang, and Bekasi. The Greater Jakarta Area is one of the largest greater cities in the world and also the largest urban area in Southeast Asia with a population exceeding 31.24 million people and the number of married respondents was 9,308,269 people (BPS 2021; BPS 2022), making the Greater Jakarta area one of the most densely populated areas in Indonesia. The Greater Jakarta Area has an area of 6,437.89 km2 accounting for 0.34% of Indonesia's total area of 1,916,906.77 km^2 (Kementerian Pekerjaan Umum dan Perumahan Rakyat, 2008).



Figure 1. Map of Greater Jakarta Area (Google Earth, 2022).

2.2. Data Collection and Respondents

In this study, data were collected through an online questionnaire and respondents were determined using the Snow Ball sampling method. The sample population was obtained as many as possible according to the results of the questionnaire distribution (over 100 respondents from all over the Greater Jakarta Area). Questionnaires were distributed through social media such as WhatsApp, Instagram, Twitter, and LinkedIn to married women (married, divorced, and widowed) aged 19-60 years in the Greater Jakarta Area randomly. The research subjects who filled out the questionnaire were reviewed to comply with the described criteria.

The present study began with a survey to find out the demographic background of the respondents, including age, marital status, educational background, occupation, age of the children they had, and subsequently measured the participants' mental well-being conditions, by asking respondents to answer a 5-point Likert scale (such as very good, good, fair, bad and very bad). This mental well-being condition was assessed using the Indonesian language version of the Warwick Edinburgh Mental Well-Being (WEMWBS) scale (Wicaksono et al., 2021). The condition of mental well-being of the respondents in the study was measured using The Warwick-Edinburgh Mental Well-being Scale (WEMWBS), which is a scale developed and used to measure a person's level of mental well-being. The English version of the WEMWBS has good validity and internal consistency with Cronbach's alpha 0.89/0.91 and reliability (retest reliability of 0.83) (Tamminen et al., 2020) whereas in this study the WEMWBS had good validity and a good level of consistency with Cronbach's alpha coefficient of 0.94. This scale is suitable for measuring mental well-being on a population scale (large and broad) because of its strong psychological measurement/assessment. This scale consists of 14 question items and each item used a five-point Likert response format and the cumulative score of the items ranges from 14 to 70. A higher score represents a high level of mental well-being. Three categories of mental well-being were created based on the results of the WEMWBS score, namely a Low level of mental

well-being if the score was less than 44, a High level of mental well-being if the score was more than 61, and a Moderate level of mental well-being for the rest. Furthermore, the condition of the home garden and participants' interactions with the home garden including the area of the garden and patterns of interaction including the frequency and duration spent in the home garden were also investigated. All of these surveys were conducted online, before filling out the questionnaire, participants were presented with the procedure for filling out the survey and debriefed about the study objectives to prevent confusion among the participants.

2.2. Data Analysis

The results of the questionnaire were analyzed to determine validity and reliability using the Pearson product-moment correlation (validity) and Cronbach's alpha (reliability). Data from the sample were analyzed using descriptive analysis, while also using correlation. The data processing application that was used is IBM SPSS version 26.

3. Results and Discussion

3.1 Demographic Characteristics

The total number of subjects involved in this study was 160 people and for the final sample, there were 109 people who met the criteria in this study, namely aged 19-60 years, married women (married, divorced, and widowed), and living in the area Greater Jakarta Area.

Table 1. Sociodemographic data by level of mental well-being, and Mean and Standard Deviation.

Category	Sample (n=109)	WEMWBS		
		Mean ± SD	Category	*p*-value
Age				
Early Adult (19-40 years old)	*n* = 51 (46.8%)	55.9 ± 11.38	Moderate	.267
Middle Adult (41-60 years old)	*n* = 58 (53.2%)	56.3 ± 8.3	Moderate	
Occupation				
Housewife	*n* = 50 (45.9%)	55.66 ± 8.297	Moderate	.317
Employee	*n* = 59 (54.1%)	56.56 ± 9.663	Moderate	
Income				
Not Earning	*n* = 3 (2.8%)	62.67 ± 2.082	High	.059
< IDR 2,000,000/month	*n* = 11 (10.1%)	59.09 ± 8.848	Moderate	
IDR 2,000,000 – IDR 4,000,000/month	*n* = 17 (15.6%)	48.94 ± 11.771	Moderate	
IDR 4,000,000 - IDR 6,000,000/month	*n* = 20 (18.3%)	54.95 ± 9.478	Moderate	
> IDR 6,000,000/month	*n* = 58 (53.2%)	57.67 ± 8.771	Moderate	
Education				
Junior High School	*n* = 1 (0.9%)	64	High	.619
Senior High School	*n* = 13 (11.9%)	52.46 ± 13.329	Moderate	
Diploma 1/2	*n* = 6 (5.5%)	54.0 ± 13.008	Moderate	
Diploma 3/Academy	*n* = 24 (22%)	56.83 ± 6.703	Moderate	
Bachelor	*n* = 55 (50.2%)	56.2 ± 9.73	Moderate	
Master	*n* = 10 (9.2%)	58.9 ± 10.115	Moderate	
Number of Children				
No children	*n* = 30 (27.5%)	55.43 ± 12.414	Moderate	.458
1 (one)	*n* = 13 (11.9%)	54.54 ± 8.222	Moderate	
2 (two)	*n* =37 (33.9%)	56.59 ± 9.593	Moderate	
3 (three)	*n* = 25 (22.9%)	56.96 ± 7.464	Moderate	
More than 3	*n* = 4 (3.7%)	56.0 ± 11.045	Moderate	
Chronic Diseases				
Hearth Failure	*n* = 1	56 ±	Moderate	.724
Hypertension	*n* = 2	46.5 ± 4.95	Moderate	
Diabetes	*n* = 1	58	Moderate	

None	*n* = 105	56.29 ± 9.881	Moderate	
Status of Residence				
Own residence	*n* = 11	51.27 ± 12.939	Moderate	.631
Living with nuclear family (husband, wife, and child)	*n* = 78	56.59 ± 9.167	Moderate	
Living with extended family/ relatives	*n* = 20	56.8 ± 10.103	Moderate	
Number of people living with				
0	*n* = 4	55.0 ± 18.493	Moderate	.402
1 (one)	*n* = 10	56.8 ± 7.052	Moderate	
2 (two)	*n* = 9	54.56 ± 11.501	Moderate	
3 (three)	*n* = 26	54.88 ± 8.468	Moderate	
4 (four)	*n* = 21	56.24 ± 11.541	Moderate	
5 (five)	*n* = 29	57.55 ± 9.553	Moderate	
>5 (more than 5 people)	*n* = 10	55.8 ± 8.779	Moderate	

Respondents' ages were grouped into two groups based on the grouping of the Central Bureau of Statistics, namely the early adult age group (19-40 years old) and the middle adult age group (41-60 years old). This study restricted participants' age to 60 years because the age over 60 years or commonly called old age becomes the closing period in a person's life span. At this age, physical and psychological changes begin to decline so that productivity decreases and is limited compared to a younger age. Thus, activities that can be done in the Home Garden becomes also more limited. The early adult age group in this study made up 46.8 percent of the total respondents and the middle age group was 53.2 percent. Most of the respondents had higher education, where as many as 50.5 percent of respondents had a university degree, namely a bachelor's degree, while the lowest education was junior high school, as many as 0.9 percent. In terms of occupation, the majority of respondents were housewives/not working as many as 45.9 percent, followed by employees as many as 54.1 percent with the highest income of more than IDR 6,000,000/month (53.2%) and the lowest is below 2,000,000/month. 27.5 percent of respondents did not have children, while 11.9 percent had one, 33.9 percent had two, 22.9 percent had three, 3.7 percent had more than three children under 5 years, and 13.8% of respondents had children with special needs (Table 1).

3.2 Well-being Condition

The results of this study indicate that within the Greater Jakarta Area, a significant proportion of women exhibited varying levels of mental well-being. Specifically, 39 individuals (35.8%) displayed a high level of mental well-being, while 58 respondents (53.2%) demonstrated a moderate level and followed by 12 respondents (11%) in the Greater Jakarta Area reported a low level of mental well-being. The average score on the Warwick-Edinburgh Mental Well-being Scale (WEMWBS) in this study was 56.09, as shown in Table 2. These results provide evidence that women in the Greater Jakarta Area have attained sustainable mental well-being, characterized by a healthy and prosperous mental state. This state is characterized by reduced levels of stress, guilt, depression, and other negative emotions.

In the contemporary psychological context, the definition of well-being has evolved to encompass various dimensions, including physical, socio-emotional, spiritual, cognitive, and behavioral aspects (Manita et al., 2019). The Oxford dictionary defines wellness as a state of good health, while well-being refers to a positive condition in an individual's life, such as happiness, health, or prosperity (McMahon et al., 2010). When viewed in a broader sense, well-being is a comprehensive construct that can be approached from two perspectives: the hedonic perspective, which focuses on subjective well-being and life satisfaction, and the eudaimonic perspective, which centers on psychological well-being and self-realization. Positive mental health encompasses factors such as self-esteem, optimism, a sense of mastery and coherence, fulfilling personal relationships, and resilience—the ability to navigate challenges and cope with stressors (Ryan & Deci, 2001).

Table 2. Data based on WEMWBS score.

WEMWBS	***N***	**%**
Low	12	11
Moderate	58	53.2
High	39	35.8
Mean±Stdev	56.09±9.798	

3.2.1 Mental Well-being from Sociodemographic Status

The results of the correlation analysis that has been conducted based on the data of this study indicated that there was no strong and significant relationship (Table 3). Thus, it can be concluded that sociodemographic factors are not associated with the mental well-being of the respondents living in the Jakarta Greater Area. This can happen because individuals' well-being can be influenced by many factors aside from sociodemographic factors, namely demographic factors (Ryff, 1989), personality (Ryan & Deci, 2001), social support (Shujaat, 2018) as well as contextual and situational factors (van Hoorn, 2008).

Table 3. Correlation between sociodemographic status and level of mental well-being.

	Variable/factor	
	Age	Occupation
WEMWBS	.750	. 674
	Income	Education
WEMWBS	.541	.422
	Number of children	Chronic disease
WEMWBS	.959	.331
	Status of residence	Number of people living with
WEMWBS	.200	.967

Note: (*) p-value ≤ 0.05, (**) p-value ≤ 0.01; p-value correlation between mental well-being and sociodemographic characteristics.

3.2.2 Level of Mental Well-being by Interaction Patterns

3.2.2.1 Interaction with Outdoors

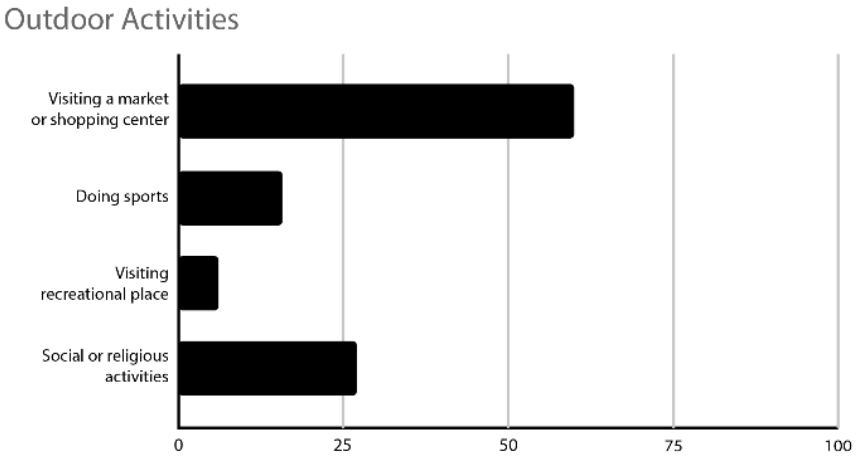


Figure 2. Outdoor activities performed by respondents living in Greater Jakarta (respondents can choose more than one activity).

The results show that almost half of the respondents who filled out the questionnaire admitted that they only left their homes 1-2 times a week (45.9%) (table 4). In term of activities carried out by the respondents in the Greater Jakarta Area beside routine activities such as work or school, 60 Respondents in the Greater Jakarta Area visited markets/shopping centers (55%) to meet their needs, 16 Respondents did sports (14.7%)), 6 respondents visited recreational areas (5.5%) and 27

respondents attended social and religious events (E.g., Muslim forum, rotating savings, prayer, social services, and so on.) (Figure 2).

Table 4. Data based on outdoor interaction with level of mental well-being as well as Mean and Standard Deviation.

Category	Sample (*n*=109)	Level of Mental Well-being (WEMWBS)		
		Mean±SD	Category	*p*-value
Frequency of weekly outdoor activity				
Never	*n* = 4 (3.7%)	49.5 ± 10.97	Moderate	.269
1-2 times a week	*n* = 50 (45.9%)	55.84 ± 9.43	Moderate	
3-4 times a week	*n* = 24 (22.0%)	57.46 ± 8.11	Moderate	
5-6 times a week	*n* = 15 (13.8%)	55.67 ± 10.06	Moderate	
6-7 times a week	*n* = 16 (14.7%)	56.87 ± 12.89	Moderate	

The results of the study from the correlation analysis as presented in Table 5 indicate that there was no significant correlation between the frequency of weekly leaving the house and the level of mental well-being among respondents living in the Greater Jakarta Area. This finding may be attributed to the fear of contracting COVID-19, which is still prevalent among respondents. Fear of transmission is likely to undermine the mental health benefits of outdoor activities and may help explain why in some areas the number of visitors to green spaces during the pandemic declined (Marques et al., 2021).

Table 5. Correlation between outdoor interaction pattern and level of mental well-being.

	WEMWBS
Frequency of weekly outdoor	.477

Note: (*) *p*-value ≤ 0.05, (**) *p*-value ≤ 0.01; *p*-value of correlation between mental well-being and frequency of weekly outdoor activities.

3.2.2.2 Interaction with Public Green Space

Table 6. Data based on public green interaction patterns and level of mental well-being as well as Mean and Standard Deviation.

Category	Sample (*n*=109)	Level of Mental Well-being (WEMWBS)		
		Mean±SD	Category	*p*-value
Frequency of public green visits				
Never	*n* = 36 (33%)	53.83 ± 11.08	Moderate	.212
1-2 times a week	*n* = 59 (54.1%)	56.86 ± 8.53	Moderate	
3-4 times a week	*n* = 9 (8.3%)	61.78 ± 6.32	Moderate	
5-6 times a week	*n* = 2 (1.8%)	48.5 ± 14.85	Moderate	
6-7 times a week	*n* = 3 (2.8%)	56 ± 18.52	Moderate	
Travel Duration				
< 5 minutes	*n* = 22 (20.2%)	60.5 ± 7.61	Moderate	.093
5-10 minutes	*n* = 27 (24.8%)	55.48 ± 10.39	Moderate	
11-30 minutes	*n* = 34 (31.2%)	53.29 ± 9.80	Moderate	
31-60 minutes	*n* = 14 (12.8%)	59.29 ± 7.19	Moderate	
> 60 minutes	*n* = 12 (11%)	53.58 ± 11.98	Moderate	

In addition, during the past month respondents visited public green areas at least 1-2 times a week (54.1%) with travel time to reach the nearest green area varying from >5 minutes (20.2%), 5-10 minutes (24%), 11-30 minutes (31.2%), 31-60 minutes (12.8%) and >60 minutes (11%) (table 6). Based on the available data, it is evident that the frequency of visits to public green spaces by the respondents remains extremely low. This lack of visits can likely be attributed to concerns about contracting Covid-19 (Marques et al., 2021). Despite the relaxation of community activity restrictions, the number of respondents visiting public green spaces remains consistently low. This apprehension not only diminishes the mental health benefits derived from outdoor activities but also leads to the absence of a correlation between the level of mental well-being and general interactions with green

spaces, as indicated in Table 7. Additionally, it was observed that respondents exhibited a preference for visiting nearby parks, which aligns with previous research (Xie et al., 2020) highlighting that people tend to opt for parks in their immediate vicinity that can be reached within 10 minutes. This preference further emphasizes the significance of having a private home garden, which serves as a convenient alternative for enhancing an individual's well-being. Notably, even in this study, respondents required 11-30 minutes to reach public green open spaces, reinforcing their inclination to interact with their private gardens. The ease of access afforded by home gardens enables individuals to visit and engage with green spaces more frequently, eliminating the need for long-distance travel or significant expenses to connect with nature.

Table 7. Correlation between public green space interaction pattern and level of mental well-being.

	WEMWBS
Frequency of public green space visit	.244
Travel duration	.093

Note: (*) p-value ≤ 0.05, (**) p-value ≤ 0.01; p-value of correlation between the level of mental well-being and public green space interaction pattern.

3.2.2.3 Interaction with Home Garden

Table 8. Data based on home garden interaction pattern and level of mental well-being as well as Mean and Standaard Deviation .

Category	Sample (n=109)	WEMWBS		
		Mean±**SD**	Category	p-value
Frequency of home garden visit				
Never	n = 26 (23.9%)	49.65±10.68	Moderate	
1-2 times a week	n = 4 (3.7%)	42.5±7.37	Low	
3-4 times a week	n = 12 (11%)	56.75±6.94	Moderate	.000
5-6 times a week	n = 10 (9.2%)	58.50±5.99	Moderate	
6-7 times a week	n = 57 (52.3%)	59.42±8.26	Moderate	
Duration of home garden activities				
Never	n = 26 (23.9%)	49.65±10.68	Moderate	
<30 minutes a day	n = 47 (43.1%)	56.91±8.37	Moderate	
1 hour a day	n = 18 (16.5%)	59.06±7.56	Moderate	.193
2 hours a day	n = 9 (8.3%)	63 ± 6.82	High	
> 3 hours a day	n = 9 (8.3%)	57.67±11.53	Moderate	

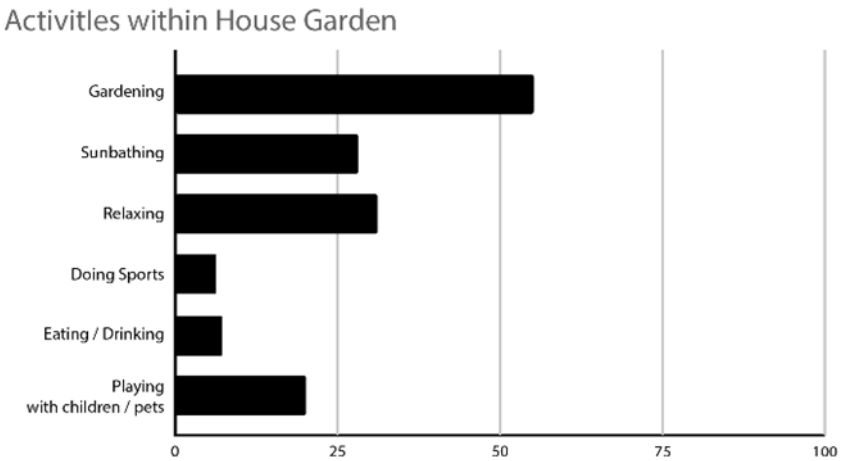


Figure 3. Home garden activities performed by the respondents living in Greater Jakarta (respondents can select more than one activity).

The results of this study indicate that as many as 57 respondents (52.3%) in the Greater Jakarta Area over the past month have visited the home garden more often, at least 6-7 times a week, and spent less than 30 minutes a day (42.2%) (table 8). They performed various activities including gardening, sunbathing, relaxing, exercising, eating/drinking, and playing with children/pets. The most frequent activity in their home garden was gardening (picture 3). On average, the findings of this study indicate that respondents in the Greater Jakarta Area had a moderate level of well-being, which improved as their interactions with their home gardens became more frequent. These results align with the outcomes of the correlation analysis conducted between the frequency of visits, duration of time spent in the home garden, and the respondents' mental well-being. The analysis revealed a positive relationship between these interactions and the level of well-being (see Table 9). Consequently, it can be inferred that more frequent interactions with the home garden correspond to higher levels of well-being. This reaffirms the significant role of visiting a home garden in enhancing mental well-being. Furthermore, longer durations spent in the home garden provide individuals with greater benefits, and consistent weekly visits have shown a noteworthy increase in the level of mental well-being.

Supporting these findings, (Elsadek et al., 2019) conducted a study comparing buildings with green facades to those without. The results revealed distinct differences that influenced the relative strength of alpha brain waves. Notably, participants exhibited consistently higher alpha wave amplitudes when observing green facades compared to regular building walls. Increased alpha wave activity has been associated with reduced stress levels and is commonly observed during states of rest, concentrated meditation, and relaxation. Alpha wave activity also plays a vital role in neuronal networks and has been linked to cognitive performance, mental coordination, calmness, attention, and overall awareness. Moreover, a study conducted in the UK by (Pouso et al., 2020) demonstrated that spending a minimum of two hours per week in a blue-green environment outdoors could yield significant well-being benefits for more than 20,000 individuals. The study also highlighted that daily durations of 30 minutes to one hour spent in these environments could contribute to improved well-being. Furthermore, research by (Xie et al., 2020) indicated that three hours of daily interaction with nature represented the upper threshold for individuals, suggesting that 30 minutes to one hour per day is sufficient to derive benefits. In summary, the findings of this study underscore the positive association between interactions with home gardens and the well-being of respondents in the Greater Jakarta Area. Increasing the frequency of visits, extending the duration spent in the home garden, and adhering to consistent weekly visits contribute to enhanced well-being. These outcomes align with previous research that demonstrates the positive effects of nature interactions on mental well-being, including reduced stress levels, increased alpha wave activity, and cognitive benefits.

Table 9. Result of correlation analysis between the level of mental well-being and frequency of home garden visit and duration of activites in home garden.

	WEMWBS
Frequency	.000**
Duration	.001**

Note: (*) p-value ≤ 0.05, (**) p-value ≤ 0.01; p-value of correlation between level of mental well-being and frequency of home garden visit and duration of activities in the home garden.

3.2.3 Level of Mental Well-being by Home Garden Conditions

Based on the results of this study (Table 10), 83 respondents (76.1%) had a home garden, while 26 respondents (23.9%) did not have a home garden. As many as 27 respondents (24.8%) living in the Jakarta Greater Area in this study had a garden area of less than 5 m^2, while 25 respondents (22.9%) had a home garden of 6-10 m^2. From the results, the average level of mental well-being of the respondents living in the Jakarta Greater Area was at a moderate level.

Table 10. Data based on the condition of the home garden by the level of mental well-being as well as the Mean and Standard Deviation.

Category	Sample (*n*=109)	WEMWBS		
		Mean±**SD**	Category	*p*-value
Size of the garden				
No garden	*n* = 26 (23.9%)	49.65±10.68	Moderate	.048
Less than 5 m^2	n = 27 (24.8%)	56.19 ± 8.85	Moderate	
6-10 m^2	n = 25 (22.9%)	57.44 ± 9.05	Moderate	
11-15 m^2	n = 8 (7.3%)	56.88 ± 3.18	Moderate	
16-20 m^2	n = 4 (3.7%)	60.25 ± 14.85	Moderate	
> 20 m^2	n = 19 (17.4%)	61.79 ± 8.66	High	

The findings of the correlation analysis indicate a significant positive relationship between the size of home gardens and the level of mental well-being among respondents residing in the Jakarta Greater Area (Table 11). This implies that larger home gardens are associated with higher levels of mental well-being for individuals in urban settings. Despite the constraints by limited land availability in urban areas, this study emphasizes the significant positive influence that small home gardens can have on an individual's mental well-being. It is crucial to recognize and consider the size of a private home garden, ensuring that it aligns with a person's specific requirement for green space while also taking into account the overall area of the house. By carefully assessing these factors, individuals can optimize the benefits of their home gardens on their mental well-being, even within the limitations of urban living. This consideration aligns with the guidelines provided by Public Works Regulations Number 05/PRT/M/2008, which outline the provision and utilization of green open spaces in urban areas. These regulations ensure that the area of the garden corresponds appropriately to the individual's requirements for green space.

Table 11. Result of correlation analysis between mental well-being and position and size of home garden

	WEMWBS
Size	.000**

Note: (*) *p*-value ≤ 0.05, (**) *p*-value ≤ 0.01; *p*-value of correlation between the level of mental well-being and position and size of home garden.

4. Conclusions

In summary, the study focused on women in the Greater Jakarta Area and their interaction patterns with home gardens. It found that the women generally had a moderate level of mental well-being (53.3%), with a high level observed in 35.8% of participants and a low level in 11% of participants. The women spent more time in their home gardens, typically 6-7 times a week for less than 30 minutes each day, compared to outdoors or public green areas. The study revealed a positive relationship between interaction patterns and mental well-being, indicating that those with more frequent interaction with their home gardens had higher levels of well-being.

The majority of home gardens in the study were small, with areas less than 5 m2 and 6-10 m2. The condition of the home garden was found to be positively associated with mental well-being. These findings support the hypothesis that even small home gardens can positively impact an individual's mental well-being, despite the limited land availability in urban areas. Furthermore, the study contributes valuable insights into the role of urban home gardens in enhancing the mental well-being of women in the Greater Jakarta Area, specifically considering interaction patterns and the characteristics of private garden houses.

By highlighting the positive impact of urban home gardens on mental well-being, even in limited spaces, this study underscores the importance of promoting positive mental health in urban contexts. The findings offer valuable information for policymakers and practitioners seeking to enhance mental well-being and improve access to green spaces in urban areas. Given the constraints imposed by the

COVID-19 pandemic, which hindered the collection of in-person data for this study, future research could benefit from incorporating in-person data collection methods. This would allow for a more diverse and representative sample, reducing potential biases and enhancing the generalizability of the findings.

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The authors declare no conflict of interest.

Data availability statement
The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding author/s.

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Original scientific paper

Exploring Identity Issues in Development Areas of Vernacular Rural Settlements: A Case Study of Behramkale, Türkiye

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ABSTRACT

Sustainable rural development is a challenging issue, considering the pressure of change brought by the demands of globalisation and intensified tourism activities in rural vernacular settlements. While studies in this field often focus on historical centres, research on the distinctive urban and architectural identity of "village development areas" in rural vernacular settlements remains scarce. To address this gap in the literature, a field study was conducted in the vernacular rural settlement of Behramkale, located in the Northern Aegean region of Türkiye. The study explored the continuity of architectural and urban identity and its significance. The research involved a qualitative assessment of primary data obtained through architectural surveys and archival documents collected in 2017 and 2021. Data analysis not only focused on static features of place identity but included dynamic and perceptual features of place identity. Planning policy inadequacies and the implications of top-down decisions on vernacular rural Türkiye are discussed. The key finding from the study highlights the necessity for a more participatory and site-specific approach to preserving vernacular rural heritage's urban and architectural identity for sustainable development. In this regard, the paper proposes that an identity-based and people-centred approach should be integrated into the policies for the development areas of vernacular rural settlements. This integration aims to preserve the local architectural identity and promote a belongingness community among residents.

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Highlights	Contribution to the field statement
- Contrary to the mainstream literature, which concentrates on the static (architectural) features of identity, this study investigates the continuity or discontinuity of static, dynamic, and perceptual features of vernacular identity. - This study illustrates that existing top-down methods in Türkiye fail to address the issue of preserving and maintaining local identity in vernacular heritage settlements. - A reduced connection between the old and new areas has resulted in a lack of community attachment and a reduced sense of belonging, potentially leading to social and economic segregation between the development area and the vernacular settlement. - It reveals that from the planning process, a lack of site-specific and identity-based design decisions generates dis-identity issues in the development area of vernacular rural settlements.	- This paper adds to the existing literature by focusing on the distinctive urban and architectural identity of "village development areas" in rural vernacular settlements. - The originality of this paper lies in the methodology and findings where the authors broadened the scope of place identity in their research with an angle borrowed from social sciences. - This paper suggests areas for further study on the conservation of rural heritage sites.

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1. Introduction

In recent years, due to the growing adverse impacts of climate change on the water-food-energy nexus, as well as the SARS-CoV-2 (COVID-19) Pandemic, sustainable rural development has become a high-trending topic on the policy agenda of many countries. Rural development aims to bring about social change and sustainable economic growth to benefit the rural community's ongoing development (Mihai & Iatu, 2020). The World Social Report of the United Nations (Department of Economic and Social Affairs, 2021) points out how rural development can be reset to achieve sustainable development.

While promoting sustainable development and improving the quality of life for residents in rural settlements, preserving vernacular heritage settlements plays a vital role in creating economic, environmental, and social benefits (Vythoulka et al., 2021). Vernacular heritage is defined as the fundamental expression of a community's culture and its relationship with its territory and as an effective response to functional, social, and environmental constraints. A vernacular settlement's urban and architectural identity is shaped by a complex set of cultural, environmental, and historical factors that reflect the unique character of the region and its people. The built environment plays a critical role in shaping our experience of places. Moreover, it can contribute to creating and expressing place identity through the design, construction, and maintenance of buildings, public spaces, and other urban landscape elements (Farhad et al., 2022). Conserving the identity of architecture in the built environment helps to strengthen place identity, which is always associated with other terms such as memory, character, and genetic code (Bascherini, 2018). Thus, the authenticity of vernacular architecture does not only refer to the built environment associated with the "static authenticity" of forms, textures, and materials. Instead, it is the product of an ongoing process constantly redefined through changes and practises. Therefore, it is dynamic and pluralistic, built upon narratives and time (Esparza, 2018)

As a result of changing social, economic, and environmental factors, heritage settlements may undergo regeneration, which involves revitalising and renewing settlements and introducing development areas to meet the needs of current and future generations. However, introducing development areas and infills might expose the heritage settlements to severe pressures of commercialisation, poor design, and cultural uniformity that fade away their place identity (Said et al., 2013). In such a design approach, the meanings of places and their identities are ignored; places look and feel alike and offer similar bland possibilities for experience. Conversely, loss of identification in the built environment might cause a kind of nostalgia that ends up resulting in the design of "false vernacular" environments, where architectural elements of vernacular architecture are extracted from their original contexts and used in an eclectic way (Berleant, 1997; Kavas, 2015).

Despite an abundance of studies on vernacular rural settlements, there is little research on the distinctive urban and architectural identity of the development areas of vernacular rural settlements (Karahan et al., 2021). In this regard, the study aims to closely examine the design practice of development areas of vernacular rural settlements in Türkiye from the perspective of identity preservation and to contribute to conservation policies. To achieve this, we have formulated the following research questions:

RQ1: How can we effectively address the identity problem in these regions?

RQ2: What policies can be formulated to ensure the preservation of urban and architectural identity in development areas while promoting continuity?

By addressing these research questions, we aim to shed light on the best approaches to maintaining the unique identity of these settlements amidst ongoing development.

Behramkale has been selected as a case study, with its cultural heritage dating back to the Bronze Age (Arslan & Aslan, 2014) and the designated development area established in 1993. This study helps to address the inadequacy of planning policies in heritage conservation and the consequences of top-down decisions in the formation of development areas in vernacular rural settlements. Conservation practices of this settlement have been discussed from the aspects of identity and community

engagement, promoting a more participatory and site-specific approach. The framework of the study can be followed through Figure 1, as seen below.

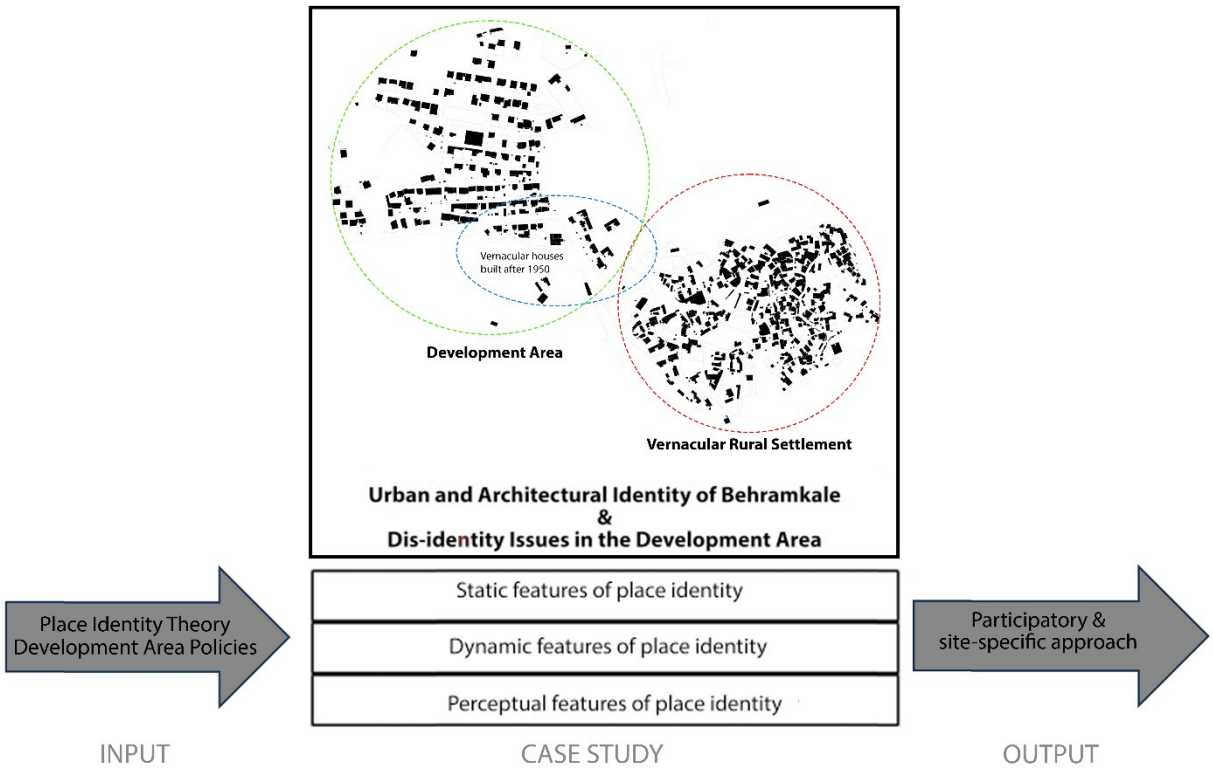


Figure 1. Framework of the Study (Developed by the Authors).

2. Theoretical Background

2.1 Urban and Architectural Identity of Vernacular Rural Settlements

As stated by the International Union of Architects (UIA) in the Copenhagen Declaration on December 7, 2009, all architecture projects are linked to their wider natural surroundings and reflect social, cultural, and heritage values (Salgın et al., 2017). Vernacular settlements depict the plainness of this architecture formed by geography, social and cultural values, daily life, local materials, and production methods (Ergöz Karahan et al., 2023).

Identity includes personal evaluations, experiences, and views in addition to physical, cultural, and social traits (Anastasiou et al., 2022). It is the degree to which a person can recognise or recall a place as separate from others by having vivid, unique, or distinguishing characteristics (Lynch, 1960, 1984). According to (Abusaada & Elshater, 2023) detailed review, place identity is linked to meanings, everyday lifestyles, and urban forms. (Duan et al., 2022) state that urban identity is linked to culture and physical form. Architecture is a component of identity and contains the themes, traits, and ideas assigned to society (Alzahrani, 2022). The broad spectrum of architectural forms is an unlimited source of crucial elements of identity that are formed over time, built on long-term experiences and a need for functionality applying local building materials (Skataric et al., 2021). Vernacular settlements are often characterised by their unique architectural and urban features reflecting local culture, climate, and social organisation. Some of the essential elements of urban and architectural identity in vernacular settlements, such as mass and articulation, openings, architectural detail, materials, and principles of facade arrangements, have vital importance in preserving and enhancing the character and identity of historical urban environments (Yasin Baper & Hassan, 2012). Since buildings and the built environment are physical manifestations of a society's culture and history, historic buildings, streetscapes, and public spaces become tangible reminders of the past and contribute to a collective sense of identity and belonging.

Kandemir, (2017) defines urban identity as a dynamic and susceptive impression of every change invoked on its inhabitants by environmental, historical, sociocultural, and spatial values. Susceptiblity to change is highly sensitive in historical environments and requires interventions to preserve the local identity to maintain a sense of continuity and connection to the cultural heritage of a place. Each building has its unique identity based on the creative vocabulary of the architect, whereas vernacular architecture preserves the region's identity. The architectural identity of a region reflects this society's culture and lifestyle through its built environment (AL-Mohannadi et al., 2023). A specific local culture's architectural identity represents a living landscape with a common sense of place generated over time by the community's collective efforts to include meanings and ways of life (Nooraddin, 2012). The features and properties of an urban physical setting that give an individual a sense of place, are referred to as urban and architectural identity (Saleh M.A.E., 1998).
The connection between the built environment and community culture can be weakened due to rapid sociocultural and environmental transformations due to globalisation, intensified tourism, or changes to governance and policies. Architects, urban designers, and planners must tackle the issue of continuity of tradition following the demands of contemporary life to cope with continuous change in built environments. Using traditional materials, design elements, and building techniques can help reinforce a sense of continuity with the past. At the same time, contemporary interventions sensitive to the historical context can add a new layer of meaning and identity to the urban environment.

2.2 Development Areas Policies of Vernacular Rural Settlements in Türkiye

The need for development areas in vernacular rural settlements may occur with the increase in population of the settlements (when there is no adequate parcel to build a house) or because of the building restrictions in heritage sites where the construction of new buildings is banned.
Villages outside the metropolitan municipalities' boundaries are subject to the Village Law (Law No. 442-1924) and Law No. 3367 (1987), which include the legal provisions about development areas. The planning process of development areas is stated in Law No. 3367 as follows; with the confirmation of the council of elders, the head of the village applies to the affiliated civilian authority for the planning of the "village development area" with a list of locals who demand to have their place in the village. The Directorate General of Spatial Planning states that a commission of experts and a representative from the village decide the most suitable place as a development area for the village. The village settlement plan, which includes the existing settlement and development area, is a subdivision plan apart from Zoning Law No. 3194 and the related regulations. It is prepared according to the needs of the village, considering the current situation and the future potential of the village, in the form of upper-scale plans, cadastral sheets, and opinion letters taken from relevant public institutions and organisations (Erdem & Yalçınöz, 2023).

Since the 2000s, concerns about the quality of new buildings in vernacular rural settlements have risen among researchers (Balta & Atik, 2022; Şimşek, 2020) and authorities of the government. Between 2008-2017, in cooperation with public enterprises and universities, research projects were conducted in the villages of Balıkesir, Kayseri, and İzmir, as well as in Kastamonu-Küre Village and Erdek-Yukarıyapıcı Village, to analyse their architectural properties and prepare a guide for new design decisions in these villages and their development areas (Çorapçıoğlu et al., 2010, 2011; Guler K., 2020; Hasgül et al., 2021). However, such comprehensive studies were limited to those listed above. In 2016, the Ministry of Environment, Urbanization, and Climate Change declared that with an aim for the "revitalisation of the local architectural texture, which is under threat due to uncontrolled construction in rural areas", they presented "residential projects in accordance with the local architecture" for 81 provinces of Türkiye (Polat E.O., 2016). Eventually, between 2017-2019, to "create a sustainable historical environment and a local silhouette that is authentic to the 'place' in rural areas", the Ministry of Environment, Urbanization, and Climate Change published the books "Residential Projects in Accordance with Vernacular Architectural Properties I-II-III-IV" for thirty-four cities in Türkiye. As a supplementary document for the design of new residential buildings in rural settlements, the books

include some drawings of typical projects for each city (Figure 2). These books are also recommended to the residents of the recently planned village development areas. According to the plan notes of these development areas, if villagers ask for any projects from the municipality, they would be directed to the ministry's books.



Figure 2. Amasya Vernacular Buildings and the Plan and 3D Drawing of Type 1 As a Proposal (Oruç et al., 2017).

3. Method and Materials

3.1 Case Study Selection Criteria

Behramkale is selected as a case study for this research because of its unique vernacular characteristics and the formation of a development area after 1993, following Law No. 3367 (1987). Construction of new houses has been banned in the vernacular rural settlement since 1982 when Behramkale was protected as a heritage site. However, the entire development area has been filled in over the past 30 years. Observing continuity and changes to the urban and architectural identities by comparing the vernacular settlement to the development area provides opportunities to decode the reasons and motivations behind these decisions. The primary data for the research is based on architectural surveys and archival documents that were collected by the research team in 2017 and 2021. This case study provides an opportunity to discuss recent supplementary documents released by the Ministry for Development Areas and to argue for a more participatory and site-specific approach to sustainable development.

3.2 Data Collection Methods and Analysis

Primary data for this research has been obtained through architectural surveys and archival documents. These valuable sources were collected by the research team during two distinct periods: first in 2017 and then again in 2021. The decision to gather data at two different periods allows for a comprehensive analysis, capturing potential changes and developments over time. A qualitative data analysis method that enables a deep exploration and understanding of the nuances and complexities present within the data is employed in this study. The findings of the data analysis have been presented under well-known components and elements in place identity literature, such as static, dynamic, and perceptual features.

3.3 Analysis Framework

Empirical data has been analysed by using Relph E.C., (1976) conceptualisation of place identity. According to Relph E.C. (1976), the identity of places is composed of three interrelated components: natural and artificial characteristics, observable activities and functions, and the meanings given to them by human intentions. Natural and artificial characteristics are the physical features that shape the physical environment and the materialist fabric of structures and open places. These are the “static features” of urban identity. Activities and functions that refer to the mutual interaction among people and the way they use physical fabric are called “dynamic features”. Lastly, features of meaning that are connected to human behaviours, intentions, experiences, and expertise, including signs and symbols, refer to the “perceptual features” of urban identity (Ibrahim et al., 2014; Surchi & Nafa, 2021) (Table 1).

Table 1. Components and Elements of Place Identity (Relph, 1976; İbrahim et al., 2014; Surchi & Nafa, 2021).

Components	**Elements**
Static features (Physical characteristics and appearances)	Natural characteristics; urban and architectural characteristics (spatial features; building form/spatial organisation; construction techniques and building materials; traditional indoor design elements)
Dynamic features (Activities and functions)	Indoor and outdoor activity; liveability; interaction; containment; access; and permeability
Perceptual features (Meanings, signs, symbols)	Image; experiences; sensations; the conception of the inhabited and lived space; recognising the formal and spatial characteristics of the building, on behalf of the observer

The urban and architectural identity of the vernacular settlement and development area of the case study has been analysed in the context of the components and elements of place identity (Table 1) under the results section.

3.4 Case Study: Behramkale

Behramkale lies on the Aegean coast in the Ayvacık district of Çanakkale province, Türkiye. The distance to Istanbul is 147 kilometres. (Figure 3). Behramkale's (the ancient city of Assos) history dates to the Bronze Age (Arslan & Aslan, 2014). It faces the southern Aegean Sea shoreline to the west, Mount Ida to the east, and Lesbos to the south across the Straits of Mytilene from its location above a hill 235 meters above sea level (Arslan & Aslan, 2014). The ancient city's geographical area partially overlaps with the historical settlement of Behramkale located inside the ancient city walls, which became an Ottoman territory port in 1330 and has been under Turkish authority without interruption since then (Serdaroglu U., 1995). The village has a Mediterranean climate (hot Mediterranean summers) and rich forests. Summers are dry and hot, while winters are warm and wet.



Figure 3 . Location of Behramkale, Türkiye (Google Earth and Authors)

After the start of archaeological excavations in 1981 and the designation of Assos, the ancient city, and the harbour as 1st-degree Archaeological sites in 1982 by the Superior Council of Immovable Antiquities and Monuments, the strain on this location has grown. The geographic border of the first-degree Natural Site was established by the same act. The historical part of the village has been placed under protection. Village inhabitants (population 660 (Ergöz Karahan et al., 2023) mostly worked in

fisheries, livestock, forestry, and agriculture until the designation. Since then, tourism has been their primary source of income (Gocer et al., 2021). The area had 254 houses, some of which were vacant or utilised as summer residences. The designation of the site was changed to Urban Archaeological Site later in 2000. Since 1991, Behramkale has been considered within the bounds of the tourism development area. In 2017, UNESCO added the archaeological site of Assos to its World Heritage Tentative List. Delays in developing the Behramkale Conservation Plans interrupted the locals' usual practice of building their homes in new spaces. Previously, younger generations used to build a house in the courtyard for seniors to reside in when they constituted a new family. The increased demand for spatial change, however, was barred by protection restrictions; as a result, a development area was established in 1993 to respond to the needs of the locals, out of the historical settlement near the river, on the borders of a 3rd-degree Natural heritage site.

4. Results; Urban and Architectural Identity of the Vernacular Settlement and Dis-identity Issues in the Development Area

The urban and architectural identity of Behramkale and the dis-identity issues in the development area of the village are discussed according to the static, dynamic, and perceptual features as indicated in Table 1.

4.1. Static (Physical) Features of Place Identity and Dis-identity

The vernacular settlement of Behramkale has an organic urban pattern in harmony with the topography. The separation of the agricultural fields and residential areas gave birth to the village's compact morphology. In simple prismatic forms with stone masonry walls and courtyards, the settlement presents North Aegean traditional dwelling characteristics. Functional units (such as a stable, toilet, storage, fountain, hearth, and granny flat) are arranged around the courtyard. High courtyard walls and stone-paved roads characterise the streets.

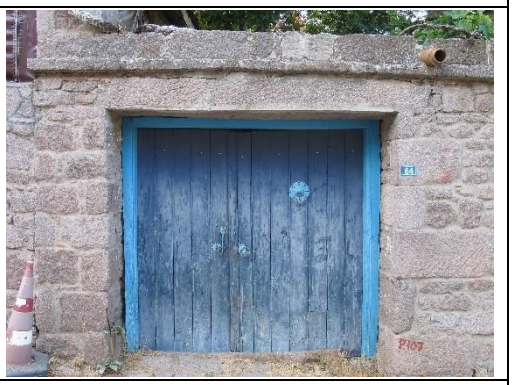
Most of the resources used in the historic part were regional and natural, including andesite stone, wood, and earth. Due to the necessity of obtaining materials close to construction locations, the vernacular buildings' construction methods and materials were directly influenced by the climate and endemic environment (Ergöz Karahan et al., 2023). The historic part is situated on the north slope of the hill and aligned with the topography in the wind's predominant direction to allow natural ventilation. Primarily square-shaped houses have 70-100 cm thick masonry walls. Earlier examples of vernacular houses had flat roofs of pressed mud. However, most of them are renovated to pitched roofs with ceramic tile (Table 2).

In contrast, the village development area was designed in a grid pattern, with broad and unpaved streets and extensive rectangular parcel lands in contrast to the organic layout of the old settlement. Furthermore, the ancient city walls served as a physical barrier between the old settlement and the development area, preventing them from developing a close bond. Still, the earliest buildings from the 50s and 60s were built with vernacular character. More recent structures vary in materials/construction techniques, plan size/ layout, and facade proportions, with bigger floor areas, large openings, and a variety of contemporary facade materials. Villagers continue to build with stone, but it is commonly found on the lower floors or as cladding for some buildings. Most houses, especially the upper floors, are constructed using hollow brick or aerated concrete brick masonry. The settlement contains reinforced concrete houses with hollow brick filling. Some structures have cement plaster or stone cladding covering their exterior walls (Table 2), which serves both aesthetic and protective purposes. Buildings that were built traditionally tend to have similar facade proportions to the historical settlement in the area. These structures reflect the architectural heritage and maintain visual harmony with the surrounding traditional buildings. However, there are also buildings in the area that deviate from the traditional pattern. These modern structures often incorporate design elements, such as terraces, balconies, and large windows, that are not typically found in historic houses. These additions cater to contemporary lifestyle preferences and offer improved natural lighting, outdoor spaces, and views. While stone is still utilized in construction; its use has become more selective, with hollow

brick, aerated concrete, and reinforced concrete being more commonly employed for practical and economic reasons (Ergöz Karahan et al., 2023).

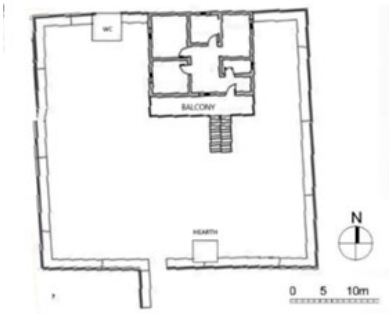
Table 2. Urban and Architectural Characteristics of Vernacular (Old) Settlement (Developed by Authors)

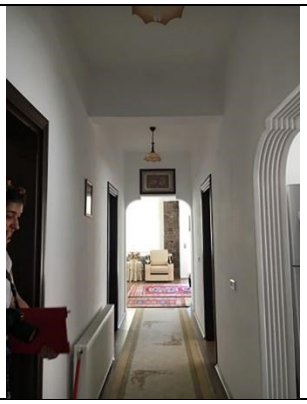
<table>
<tr><td rowspan="2">Settlement Characteristics</td><td>  </td><td>  </td></tr>
<tr><td colspan="2">* Houses are located on north facing slope of the hill
* Organic pattern in harmony with topography allows wind flow around the buildings
* Sinuous curving streets with stone pavement and high stone walls surrounding courtyards
* Green elements in the courtyard to provide passive cooling strategies</td></tr>
<tr><td rowspan="4">Building Form/Spatial Organization</td><td>  </td><td> 
</td></tr>
<tr><td colspan="2">* Functional units (stable, toilet, storage, fountain, heath, granny flat, etc.) around a courtyard
* 1-2 story height buildings, compact form (more likely 50–60 m^2 square/rectangular plan)
* With few, small openings, shade, and a high thermal mass, the temperature within is stabilised.</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Courtyard</td><td>Courtyard with green</td></tr>
</table>

<table>
<tr><td></td><td>  </td><td>  </td></tr>
<tr><td></td><td>Hearth</td><td>Fountain</td></tr>
<tr><td rowspan="4">Construction Techniques & Building Materials</td><td>  </td><td>  </td></tr>
<tr><td>Wooden beams supporting the wooden slab</td><td>Remains of the stone walls and timber beams</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td colspan="2">* Local materials and traditional construction methods (masonry stone walls without plaster and timber floors with timber beams)
* Earliest buildings with flat roofs
* Timber window frames with timber shutters and timber doors
* Timber floor coverings in living and sleeping areas, stone floor coverings in other areas
* Plaster and paint on inner walls or natural stone</td></tr>
<tr><td>Traditional indoor design elements & ornaments</td><td></td><td> 
Wooden cabinet system (*yüklük*)</td></tr>
</table>

		
	Bathing cubicle (*gusülhane*)	Hearth/ Fireplace

Table 3. Urban and Architectural Characteristics of Development Area (Developed by Authors)

Settlement Characteristics		
	* Grid pattern with a flat topography that blocks wind effect * Courtyards turn into vegetable gardens and are surrounded by short masonry (stone or brick) walls * Toilets and hearths are still used in the gardens * Wide and unpaved streets	
Building Form/Spatial Organization		
	House Exterior	Typical house plan in the development area

		
	Kitchen	Interior furniture
	* 2-3 storey buildings, larger floor areas (100-120 m^2) square/rectangular i * Large openings and windows without shutters * Low thermal mass, which causes sudden increases or decreases in indoor temperature * Specialized spaces and enlarged parcel area for the modern lifestyle	
Construction Techniques & Building Materials		
	* Contemporary construction methods and materials * Concrete slab/RC frame and timber floor & ceramic floor finishes * PVC (Polyvinyl Chloride), metal, or timber window frames with single or double glazing * Plaster and paint on inner walls, ceramic on inner walls in wet areas	

In the old settlement, ornaments, decorations, and unique interior design elements (such as gusülhane and yüklük) played a significant role in shaping the vernacular architectural identity (Asatekin, 2005). Gusülhane is a kind of shower for a full-body wash before prayer, and yüklük is a small niche or cupboard, two essential elements of Turkish traditional houses that serve specific functions. These elements are typically designed with wooden doors or curtains (Table 2). Unfortunately, ornaments and these interior design elements disappeared from the spatial layout of the new house design. On the other hand, specialised spaces such as the kitchen and bathroom replaced these interior design elements and caused the enlargement of the parcel area (Table 3).

4.2. Dynamic Features (Features of Activities) of Place Identity and Dis-identity

The historic vernacular settlement's morphology can be characterised as an "organically evolved landscape" formed by its physical and cultural surroundings. In the vernacular settlement, courtyards were designed to be functional and practical, accommodating the needs of residents within a private outdoor setting. They often served as central communal spaces where various daily activities such as social gatherings, cooking, drying clothes, and children's play took place. These were places for women to gather and help each other with chores (Ergöz Karahan et al., 2023). Furthermore, the high stone walls of these courtyards acted as protective barriers, keeping youngsters safe from traffic hazards. However, the development area of the village was designed in a grid pattern. Therefore, in

the development area of Behramkale, each parcel has an individual living unit with a larger average floor space than the vernacular settlement, located within the parcel with a front yard. On the contrary, the historical settlement has been composed of functional units around a courtyard with high stone walls bordering the street defining an introverted open space for daily activities. The fragmented composition of the units of varied sizes derived from the functional requirements no longer exists in the development area. The introverted design of the vernacular house gave way to an extraverted layout. Therefore, the use of the outdoor spaces has been changed, and the courtyard has lost its identity as the heart of social life. Instead of being used for daily living activities, gardens in the development area are mainly used for planting flowers or food plants. This change in garden usage reflects the changing lifestyles and priorities of the inhabitants (Figure 4).



Images are from the vernacular (old) settlement.



Development area

Figure 4. Courtyards and the Streets of the Vernacular Settlement and the Development Area.

In Behramkale, the mosque and village coffee houses supported social life by being meeting points and neighbourhood networking areas for locals as well as tourists. There is a coffee house in the development area, too. However, instead of being at the centre of the settlement, it is located on the main road connecting it to the other provinces.

4.3. Perceptual Features (Features of Meaning) of Place Identity and Dis-identity

The introduction of the development area in Behramkale conflicts with the values of unique architecture, cultural traditions, and historical significance and does not align with the existing vernacular character of the settlement. This erodes the settlement's cultural and historical identity and the authenticity of the area, making it less appealing to visitors, disconnecting locals, and diminishing the sense of maintaining a cohesive and vibrant community. It is seen that modern construction methods and materials have been prioritised over traditional building styles in the development area. This creates a contrast that detracts from its cultural identity, compromises the integrity and longevity of traditional buildings, and leads to the loss of traditional building skills and techniques. Conflict between old and new undermined the authenticity of the heritage settlement, making it difficult for locals and visitors alike to connect with the area's history and culture. The development area is detached from the vernacular settlement and functions solely as affordable housing for local inhabitants. Resulting in a fragmented and disjointed urban environment creates social and economic segregation between the development area and the vernacular settlement, potentially leading to

disparities in access to resources, opportunities, and social interaction. The separation of the development area (ironically, the ancient walls highlight this separation physically) from the vernacular settlement has resulted in a lack of community attachment, a reduced sense of belonging, and diminished opportunities for community-driven initiatives and economic benefits. According to in-depth interviews with the locals, the architectural identity of the village was important to the older generation, who mostly lived in the old settlement. Some locals who had an enterprise or could afford the renovation of their houses continued to live in the old settlement. Locals who had close bonds with the village also wanted to see the continuity of the architectural values of the village in the development area.

5. Discussion

5.1 Summary of Case Study Findings

5.1.1 Static Features

The vernacular settlement of Behramkale exhibits an organic urban pattern with compact morphology, characterised by stone masonry walls and courtyards, reflecting North Aegean traditional dwelling characteristics. The historic settlement predominantly used natural and regional resources like andesite stone, wood, and earth in construction, influenced by the climate and endemic environment. However, the village development area, planned in a grid pattern, differs from the organic layout of the old settlement and features modern structures with contemporary materials and design elements. While stone is still used, hollow brick, aerated concrete, and reinforced concrete are now more commonly employed for practical and economic reasons. Regrettably, the distinctive interior design elements of the old settlement, such as gusülhane and yüklük, which held significant importance in shaping the vernacular architectural identity, have vanished from the spatial layout of the new house designs in the development area. In their place, specialised spaces like kitchens and bathrooms have been incorporated, leading to an enlargement of the parcel areas.

5.1.2 Dynamic Features

The historic vernacular settlement of Behramkale has an "organically evolved landscape" morphology, shaped in response to the natural and cultural environment. Courtyards in the vernacular settlement served as central communal spaces for various daily activities and social gatherings. However, in the development area, individual living units with larger floor spaces replaced the fragmented functional units around courtyards. The development area's extraverted layout changed outdoor space usage, with gardens primarily used for cultivating flowers or food plants. Additionally, while the vernacular settlement's mosque and coffee houses served as social hubs, the coffee house in the development area is located on the main road rather than at the centre of the settlement.

5.1.3 Perceptual Features

The introduction of the development area in Behramkale has led to conflicts with the unique architecture, cultural traditions, and historical significance of the settlement, eroding its cultural identity and authenticity. Modern construction methods and materials have been prioritised over traditional building styles, leading to a contrast that compromises the integrity of traditional buildings and construction skills. The reduced connection between the old and new areas has resulted in a lack of community attachment and a reduced sense of belonging, potentially leading to social and economic segregation between the development area and the vernacular settlement. Locals, especially the older generation residing in the old settlement, place great importance on preserving the architectural identity of the village and wish for the continuity of its values in the development area, reflecting their strong bonds with the village.

5.2 Role of Policies for Development Areas in Place Identity Conservation

Although the rural settlements in Türkiye have different urban morphologies, as in the Behramkale case, village development areas are planned as a product of zoning plans that have a texture of linear consistency and are uniformly imposed in all regions of the country without considering design aspects like climatic conditions, terrain, and socio-cultural structure. For this reason, these settlements have

no sense of local "identity" (instead having more urban character) or a sense of "placelessness" (Varolgüneş & Canan, 2017), which is explained as "the casual replacement of the diverse and significant places of the world with anonymous spaces and exchangeable environments" (Relph E.C., 1976). In zoning plans, parcel layout, design of open and closed spaces, and average floor area are considered according to standard implications.

Apart from the urban morphology, facade organisation, architectural elements, construction techniques, and materials also play a significant role in shaping the architectural identity of a settlement. They contribute to aesthetics, cultural expression, and historical context, creating a sense of place and identity. Zoning plans give limited information about the design of buildings in development areas, such as height and floor area ratio. In such an ambiguous construction environment, the development area of Behramkale did not originate with a homogenous and qualified character but with an architectural cacophony. There is a lack of continuity and transmission of conventional construction techniques' knowledge and abilities to new buildings because of several potential causes, including the high cost of masonry and timber materials and a shortage of masonry artisans (Ergöz Karahan et al., 2023).

As described in the policies for development areas section above, until the 2000s, there was no concern among government authorities about the quality of buildings in the development areas. Village design guides could be beneficial supplementary tools for an identity-based approach to conserving the identity of vernacular rural settlements (Boyacıoğlu et al., 2015). However, since 2017, the "Ministry of Environment, Urbanization, and Climate" has referred to the books named "Residential Projects in Accordance with Vernacular Architectural Properties I-II-III-IV" in case of a request for assistance for the design of houses in development areas. The cities mentioned in these books have several types of rural settings; for instance, mountain villages and coastal villages do not share the same type of morphology or architecture. However, it is observed that suggested projects ignore such differences and rely on a kind of typification that reduces the design to a formal approach, where the elements of vernacular vocabulary come together randomly (Guler K., 2020; Polat E.O., 2016) and create "false vernacular" environments. In case of the expansion of the development area of Behramkale, locals will be directed to residential projects prepared for Çanakkale that have different architectural properties than Behramkale, since the vernacular houses in Behramkale do not have either projections or timber claddings on the façade (Oruç et al., 2017) (Figure 5).

It is evident that village development areas in vernacular rural settlements can be planned, neither like tabula rasa nor like the setting of a theatre. As the Behramkale case proved new tools are needed to plan the development areas of vernacular rural settlements to sustain local features while promoting scenarios for rural development. Identity-based and people-centred approaches can be practical tools for understanding the natural, built, and sociocultural characteristics of vernacular rural settlements and finding plausible ways of integrating these features into the evolution of village development areas. An approach that considers the architectural identity of the place as well as the locals' needs can strengthen the role of architecture in conceptualising and realising innovative ideas around vernacular living that focus on place-making. As stated by Salman (2019), awareness of vernacular architecture, understanding its importance, and enhancement of the built environment are not nostalgic approaches to the past but an endurance of the local identity.

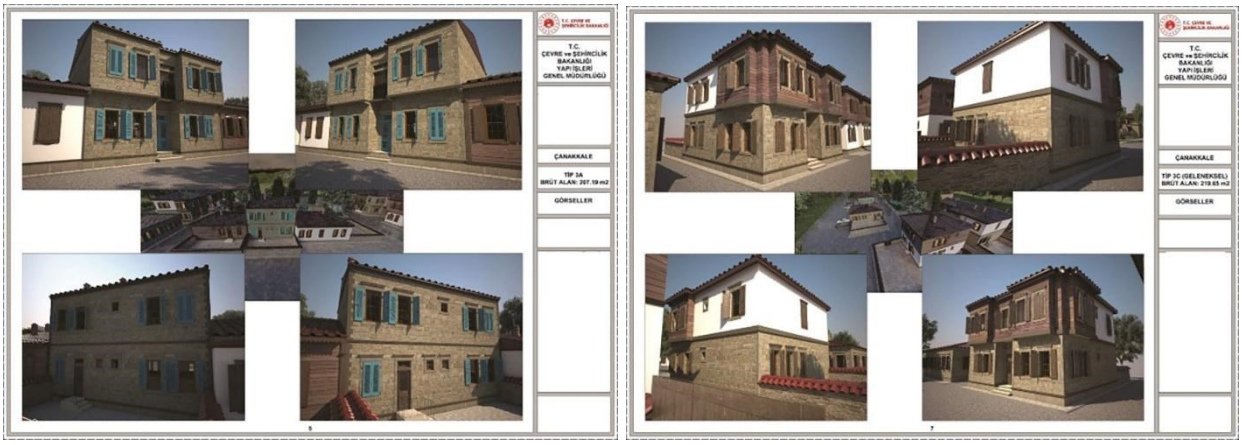


Figure 5. Typical Residential Projects Prepared for Çanakkale Region (Oruç et al., 2017)

5.3 Recommendations for Future Applications

The findings from the case study highlight the importance of careful planning and designing development areas in heritage sites to integrate harmoniously with the existing vernacular settlement and preserve its cultural identity, historical continuity, and social fabric. This can be achieved through inclusive community engagement, adherence to local architectural styles, and a focus on sustainable development practices that respect and enhance the character of the heritage area. A place-making strategy, responsive to the context through examination of issues that make the place meaningful for insiders who intensely experience it, might be more efficient for the design of the development areas of vernacular rural settlements. Participatory design approaches involving locals and stakeholders in the design process can help ensure that the development areas reflect the community's unique cultural and social values. Involvement of local communities in the decision process is often too minimal in Türkiye, limited by consultation or even declaration when proposals are already well-developed, rather than a dialogue throughout the entire process. However, promoting community participation in the development areas' design would benefit every actor.

6. Conclusions

In conclusion, this research has explored identity issues in the development areas of vernacular rural settlements through the case study of Behramkale, Türkiye. The study has offered valuable insights into the complexities of preserving architectural and urban identity in the face of modernization and development pressures. Contrary to conventional literature, which predominantly focuses on the static architectural features of identity, this study has extended its scope to encompass dynamic and perceptual aspects of identity as well.

Through the analysis of the Behramkale case, it became evident that existing top-down planning methods in Türkiye do not effectively address the challenge of conserving local identity in vernacular heritage settlements. The introduction of development areas often lacks site-specific and identity-based design considerations, leading to dis-identity issues that compromise the unique architectural and urban characteristics of these settlements. The study has revealed the importance of acknowledging both the physical and intangible elements that contribute to place identity.

Furthermore, the research has underscored the significance of a people-centred approach and community engagement in the design and planning of development areas. The lack of community attachment and reduced sense of belonging observed in the development areas of Behramkale emphasize the need for a more inclusive and participatory process. Such an approach not only ensures the preservation of architectural heritage but also fosters a stronger sense of community and cultural continuity.

In light of the findings, it is recommended that policies for the development areas of vernacular rural settlements should be restructured to integrate an identity-based and people-centred approach. By involving local communities and stakeholders in the decision-making process and tailoring design

decisions to the specific cultural, historical, and environmental context of each settlement, it becomes possible to create development areas that seamlessly coexist with the existing vernacular settlements. This not only promotes sustainable development but also strengthens the bond between residents and their built environment.

In the broader context, this study contributes to the literature by highlighting the importance of considering the continuity of identity in development areas of vernacular rural settlements. By extending the analysis beyond static architectural features, the research enriches our understanding of how cultural and historical identity can be preserved amidst ongoing urbanization and modernization. For further research, a site-specific and people-centred model for the development areas of the vernacular rural settlements is planned to be conducted as a guide for both the governmental authorities and the villagers.

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Original scientific paper

Territoriality in Post-conflict Neighbourhoods: Unravelling the Dynamics of Territorial Marks in Ile-Ife, Nigeria

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ABSTRACT

The pervasiveness of territorial marks in post-conflict neighbourhoods elicited this study. Relying on residents' perceptions, the study explored the dynamics underpinning residents' use of territorial marks. Primary data was collected by administering questionnaires to residents of various neighbourhoods within the study area. Physical observations were conducted to identify all residential neighbourhoods and categorised into three homogenous zones. From each homogenous zone, 30 neighbourhoods were purposively selected. In total, 2055 buildings were identified within these selected neighbourhoods. Thereafter, systematic sampling was employed, resulting in the selection of 206 residents living in separate dwelling units. Findings revealed significant territorial behaviour across all socioeconomic classes. Indigenous territorial marks were predominantly used across all income groups as elements used to communicate land ownership. The study concluded that while crime prevention may be correlated with territoriality, however, in post-conflict neighbourhoods, the need to demarcate land boundaries and communicate ownership was more important, as demonstrated in the adoption of indigenous elements as territorial marks. The paper concluded that in these neighbourhoods, territoriality is chiefly a land boundary regulation mechanism. The paper recommends clear-cut land policies in post-conflict communities while advocating for the recognition of indigenous territorial marks in Afro-centric literature.

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Highlights	Contribution to the field statement
-Humans irrespective of socio-cultural and economic background demonstrate significant territorial behaviour - The complexities of land law and administration in a setting impact human territorial behaviour. - Territoriality should feature prominently in discussions on land ownership and dispute - Economic factors more than user intention determine the type of territorial marks used - Indigenous territorial marks feature prominently in traditional African settings. - Indigenous territorial marks unique to traditional African settings should be captured and explored in the literature	The originality of this paper is grounded on the analysis of the relationship between the use of territorial marks and poor land administration in post-conflict urban settings. The study observed that beyond the themes of CPTED and social inequality, the use of territorial marks is clearly predicated on the complex nature of land law in African cities, and this is evident in the proliferation and use of diverse indigenous elements to communicate ownership and mark land boundaries. The study argues for the identification, recognition and control of indigenous territorial marks in attempts at effective land ownership administration.

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1. Introduction

In recent years, studies on human-environment interaction have gained significant traction among researchers. Within the sphere of environmental psychology, researchers attempt to understand the behaviours and attitudes demonstrated by individuals and groups over and within physical space (Özaşçılar, 2022; Preston & Gelman, 2020; Wnuk & Oleksy, 2021; Zubaidi et al., 2013). Among the various themes explored in this field, territoriality stands out as a compelling construct. This concept is particularly pervasive in the context of residential units within urban neighbourhoods (Toruńczyk-Ruiz & Martinović, 2020). Gifford (1997) defines territoriality as the patterns of behaviour and attitude, demonstrated by individuals or groups, based on perceived, attempted or actual control of a definable physical space that involves habitual occupation, defence, personalisation and marking of such space. While space marking is integral to the concept of territoriality, it also manifests in other themes within built environment debates.

Territorial marks particularly fences and gates, feature prominently in various debates. These marks are recognized for their multifaceted functions, which transcend predictable roles. Some studies identify these marks as Crime Prevention Through Environmental Design (CPTED) strategies primarily serving crime prevention purposes (Badiora & Abegunde, 2015; Badiora et al., 2014; Odunlade et al., 2023; Özaşçılar, 2022; Nwokaeze et al., 2022), while others propose that they also have socio-economic implications such as enhancing privacy (Adedeji et al., 2016; Fahad et al., 2021; Kintrea et al., 2010), aesthetics, ownership (Edney, 1976; Manzo & Perkins, 2006; Saisanath & Gnanasambandam, 2020; Sanchez et al., 2005) and improving property value (Olujimi, 2010; Soyeh et al., 2020). However, complexity arises from an incoherent understanding of the factors motivating their use and prevalence. This knowledge gap poses a considerable challenge in formulating articulate planning policies to regulate the use of territorial marks (Gooblar, 2002).

Moreover, the presence of these marks in discussions on land boundary regulation introduces an additional layer to the debate, suggesting that territoriality takes on distinct nuances in various settings (Bagaeen et al., 2010; Bandauko et al., 2021; Preston & Gelman, 2020), with neighbourhoods or communities with a history of land disputes offering a particularly compelling and underexplored context (Wnuk & Oleksy, 2021). To guide our exploration, we raise several crucial questions: Why are territorial marks prevalent in post-conflict neighbourhoods? What role do human socio-economic needs play in the prevalence of territorial marks? Are these marks primarily CPTED strategies and could they be mechanisms for land boundary regulation in response to land disputes?

In the aftermath of conflicts, communities grapple with various issues, such as land disputes and safety concerns, significantly impacting their interactions with the urban landscape (Badiora & Abegunde, 2015). Yet, scholarly attention to territoriality within post-conflict neighbourhoods remains limited. While previous studies on territoriality in post-conflict communities explored inter-community level land boundary demarcation (Wnuk & Oleksy, 2021), some other studies have shown the intricacies in territorial dynamics between and across neighbourhoods (Jabareen & Eizenberg, 2019; Di Masso et al., 2011), leaving room for further exploration. This study aims to bridge this knowledge gap by delving into territorial marks used at plot size and within the neighbourhood.

In light of these considerations, this study will examine territoriality at both the plot size and neighbourhoods of a post-conflict community. This is particularly important, given the growing prevalence of reports and studies on perimeter fencing and gated neighbourhoods around the micro-units of the community i.e. around neighbourhoods and individual dwelling units (Bandauko et al., 2021; Mark & Overall, 2015; Olajide & Lizam, 2016; Zurainah et al., 2020). Perimeter fencing and gates are territorial marks and their prevalence highlights the urgency to understand the complexities of territoriality within post-conflict urban landscapes. Moreover, the presence of fencing and gates in social, cultural and economic themes raises intriguing debates about their true purpose and significance (Adedeji et al., 2016; Edney, 1976; Kintrea et al., 2010; Manzo & Perkins, 2006; Olujimi, 2010; Saisanath & Gnanasambandam, 2020; Sanchez et al., 2005). This research seeks to shed light on the multifaceted aspects of territoriality in urban landscapes, providing valuable insights into the intricate

relationship between humans and their environments. It seeks to expand beyond gates and fences, exploring territorial markers in urban landscapes and identifying transcendent motivators.

This study delves into territorial marks within neighbourhoods, aiming to unravel the underlying reasons behind their utilization. By shedding light on the multifaceted aspects of territoriality in urban landscapes, this study seeks to contribute valuable insights that can inform urban planning and enhance our understanding of the intricate relationship between humans and their environments. In Nigeria, and Africa there is limited knowledge regarding the various types of territorial marks and the factors that influence territoriality, even though they are ubiquitous (Mark & Overall, 2015; Odunlade et al., 2023). Moreover, previous research mainly focuses on gates and fences as they relate to social inequality and crime prevention (Adedeji et al., 2016; Badiora & Abegunde, 2015; Vesselinov et al., 2007). The current study argues that territoriality within neighbourhoods transcends the use of fences and gates. And beyond crime prevention, the use of territorial marks may find an explanation for the social, cultural and economic needs of users.

Therefore, the current study is positioned to test this argument using the post-conflict community of Ile-Ife, southwest Nigeria as a suitable example. As earlier posited, post-conflict communities offer distinct nuances given the history of land conflict and the appearance of land boundary demarcation in territoriality. Moreover, the suitability of neighbourhoods in Ile-Ife as a case study is premised on the age-long reputation of inter-communal crises fuelled by land disputes and the complex nature of the land tenure system in Nigeria (Badiora & Abegunde, 2015; Otubu, 2007). In addition, Ile-Ife is a city defined by territorial marks before and post-colonization. According to Ayangbuile and Abiodun (2014), before colonialism, the town's morphology was characterized by walls. The ancient city developed within a valley that was surrounded by seven hills, which acted as territorial boundaries. Additionally, walls were constructed around it to ensure security (Marcuse, 1995). These attributes present Ile-Ife as a suitable case study.

The study leverages residents' perceptions to investigate the various territorial marks used in these neighbourhoods, beyond the conventional gates and fences, and to understand the factors influencing their utilization. Understanding this could aid zoning regulations and city aesthetics, especially in other traditional African settings, where territorial marks are ubiquitous. Additionally, the study aims to shed light on the implications of territoriality beyond issues of social inequality and crime prevention in urban settings. The study's findings hold significant implications for urban planning, as it could inform the design of more inclusive and cohesive neighbourhoods, taking into account the complexities of territoriality in post-conflict communities. Moreover, the research outcomes will be valuable for community development and land dispute resolution efforts, as understanding the factors influencing territoriality can help promote peaceful coexistence in vulnerable urban settings. To achieve this, this paper gives an overview of land administration in Nigeria as a background to understanding land disputes.

2. Land Tenure in Nigeria; a Driver of Territoriality?

In Nigeria, the land tenure system is a complex interplay of customary and statutory practices (Otubu, 2007). Customary land tenure is prevalent in southwestern Nigeria, granting communal ownership and usage rights to families and communities based on traditional customs). In contrast, statutory land tenure - that has the Land Use Act of 1978, as one of its most significant legislation- overseen by the state government, governs urban and peri-urban areas, allocating land for various purposes (Otubu, 2017). The coexistence of these two systems leads to overlapping interests in land, fuelling conflicts as parties assert their claims to specific parcels.

This study argues that the observed proliferation of territorial marks especially fences and gates is in a bid to protect interests and communicate possession. Hence, individuals and families use visible and multiple territorial marks, such as fences or stone walls, and survey beacons, as tangible evidence of ownership and delineation. This practice aims to safeguard their rights and deter encroachments by other parties. However, only a few studies within the Nigerian space explored human-environment behaviour in a post-conflict setting and such studies seem to focus on why and how criminal behaviour

thrives in the post-conflict urban landscape (Badiora & Abegunde, 2015). Hence, it remains to be seen, how the ownership and right considerations could impact territorial behaviour, especially at the neighbourhood plot/parcel level in urban spaces. Understanding the dynamics of land tenure and its effects on territoriality is crucial for effective land management and conflict resolution.

3. Conceptualizing Territoriality

Research has shown that the quest to claim and exercise a right of ownership over land and identified territories is significant and is of serious concern within the built environment (Gifford, 1997; Di Masso et al., 2011; Preston & Gelman, 2020). However, the concept of a territory remains rather elusive and a full understanding of the concept of territoriality cannot be achieved except clear definitions are given to the term "territory". In the existing literature, territory has been defined from two distinct but interconnected schools of thought. The first school of thought describes territory purely as physical and or material (Gifford, 1997). The second school of thought observed territory from a mental and psychological viewpoint. The mental territory represents and has been identified and categorized as "place attachment", "community attachment" and "belonging feeling" (Guest, 1984; Brown et al., 2004; Preston & Gelman, 2020; Wnuk & Oleksy, 2021). This categorization is based on the psychological effects of human and environmental interaction. On the other hand, the physical territory from the first school of thought connotes tangible elements that can be seen and expressed in space as territory (Brighenti, 2010; Iranamesh, 2012).

Both the physical and psychological territory are intricately connected. While the psychological dimension plays a pivotal role in shaping how individuals perceive and interact with these physical spaces, it informs why territorial marks such as fences and gates, are not merely functional but hold deep emotional and cognitive significance for users, the Physical territory represents the tangible spaces that individuals or groups occupy, personalize and defend as highlighted in the literature on territorial markers and their multifaceted functions (Odunlade et al., 2023). Given these intricacies, this study explores the physical territory defined by individuals and groups, the marks used in defining this territory and the multifaceted functionality of the marks.

Hence, the definition of Iranamesh (2012) that relates a territory to a geographical entity or a place that has a distinct boundary, habitually occupied by a group or individual who exercises control or domineering power over it, is how territoriality is conceptualized in this study. Although only a handful of studies conceive territoriality in this light (Fahad, 1992; Odunlade et al., 2023), it makes for a compelling exploration, to understand the dynamics of territoriality at this level of the urban area. In other words, a territory is a physical space, with distinct boundaries and habitually occupied, conceived and limited in this study to a neighbourhood and individual dwelling units or plots. Moreover, groups and individuals controlling the territory are limited to the residents within a neighbourhood. Hence, territoriality in this study is conceived as the use of signs of identity (markers) by individuals or groups on an identified territory (neighbourhood and dwelling units) to communicate ownership, defence and control among other needs.

3.1 Territoriality and the Theory of Human Need

There is a relationship between the built environment and human needs. Iranamesh (2012) established this with Maslow's Hierarchy of Needs. This relationship is crucial and thus explained. Humans just as in other animals are observed to be conscious of their territories (Edney, 1976). This heightened consciousness is demonstrated by the feeling of insecurity that accompanies the encroachment of territories. Humans thus make attempts to demarcate and fortify their territory against external evasion, to foster the continuation of privacy and security. Subsequently, as humans move up in the level of their need, the importance of territoriality to man transcends or goes beyond the need for privacy and security only. Man tries to use his environment as a medium of communication. He wants others to know his status by merely looking at where he resides. He wants his environment to speak for itself. These needs are in the form of architecture and aesthetics (Fahad, 1992). Thus, the definition of

territoriality must reflect the psychological needs of man as well as the need for self-esteem, self-actualization and aesthetics among others.

Arguing along this line, Hayter (1981) opines that territoriality serves as a mechanism for supplying the three great needs of stimulation, identity and security. In other words, territoriality is not solely for establishing physical boundaries, it has evolved in its use to the meeting of other social needs of individuals and groups. It is a status symbol, which represents social class, cultural as well as ethnic affiliation. Culture is a significant determinant of the meanings and functions attached to any physical and social phenomenon and territoriality is not an exception (Iranamesh, 2012). Summarily, the need for territoriality within the literature is pinned to defence (Hayter, 1981; Newman, 1972; Newman, 1996), space marking (Brighenti, 2010; Iranamesh, 2012), esteem and belonging (Manzo & Perkins, 2006) among others.

3.2 Territorial Marks

Territorial marks are of a multifaceted dimension (Grant & Mittelsteadt, 2004; Iranamesh, 2012). Various forms of territorial marks are adopted by various groups and individuals in their physical space. Oftentimes time the choice of territorial mark is dependent on several social and economic as well as cultural attributes of the individual or group. As observed in the literature, the higher economic class especially in Nigeria adopted the use of walls and perimeter fences in territoriality. In other instances, soft landscape elements of trees and flowers are often adopted. However, the issues of territorial marks may transcend these. Other territorial marks may be employed by individuals and groups and they need to be documented, especially as it deals with culturally induced and indigenously sourced territorial marks. Accordingly, this study has tried to identify and classify several territorial marks as observed in the literature.

3.2.1 Image and Milieu

Newman (1972) described the capacity of a design feature to communicate a territory's uniqueness, isolation and stigma as an image and milieu. Such features are specifically used to achieve the dual objective of access control and boundary delineation. These objectives are intricately tied to the concept of territoriality. They connote divide and or mark spaces while identifying the shadings between public and private spaces.

3.2.2 Security Barriers

Barriers in CPTED restrict access to target areas, reducing crime by promoting social control through territorial reinforcement and improved proprietary concern. Clear delineation of private space creates a sense of ownership, encouraging vigilance against intruders and aiding in their identification. Natural territorial reinforcement is achieved through the use of buildings, fences, lighting, and landscaping to express ownership and define public, semi-public, and private spaces. Agbola (1997) identified two barrier types: physical, which physically prevents access, such as fences and locked doors, and symbolic, which uses design to signify ownership. Arguably, both types contribute to crime reduction and enhanced security.

3.2.3 Graffiti or Symbolic Barriers

Symbolic barriers are also often identified in the literature as graffiti. These forms of territorial signs are less tangible. From the use of low decorative fences, and flower beds, changes in sidewalk patterns or materials and prominent use of signs that can be cultural, traditional or universal, such as; "No Trespassing, beware of dogs, No movement beyond a specified time" among others. In short, any form of tangible or legible material could serve as a symbolic barrier. The only requirement is that it defines a boundary, and it may not prevent physical movement.

3.2.4 Landscape, Greenery and Biophilic Marks

Landscaping is of two forms. The hard and soft landscaping. The latter represents the use of flowers, trees and other elements that bring man closer to nature, hence the nomenclature as greenery or biophilic marks. The former represents the use of concrete and paved surfaces among others. Although one may be forced to argue that landscaping is done with the intent to achieve beautification of areas. However, in most instances, the quest for landscaping transcends the objective of beauty. Individuals and groups employ the elements of the landscape to clearly define their territories and communicate to a potential intruder that such space is preoccupied. Landscaping serves as a versatile design element, functioning as a symbolic barrier to mark transitions between zones and convey an alert and active presence (Agbola, 1997). Features like decorative fencing, flowerbeds, and varied cement patterns indicate zone separation, while evergreen hedges can provide more substantial barriers if necessary.
A cursory look at the global literature on territorial marks, reveals an incoherent outlook, it is on this premise that this study aims to explore territorial dynamics in a post-conflict community, beginning with an overview of post-conflict Ile-Ife's morphology to shed light on its territorial history.

4. Morphology of Post-Conflict Ile-Ife

Ile-Ife, a historical Yoruba city, predates the British colonization of Nigeria. It is located at Latitude 7°29° N, 7°31° N of the Equator and Longitudes 4°43° E, and 4°45° E of the Greenwich Meridian. As with many traditional Yoruba cities, such as the Old Oyo Empire, Ile-Ife was built in a valley surrounded by seven hills that delineated the boundaries of the ancient city. According to Marcuse (1995), beyond the hills, walls were erected as an extra layer of security around the ancient town. Hence, Ayangbuile and Abiodun (2014) summarized the town's pre-colonial morphology as one defined by territorial markers. The additional walls had a dual purpose. They were initially meant to divide the town into five sections: Iremo, Okerewe, Moore, Ilode, and Ilare (Badiora & Abegunde, 2015). These walls also indicated the social hierarchy of the residents in each section (Ayangbile & Abiodun, 2014). Essentially, the walls not only enclosed the areas but also established a hierarchy within each section. Currently, these sections are considered the traditional town centre or core residential areas. As expected, there are significant historical and cultural structures in the traditional town centre, including the palace, shrines, and groves. Protective walls were constructed around these buildings as a symbol of their historical and cultural significance, and they remain standing today.
The traditional town centre had its most significant evolution following the collapse of the old Oyo Empire in the 19th century. Given the Yoruba knitting between the Ifes and Oyos, a section of the Oyos migrated to an area in Ile-Ife, known now as Modakeke-Ife. However, as the immigrants grew in population, cultural identity, economics and politics as reflected in land ownership and payment of land rent (Isakole), a crisis ensued between the immigrants and their host. A conflict that lasted for centuries, thereby creating invisible social and economic partitions among constituent neighbourhoods in the city, with the Modakeke partition being the stronghold of immigrants. This part of town has been referred to as post-conflict neighbourhoods in previous studies (Badiora & Abegunde, 2015). The post-conflict neighbourhoods were initially a part of the traditional town centre (see Figure 1). However, its current social and physical conditions have evolved due to the various Ife-Modakeke crisis. The area now comprises freestanding row houses, dilapidated buildings, vacant spaces, unoccupied structures, dump sites, and low trees and bushes scattered between the buildings.

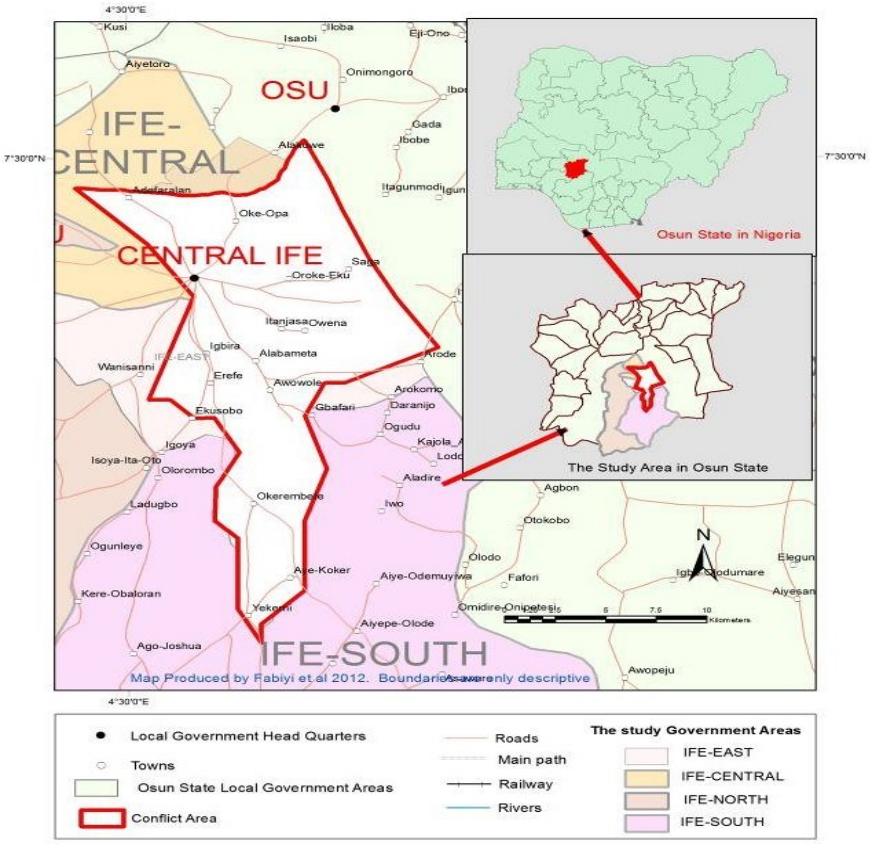


Figure 1. Conflict-Affected Areas within the Context of Ile-Ife, Osun State, Nigeria
Source: Fabiyi et al (2012).

The advent of colonialism brought some noticeable sanity to the conflict-torn community. Developmental strides and noticeable transformation and developmental strides ensued, with growth spanning beyond the traditional town centre and the complimentary walls. The city thus has two distinct centres - one representing traditional architecture and the second showcasing modern design. The modern area shares similarities with those Onekerhoraye, (1977) identified as transition or intermediate areas in other African traditional cities like Ogbomosho, Ilorin, and Benin.

Post-colonialism in Nigeria, the town witnessed a surge in developmental activities, mainly facilitated by the establishment of the University of Ife (now Obafemi Awolowo University) and its Teaching Hospital in 1962 and 1975 respectively. According to Ayangbile and Abiodun (2014), the social and economic status of residents increased mainly because of the economic opportunities presented by these institutions. As a result, there was an increase in income status and a more diverse population. This led to noticeable differences in the availability of urban infrastructure in different areas of the town. Educated elites moved to new areas, which are referred to as modern residential areas in this study. Summarily, the morphology of post-conflict Ile-Ife can be described as having three distinct residential neighbourhoods, the traditional town centre (including the post-conflict neighbourhoods), the transition neighbourhoods and the modern neighbourhoods. An understanding of the evolution and morphology of the study area, provided a basis for the methodology used in this study, as summarised in the next section.

5. Materials and Methods

Primary data was collected by distributing questionnaires and observing the physical and environmental characteristics of the study area's neighbourhoods. These methods have been widely used in similar studies (Farhad et al., 2021; Gifford, 1997; Özaşçılar, 2022).

We gained a comprehensive understanding of how residents use territorial marks in their neighbourhoods by observing their physical composition. To gain further clarity on these dynamics,

we administered questionnaires using a multi-stage sampling procedure. First, we identified residential neighbourhoods in the study area and divided them into three groups based on physical characteristics: traditional town centre, transition, and modern residential zone, as discussed in Section 3.

Firstly, a thorough inventory was conducted to list all 120 residential neighbourhoods within the study area. These neighbourhoods were subsequently categorized into three residential zones: traditional, transition, and modern, consisting of 36, 64, and 20 neighbourhoods respectively. To ensure representation from each zone, 25% of neighbourhoods from each zone were purposively selected, resulting in 9, 16, and 5 neighbourhoods selected from traditional, transition, and modern zones respectively. Overall, 30 neighbourhoods were included in the study, representing all residential zones. To ensure accuracy, we conducted a thorough count of the buildings in each of the selected neighbourhoods using Google Earth Imagery. We counted a total of 2055 buildings, with 480 in the core area, 1125 in the transition, and 450 in the modern neighbourhoods. Then, we used systematic random sampling to choose sample residential units or buildings. With this technique, we selected every 10th building in a straight line directly adjacent to the street, starting with a random first building. From these buildings, we drew a sample of respondents from 206 residential buildings and administered questionnaires to adult males, preferably the household head. Data collected were analysed using frequency distribution, percentages and an index measuring residents` rating of territorial marks tagged the Territorial Marks Importance Index (TMI). To calculate the TMI, residents were asked to allot weight to the importance of each territorial mark on a 5-point Likert scale. To calculate the Sum of Weighted Value (SWV) for each variable, we added up the number of responses for each rating for a territorial mark and multiplied it by the corresponding weight of the value. Next, we found the mean index (TMI) for each territorial mark by dividing the SWV of each variable by the total number of respondents, which was 206.

6. Results

6.1 Socio-economic Attributes of Residents in Ile-Ife

We analysed the socio-economic characteristics of those who participated in the study, which included their gender, religion, type of tenure, years, spent in the neighbourhood, level of education, and household monthly income. These details can be found in Table 1. It was observed that most of the respondents (84.0%) were male, while the remaining 16.0% were female. Religion played a significant role in the use of territorial marks, with 67.5% identifying as Christians, 25.2% as Muslims, and 7.3% as practitioners of traditional religion.

The status of tenure could play a role, in influencing decisions on the use of perimeter fences. Specifically, 40.8% of respondents lived in rented houses, 37.4% in self-owned houses, 14.6% in compound houses, and 7.3% in inherited houses. Additionally, the length of stay in the neighbourhood impacted residents' disposition towards the installation and use of territorial marks. Of the respondents, 36.9% had lived in their current neighbourhood for ten years or less, 85.3% between ten to twenty-five years, 5.3% between twenty-six to forty years, and 2.45% for more than forty years, influencing their assessment and investment in the neighbourhood.

Educational attainment and average monthly income were also vital factors shaping individuals' perceptions of self and the environment. Notably, 9.7% and 41.3% of residents sampled had primary and secondary education, respectively, while 7.8% and 35.9% had technical and tertiary education, respectively. It was evident that a significant majority (35.9%) had tertiary education, and nearly half (49.1%) possessed at least a secondary education, with only 5.3% having no formal education. The findings on residents' average monthly income revealed varied income classes, with 9.7% earning less than ₦30,000, 16.0% between ₦31,000 – ₦60,000, 27.7% between ₦61,000-₦90,000, and 46.6% earning above ₦90,000. Further analysis revealed that the income of residents varied across different residential areas. Statistical test computed confirmed that residents` income varied significantly across the different residential neighbourhoods ($F=19.155$, $p=0.000$).

Based on these findings, there is a clear difference in income levels among the residential zones. The traditional town centre has more very low-income earners, while the transition neighbourhoods have

more low and middle-income earners. The modern residential zone has a higher concentration of high-income earners. These socio-economic insights offer valuable perspectives on the use of territorial marks in urban landscapes.

Table 1. Residents' Socio-economic Characteristics.

Attributes	**Traditional** Freq. (%)	**Transition** Freq. (%)	**Modern** Frequency (%)	**Total** Frequency (%)
Gender				
Male	41 (85.4%)	103 (92.3%)	29 (63.0%)	173 (84.0%)
Female	7 (14.6%)	9 (8.0%)	17 (37.0%)	33 (16.0%)
Total	**48 (100.0%)**	**112 (100.0%)**	**46 (100.0%)**	**206 (100.0%)**
Religion				
Christian	19 (39.6%)	81 (72.3%)	39 (84.8%)	139 (67.5%)
Islam	19 (39.6%)	27 (24.1%)	6 (13.0%)	52 (25.2%)
Traditional	10 (20.8%)	4 (3.6%)	1 (2.2%)	15 (7.3%)
Total	**48 (100.0%)**	**112 (100.0%)**	**46 (100.0%)**	**206 (100.0%)**
Type of Tenure				
Rented	26 (54.2%)	53 (47.3%)	5 (10.9%)	84 (40.8%)
Self-Owned	5 (10.4%)	36 (32.1%)	36 (78.3%)	77 (37.4%)
Compound	12 (25.0%)	16 (14.3%)	2 (4.3%)	30 (14.6%)
Inherited	5 (10.4%)	7 (6.3%)	3 (6.5%)	15 (7.3%)
Total	**48 (100.0%)**	**112 (100.0%)**	**46 (100.0%)**	**206 (100.0%)**
Years Spent in the Neighbourhood				
≤10 years	2 (4.2%)	3 (2.7%)	17 (37.0%)	76 (36.9%)
10-25	5 (10.4%)	6 (2.4%)	29 (63.0%)	114 (85.3%)
26-40	20 (41.7%)	65 (58.0%)	0 (0.0)	11 (5.3%)
≥ 40	21 (43.8%)	38 (33.9%)	0 (0.0)	5 (2.4%)
Total	**48 (100.0%)**	**112 (100.0%)**	**46 (100.0%)**	**206 (100.0%)**
Level of Education				
Primary	7 (14.6%)	10 (8.9%)	3 (6.5%)	20 (9.7%)
Secondary	32 (66.7%)	45 (40.2%)	8 (17.4%)	85 (41.3%)
Technical Training	5 (10.4%)	6 (5.4%)	5 (10.9%)	16 (7.8%)
Tertiary Education	0 (0.0)	46 (41.1)	28 (60.9)	74 (35.9)
No formal Education	4 (8.3%)	5 (4.5%)	2 (4.2%)	11 (5.3%)
Total	**48 (100.0%)**	**112 (100.0%)**	**46 (100.0%)**	**206 (100.0%)**
Monthly Income (₦)				
≤ ₦30,000 (<$40)	20 (41.7%)	0 (0.0)	0 (0.0)	20 (9.7%)
₦31,000 - ₦60,000 ($40-$79)	26 (54.2%)	7 (6.3%)	0 (0.0)	33 (16.0%)
₦61000-₦90,000 ($80-$100)	2 (4.2%)	55 (49.1%)	0 (0.0)	57 (27.7%)
Above ₦90,000 (>$100)	0 (0.0)	50 (44.6%)	46 (100.0%)	96 (46.6%)
Total	**48 (100.0%)**	**112 (100.0)**	**46 (100.0)**	**206 (100.0)**

6.2 Types and Ratings of Territorial Marks Used Around Neighbourhoods

By observing physical marks used around neighbourhoods, twelve (12), distinct territorial marks were identified across the three residential neighbourhoods of the study. As summarised in Table 2, in the traditional town centre, the mean rating of importance ($\overline{\mathbf{TMI}}$) was 2.98, with roads (4.17) rated as the most important territorial mark. This was followed closely by Graffiti/street signs 4.16) and Landmarks and Monuments (TMI = 4.14). Others were Boundary stones (4.10), Bridges (3.99) and Water bodies. Around the transition neighbourhoods ($\overline{\mathbf{TMI}}$= 2.94), Gates

(3.69), Graffiti/Street signs (3.64) and Roads (3.22) were rated as most important in descending order of importance. Others rated as more important were Fences/walls (3.25), security posts (3.22) and Landmarks/Monuments (3.12). Around the Modern neighbourhoods ($\overline{\mathbf{TMI}}$= 2.99), Gates (4.37), Fence/Wall (4.32), and Security posts (4.27) in descending order were identified as the most important territorial marks with Graffiti (4.12), Road (4.27) and Landmark/Monument (3.01) following closely in descending order of importance.

These findings around the $\overline{\mathbf{TMI}}$ revealed that residents in neighbourhoods of the traditional town centre attached high importance to territorial marks almost at the same level as their counterparts in the modern neighbourhoods. Moreover, within the traditional town centre, low-cost and more permanent territorial marks were used around neighbourhoods, unlike neighbourhoods in modern areas that relied on gates and fences (see Plate 1 & 2). This is a further reflection of the economic disparity between the social classes of residents within these neighbourhoods.

Table 2. Importance Rating of Territorial Marks at Neighbourhood Level in Ile-Ife.

Territorial Marks	Traditional (N=48)			Transition (N=112)			Modern(N= 46)		
	TMI	TMI- $\overline{\mathbf{TMI}}$	Rank	TMI	TMI- $\overline{\mathbf{TMI}}$	Rank	TMI	TMI- $\overline{\mathbf{TMI}}$	Rank
Boundary stone	4.10	1.12	4	2.22	-0.72	11	2.86	-0.08	7
Bridge	3.99	1.01	5	2.48	-0.46	9	2.37	-0.57	8
Electric Pole	1.46	-1.52	10	2.21	-0.73	12	1.40	-1.54	11
Fence/Walls	1.33	-1.65	11	3.25	0.31	4	4.32	1.38	**2**
Gate	1.00	-1.98	12	3.69	0.75	1	4.37	1.43	**1**
Graffiti/Street signs	4.16	1.18	2	3.64	0.70	2	4.12	1.18	4
Landmark/Monuments	4.14	1.16	3	3.12	0.18	6	3.01	0.07	6
Moat/trenches	3.38	0.40	7	2.82	-0.12	8	2.34	-0.60	9
Road	4.17	1.19	1	3.36	0.42	3	3.98	1.04	5
Security post/house	2.54	-0.44	8	3.22	0.28	5	4.27	1.33	**3**
Trees	1.67	-1.31	9	2.33	-0.61	10	1.37	-1.57	12
Waterbody	3.87	0.89	6	2.91	-0.03	7	1.43	-1.51	10
	$\overline{\mathbf{TMI}}$=2.98			**$\overline{\mathbf{TMI}}$ = 2.94**			**$\overline{\mathbf{TMI}}$ = 2.99**		



Plate 1. Gates and Graffiti as Territorial Marks around Transition neighbourhoods.



Plate 2. Fence and Gates as territorial marks around Modern neighbourhoods.

6.3 Types and Ratings of Territorial Marks Used Around Dwelling Units

A more inward observation of dwelling units within neighbourhoods of the study area revealed an aggregate of sixteen (16) distinct territorial marks used. As summarised in Table 4, residents in the traditional town centre were with the highest mean rating of $\overline{\mathbf{TMI}}$= 3.11, with the Modern ($\overline{\mathbf{TMI}}$= 3.03) and Transition ($\overline{\mathbf{TMI}}$= 3.00) following in descending order of overall importance attached to territorial marks.

More specifically, residents in the traditional town centres placed the most importance on Grave/tombstones (4.87), Survey Beacons (4.56) and Graffiti/Inscriptions (4.52, plate 2) in descending order. Other territorial marks with more importance among residents in the neighbourhoods in descending order were Boundary stones (4.33), Landmarks/monuments (4.29) and Charm/Religious items (3.98). In the transition neighbourhoods, residents placed the most importance on Survey Beacon (4.48), Boundary Stone (4.01) and Fence/Walls (3.88) in descending order. Others with more importance in the same order were Gate (3.87), Grave/Tombstone (3.52) and Graffiti/Inscriptions (3.44, see Plate 3). In the Modern neighbourhood areas, in descending order, residents attached the most importance to Gates (4.87), Fence/Walls (4.85) and security posts (4.27). Others were Survey Beacon (4.11), Garden/Lawn/Pavement (4.01) and Wires/Barbs/Mesh (3.98). In Modern neighbourhoods, residents attributed the most importance to Gates (4.87), Fences/Walls (4.85) and Security Posts (4.27). Others in descending order were Survey Beacon (4.11), Garden/Lawn (4.01) and Wires/Barbs (3.98).

As with neighbourhood land areas, these findings on the importance of territorial marks on dwelling units revealed that residents in the traditional neighbourhoods, despite their low-income status display more territoriality. However, they are more predisposed to the use of low-cost traditional materials, unlike residents of modern neighbourhoods whose territorial marks are more sophisticated as presented in the importance attributed to gates, fences, security posts and lawns (see Plate 5). Also obvious is the prevailing use of survey beacons (see Plate 4) across all neighbourhood zones.

Table 3. Importance Rating Marks at the Level of Dwelling Units in Ile-Ife.

Territorial Marks	Traditional (N=48)			Transition (N=112)			Modern (N= 46)		
	TMI	TMI- $\overline{\overline{\mathbf{TMI}}}$	Rank	TMI	TMI- $\overline{\mathbf{TMI}}$	Rank	TMI	TMI- $\overline{\mathbf{TMI}}$	Rank
Boundary Stone	4.33	1.22	4	4.01	1.01	2	3.15	0.12	10
Charm/Religious items	3.98	0.87	6	2.26	-0.74	13	1.19	-1.84	14
Artefacts/Arts/Sculptures	2.54	-0.57	11	2.95	-0.05	11	3.93	0.90	8
Fence/Walled Stone	2.34	-0.77	12	3.88	0.88	3	4.85	1.82	2
Footpaths	3.00	-0.11	7	1.19	-1.81	15	1.00	-2.03	15

Garden/Lawn/Pavements	1.47	-1.64	16	3.29	0.29	7	4.01	0.98	5
Gates	2.71	-0.40	10	3.87	0.87	4	4.87	1.84	1
Graffiti/inscriptions	4.52	1.41	3	3.44	0.44	6	3.37	0.34	9
Grave/Tombstone	4.87	1.76	1	3.52	0.52	5	1.00	-2.03	15
Landmark/Monuments	4.29	1.18	5	1.92	-1.08	14	3.00	-0.03	11
Plants/Trees/Shrubs	2.77	-0.34	9	3.19	0.19	8	3.95	0.92	7
Row of Shop(s)	3.00	-0.11	7	2.69	-0.31	12	1.34	-1.69	13
Security Watch Post	1.57	-1.54	14	3.12	0.12	9	4.27	1.24	3
Sign Post/Sign Board	2.24	-0.87	13	3.00	0.00	10	2.47	-0.56	12
Survey Beacon	4.56	1.45	2	4.48	1.48	1	4.11	1.08	4
Wires/Barbs/Mesh	1.53	-1.58	15	1.14	-1.86	16	3.98	0.95	6
	$\overline{\textbf{TMI}}$= 3.11			$\overline{\textbf{TMI}}$ = 3.00			$\overline{\textbf{TMI}}$ = 3.03		

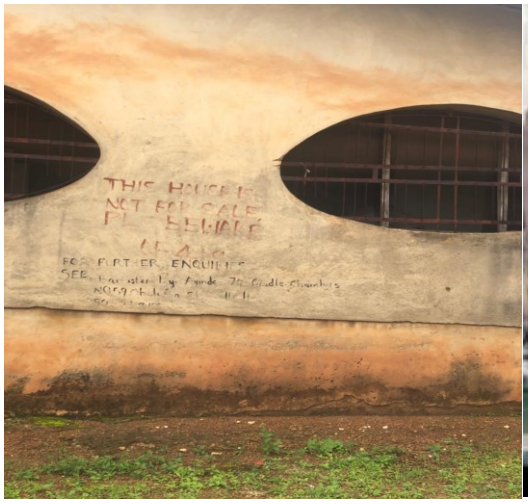


Plate 3. Graffiti on walls**.**



Plate 4. Survey Beacon, a territorial mark**.**



Plate 5. Fences, Gates and security as territorial features in Modern neighbourhoods.

6.4 Factors Influencing the Use of Territorial Marks

Given the prevailing and dynamic use of territorial marks in the study area, this study took a step further to probe the factors behind residents' use of these marks. Regression analysis was used to determine the association between factors identified in the literature to drive territoriality and the dependent variable (use of territorial marks). Summarised in Table 4, significant predictors for the use of territorial marks were privacy concern (t = -25.971; p = 0.000), crime prevention (t = 9.989; p = 0.000), income status (t = 5.233; p = 0.000), exercising property rights (t = 8.874; p = 0.000) and architecture and aesthetics (t = 5.071; p = 0.000). Others were boundary delineation (t = -8.257; p =

0.000), space marking (t = -4.773; p = 0.000), ownership and belonging (t = 2.218; p = 0.028) and Historical conflict (t = 0.956; p = 0.040). It is deductible from these findings that the prevalence of territorial marks is predicated on land disputes, income attributes (defined by income distribution and educational attainment) and crime prevention. While these findings support assertions by previous studies within the theme of crime prevention (Badiora & Abegunde, 2015; Nwokaeze et al., 2022), as well as social and economic needs, it argues however, that territoriality does not always find an explanation in cultural norms, the status of tenure and a historical predisposition to territoriality.

Table 4. Determinants of Residents` Use of Territorial Marks.

Variables	**β**	**t**	**Sig. Level**
		19.936	.000
Privacy Concern	-1.272	-25.971	.000*
Crime prevention	0.397	9.989	.000*
Income Status	0.200	5.233	.000*
Cultural norm	0.002	0.068	.946
Exercise Property rights	1.053	8.874	.000*
Ethnic/Personal Identity	0.071	0.853	.395
Architecture and Aesthetics	0.673	5.071	.000*
Property Valuation	0.013	0.450	.653
Status of Tenure	-0.011	-0.364	.016
Historic Significance	-0.147	-0.712	.477
Climate & weather	-0.095	-1.308	.193
Urban Planning Regulation	0.017	0.486	.628
Boundary demarcation	-0.317	-8.257	.000*
Space marking	-0.359	-4.773	.000*
Ownership and belonging	0.153	2.218	.028*
Historical Conflict	0.36	0.956	.040*

β: standardized beta coefficient; t: T-test statistics; Significance Level ($p \leq 0.05$)

7. Discussion

The study findings gave insights into the relationship between the use of territorial marks and land disputes in a post-conflict urban landscape. As opined in related previous studies, (Adedeji et al., 2016; Atkinson et al., 2003; Edney, 1976; Fahad et al., 2021; Kintrea et al., 2010; Manzo & Perkins, 2006; Olujimi, 2010; Saisanath & Gnanasambandam, 2020; Sanchez et al., 2005) this study gave credence to the interplay of economic attributes of residents and their use of territorial marks. In other words, as the variation in income attributes varies across the residential zones, the types of territorial marks within and around neighbourhoods also vary. Interestingly though, the variation in the type of territorial marks does not connote that low-income earners had less territorial behaviour. This study revealed that all income groups across the distinct neighbourhoods displayed significant territorial behaviour, although their income status is reflected in the type of territorial marks used, with low-cost and traditional marks prevalent in low-income neighbourhoods. This position aligns with the arguments of some previous studies (Adedeji et al., 2016; Gifford, 1997) that human territorial behaviour is a given irrespective of socio-economic status. In other words, the study revealed that humans regardless of their cultural background, are highly territorial and would want to define and assert control and ownership over perceived territory.

This study also corroborates the position of previous studies within post-conflict urban settings that, territorial marks are as crucial for land boundary demarcation as they are for crime prevention (Preston & Gelma, 2020; Di Masso et al., 2011; Nwokaeze et al., 2022; Wnuk & Oleskksy, 2021). This study reveals further that both indigenous and contemporary territorial marks predicated on users' economic ability are used to communicate the extent or boundary of their territory. Equally corroborating the

argument of previous studies opining that human territorial nature, sense of place, place attachment and identity are important themes in territoriality (Farhad et al., 2021; Saisanath & Gnanasambandam, 2020). In other words, barring any financial or legal restraints, human territorial behaviour is limitless. Hence, territoriality should feature prominently in discussions on land dispute resolution as equally in CPTED debates.

Noteworthy, revelations about the use of indigenous marks in a traditional African setting deepen the literature on territoriality, opening up a vista for future exploration in pan-African studies. However, these insights call for the need to control the use of these indigenous territorial marks with zoning regulations if some of the challenges such as land use distortion, crime incidence and social segregation attributed to personalized forms of markings are to be abated.

Moreover, the study showed that complexities of land law and administration explain the territorial behaviour of residents. This is evident in the prevailing use of indigenous marks to communicate possession and ownership of land across all neighbourhood groupings in the study area. This revelation strengthens the position of previous studies within the Nigerian land law context that the multiplicity and incoherency of legal frameworks have social and physical implications in the built environment (Otubu, 2017; Otubu, 2007). Moreover, the proliferation and mix of indigenous, contemporary and legal territorial marks, indicates the heightened tension on land disputes in the study. The need to harmonize land laws in this and similar settings cannot be overemphasized.

8. Conclusion and Recommendation

The results of the study corroborated the findings of other previous studies that privacy concerns, crime prevention, income status, exercising property rights, architecture and aesthetics, boundary delineation, space marking, ownership, and belonging, were all significant predictors of the use of territorial marks (Brighenti, 2010; Farhad et al., 2021; Kintrea et al., 2010; Manzo & Perkins, 2006; Newman, 1972; Newman, 1996). This study observed that within the context of a post-conflict neighbourhood, issues of territorial behaviour transcend cultural and historical disposition towards the use of territorial marks. It observes that territoriality in post-conflict urban settings is driven by specific needs predicated on clear demarcation of land boundaries, strengthening of ownership rights on land and clearly defining the extent of land rights. In other words, within post-conflict communities, territoriality appears to be primarily concerned with establishing clear boundaries for land rather than reflecting cultural attitudes. The study also concluded that residents adopt and adapt diverse forms of contemporary and indigenous territorial marks to meet this need.

The findings of this study have significant implications for urban planning, land dispute resolution efforts and the African literature on territoriality. In recognition of these implications, the study recommends the promotion of more inclusive and cohesive neighbourhoods and advocates for more research on the significance of gated neighbourhoods in social inequality and crime prevention. We equally advocate that policymakers and planners should take into account the socio-economic disparities observed in territoriality and design urban spaces that accommodate the diverse needs and preferences of residents. An emphasis on demarcating clear and recognized boundaries, potentially utilizing survey beacons or other universally understood marks, could contribute to reducing land disputes and fostering a sense of ownership and security for all residents.

In addition, it would be beneficial to introduce better strategies for land allocation and division in post-conflict neighbourhoods. The use of geographic information technology to demarcate land boundaries and ownership characteristics would help reduce disputes related to these issues. Moreover, a harmonized form of territorial marks especially those unique to neighbourhoods in Africa can be adopted and incorporated into zoning regulations, to improve neighbourhood aesthetics, and legibility and enshrine neighbourhood cohesion.

However, it is important to acknowledge that the study has limitations, including a relatively small sample size and a focus on a specific case study area. Moreover, taking a general disposition to the factors influencing territorial marks, it is important to also acknowledge that the specific needs of groups and individuals could define their preference for a type of territorial mark. Future research

could expand the scope to include a more diverse range of post-conflict communities and employ larger sample sizes to further validate and generalize the findings. Furthermore, future studies, could take a pan-African and indigenous look into the type of territorial marks used in the region and understand, the role of each mark for users.

Conflict of Interests
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Data availability statement
Data for this study will be made available on request.

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Abegunde A.A.: Conceptualization, Project administration, Supervision.

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Original scientific paper

Dynamics of Informal Settlement Expansion on the Urban Fringe: The Case of Birbir Town, Southern Ethiopia

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ABSTRACT

This study examines the dynamics of fringe land invasion in Birbir Town, southern Ethiopia. This study used a descriptive survey design with both qualitative and quantitative data analyses. Primary data were acquired through a household survey, key informant interviews, focus group discussions, and observations. This study also benefited from relevant secondary sources. Using a simple random sampling technique, 156 household heads were selected from Birbir and two adjacent rural areas. The study revealed that informal settlement expansion in the form of fringe land invasion occurs in Birbir Town predominantly due to population increase, urban sprawl, migration, poor land administration and governance systems, a lack of boundary demarcation, and the presence of available unserviced public land near the town. The process was intensified by actors such as farmers, local administrators, informal dealers, politicians, and local elders. The encroachment of urban fringe areas has led to deforestation, relinquishment of cultivable acreage, entitlement disputes, a prevailing trend of illicit land occupation, an unstructured urban expansion pattern, and a surge in criminality, fostering discordant communities. This study contributes to the understanding of informality on the urban fringe as posing socioeconomic and governance challenges in small towns of developing countries by presenting the case of Birbir.

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Highlights	Contribution to the field statement
-The study revealed that informal settlement expansion in the form of fringe land invasion occurs in Birbir Town predominantly due to demographic and institutional factors. -The process of fringe land invasion was intensified by actors such as farmers, local administrators, informal dealers, politicians, and local elders. -The encroachment of urban fringe areas has led to deforestation, relinquishment of cultivable acreage, entitlement disputes, and an unstructured urban expansion pattern	- The study contributes to the understanding of informality on the urban fringe as posing socioeconomic and governance challenges in small towns of developing countries by presenting the case of Birbir. - The study contributes to sustainable urban land development and management in peri-urban interfaces in the cities of sub-Saharan Africa.

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1. Introduction

Informal settlement expansion in the form of illegal land occupations poses a significant challenge in urban settings worldwide (Dovey, 2012; Hosseini et al., 2023; Lombard, 2016; Nassar & Elsayed, 2018). This phenomenon is particularly noteworthy in developing countries, where the economic disparities between affluent and impoverished countries are more pronounced, municipal authorities are unable to supply land for housing, rampant options are prevalent in the land supply process, and a web of actors is involved in the land market (Admasu, 2018; Dube, 2013; Mersha et al., 2022; Mottelson, 2020). This issue is further compounded by the swift pace of urbanization and the migration of individuals from rural to urban areas. The advent and rise of informal urban settlements can be attributed to the escalating trend of urbanization coupled with rapid population growth. Alene (2022) suggess that the growth of informal settlements in urban areas cannot be attributed to a singular determinant. The author argues that various factors contribute to the expansion of informal settlements. Notably, the prevalence of such informal settlements and urban informality is conspicuous on the outskirts of secondary cities of Ethiopia, such as Gondar (Alene, 2022), Bhirdar (Adam, 2014, 2020), Jimma (Abebe et al., 2019), Woldia (Baye et al., 2020b, 2023) and Hawassa (Admasu, 2018).

Urban fringe areas are undergoing significant transformation and are witnessing a plethora of activities that can be attributed to the swiftness of urbanization and population growth (Wehrmann, 2008)). In the vast literature, urban fringes are referred to as ‘rural-urban fringe’, ‘transition zone’, ‘peri-urban zone’, or ‘areas of interface’ between urban and surrounding rural areas (Pryor, 1968; Simon, 2008). They are conceptualized in this study, following Simon (2008), as provisional areas between typically urban and unequivocally rural areas. As Africa has undergone rapid urbanization, its urban centres are largely becoming habitats for most of its people. Population projections indicate that approximately half of Africa's population will reside in its urban centres by 2030. However, the unparalleled expansion of urban populations in Africa has resulted in a swift rise in the demand for urban land. This demand is predominantly fulfilled through informal means, typically involving the conversion of fringe lands situated at the periphery of urban areas in the Global South (Fekade, 2000; Mersha et al., 2022; Toulmin, 2009; Wehrmann, 2008). In view of this, Banks et al. (2020:1) contend that it is necessary to "reconsider informality as a site of critical analysis" to enhance the exploration and comprehension of urban dynamics.

Informal settlements spontaneously expand on urban fringes, mostly outside municipal jurisdictions. They have become a ‘perpetual challenge’ for African cities and towns. Most frequently, squatters sprawl in the transition zones of most urban centers in the developing world (Adam, 2014; Baye et al., 2020a; Mersha et al., 2022). Globally, it is estimated that over one billion individuals reside within informal settlements encompassing slums and squatters. Customary landowners serve as the primary providers of housing despite the absence of formal recognition of their land rights by the state, as is evident in the cities of sub-Saharan countries. In other urban areas, local actors play an important part in the urban land market and the conversion of urban peripheries (Bryant, 1995; Li et al., 2018; Mersha et al., 2022). Studies suggest that in the setting of accelerated urban expansion, land disputes are often particularly severe, particularly in areas located on the periphery where competition and conflicts are intense. These claims are supported by DFID (2002) and Adam (2020). As a result, these regions commonly experience unauthorized land utilization, including the formation of informal settlements, as noted by Adam, (2014); Admasu (2018, 2019); and Dube (2013). Consequently, informal land markets situated on the urban periphery provide less expensive and substandard land for individuals who lack access to formal land and housing markets.

In recent years, there has been a noteworthy intensification in the growth of urban areas in Ethiopia, causing a heightened demand for housing land on the outskirts. Consequently, this has brought about various transformative effects in these regions, including the conversion of vacant public, agricultural, and forested lands into squatter settlements. Such encroachment processes have resulted in the depletion of agricultural farms and natural beauties such as forests, grazing land, and bare land, as well as a decrease in crop and food productivity (Fekade, 2000). Most research on informal economies and settlements has focused on larger urban centers (e.g., Abebe et al., 2019; Adam, 2014, 2020; Asefa,

2020; Baye et al., 2020a, 2020b, 2023; Kinfu et al., 2019; Mersha et al., 2022), which warrants further investigation.

Much of the urbanization is expected to take place in the small urban centres of the country. Given that much of the anticipated urbanization takes place in smaller urban centres, it is vital to study the changing aspects of informal settlements in them. When they increase in size and complexity, it is difficult for municipal authorities to manage their development both spatially and socioeconomically. Moreover, small towns contribute not only to the overall development of the nation but also to urbanization, rural transformation, and food security. Thus, they deserve more attention in studies of their growth processes.

Article 40 (3) of the Constitution of the Federal Democratic Republic of Ethiopia (FDRE) asserts that authority and control over the ownership of both rural and urban land as well as all-natural resources are a unique prerogative of the state and its various nations and nationalities (FDRE, 1995). While asserting the state's ownership of land, it also prohibits private ownership. Contrary to the provisions, urban informal land markets are rampant in many cities where both formal and informal actors cooperate (Baye et al., 2023; Mersha et al., 2022). In light of this, the fringes of Birbir town have been invaded and are predominantly occupied by informal settlements. The availability of fringe lands attracts buyers, brokers, politicians, local administrators, and peri-urban residents. Thus, it is apparent that the proliferation of unstructured habitation under the guise of outlying land encroachment has emerged as an intimidating obstacle for municipal and provincial officials.

This study aims to investigate the dynamics of informal settlement expansion in the periphery of Birbir Town in South Ethiopia. This study specifically aimed to assess the scope and configurations of land encroachment, identify the participants involved in the process of land encroachment and their respective roles, analyze the driving forces behind land encroachment, and examine the consequences of land encroachment in the research area. This study contributes to the existing literature on sustainable urban land development and management, particularly in peri-urban interfaces in the cities of sub-Saharan Africa, by presenting the case of Birbir, a small town. This study positions itself within the discourse on informal urbanism as informal settlement expansion, posing a huge socioeconomic challenge for cities, unless managed with appropriate policy instruments. In reality, formal and informal procedures complement each other in the broader context of informality and growth of informal settlements in peri-urban regions. This investigation postulates that a considerable amount of urbanization is projected to transpire into smaller urban centers, which warrants humble contemplation in scholarly inquiry, policy, and application.

Following this introduction, this article briefly presents the context and methodology. The results and discussion section presents the demographic and socioeconomic characteristics of the respondents, trends of fringe land invasion, causes for it, actors in it, modes of land acquisition, its effects, and municipal responses to fringe land invasion in the study area. The article concludes with a brief discussion of the general picture and implications of the study.

2. Materials and Methods

2.1. The Study Area

2.2.1. Location

Mirab Abaya (in English, West Abaya) Woreda is located in the Gamo Zone, Southern Nations, Nationalities, and Peoples Region (SNNPR) of Ethiopia. Mirab Abaya is named after Abya Lake and is situated west of the lake. The woreda has 24 kebeles (the lowest administrative units), of which one is urban and 23 are rural. Birbir Town is the capital and administrative centre of Mirab Abaya Woreda, located along the main road from Addis Ababa to Arba Minch. It lies approximately 450 km south of Addis Ababa and 230 km away from the regional capital. Astronomically, the town lies at 6017’ 30" latitude and 37046' 30" longitude. Figure 1 shows a location map of the study area (Regional Urban Planning Institute, 2015).

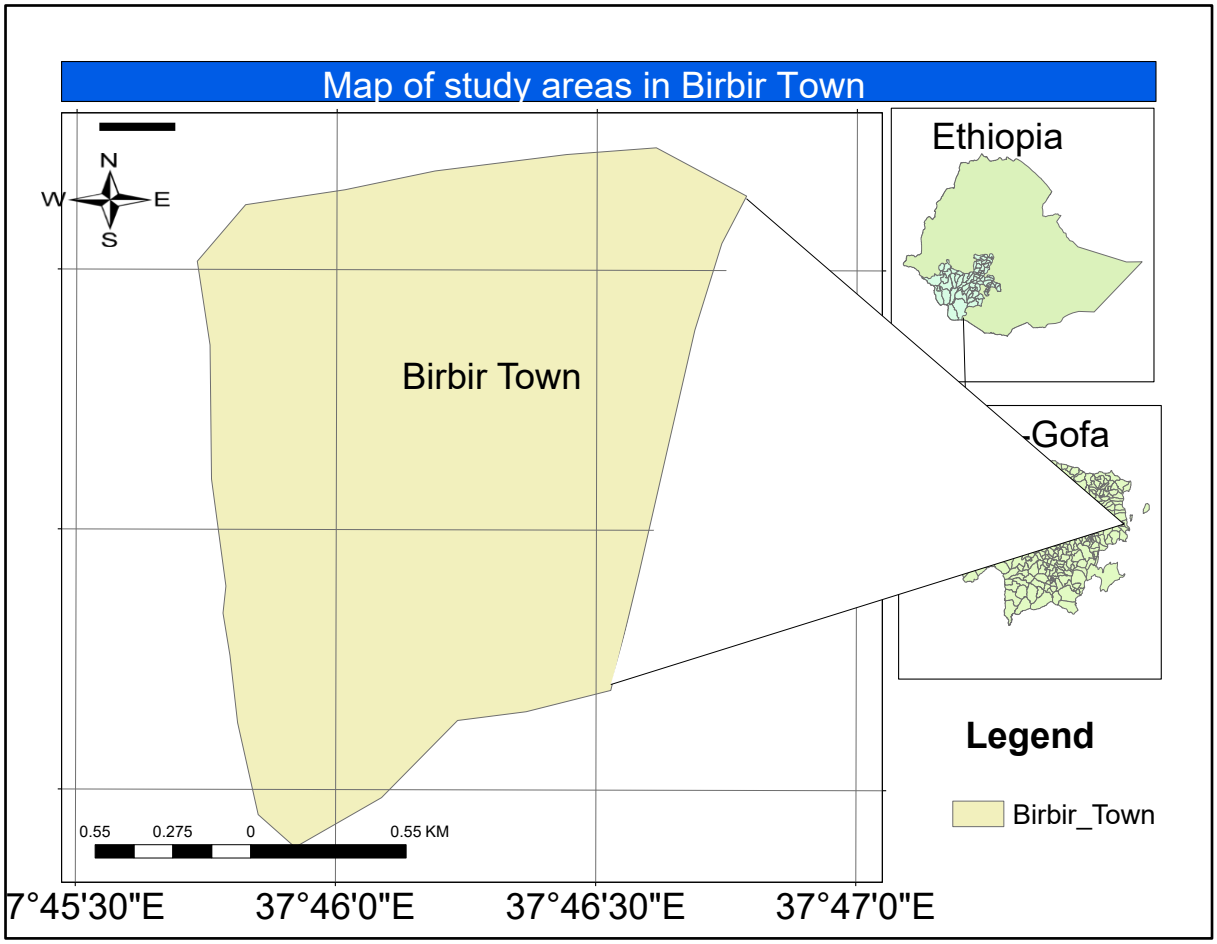


Figure 1. Location Map of the Study Area. Source: By the Authors, 2020.

2.2.2. Foundation of Birbir Town

Birbir is believed to have been uninhabited and covered with forests, bushes, and grasses. The area was administered under the Eezo Woreda of Gamo Awraja, which was based on the Gamo highlands. The woreda opened a police station at Folla Saygno, near Lake Abaya, to monitor transportation. Folla is the name of a famous person living in the area, and Saygno in Gamogna means Monday. There was a weekly market on Monday. It is believed that the first foundation of Birbir was laid in the Folla Saygno. Birbir moved to its present location after the change of the Addis Ababa-Arba Minch road from the lakeside route to the present route. Upon the completion of the Addis Ababa-Arba Minch gravel road in 1954, the market center shifted from Lake Side or Folla Saygno to its present location. Following that, in 1956, the police station was shifted to the new transport route area, that is, to the present location of Birbir. Birbir Town is believed to have been gradually founded along the new transport route since 1956. In 1991, Birbir obtained legal town status. The origin of Birbir is not clear; however, according to some sources, it is believed to have been taken from Birbir Dudane, a nearby lowland rural kebele (Regional Urban Planning Institute, 2015). Figure 2 shows the satellite image of Birbir town extracted from Google Earth.



Figure 2. Satellite Image of Birbir town from Google Earth.

2.2.3. Physical Characteristics

Birbir is situated within the expansive Great East African Rift Valley System and has an entirely *kola* (lowland) agroecology. According to recent data, this spans approximately 397.5 hectares. The altitude fluctuates between 1217 and 1272 meters above sea level. During the wet season, the town is susceptible to inundation owing to its flat terrain. The average annual temperature varies between 180 and 320 °C. Rainfall in the area is seasonal, exhibiting poor distribution and marked variability from year to year. The average annual precipitation is 1600–2000 mm (Regional Urban Planning Institute, 2015).

2.2.4. Demographic and Socioeconomic characteristics

According to the Central Statistical Agency (CSA, 2007), the total population of Birbir was 5,834, of which 2,931 were male and 2,903 were female. However, as to CSA (2023), the projected total population was 16,411, of which 7,898 were male and 8,513 were female. Between 2007 and 2023, the population increased by 64.45%. Thus, it is not surprising to expect informal settlement expansion due to this unprecedented population increase in the town. Birbir accounts for approximately 14% of the total woreda population. Concerning ethnicity, Gamo is the most dominant ethnic group, making up 71.93%; Wolaita accounts for 22.63%; Amhara accounts for 2.17%; and the rest (Gidicho, Gurage, Oromo, Tigre, Kembata, Gofa, Dawuro, Hadiya, Zeysie, and Derashe) together account for 3.27%. The religious composition of the town shows that 69.67% were followers of Protestantism, 28.31% were Orthodox Christians, 1.34% were Muslims, and the remaining 0.68% belonged to other religions (CSA, 2007). The residents of the town engaged in different economic activities; the majority of them engaged in small-scale commercial activities, agriculture, and services.

2.3. Research Design

This study employed a mixed-methods approach that integrated both qualitative and quantitative techniques. It employed a descriptive survey design and was predominantly descriptive with

exploratory elements. Clark & Creswell (2021) assert that the research design that is most efficacious is one that amalgamates quantitative and qualitative methods to procure an all-encompassing comprehension of the processes that yield the observed outcomes. In the present study, a combination of primary and secondary data was employed. Primary data were gathered via open-ended and closed-ended survey questionnaires, structured and semi-structured interviews, focus-group discussions, and field observations. Moreover, this research has made available secondary data sources by scrutinizing existing documents and publications. The main sources of secondary data were official and legal documents, books, reports, previous research, and the latest journal articles.

2.3.1. Sampling Techniques and Sample Size Determination

Birbir Town was purposefully selected for its pervasive informal settlement expansion. The town has eight menders (small units or wards lower than kebele), which are surrounded by three rural neighbouring or bordering kebeles, such as Delbo in the western and southern directions, Alge in the eastern direction, and Fetele-Dorenje kebele in the northern direction. Thus, the town's rapid land invasion is prevalent in the West. Among the four areas, two menders (mender and eight) from Birbir town and two rural kebeles, Delbo and Fetele-Dorenje, were selected, as these areas exhibit a relatively high proportion of informal settlements. The total target population was 936 households, and the sample size was 156 household heads. For each kebele, lists of household heads were taken from the kebele administration to form the sampling frame (see Table 1). A simple random sampling technique was used to carefully select heads of households that would be representative of the study area. Yaman's (1967) formula was employed to determine the appropriate sample size.

$$n=\frac{N}{1+(e)^2}$$

Where: *n* indicates the desired sample size
N indicates the target population of the study
e indicates the margin of error
In this case: $n = \frac{936}{1+936(0.07)^2}$ = 156 is the sample size of the study.

Table 1: Number of Sample Households of the Study Areas

Name of Sample *kebeles*	**Household heads**			**Sample Size**	**%**
	M	F	T	HHS	
***Mender one* (Birbir town)**	160	64	224	37	17
***Mender eight* (Birbir town)**	147	56	203	34	17
***Delbo* (Rural kebele)**	200	38	238	40	17
***Fetele-Dorenje*(Rural) kebele)**	203	68	271	45	17
Total	710	226	936	156	17

M=Male F= Female T= Total HHS= Household Heads

Source: Birbir Town Municipality.

2.3.2. Instruments of Data Collection

The study's data acquisition tools primarily comprised a questionnaire, interview schedule, FGD guide, and observation checklist. The data were collected between January and February 2019. A survey questionnaire was constructed to incorporate both open-ended and closed-ended questions. This strategic choice was implemented to avoid limiting the respondents' ideas, as closed-ended questions tend to do. On the other hand, open-ended questions are highly advantageous when seeking to garner

opinions, attitudes, and perceptions. The survey was conducted among the leaders of the selected households on the periphery of Birbir Town. To guarantee the reliability of the information gathered from respondents, the questionnaires were initially formulated in English. It was then translated into Amharic before being conducted in *Gamogna* (the local language) with the aid of native data-gatherers who were competent in elucidating the queries for those interviewees who were unable to read.

Eight key informants were selected for the study using purposive sampling. Informants were selected based on their role and knowledge in relation to informal settlements in the town. Interviews were conducted with the participants using an interview schedule. The participants included one expert from the municipality, three from the administration, and four from the local community. As the participants were directly involved in the informal land market, they were believed to provide useful and insightful information regarding fringe land invasions in the study area. They were asked about the trends, magnitudes, actors, and driving factors of fringe land invasion and the town's land management system. To this end, separate structured and semi-structured interviews were conducted with key informants. The questions were formulated with the intention of eliciting a frank and flexible response, facilitating an organic dialogue between the interviewer and the participants.

Three focus group discussions were conducted during the data collection process. These discussions consisted of 5-7 members in each group and lasted approximately two hours. The selection of FGD members was based on their influential status as local elders, kebele leaders, brokers, or peri-urban farmers. Participants were selected based on their level of involvement in the informal land market and the prevalence of informal settlements in the area. Additionally, field observations were utilized as observational evidence, which proved to be of great value in collecting supplementary information (K.Yin, 2011; K. R. Yin, 2020; R. K. Yin, 2018). Therefore, first-hand data were collected from the field by directly observing the selected areas using a digital camera from the fringes of Birbir Town. Ethical considerations were strictly followed during the data collection process. This involved obtaining appropriate letters of permission prior to data collection, seeking participants' consent, and informing them of the study's purpose.

3. Results and Discussion

3.1. Demographic and Socioeconomic Characteristics

To understand the intricacies of the proliferation of informal settlements in the town, it is crucial to consider the fundamental characteristics of the study participants. Participants' demographic characteristics included sex, age, marital status, and household size. Socioeconomic characteristics included residential zone, religious orientation, educational accomplishment, and employment status of the household head. Table 2 shows respondents' demographic and socioeconomic profiles.

Table 2. Demographic and socioeconomic background of respondents.

Variables	Categories	Frequency	Percent
Sex	Male	118	76
	Female	38	24
Age	20-29	26	17
	30-39	46	29
	40-49	66	42
	50-59	15	10
	60 and above	3	2
Marital Status	Single	30	19
	Married	98	63
	Separated	24	15
	Divorced	4	3
Family Size	1-2	8	5
	3-4	31	20

	5-6	48	31
	7-8	58	37
	9 and above	11	7
Residential Area	Rural	85	54
	Urban	71	46
Religious Background	Orthodox	63	40
	protestant	83	53
	Muslim	4	3
	Others	6	4
Educational Background	Illiterate	29	19
	Primary	66	42
	Secondary	49	31
	Tertiary	12	12
Employment Status of Household Heads	Farmers	60	38
	Town dwellers	41	26
	Daily Labourers	32	21
	Government Employees	10	6
	Merchants/Traders	8	5
	Unemployed	6	4

Source: Computed from Household Survey, 2019.

As shown in Table 2, 76% (n = 118) of the respondents were male, and 24% (n = 38) were female. Regarding age distribution, 42% (n = 66) were aged 40–49 years, 29% (n = 46) were aged 30-39 years, 17% (n = 26) were aged 20–29 years, 10% (n = 15) were aged 50–59 years, and 2% (n = 3) were above the age of 60 years. Regarding marital status, 63% (n = 98) of respondents were married, 19% (n = 30) were single, 15% (n = 24) were separated, and 3% (n = 4) were divorced. The family size of the sample respondents, 37% (n = 58) had a family size of 7-8, 31% (n = 48) had 5-6, 20% (n = 31) had 3-4, 7% (n = 11) had more than 9, and 5% (n = 8) had 1-2.

Regarding residential areas, 54% (n = 85) lived in rural areas, while 46% (n = 71) were urban residents. Concerning religious composition, 53% (n = 83) of respondents were followers of Protestantism, 40% (n = 63) were Orthodox Christians, 4% (n = 6) were followers of other religions, and 4 (3%) were followers of Islam. As Table 2 indicates the educational background of the respondents, 66 (42%) have primary education, while 31% (n = 49) have secondary education, 19% (n = 29) are illiterate, and only 8% (n = 12) have tertiary education. Gender-wise, 62% of male respondents and 19% of female respondents had formal education, while illiterate women accounted for 5% and illiterate men constituted 14%. Regarding the employment status of the household heads, 38% (n = 60) were farmers, 26% (n = 41) were urban dwellers, 21% (n = 32) were daily laborers, 6% (n = 10) were government employees, 5% (n = 8) were merchants, and 4% (n = 6) were unemployed. Thus, this study involved diverse demographic and socioeconomic groups in the study area.

3.2. Trends of Fringe Land Invasion in Birbir Town

As discussed in the background section, Birbir developed from a police post to a village and then to a town. The data obtained from the municipality show that Birbir received its first master plan in 2000 and its second basic plan in 2015. The total area of the town before 1999 was only 46 hectares, but in 2000 it increased to 360 hectares, and in 2015 it became 397.5 hectares. The trends of urban-rural fringe land invasion in two areas of the Birbir Town periphery and adjacent land (unreserved green areas near the town and along the transport route) from 2015 to 2019 are shown in Table 3.

Table 3. Trends of informal houses built and rate of change in Birbir town (2015-2019).

Year	Number of houses built informally	Period	Rate of change (%)
2015	6	-	-
2016	13	2015-16	53.81
2017	22	2016-17	50.00
2018	37	2017-18	40.54
2019	78	2018-19	52.56

Source: Based on Bibir Town Municipality, 2020.

As Table 3 shows, there has been a remarkable increase in the documented number of houses built informally between 2015 and 2019 in Birbir Town. Quantitatively speaking, the figures might appear small, as the study town was small. However, when looking at the annual rate of change, the increment was alarming. Except for 2017-18, for the three periods, the rate of change in the number of houses informally built on the fringes of Birbir was 5% or slightly higher. However, it should be noted that the data presented only indicates which municipality can be identified and counted. However, because of its informal nature, the actual figure can be much higher than that presented above. Key informants and participants in the focus group concurred that the town experienced planned and unplanned growth and expansion. The building of informal houses occurs largely in areas meant for greening and in the peripheries of the town along the main transport route. Informants also noted increased migration from the Gamo highlands to Birbir, which in part increased the demand for land on the fringes of Birbir. Figure 3 shows a sample of informally built houses on the fringes of Birbir Town.



Figure 3. Sample of informally built houses in the periphery of Birbir Town.
Source: Photo by Researcher, 2019.

3.3. Causes for Fringe Land Invasion in Birbir

Land invasion is rampant in cities in the developing world, particularly in the Global South. This could be due to the interplay between several factors. The respondents were asked about their perceived causes of urban fringe land invasion in Birbir Town. The responses are shown in Figure 4.

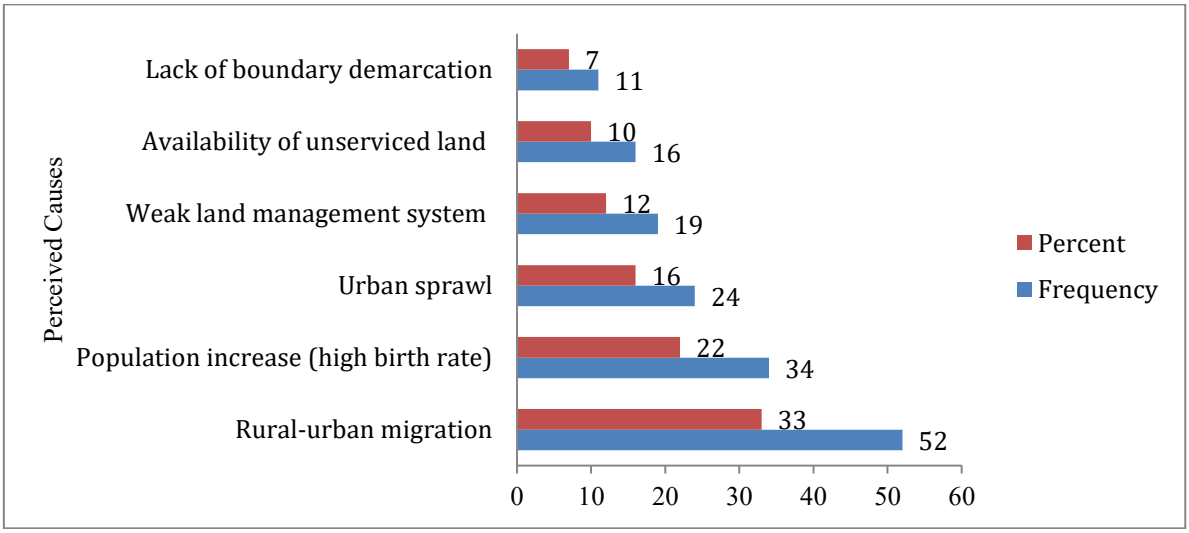


Figure 4. Perceived causes for informal settlement expansion in Birbir Town.
Source: Computed from Household Survey, 2019.

As illustrated in Figure 4, the primary perceived catalysts driving the expansion of informal settlements and subsequent land encroachment on the outskirts of Birbir town comprise population growth resulting from rural-urban migration, natural increase, and urban sprawl. Furthermore, the suboptimal land management system of the municipality, coupled with the presence of unoccupied land or land designated for green spaces on the fringes, and the absence or erosion of boundaries between urban and rural jurisdictions, exacerbate the situation. The current findings align with those of Asefa (2020), who concluded that the inefficiency of the formal land supply system contributed to the spread of informal settlements. This is mainly due to the fact that the formal system prevents access to land by the overwhelming majority in cities; the problem is rampant in cities in East Africa (Admasu, 2018; Baye et al., 2020b, 2023; Mersha et al., 2022).Consequently, informal land transactions fill the exclusion gap to the extent that informality is considered the norm. In the context of sub-Saharan Africa, it can be observed that the majority of urban residents are excluded from the formal housing markets due to financial reasons, thus forcing them to reside in informal settlements (Mottelson, 2020)

3.4. Modes of land acquisition by Respondents in Birbir

It is clear that there are different modes of land acquisition in the urban centers of the global south. As the formal channels of land supply and delivery are not efficient, people resort to informal channels with the expectation of formalization sometime in the future. Respondents were asked how they acquired the land upon which they had built their houses. According to their replies, they acquired it using different means. Figure 5 illustrates the mode of land acquisition by respondents in Birbir Town.

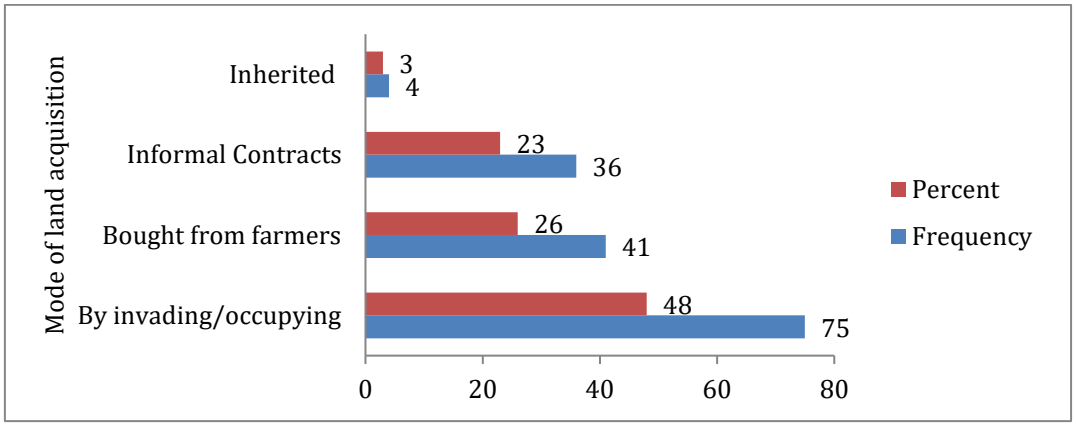


Figure 5. Modes of land acquisition by respondents in Birbir Town.
Source: Computed from Household Survey, 2019.

As can be clearly seen from Figure 5, occupying land by invasion is the dominant means of land acquisition, followed by buying from farmers, short-term informal contracts for use, and inheritance. This finding is similar to that of Asefa (2020), who outlined purchasing from peri-urban farmers and inheritance as the mainland acquisition modes in Debre Berhan Town. This happens when the formal land delivery system is inefficient and cannot meet demand. Invasions always happen at night when they build a yecherqa bet, a small informal house built on the plot. This is because the increasing pressure on land has caused the commoditization of land use changes and land transactions (Mottelson, 2020; Steel et al., 2020). The majority of land seekers and entrepreneurs opt for the informal channel, as the formal one is not able to provide because of its bureaucracy, expensive administrative procedures, allocation inefficiencies, inappropriate use of public offices, and rampant corrupt practices(Alene, 2022; Dube, 2013; Mersha et al., 2022).

As per the stipulations of the Ethiopian Constitution, land is the property of the state and is not subject to any form of commercial transaction. In practice, the land market operates on different scales and involves different actors. Because the town is small, land is cheap in the informal market. For example, a person can buy a plot of land for 50,000–120,000 Ethiopian Birr (approximately 1134–2270 US Dollars (USD) at the July 2021 exchange rate of 1 USD = 44 ETB). It could also be based on negotiations between buyers and sellers and sold based on *yemender wul*, a local informal written agreement. When a *yemender wul* is signed in the presence of three individuals, the local elders also sign as witnesses. *Yemender wul* could be considered a form of social ordering that provides buyers with a higher level of positive regularization prospects than demolition. This is similar to the situation in most African cities, where access to land for housing is regulated by social order (Mottelson, 2020; Wehrmann, 2008; Zhang et al., 2020). Although the informal land market falls outside the formal channel, in most cases it is managed locally (Mersha et al., 2022). The price depends on the size of the plot and its location. Most fringe areas are preferred by buyers, as prices are cheaper than in areas closer to the town. These results are consistent with Hepner's (1985) research, which identified a multifaceted interplay of behavioural, institutional, and locational economic variables that typify the informal urban land market. This was evident in the study town. A recent study by Deuskar (2019) discussed informal urbanization and clientelism as they offer poor entrée to the state, although the benefits are insufficient and mostly not equitable. In the same study, urban centres in more clientelistic countries tended to experience informal settlement expansion. According to Mersha et al. (2022), informal settlements proliferate in peri-urban areas owing to a multitude of factors, such as heightened corruption, false electoral promises, and weak institutional capacity and coordination. The following section discusses the actors and their roles in the fringe land invasion of the study town.

3.5. Actors in fringe land invasion in Birbir Town

As informal settlement expansion is a complex phenomenon, it involves various actors. These actors play roles that facilitate the expansion of informal settlements in fringe lands. Figure 6 shows the actors involved in the fringe land invasion in Birbir.

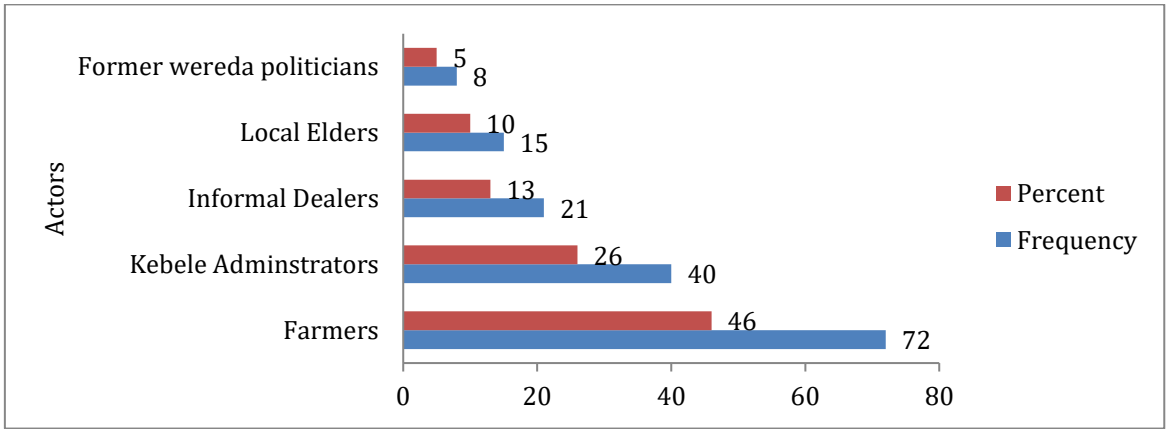


Figure 6. Actors informal fringe land invasion in Birbir Town.
Source: Computed from Household Survey, 2019.

As evident from Figure 6, the participants involved in the fringe land invasion were peri-urban farmers, kebele administrators, informal dealers or brokers, local elders, and former Woreda political leaders. The current findings align with those of Asefa (2020), who concluded that the inefficiency of the formal land supply system has contributed to the spread of informal settlements. This outcome is congruent with other investigations such as Bryant (1995), Adam (2014, 2020), and Mersha et al. (2022). Bryant (1995) emphasized the crucial role played by "local actors" in the process of converting the urban periphery into informal settlements by means of informal land transactions. Adam (2014, 2020) recognized the state, private business sector, and local community as the principal stakeholders in the urban informal land market, with conflicting interests in peri-urban land in the Ethiopian setting. According to Tellman et al. (2021), "institutional entrepreneurs" play a vital role in informal urban expansion, as evidenced by Mexico City. According to Kihato et al. (2013), the local informal land markets are distinguished by a convoluted network of societal stakeholders. These actors confer trustworthiness and validity to the presence of a local land market. The contention put forth by the authors suggests that these socially entrenched land markets illustrate the fragmentation and management of urban territory, and their presence also alters our perception of formality and informality in African cities. This scenario depicts how informal urban economies are collaboratively generated by state and non-state regulatory systems (Kihato et al., 2013).

3.6. Effects of Fringe Land Invasion in Birbir Town

It is evident that informal settlement expansion causes physical, social, political, and environmental problems in most cities in the Global South. Participants were asked about their perceived negative effects of informal settlement expansion in the form of fringe land invasion in Birbir Town. Figure 7 presents the perceived negative effects of informal settlement expansion in the study area.

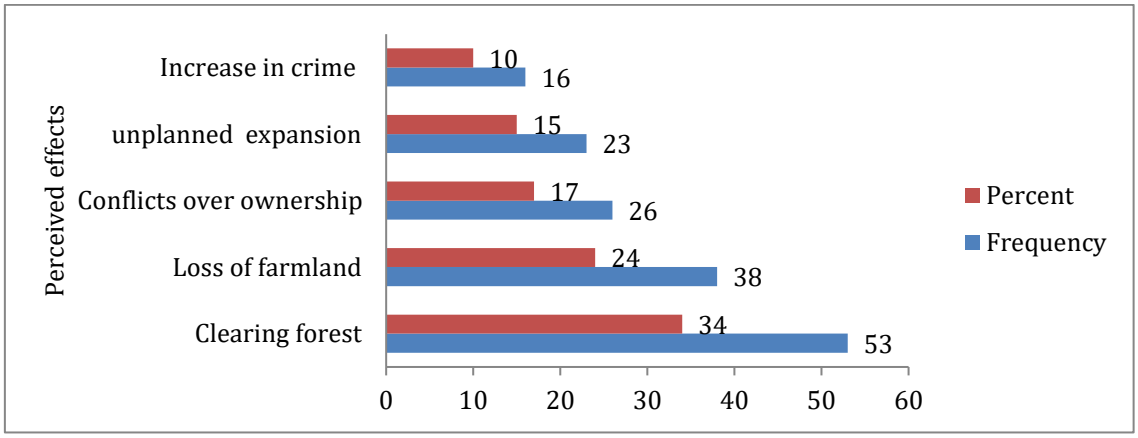


Figure 7. Perceived negative effects of informal settlement expansion in Birbir Town.
Source: Computed from Household Survey, 2019.

As Figure 7 shows, informal settlement expansion in the form of fringe land invasion has resulted in forest and bush clearance, loss of farmland to settlements, increased conflict over land ownership claims, unplanned expansion of settlements, and an increase in criminal activities. According to Zhang et al. (2020), because informal settlements expand in a disorderly fashion, they do not follow the social, economic, and environmental features of sustainable development.

3.7. Municipal Responses to Fringe Land Invasion in Birbir

Many studies have demonstrated that various municipal responses have been implemented in the cities of the Global South to address informal settlements. The two primary strategies employed in developing countries to address informal settlements are regularization and demolition. Experiences garnered from informal settlements could serve as indispensable lessons for developing inclusive, effective, and responsive sustainable urban planning strategies in the African context. Respondents were queried about their cognizance of any initiatives implemented by the local government to suppress the escalation of unregulated settlements in Birbir. As illustrated in Figure 8, the perceived interventions executed by the authorities to tackle the dissemination of informal settlements materialized in the form of peripheral land encroachment in Birbir Town.

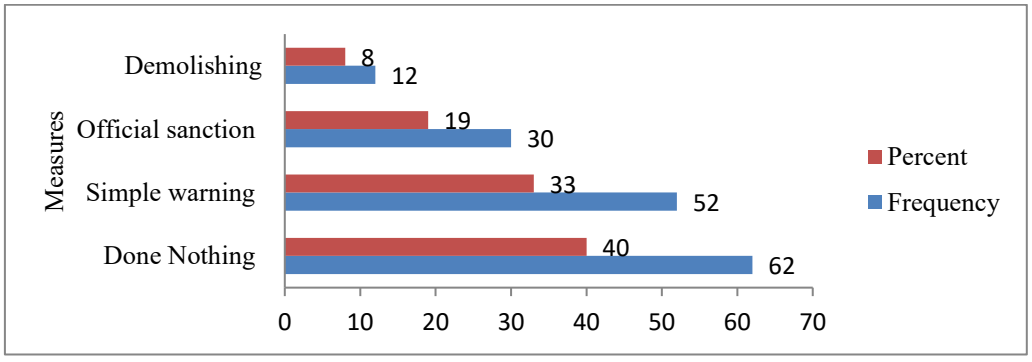


Figure 8. Measures taken on informal settlements in Birbir Town.
Source: Computed from Household Survey, 2019.

As depicted in Figure 8, despite the efforts of municipal and administrative authorities to alleviate the spread of informal settlements in the guise of land invasion on the periphery of the town, their endeavours have proven inadequate in regulating it, as evidenced by the increase in the number of dwellings constructed informally on the outskirts. For approximately 40% of the respondents, the municipality opted to do nothing about these settlements; for approximately 30%, it gave a simple warning. Hardliner measures, such as sanctions and the demolition of informally built structures were

applied less frequently in the context of Birbir. As indicated by focus groups and key informants, as fringe areas are outside the jurisdiction of the town as per the plan, it is difficult for urban authorities to control them. The key informants expressed the measures as 'lesse-faire, where, in most cases, they take no action by ignoring the scale, intensity, and severity. Such situations provided fertile grounds for invaders and settlers to continue engaging in informant land markets in the town.

4. Conclusions

This study investigated informal settlement expansion in the form of rural-urban fringe land invasion and its effects in Birbir town. Informal settlements in the study area are dramatically increasing from year to year, mainly due to fringe land invasion. Rural-urban fringe land invasion processes have been enhanced by factors such as rural-urban migration, population growth, unplanned urban sprawl, poor land administration or a weak land management system, available and unpreserved vast public land near the town, and loose or no clear boundary demarcation, which aggravated fringe land invasion in the peripheries of Birbir town.

This research makes a significant contribution to the understanding of sustainable development and management of urban land, with a particular focus on peri-urban interfaces in sub-Saharan African cities, by presenting Birbir, a small town, as a case study. This study situates itself within the discourse of informal urbanism in ordinary cities and advocates going beyond the formal-informal divide dichotomy. In reality, formal and informal procedures complement each other within the broader context of informality and the growth of informal settlements in peri-urban regions. Consequently, this will have extensive repercussions for the physical and socio-economic development of urban centres.

The study pointed out that, concerning rural-urban fringe land invasion, the actors were mainly local farmers, informal land brokers, irresponsible kebele administrators, and former woreda cabinet members or politicians. The occupiers held the land through free holding, buying it informally from farmers by the name of an informal contract for many years, and inherited it from family and relatives. The analysis also indicated that the adverse effects of the rural-urban fringe land invasion in the study area were forest and bush clearance, reduction of agricultural land, conflicts between rural-urban fringe land ownership, unauthorized land occupation trends, an unplanned pattern of urban expansion, and an increase in criminal activities that created hostile peri-urban neighbourhoods.

It is evident from the research that land has evolved into an intricate matter to manage. Thus, without proper mechanisms and frameworks in place, it would be difficult to control informal settlements in smaller urban centres such as Birbir. With ever-increasing rural-urban migration and population increases, the demand for land has increased, and it is expected to rise in the unforeseeable future. In the past, state land, public land, and private land were not well identified, mapped, properly delimited, classified, and registered in the main land bank. This made it difficult for authorities at different levels to administer and manage the peri-urban land. It is evident that informal settlement expansion has led to the unwise use of urban land and created serious challenges for service and infrastructure provision on the fringes of the town. Despite the growing challenge of informal settlement expansion and fringe land invasion in the study town, the authorities opted for a do-nothing or laissez-faire approach. This implies that as the town grows in size and complexity, the problem persists and poses a huge developmental challenge to local authorities.

The findings of this study indicate that formal and informal sector processes coexist in relation to informal land transactions, fringe land invasion, and informal settlement expansion on town outskirts. This study enriches our understanding of informal settlement expansion, not as a manifestation of the dichotomy between formal and informal sectors but rather as a mutually reinforcing phenomenon. The discussion in this study primarily centers on the participants involved in the process of fringe land invasion in the study town. Consequently, it is imperative to adopt multiscale approaches to examine informality in general and informal settlement expansion in small towns in particular.

The topic of informal settlement has garnered significant worldwide interest as a key facet of inclusive and sustainable urban development. The inadequacy of formal land provision stood in stark contrast to the rising urban population and concomitant need for land. Thus, to ensure sustainable and inclusive

urban development in smaller towns in the context of Ethiopia, urban expansion should be properly planned, monitored, proactively administered, and managed by competent institutional frameworks while ensuring equitable access to the needy. There is a need for urban and rural administrations to work together to ensure equitable access to urban land and fair and lasting benefits for peri-urban or fringe residents.

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Conflict of Interests
The Author(s) declares(s) that there is no conflict of interest.

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Data availability statement
The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding author/s.

CRedit author statement
Conceptualization: A.H.H., E.E.D. Data curation: A.H.H., E.E.D. Formal analysis: A.H.H., E.E.D. Funding acquisition: A.H.H. Investigation: A.H.H. Methodology: A.H.H., E.E.D. Writing-original draft: A.H.H. Writing-review & editing: E.E.D. All authors have read and agreed to the published version of the manuscript.

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Original scientific paper

The Nexus between Residential Density, Travel Behavior and Traffic Congestion in Developing Metropolitans: A Case Study of Harare, Zimbabwe

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ABSTRACT

There is a noticeable dearth of empirical studies on the mediating role of travel behaviour on the influence of residential density on traffic congestion in developing countries, particularly in Zimbabwe. To address this gap, this study examined the effect of residential density on traffic congestion and delved into the potential mediating role of travel behaviour in this relationship. This study used data from a sample of 384 households in the Harare metropolitan province of Zimbabwe. Structural equation modelling was used to test the research hypotheses. The findings indicate that residential density and travel behaviour have a positive effect on traffic congestion. The results also established that travel behaviour partially mediates the relationship between residential density and traffic congestion. This study adds to the existing body of knowledge by providing an array of indicators that can inform policymakers in transportation and urban planning to alleviate traffic congestion.

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Highlights	Contribution to the field statement
- The paper provides the effect of residential density on traffic congestion - There is a positive relationship between residential density and travel behaviour - The study confirms a positive direct relationship between travel behaviour and traffic congestion - Travel behaviour mediates the effect of residential density on traffic congestion - This study provides valuable insights that can assist urban and transport planners in making informed decisions regarding zoning, land use, and the design of infrastructure that promotes sustainable transportation and efficient travel patterns	The study adds to the existing body of knowledge by providing an array of indicators that can inform policymakers in developing metropolitan to consider the interaction between land-use and transportation in alleviating traffic congestion. Additionally, the proposed research model sets the ground for future research to further develop insights on residential density, travel behaviour and traffic congestion.

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1. Introduction

Traffic congestion is commonly understood as the evaluation of how the utilization of a transportation system compares to its capacity (Albalate & Fageda, 2019). Similarly, Afrin and Yodo (2020) assert that traffic congestion can be approached through the lenses of demand and supply. Additionally, Ewing and Cervero (2017) highlight that the supply perspective is closely related to the configuration of street networks, dictating the extent of roadway coverage, while the demand perspective underscores that diverse forms of land usage contribute to variations in travel behavior (i.e., mode choice, travel frequency, and trip length), which exert a significant influence on the degree of traffic congestion. For instance, sprawl-like land uses characterized by low density, isolated land use, and poor street networks lead to more vehicle kilometers traveled. In the United States, cities have the highest number of low-density areas and are by far the most car dependent. They are followed by Australian and Canadian cities, while European and Asian cities have medium- and high-density suburbs, which depend heavily on public transport (Engelfriet, 2015).

In contrast, the colonial philosophy of development, coupled with strict racial segregation, laid the groundwork for the adoption of rigid standards that created a dual system in African urban areas where the poor are marginalized and live on the fringes of cities and towns, where they trade off cheaper housing against higher transportation costs, the opposite of what one would expect from traditional residential location theory (Alonso, 1964). In addition, poor integration between land use and transport plans in most African urban cities has resulted in traffic congestion, which costs millions of dollars every day due to wasted time, environmental pollution, and increased stress. For instance, the Nairobi city traffic jam costs 37 billion Kenyan shillings annually (Olagunju, 2015). Some African cities with heavy congestion costs include Lagos, Nigeria, Dar es Salaam, Tanzania, Lusaka, Zambia, Nairobi, Kenya, Johannesburg, South Africa, Cairo, Egypt, Addis Ababa, Ethiopia, Kinshasa, the Democratic Republic of Congo and Luanda, and Angola (Olagunju, 2015). Despite these misfortunes, there is a dearth of studies on the interaction between land use and traffic congestion in Africa, although new evidence has been steadily accumulating.

Like most African countries, the urban planning frameworks in Zimbabwe were mainly designed to cater to the capitalist and selfish interests of the settler community. Although transport and urban settlement plans are under the purview of metropolitan councils, little attention has been given to upgrading and improving the transportation system within the context of integrated land use and transport planning (Kanyepe et al., 2022b). Despite the rapid growth of cities in terms of population and spatial dimensions, urban roads are grossly inadequate to meet the mobility needs of city dwellers, reflecting a lack of proper coordination between transport and land use plans (Marondedze & Schütt, 2019). The post-independence urban trajectory in Harare could follow the development trends experienced in the United States and Britain in the post-World War II era, where cities such as Detroit, Boston, Massachusetts, and Michigan in the United States and Birmingham and Bristol in the United Kingdom have experienced strong residential dispersion toward the periphery. The dispersion has transcended commercial, office, and industrial activities forming the central business districts, extending toward shopping centers, office areas, and industrial areas (Kiakou, 2021). This has changed the spatial relationship between residences, workplaces, shops, and other destinations.

The separation between residences, workplaces and other destinations has been blamed for increasing auto dependency (Okeke et al., 2020). Statistics from the Central Vehicles Registry (CVR) show that from 2007 to the end of the first quarter of 2017, at least 510 275 second-hand vehicles were imported into Zimbabwe. Munuhuwa et al. (2020) estimates that 70% of these vehicles are in Harare, which has worsened traffic congestion. During the peak rush hour, traffic congestion in the Harare Metropolitan region is worsening. Motorists spend considerable time trying to weave their way through pedestrians conducting economic activities. The City of Harare is fed by five major roads that connect it to residential areas. The highways include Seke Road from the southern suburbs, Samora Machel from the western suburbs, Simon Mazorodze from the southwestern suburbs, Sam Nujoma Avenue from the northern suburbs and Robert Mugabe from the eastern suburbs. These roads are often choked by traffic congestion during the peak hour period. This prompted Harare City fathers and other key

stakeholders in the transport sector to implement various measures to curb traffic congestion. However, most of the measures fall in the category of emergent short-term traffic management tactics that have been implemented on an ad hoc basis and isolated ways, not backed by adequate empirical studies. The implementation of appropriate planning policies that integrate residential, employment, and transportation systems can significantly reduce traffic congestion. Nonetheless, Harare City fathers seem to pay lip services to this important issue.

A relatively well-developed body of research conducted in developed countries has analyzed the relationship between residential and traffic congestion (Goel & Mohan, 2020; Song et at. 2019; Wang & Debbage, 2021). Evidence shows that although a consensus has been reached, the magnitude and impact of the interface between traffic congestion and residential density depend on local factors and the implementation of long- and short-term strategies. Local research addressing the alleviation of traffic congestion through informed residential development to address this issue is lacking. For example, most studies in Zimbabwe (Mudzengere et al. 2013; Marondedze & Schütt, 2019) are related to land use and land cover, whereas others (Munuhuwa et al., 2020) deal with traffic management as separate issues. None of these studies have examined the relationship between residential density and traffic congestion. In addition, there is also a paucity of studies on the mediating role of travel behavior in this relationship, especially in developing countries, notably Africa. This has become a significant research gap in the literature. The need to test the mediating role of the relationship between residential density and traffic congestion has elicited interest in this regard.

It is therefore on the basis of this background that the study sought to contribute to the existing academic discourse by examining the effect of residential density on traffic congestion in the Harare metropolitan region of Zimbabwe. The study further considered the mediation effect of travel behavior on the relationship between residential density and traffic congestion. The objectives of the study were to establish the effect of residential density on traffic congestion, determine the effect of residential density on travel behavior, determine the influence of travel behavior on traffic congestion and test the mediating role of travel behavior on the influence of residential density on traffic congestion. This study provides valuable insights that can assist urban and transport planners in making informed decisions regarding zoning, land use, and the design of infrastructure that promotes sustainable transportation and efficient travel patterns. Additionally, it is important to emphasize that traffic congestion can deteriorate ambient air quality and increase the risks of nonallergic respiratory morbidity, cardiovascular morbidity, cancer, adverse pregnancy and birth outcomes, and diminished male fertility in individuals living near roadways. Furthermore, traffic congestion affects economic productivity and environmental quality by increasing fuel consumption and the costs of goods and services. Therefore, the findings of this study may offer ways to mitigate these impacts by shaping urban and planning policy which is key in enhancing the social and economic dimensions of contemporary urbanization. The paper is organized as follows. First, it provides an overview of residential density, traffic congestion, and travel behavior and the development of research hypotheses. Finally, this study discusses the findings, implications, limitations, and potential avenues for future research.

2. Theory and Hypotheses

2.1 Utility maximization theory

This study is based on utility maximization theory. Unlike theories in transport geography, the utility maximization theory suggests that travelers optimize their preferences for mobility decisions and consider the overall costs of travel in relation to their income limitations with the aim of maximizing their satisfaction or utility (Ben-Akiva & Lerman, 1985). In this study, utility maximization theory was used to explain the relationship between residential density, travel behavior, and traffic congestion. According to this approach, the number of trips generated by an individual can be adjusted and modified depending on the available transportation system and alternatives that can be utilized depending on the degree of value or "utility" to an individual seeking to maximize their benefits, even if it means sacrificing more travel time for increased mobility between locations (Malokin et al., 2019).

2.2 Residential Density

Residential density refers to the degree of concentration of housing units or populations within a particular area. It is typically measured by the number of housing units or individuals per unit of land area, such as the number of dwellings per acre or people per square kilometer (Kanyepe et al. 2022a). According to Song et al. (2017), residential density is a key indicator of concentrated density. This notion is supported by Goel and Mohan (2020), who argue that residential density should be considered in conjunction with land-use diversity and area design, including the availability of parking spaces, footpaths, and cycle tracks, to facilitate efficient traffic flow. Similarly, Jain (2023) underscored the importance of integrating commercial and service establishments with residential density to ensure convenient pedestrian access to these amenities. Furthermore, Zhu et al. (2017) maintained that consolidating facilities in a smaller space can conserve land resources and reduce the costs associated with infrastructure provision and maintenance. Considering recommendations from various scholars, density should be assessed alongside other land-use indicators (Ewing et al., 2017). This study incorporated factors such as job-housing balance, land-use mixture, design of pedestrian and cycling facilities, and proximity to public transit.

2.3 Traffic Congestion

There is no universally accepted definition of traffic congestion. Consequently, scholars have proposed various definitions. Traffic congestion is the disparity between the demand for road capacity and the availability of infrastructure (Cheng et al., 2020). On the other hand, Talukdar (2013) observed that when there is traffic congestion, travel speed decreases. On the other hand, Stupin et al. (2022) posits that traffic on a certain road can be considered congested when traveling at a speed lower than the design capacity of that road because the driver cannot go any faster. This study defined traffic congestion as an increase in travel time, travel speed, and delays. Moreover, the measurement of traffic congestion includes factors such as vehicle concentration, road capacity, and speed.

2.4. Travel behavior (TRB)

Travel behavior encompasses various aspects of transportation planning outcomes, including metrics such as person miles traveled (PMT) and vehicle miles traveled (VMT) as well as factors such as modal split, route selection, and trip frequency (Sardari et al., 2018; Sardari et al., 2023). The demand for travel is considered "derived" since people primarily travel to engage in daily activities such as work, shopping, recreation, and education, and travel enables access to these activities (Shah et al., 2022). Despite the time, cost, and resource consumption involved, travel is necessary because of the spatial separation of human activities (Wegener, 2021). Therefore, the study of travel behavior aims to understand people's spatial actions and transportation usage, which is a complex phenomenon influenced by various factors, such as personal or household attributes, socioeconomic characteristics, trip purposes, origins and destinations, and mode of transport, considering constraints such as time, cost, comfort, and availability (Dean et al., 2020; Yang et al., 2021). The interaction between activity choices and constraints shapes individuals' travel behavior (Pudāne et al., 2019). An et al. (2023) emphasized that travel behavior encompasses an individual's travel characteristics, including mode choice (e.g., walking, private car, and public transport) and trip purpose (e.g., shopping, commuting, and leisure). The spatial distribution of daily activities and increased vehicle ownership significantly contribute to higher travel distances and vehicle dependence, highlighting the importance of considering the resulting travel-related externalities (Lopes et al., 2019; Mouratidis et al., 2021).

2.4. Development of research hypotheses and research model

Conventional wisdom on land use and traffic congestion suggests that the presence of low-density housing leads to longer commuting distances and more frequent trips. This ultimately leads to a higher level of traffic congestion (Mitchell and Rapkin, 1954). The way in which land is utilized influences traffic congestion (Kafrawy et al., 2022). Moreover, Xiao et al. (2021) found that a lack of affordable

housing near workplaces increases commuting times, thus contributing to traffic congestion. Similarly, Sarzynski et al. (2006) explained that densely populated urban areas with concentrated activities experience higher volumes of automobiles and traffic delays. As a result, we propose the following hypothesis:

Hypothesis **H1**: Residential density positively affects traffic congestion.

Despite ongoing scholarly debate, many scholars acknowledge and support the fundamental principle that residential location influences travel behavior (Mokhtarian & Cao, 2008; Handy et al, 2005; Van Acker et al, 2007; Sarzynski et al., 2006; Cervero, 2013; Ewing et al., 2016). Numerous studies have investigated the relationship between residential density and travel behavior, lending credibility to the claims of proponents of new urbanism, who contend that walkable environments, mixed-use residential areas, and density promote the use of sustainable transportation modes, such as walking and public transit, thereby reducing reliance on cars (Andraos et al., 2021; Song, 2022; Douglas, 2022). For several decades, scholars have struggled with the issue of residential self-selection, by which households or individuals may choose their place to live centered upon their travel choices (Cao et al., 2009). Consequently, accounting for self-selection effects is crucial in establishing causality and directionality between residential density and travel behavior. Zhu et al. (2017) argued that high-density residential areas can influence mode choice by making public transportation, walking, and cycling more attractive than private cars. Thus, it is posited that:

Hypothesis **H2**: Residential density has a positive effect on travel behavior.

Travel behavior encompasses various factors, such as trip length, car ownership, mode choice, trip frequency, and vehicle miles traveled (Wang & Renne, 2023). According to Nugmanova et al. (2019), an increase in car ownership leads to an expansion of road capacity in congested areas, known as "induced travel." This concept is explained by the principles of supply and demand, in which increased capacity reduces travel time and lowers the cost of driving, resulting in more driving. The use of private vehicles creates demand for parking spaces and road capacity. Similarly, Sardari et al. (2018) emphasized that traffic flow is disrupted when the demand for road capacity exceeds its limits, leading to congestion. Likewise, Moyano et al. (2021) observed that as the preference for private vehicles increases, cities become more susceptible to congestion. On the other hand, Ewing et al. (2018) and Barrington-Leigh and Millard-Ball (2019) suggest that higher travel frequency increases the likelihood of encountering traffic congestion. Thus, it is posited that:

Hypothesis **H3**: Travel behavior has a positive effect on traffic congestion.

There are few studies on the mediating role of travel behavior on the effect of residential density on traffic congestion in developing countries. Residential density is connected to various aspects of travel behavior, such as trip length, car ownership, trip frequency, mode choice and vehicle miles traveled (Cervero, 2013; Zhu et al., 2017; Mitra & Saphores, 2020; Shi et al., 2023). On the other hand, Choi (2018) observed that modifying residential density can lead to changes in travel behavior and consequently result in traffic congestion. Similarly, Ewing and Cervero (2010) stressed the significance of land-use factors such as density, diversity, and accessibility in influencing travel behavior. According to Jing et al. (2018), developments resembling urban sprawl with limited street connectivity and distant accessibility result in more frequent and longer motorized trips, contributing to increased traffic congestion. Similarly, Mattson (2020) argues that a higher residential density reduces the frequency of household trips. On the other hand, Ewing et al. (2018) observed that compact urban areas with higher travel frequencies tend to experience more traffic congestion than sprawling areas. The conflicting dynamics between job and housing distribution also play a crucial role in how travel behavior influences the relationship between residential density and traffic congestion (Ewing

et al., 2003). This discussion highlights the mediating role of travel behavior on the effect of residential density on traffic congestion. Therefore, it is reasonable to assume that travel behavior can act as a mediator between residential density and traffic congestion. Thus, it is posited that:

Hypothesis **H4**: Travel behavior mediates the influence of residential density on traffic congestion.

Based on the above discussion, Figure 1 shows the overall underlying research model, where traffic congestion (TC) represents the dependent variable, residential density (DEN) represents the independent variable, and travel behavior represents the mediator.

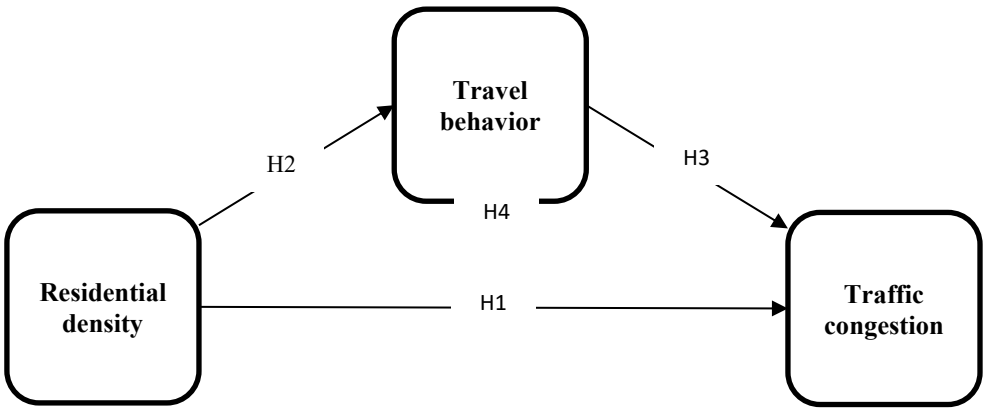


Figure 1. Research Model.

3. Methods

The population of this study comprised 530 668 households in the Harare Metropolitan Region (ZimStats, 2017). The sample size for this study was 384 households. This was obtained using Krejcie and Morgan's (1970) formula. One respondent was chosen to represent each household, meaning that a total of 384 questionnaires were distributed. The sample size obtained is consistent with the principle that the sample should be at least 200 to meet the requirements of maximum likelihood estimation (Hair et al., 2013). Additionally, the sample size of 384 was also justified following the recommendations by Shi et al. (2020) that a minimum sample size of 200 is required to allow statistical analyses such as factor analysis, which was performed in this study. Furthermore, the Kaiser–Meyer–Olkin Measure of Sampling Adequacy (KMO) was performed, and the sample was found to be statistically significant for each of the constructs under investigation in the study. The sample was selected using simple random sampling in which all households had an equal chance of being selected. A comprehensive database containing the addresses of all households was obtained from the relevant authorities. Using the database, each household was assigned a unique random number to ensure an equal opportunity for selection, and the process was independent of external factors. The researcher visited the selected households to facilitate participation in the survey. Simple random sampling was employed because it allows the creation of a sample that is representative of the entire population (Salganik & Heckathorn, 2004). The research methodology procedure is depicted in Figure 2.

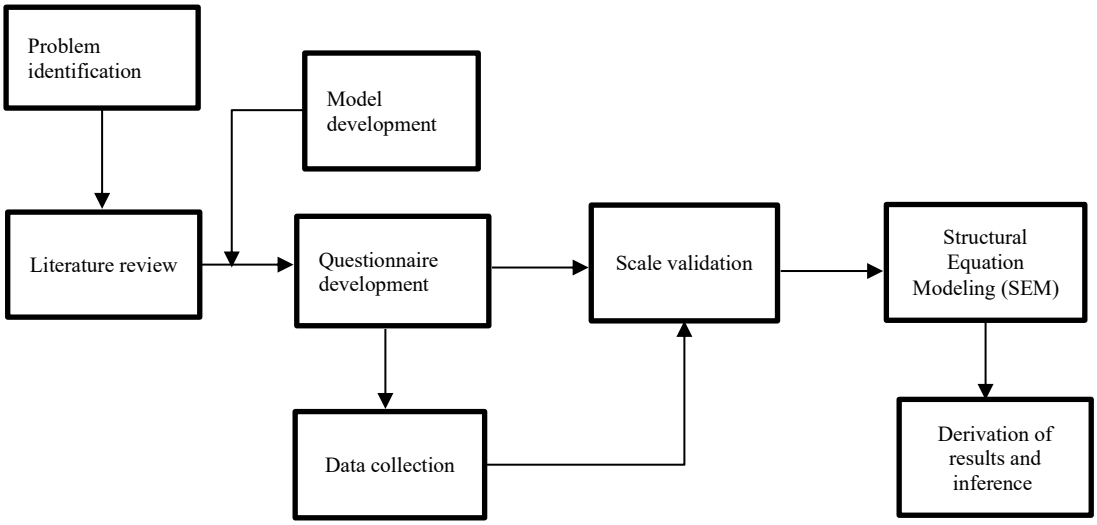


Figure 2. Methodology procedure.

The constructs for the current study were residential density (DEN), traffic congestion (TC) and travel behavior (TRB). These constructs were based on the theoretical framework for this study. The study used a 5-point Likert-type scale ranging from 1 (strongly disagree) to 5 (strongly agree) to measure all the variables. The measurement items on the questionnaires were obtained from prior related studies and modified to align with the objectives of this study. Measurement items for traffic congestion were obtained from Afrin and Yodo (2020) and Chakrabartty and Gupta (2014). A sample item for this variable was "Travel time has increased." In addition, the measurement items for residential density were obtained from Ewing et al. (2017), Chhetri et al. (2013), and Zhang et al. (2022). A sample item for this variable was "Economic activities are poorly mixed in neighborhoods". Furthermore, the measurement items for travel behavior were obtained from Bohte et al. (2009), De Vos (2019), and Bourne et al. (2020). A sample item for this variable is "Vehicle ownership and usage has increased." Data were validated using exploratory factor analysis (EFA), reliability analysis, convergent validity, and discriminant validity. These analyses were performed using SPSS version 20 and Amos version 21. EFA allowed the researcher to transform the data, to test the hypothesis and to map and scale the data. Factors that loaded poorly (those below 0.5) or that had double loadings were deleted. Only those factors that loaded successfully above 0.5 were selected. To obtain robust parameter estimates for the model, the study used maximum likelihood estimation (MLE) (Hair et al., 2013). In addition, the standardized factor loadings (λ) and critical ratios (CRs) were used to determine convergent validity. Moreover, discriminant validity was used to measure whether the constructs under study are different from each or not. Furthermore, the research hypotheses were tested using structural equation modeling (SEM) in Amos version 21.

4. Results

4.1 Scale Validation

Prior to conducting structural education modeling (SEM), various validation techniques, such as exploratory factor analysis (EFA), reliability analysis, convergent validity, and discriminant validity, were employed. EFA was utilized to understand the structure of the variables and to identify items on the questionnaire that measured the underlying constructs. Sample adequacy was assessed using the Kaiser–Meyer–Olkin measure (KMO) and Bartlett's test of sphericity. The study confirmed that the sample was adequate (KMO of 0.643, Aprox. Chi-square of 297.534, degrees of freedom [df] of 253; $p < 0.001$), meeting the minimum requirement set by Shi et al. (2020). Factor analysis was performed, which converged in 13 iterations with 69.857% of the total variance explained by the data. The solution yielded 3 components as expected, namely, TRC, TRB and RES. Additionally, reliability analysis

demonstrates that all constructs exhibited alpha coefficients above 0.7, indicating their reliability. Table 1 presents the results of the reliability test.

Table 1. Reliability Analysis.

Construct	**Number of items**	**Cronbach's Alpha**
Traffic congestion	4	.912
Residential density	5	.851
Travel Behavior	4	.833
Total	**13**	**.865**

Model fit indices, critical ratio and average variance extracted and standardized ratios were used to determine convergent validity. The study employed several model indices, such as CMIN/DF ($\chi 2$/Df), Goodness-of-Fit Index (GFI), Adjusted GFI (AGFI), Normed Fit Index (NFI), Tucker–Lewis Index (TLI), Comparative Fit Index (CFI), and Root Mean Square Error of Approximation (RMSEA). Table 2 shows that the model fit indices were acceptable, as recommended by (Hair & Alamer, 2022). In addition, Table 3 shows that standardized factor loadings for all items exceeded a minimum threshold of 0.6, as recommended by Bagozzi and Yi (1988). Moreover, the critical ratios (CRs) were notably large and statistically significant at $p<0.001$. Furthermore, the average variances extracted (AVEs) for all measured constructs surpassed the required threshold of 0.5 (Fornell & Larcker, 1981), satisfying the prerequisites for achieving convergent validity.

Table 2. Measurement model fit index.

Fit indices	Measurement model	Recommended values	Sources
$\chi 2$/Df	2.08	≤3.000	Hair and Alamer (2022)
GFI	.908	>0.900	
AGFI	.940	>0.900	
NFI	.951	>0.900	
TLI	.945	>0.900	
CFI	.964	>0.900	
RMSEA	.055	<0.080	

Table 3. Constructs, items, λ and CR.

Constructs	Items	λ	CRs
Residential Density	RES1	.701	-
	RES2	.744	10.529***
	RES3	.612	16.166***
	RES4	.815	13.646***
	RES5	.625	9.758***
Travel Behavior	TRB1	.713	-
	TRB2	.749	16.901***
	TRB3	.702	14.772***
	TRB4	.643	13.557***
	TRC1	.708	-
Traffic Congestion	TRC2	.643	11.842***
	TRC3	.603	9.855***
	TRC4	.670	10.275***

Note: - CR is fixed; *** $p < 0.001$

Discriminant validity was assessed using the Fornell-Larcker criterion, which involves comparing AVE values with the squared interconstruct correlations (SICCs). The criterion of the square root of

each construct's AVE exceeded its respective SICCs. Table 4 shows that the conditions for discriminant validity were met.

Table 4. AVEs and SICCs.

Construct	RES	TRB	TRC
Residential Density (RES)	**.714**		
Travel behavior (TRB)	.237	**.733**	
Traffic Congestion (TRC)	.498	.406	**.695**

Note: Diagonal elements in bold represent AVEs

4.2 Structural Equation Modeling

Research hypotheses H_1, H_2, and H_3 were tested in AMOS version 21. The model fit indices were acceptable: CMIN//DF = 2.08; GFI =.908; AGFI =.940; NFI =.951; TLI =.945; CFI =.964 and RMSEA =.055). The results of the hypothesis tests are shown in Table 5.

Table 5. Hypothesis Testing.

	Hypothesized Relationship	SRW	CR	Remark
H_1	Residential density → Traffic congestion	.259	10.997***	Supported
H_2	Residential density → Travel behavior	.414	13.375***	Supported
H_3	Travel behavior → Traffic Congestion	.327	8.914***	Supported

Notes: SRW standardized regression weight, CR critical ratio, ** significant at $p<0.05$, *** at $p<0.001$

The results show that residential density has a direct positive effect on traffic congestion. In addition, residential density positively influences travel behavior. Moreover, the results confirm that travel behavior has a positive effect on traffic congestion. Furthermore, the study tested the mediating role of travel behavior on the effect of residential density on traffic congestion. The structural model for the mediating role of travel behavior shows satisfactory fit indices: CMIN//DF = 2.150; GFI =.908; AGFI =.865; TLI =.9308; CFI =.867; and RMSEA =.039. The results for H4 are presented in Table 6.

Table 6. H_4 testing results**.**

Hypothesis	Path	Description	Path Coefficient	Results/ Comments
H_4	RES ⟶ TRB ⟶ TRC	TRB mediates the effect of RES on TRC	0.509***	Partial mediation

Note: ***Significant at $p<0.001$

Table 6 indicates that H_4 was supported, suggesting that travel behavior partially mediates the relationship between residential density and traffic congestion. This implies that residential density affects various aspects of travel behavior, such as length of trips, car ownership, mode of choice, trip frequency, and vehicle miles traveled, which ultimately results in traffic congestion. For instance, when a residential neighborhood is situated far from the central business district, individuals tend to rely heavily on cars and spend increased time commuting to access economic opportunities. In addition, when economic activities are unevenly distributed within residential areas, people tend to drive more frequently.

5. Discussion

The study examined the effect of residential density on traffic congestion. The study also explored the mediating role of travel behavior on the effect of residential density on traffic congestion in the Harare Metropolitan Province in Zimbabwe. The study provides adequate confirmation that residential density

positively influences traffic congestion. These findings are consistent with those of previous studies by Wang and Debbage (2021), which found a positive effect of residential density on traffic congestion. Cervero (2013) stated that an increase in residential units leads to more traffic during the evening peak hours. Therefore, H_1 was accepted. In addition, the study findings indicate that residential density positively influences travel behavior. This implies that residential density affects trip frequency, mode choice, and trip length. Empirical studies by Hong (2015) and Choi (2018) have confirmed a positive relationship between residential density and travel behavior, further strengthening the consistency of this finding. Additionally, this study reveals that the distance between residential developments and economic activities plays a crucial role in the relationship between residential density and travel behavior. Thus, H_2 was accepted.

Moreover, the study also revealed that travel behavior has a positive effect on traffic congestion. This suggests that traffic congestion is influenced by factors such as vehicle miles traveled, number of vehicle trips generated, vehicle ownership, and mode choice. These findings align with findings by Kanyepe et al. (2022c), who observed that traffic congestion in Harare is primarily caused by an increase in vehicle ownership, which is exacerbated by the influx of second-hand vehicles. Thus, H_3 was accepted. Furthermore, the study established that travel behavior partially mediates the relationship between residential density and traffic congestion. This implies that traffic congestion increases when individuals generate more vehicle trips, commute longer distances and frequently drive from their homes to the central business district. Based on this, travel behavior provides insights into the effect of residential density on traffic congestion. This finding is consistent with several empirical studies, including those by Sarzynski et al. (2006), Nasri and Zhang (2012), Ewing et al. (2016), Ewing et al. (2017), and Chang et al. (2021), which demonstrated how travel behavior influences residential density and traffic congestion. However, given the scarcity of empirical evidence on the mediating role of travel behavior on the relationship between residential density and traffic congestion in developing countries, this finding represents a significant contribution that this study makes toward land use and transport interaction.

6. Implications

While previous studies have focused on the influence of residential density on travel behavior, little research has been conducted on how travel behavior mediates the relationship between residential density and traffic congestion in developing countries. This study contributes to the literature on land use and transport interaction by investigating these relationships in developing countries, particularly in Zimbabwe. It is important to highlight that the conventional methods used to alleviate traffic congestion in Harare, such as the construction of more roads and expanding existing ones, have turned out to be expensive, impractical, and lack foresight. Consequently, a new set of strategies is necessary to tackle Harare's future traffic challenges. Considering that travel demand is influenced by other factors, it is advisable for planners and policymakers to explore land-use planning as an alternative approach for mitigating congestion. Moreover, by implementing coordinated land use planning, the greatest long-term benefits in terms of mobility can be achieved, making it essential to revive this method as a legitimate way to manage traffic congestion.

7. Conclusions

This study presents unique findings regarding the moderating effect of travel behavior on the relationship between residential density and traffic congestion. Valuable lessons can be learned from these findings. First, there was a positive relationship between residential density and traffic congestion. Second, residential density is positively linked to travel behavior. Third, travel behavior is positively associated with traffic congestion. Finally, travel behavior partially mediates the effect of residential density on traffic congestion. However, it is important to note that the study was limited to households in Harare Metropolitan Province in Zimbabwe, which may restrict the generalizability of the findings to other metropolitan areas and countries. Moreover, it is important to note that the results on the relationship between study variables can vary based on socioeconomic factors across different

cities and countries; therefore, it is recommended that future research be conducted in other metropolitan areas in other countries to gain a deeper understanding of this phenomenon. Furthermore, future studies can explore complex models such as moderation-mediation to understand the relationship between study variables.

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Conflict of Interests
The author declared that there was no conflicts of interest relating to the conduct, outcome and publication to this study.

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Data availability statement
The data used in this study are available upon request from the corresponding author for researchers who meet the criteria for access. Restrictions may apply to the availability of certain data, as they were obtained under strict ethical guidelines governing human subjects' confidentiality and privacy.

CRedit author statement
James Kanyepe contributed to the conception and design of the study, data analysis and drafting of the manuscript. The author read and approved the final version of the manuscript.

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Parametric Architectural Design for a New City Identity: Materials, Environments and New Applications

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ABSTRACT

In contemporary architectural Design, we speak of a parametric structural design. A design that integrates new functionalities crossed with the spatial geometry of objects. It has been considered structured because it optimizes combinations that integrate a minimum of materials and data to respond to functions, uses, and needs more adapted to a society in perpetual evolution. Parametric modelling allows the usability of new materials and the integration of new structures in a variety of design environments. This transdisciplinary research explores aspects of parametric modelling, a design method that creates digital models using algorithms and parameters. By focusing on the material and immaterial plurality of the designed space, this method enables the generation of complex and innovative forms that would be difficult to realize with traditional methods. Then, from a position that redefines the city as both a "medium" city and an "object" city, we explore the fields of application and novelties that are investing in the fields of architectural construction. We examine how parametric modelling can be used to create more sustainable and environmentally efficient buildings, using parametric processes, and optimizing the use of space. In this sense, our research will lead us to identify two aspects of parametric modelling: the conceptual parametric design aspect and the constructive parametric design aspect. Finally, the results of our research enable us to identify a design process that demonstrates the feasibility of using parametric modelling to generate viable, sustainable, and versatile spaces.

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Highlights	Contribution to the field statement
- This paper explores the fundamentals of parametric design as an innovative digital environment for architectural design - It captures the architectural specificities of the city of Tunis through parametric modelisations. - It highlights the conceptual and constructive specificities of the city's architectural design - Emphasizes the importance of participatory design in the architectural design process to create more inclusive and sustainable urban spaces.	The article contributes to the field of architecture and urban planning by exploring innovative approaches to design, sustainability, and city identity, while also advocating for a more inclusive, human-centered, and participatory design process that considers the well-being and preferences of local communities. These contributions have the potential to positively impact the social and cultural fabric of cities and their inhabitants. Overall, this manuscript provides a significant contribution to the existing literature on parametric architectural design and explores the importance of participatory design in the architectural design process. By involving stakeholders from the beginning of the design process, this approach makes it possible to create urban spaces that are more inclusive and responsive to the needs of local communities.

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1. Introduction

Our research focuses on exploring the potential of parametric architectural design to define a new urban identity. Parametricism is thus growing up and becoming serious about making an impact in the world (Schumacher, 2016). We focus on using parametric modeling to create buildings that are responsive to user needs while being environmentally and socially sustainable. By using algorithms and parameters to generate digital models, architects can create complex and innovative forms that would be difficult to achieve using traditional methods (Kelly, 2014). We also seek to bring together elements that could consolidate the new parametric modeling experiments developed by designers and researchers in spatial geometries with the new constraints of architectural construction. The computational grasp of parameter-dependent processes of emergence and transformation is also a winning proposition in the field of urban planning and design (Schumacher, 2016). Therefore, this paper examines how parametric modeling can be used to optimize the construction and fabrication of new buildings, using environment-friendly materials, and optimizing the use of space. Finally, we seek to create a homogenized and improved spatial interpretation and identification of the city using parametric modeling. By focusing on the material and immaterial plurality of the designed space, this method generates complex and innovative forms that reflect the unique identity of each city. An identity constructed according to ambivalent criteria based on the architectural space's use and functionality. This territorial identity matches together natural identity elements which are related to the natural environment data of the city, with human identity elements which are the individual and the society, both are linked to the artefactual identity elements identified as arrangements made in a city (Sönmez, 2020). The results of our research identify the crucial role of parametric modeling as a design process in generating viable, sustainable, and versatile spaces for the cities of the future. Parametric architectural design is an innovative approach in the field of architecture that is intended to create buildings and public spaces using advanced digital tools. It is founded on the use of parameters that control all aspects of an architectural project, from geometry to environmental performance. This approach aims to design buildings and public spaces that are relevant to environments and communities and can reflect a sense of belonging and experience. The word ‘architecture’ seems to mean both a thing and an activity. On the one hand, it seems to imply buildings with certain ‘architectural’ attributes imposed on them. On the other, it seems to describe what architects do, a certain way of going about the process of making buildings. (Hillier, 2007). By modeling the architects’ designers can include various parameters such as topography, natural light, wind, materials...etc. Computer modeling is a method of virtual representation that provides a form of electronic prototyping. It allows ideas to be developed, described, visualized, and evaluated in terms of environmental performance without the expense of actual construction or the time-consuming task of producing drawings (Frazer, 2016). In that sense, we have decided to study parametric architectural design to define it in a specific context related to the methods of conception, to the construction environments, and especially to architectural city modelization. This involves, among other things, a search for an answer to the following questions:

- How can parametric designing with new architectural software include essential algorithms for optimizing the configuration and enhancement of a project?
- What are new investigation environments that parametric design explores to optimize the lived experience in the city?
- What are the distinctions between conceptual parametric design models and constructive parametric design models?
- Should a city's architectural sustainability depend more on the preservation of its environment or its constant updating through design parameters?

1.1 Methodology

Our research is divided into four parts and is based on a mixed methodological approach that combines theory and practice. First, we define the properties of parametric modeling by reviewing different design methods that use algorithms and parameters to generate numerical models. We'll explore how

this method can be used to create more sustainable, efficient, and aesthetic buildings. Next, we'll begin an explanatory section devoted to architectural application environments and their dimensions. We'll look at how parametric modeling can be used to optimize the construction and fabrication of structures, using specific materials, and optimizing the use of space. We will also explore ways in which this method can be used to design buildings that fulfill users' needs while being environmentally friendly and viable in a sustainable way. Third, we will distinguish between the characteristics of the city as a "medium" and the city as an "object" (Table 4). We will examine how parametric modeling can be used to create complex and innovative forms that reflect the unique identity of each city. We will also explore how this method can be used to create more citizen-friendly public spaces. Finally, we will discuss a new architectural vision that includes the user as the first actor in the design of his city.

1.2 Aim and Materials

The main objective of this research is to explore how parametric architectural design can be used to create a unique identity to achieve a participative appropriation of the city. This approach involves focusing on the materials used in construction, the environments created by architecture, and possible new applications with parametric design. It's about bringing together our most distinctive and cohesive architectural and participatory elements into a strong and meaningful city statement. The socio-economic and territorial development of a society can be significantly influenced by exploring parametric architectural design to create a unique identity for a city. By creating a city with strong, coherent urban planning, it is possible to support and strengthen the cultural identity of the city. This identity can be shaped by elements such as architecture, parametric planning, the arts, and citizen participation. Encouraging community participation in the creation of this identity can strengthen residents' sense of belonging. Through a cartographic study specific to the city of Tunis, we aim to highlight architectural and environmental dimensions that actualize aspects of the user amenity experience. A parametric demonstration based on programs, plugins, and presenting architectural indicators will be implemented. We will examine how the usability of materials and new algorithms can be linked to inclusive parametric architecture and connected society. The following illustration (Figure 1) outlines the specific methodology process required to put this research into action. It represents a frieze that defines the starting point of our research which is based on the literary modalities that define parametric architectural design. This methodology is then divided into two distinct levels: the first involves imagining and drawing digital models, while the second involves imagining and making these models. By exploring these two different design phases, our research aims to identify the advantages and constraints of parametric modeling. A transition is highlighted to link definitions and theory to a qualitative state of art that reveals the city as a duality inscribing a conceptual-environmental and constructive-architectural schematization. After testing and displaying mapping simulations focused on users' experiences in the city of Tunis, its way findings, and amnesties, (figure 5) designed to demonstrate the value of social and architectural inclusion; we'll be able to identify the key factors for a better parametric architectural design. An original architectural parametric design for the city will be suggested, integrating all social specificities, and enhancing functionality and usability for a more interconnected society.

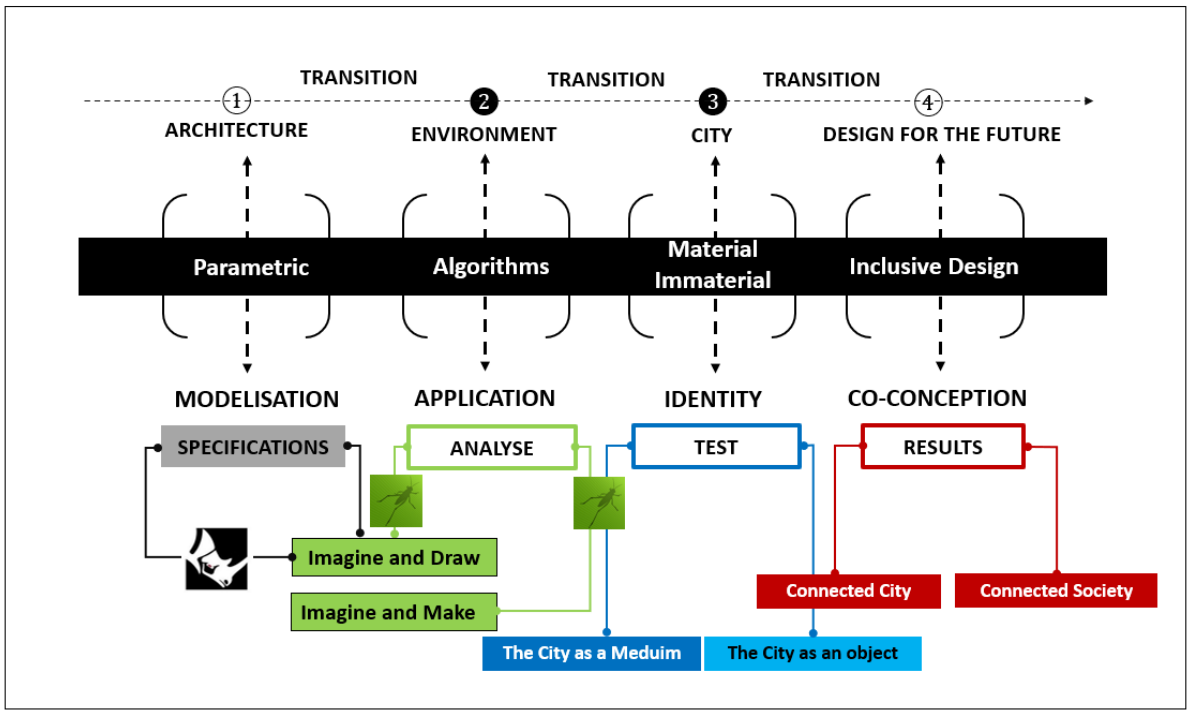


Figure 1. Methodological process.

2. Theoretical Background: The fundamentals of parametric design

One of the most profound aspects of contemporary architecture is not the rediscovery of complex curving forms, but the newfound ability to generate construction information directly from design information through the new processes and techniques of digital design and production (Branko, 2003). Otherwise, to encapsulate the cardinal principles of parametric design we adopt through this research a multidimensional approach that links parametric architectural design to definitions identifying theory and practice. This chapter has the merit of focusing on new parametric architectural design methods, which attempt to redefine the dimension of research/design in both an epistemological and digital context. The epistemological aspect is seen through the modeling processes and the numerical aspect through the new architectural principles of parametric realization. The fundamentals of parametric design are explained in this section according to a reading direction identifying the birth of the parametric architectural notion through different interpretations and reasonings. Etymologically, parametric design is a paradoxical term. The adjective "parametric" refers to parameter, which comes from the Greek "para", signifying a subsidiary or assistant, and the term "metron", which implies "measurement". This, in turn, opens two windows on its significance- the one mathematical, reflecting a measurable factor that defines a system or sets the conditions for its operation, and another that is more general, describing the boundary and scope of a specific process or activity (Semlali, 2017).

Modeling and configuring architectural space have nowadays become a tool that offers spatial experimentation and mutually integrates the user and the architect in a reading and interpretation phase. In this sense, each modeling work requires configured expertise and creativity based on specific architectural knowledge. Digitally modelled representations that handle function and are used to identify constantly changing needs. In this sense, Robert Woodbury states that Design is changed. Parametric modeling represents change (Woodbury, 2010) We highlight the term "change" since it is defined in a computer modeling context; the character of a parametric design project is identified in terms of changes during its realization. The use of relationship programs for generating shapes, fragmenting spaces, and even performing algorithms, constantly invites iteration to be part of the design process. Each modification represents a new parameter setting, and each new parameter setting produces a new creative experience. Alternating tasks that focus on specific spatial prototyping and identifying functionalities and usability. Graphical and parametric exploration is a process that leads the designer into an interactive research phase and allows him to explore a set of solutions to define

his final project. In this same definitional context, (Wassim, Shwe, Peter, Robert, & Simon, 2017) integrates a specific vocabulary that refers to parametric architectural configuration as a kind of prototype, he defines the integration of new programs alternating solutions and combinations between color material and environment as "electronic prototyping" (Wassim, Shwe, Peter, Robert, & Simon, 2017). This dynamic research is methodologically carried out according to the project phases and we can even talk about parametric methods. First, it is a matter of manipulating complex data and mastering programming language to reach the desired design " Desired Design-outcomes " (Helmut, Andreas, Michael, & Kilian, 2009). Next, it is required to carry out what we can describe as "Algorithm-Thinking" (Wassim, Shwe, Peter, Robert, & Simon, 2017) to solve problems by applying parameters. Finally, it is a question of being part of an experimental field for architectural construction prototypes. Prototyped models offer simulations of shapes, materials, textures, and colors and define functionalities and uses. Modeling or simulating are tasks targeting the creation of a thought and a generated architectural visualization. Patrick Janssen (Patrick & Rudi, 2015), defines a parametric model as an algorithm that generates models consisting of geometry and attributes (material definitions). This algorithm uses functions and variables, including both dependent and independent variables. Some of the independent variables can be given a more prominent status, as the interface to the parametric model, these are referred to as the parameters of the model (Frazer, 2016).

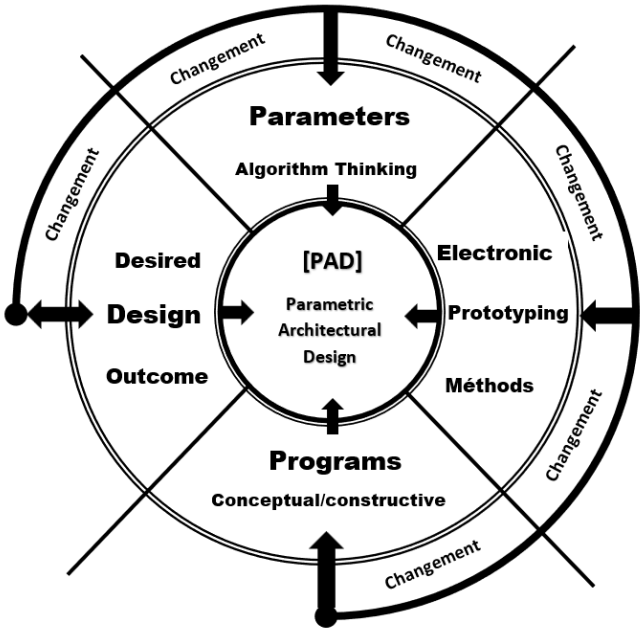


Figure 2. [PAD] Involving change, (Developed by Author).

Generated architectural modeling is a methodical design in which the insertion of sound images and architectural models is generated from the implementation of several rules depending on a very specific algorithm. Each generated design is configured with a set of modeling parameters. It is a generative design based on algorithmic thinking allowing to apply parameters and rules that altogether define, encode, and clarify the relationship between the imagination of the architectural space and its desirable construction. In other terms, parametric architectural design becomes recognizable according to the intention of the design and the response inventoried algorithmically. We will be able to classify thus on one hand the intention of the design and on the other hand the response of the design. Generative design is becoming increasingly important, largely due to new programming environments (Peters & Brady, 2018), in his chapter "Parametric Environmental Design Simulation and Generative Processes", looks at the intricacies of architectural construction. He underlines the need for architects to navigate in a dynamic digital landscape, using a diverse range of tools for tasks encompassing document creation, communication, graphics, drawing, design, and the use of new information technology tools. He confirms that the development of the programming tool Processing offered another alternative environment in which algorithmic design could be explored and shared with an interested community.

There is a trend in architecture towards parametric design—in which the designers focus their attention on the creation of generating algorithms rather than specific instances. In this paradigm, variants of the design are produced by varying the parameters of the underlying algorithm, and it is in the evaluation of design variants where computer simulation can play a significant role (Peters & Brady, 2018). The description of parametric design basics in this section, helped us to understand that technological innovation based on new digital performance software, is a process that is introducing change for the optimization of architectural and urban planning research. Architects, interior designers, and engineers are faced with a significant challenge: conceptual and constructive, it involves equally thinking and doing. However, according to (Ajla, 2016), design professionals are currently faced with many challenges– rapid technological changes, the necessity to innovate and raise the bar in building performance, and a paradigm shift in architecture. There are several reasons why progressive practices must continuously invest in research and the implementation of advanced technologies, but the need to improve design processes and services is typically the overarching drive (Ajla, 2016).

2.1 Software

The second part of our research is dedicated to demonstrating the fundamental role of innovating and creating in architectural design. Using applications dedicated to parametric architectural design, we intend to examine some examples of parametric architectural models identifying the construction drawings of urban cities as mentioned in figure 4 and figure 5. These examples will refer to the interoperability of two environments and are configured using Rhino 3D parametric design software with Grasshopper. To communicate the successful integration of new software into the architectural design environment (Fink & Reinhard, 2019) stated that Rhinoceros 3D is a commercial Computer-Aided-Design (CAD) software developed by Robert McNeel & Associates that bases geometry on mathematical nurbs models (Fink & Reinhard, 2019). Also approved by (Peters & Brady, 2018), who specified that in 2007 the introduction of Grasshopper, a new visual scripting plug-in for Rhinoceros was recognized. The architectural community was ready for an algorithmic design tool, so Grasshopper rapidly gained in popularity. It is financially accessible; it has a vibrant online community, and it makes it easy for designers to create their appropriate design tools. Crucially, in the context of introducing simulation to the digital design environment, what Rhino/Grasshopper has offered is the ability to easily create custom plug-ins. (Peters & Brady, 2018). Interoperability between Rhino 3D and Grasshopper is one of the key features that make them powerful tools for architects and designers. The two programs work seamlessly together, allowing designers to create complex designs that can be easily modified and updated. Rhino 3D provides the platform for creating 3D models, while Grasshopper provides the tools for creating parametric designs. Interoperability between the two programs means that designers can move quickly and easily between them, using the strengths of each to create designs that are both visually stunning and highly functional. The most preferred design software package for 3D modeling and parametric design is Rhinoceros and Grasshopper3d. Rhinoceros is a professional modeling software and Grasshopper is a plug-in for Rhinoceros which provides it with a visual programming environment that is used to define algorithms that automate tasks in Rhino (Apellániz & Vierlinger, 2022).

3. Case Study: Environments of architectural applications versus representative dimensions

For the purposes of our research, this section aims to study design environments that generate readings of architectural configurations and identify city-specific parameters (Peters & Brady, 2018) specified that Homes and buildings are in constant negotiation with their immediate environment. The reality of architectural design reveals a constant duality between the building and its environment, on the one hand, and the design process, which can anticipate this duality and thus improve this relationship, on the other hand. Architectural representations and models offer a future vision that can optimize the spatial viability of buildings. They situated the act of drawing as being a predictive act of experimenting with possible futures. The building's architects' design today form the cities of the future. Simulation is a way in which designs can be tested for their future performance. (Peters &

Brady, 2018). As we made clear in our first section when we defined PAD, (Figure 2) parametric simulation depends on a process involving change, an approach linked to two different application environments: one related to concepts and ideas, and the other to algorithm generation and construction. In the context of historical determination (Stavric & Marina, 2011) has identified 1990 as the year when parametric design influenced the development of digital architectural design, where we can distinguish between architectural CONCEPTUAL parametric design (Table 2) and architectural CONSTRUCTIVE parametric design (Table 3), (Stavric & Marina, 2011). These architectural models which are designed with parameters and program synchronizations are the object of virtual representations covering simultaneously invariant entities and contingent entities (Agbodan, Marcheix, Pierra, & Thabaud, 2023) which are algorithmically configured to display architectural spaces. The space experimentation through prototyping or simulating models aims to integrate the user consumer of the building in an atmosphere approximately close to reality. Modeling and configuring the space becomes a tool facilitating the user's experimentation and integrating them at the same time into a reading and interpretation phase. In this sense, each modeling activity requires configured Form-Thinking and creativity based on architectural knowledge. The interaction between thinking and doing will be explained by translating and transforming architectural knowledge into graphic Form-Making representations. Parametric architectural design recognizes the particular characteristics of the city and uses them to create buildings and public spaces that are adapted to the specific features of each neighborhood. The particularity of the city is recognized through its climate, its environmental insertion, its urban structuring, and its appropriation. By configuring and classifying these parameters, Rhinoceros 3D and Grasshopper display the city and connect it with its environment in a way that optimizes its sustainability. Through (Table 1) we set out some examples of the kind of parameters that bring ideas to fruition. These are just some of the plug-ins that are appropriate for the software environment.

Table 1. Table Showing parameter classes from, Form-Thinking to Form-Making Design Plugins Assistance.

Classes of Parameters	**The Meta-Parameters classes**
Parametric Architectural CONCEPTUAL Design	Parametric Architectural CONSTRUCTIVE Design
Form Thinking- Imagine and Draw	Form Making – Imagine and Make
Structure and format	Combining, synchronizing, and prototyping
Space + Area + Scale+ Measurement	Envelope + Texture + Covering + Walls
Size + Ergonomics + Function	Usability + Shapes + Contours + Functionality
Lighting-dark/light + Colors + Fashion + Materials+ Climate+ Energy+ Environment	Population + Genome+ Fitness, Selection, Crossing-over + Mutation

[PAD] Results through visualizations simulations and prototypes.

To create a geometric simulation in Rhino, Grasshopper offers a visual programming function. Users can switch and group nodes between multiple functions to create code that defines what is being created and calculates adequate solutions. That's why this methodology is often referred to as computer modeling. According to Peters and Brady (2018), design simulation can predict building performance by comparing early geometries in terms of energy consumption, daylight, shading, airflow, comfort, sunlight, and other parameters. (Peters & Brady, 2018).

3.1 Imagine and Draw, Imagine and Make

Parametric architectural conceptual design is an approach to designing buildings that uses parametric modeling techniques to imagine and then draw 3D models and plans with adjustable parameters. This enables architects and designers to imagine and make (Lafhaj, AlBalkhy, & Linner, 2023), to explore,

and test different design options quickly and efficiently, based on specific design objectives and constraints. The emphasis is on generating a concept, a form that can later be developed into a more detailed design. Parametric architectural Constructive design is an approach to building system design that uses parametric modeling mechanisms to generate detailed, constructive design solutions. It involves the creation of three-dimensional models with adjustable parameters linked to building elements and systems. This enables architects to optimize constructability, structural integrity, material efficiency, and other construction site considerations. The aim is to create a design that can be efficiently translated into a built structure.

3.1.1 Parametric Architectural CONCEPTUAL Design

Conceptual Parametric Modeling is an architectural design method that allows architects and designers to create digital models using algorithms and parameters. Using extensions such as Ladybug and Honeybee in Grasshopper, building professionals can design for a specific environment based on climatic and geographic data. This allows architects to configure a climate based on the city, which can help create more sustainable and energy-efficient building designs. Ultimately, conceptual parametric modeling offers an innovative approach to architectural design that allows architects to create more accurate and customized models to meet their clients' needs. The climate simulation of downtown Tunis is a concrete example of the use of parametric conceptual modeling in architecture as shown through (Figure 3).

Table 2. Ladybug and Honeybee as two examples of Parametric Architectural CONCEPTUAL Design.

Typical program application	⇄	***Interoperability with extensions***
Ladybug *is a Grasshopper plug-in for visualizing and analyzing atmospheric data. It provides representations such as sun position and trajectory, wind simulation, psychrometric map, etc., as well as geometric analyses such as radiation analysis, shadow study, and view and visibility analysis. (Energy Plus Weather File)*	⇄ ⇄	***Honeybee*** *is a Grasshopper3D extension that connects to certified simulation models such as Energy-Plus/Open-Studio for building energy management, HVAC calibration, climate comfort... etc. As regards Radiance for daylight and transparency simulation, Honeybee is a*

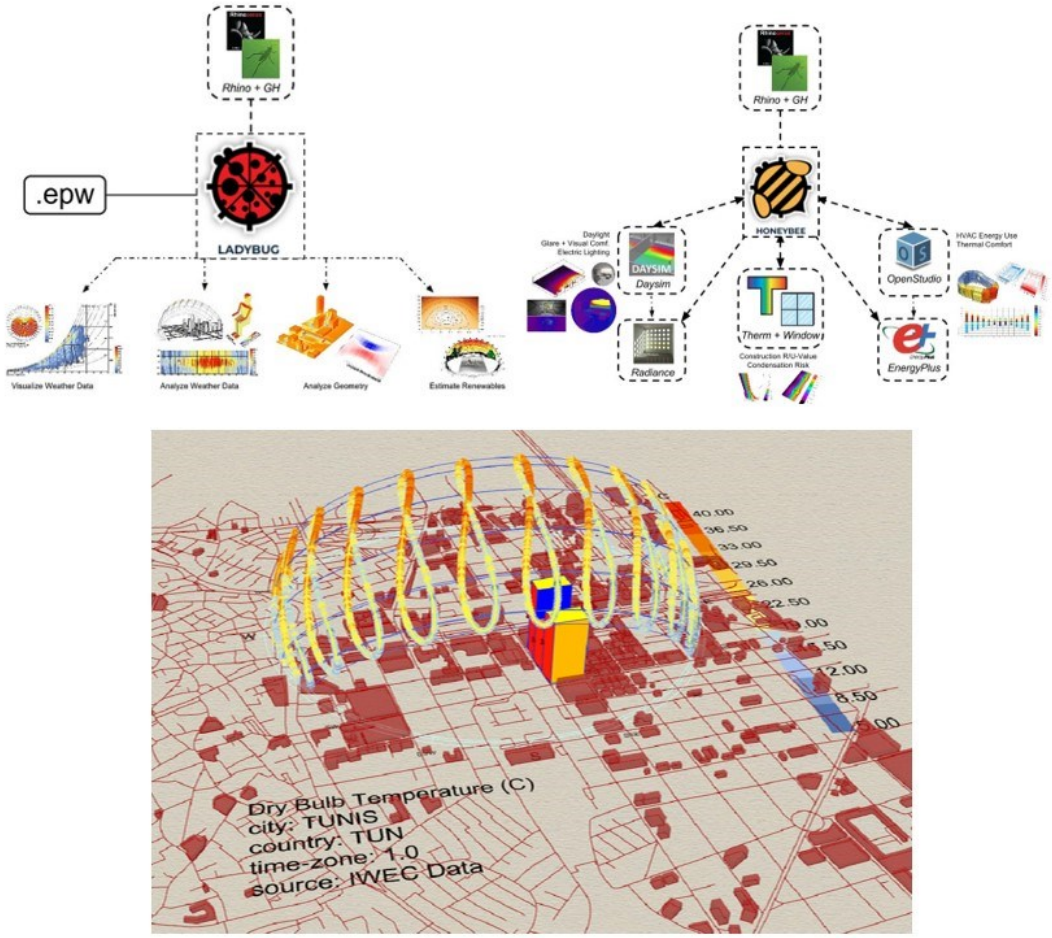


Figure 3. Climate modelisation with Ladybug and Honeybee, downtown Tunis.

3.1.2 Parametric Architectural CONSTRUCTIVE Design

By presenting these study cases, which explain both the properties of some of the Rhino and Grasshopper programs and show examples of customized downtown Tunis simulations, we show how program and plugin management can be used to optimize and read architectural renderings. We began with the idea of a concept defined using an immaterial environment integrated into units of measure to create simulations identifying the city's atmosphere and demonstrating its capability to interact with its environment on the one hand, and with its users on the other.

Next, we became aware of algorithms supporting genomes and concordances to generate architectural models that are specific to both environmental and architectural parameters. Integrated features in Rhino and Grasshopper enable parameters to be applied to different territory components, offering great design flexibility. Grasshopper modeling enables complex geometries to be managed and shaped, facilitating the creation of innovative, customized designs. This is what the authors Domenica, Arianne, and Pepe (2022) have pointed out by asserting that the parameterization of the objects can be applied to different elements of the territory by means of the tools implemented in Rhino and Grasshopper. Indeed, programming in Grasshopper makes it possible to manage and model even complex geometries (Domenica, Arianna, & PEPE, 2022).

Table 3. Urbano and Galapagos as two examples of Parametric Architectural CONSTRUCTIVE Design.

Typical program application	⇄	***Interoperability with genomes***
Urbano: *To explore the city's geospatially in 2D and 3D, Data is collected from the OSM website. As soon as the model is downloaded from the platform, it becomes usable in the Rhinoceros/Grasshopper. (Figure 4)*	⇄	***Galapagos***: *Galapagos provides a prospecting genome to achieve fitness that can be maximized or minimized.* *Galapagos* ***minimizing and maximizing*** *mass-addition distances between the searched best point and all amenities prospected on the map as shown on (Figure 5)*

Starting from an immaterial conceptual vision and interoperating with constructive properties, the city takes shape and form, not only according to its environment and atmosphere but also according to a communal imaginary and social DNA. The interoperability of model generation makes it possible to develop a coexistence between architectural experience and perception. Digital simulations can be used to convert quantitative building structure data into more qualitative and sensorial experiences, as (Yanni, 2012) confirms by explaining that computer simulations transform quantitative models of building physics into qualitative sensory experiences (Yanni, 2012). In this same context, (Oxman & Gu, 2015) defined the particularity of this type of design as generative modeling which is mentioned as a complex process involving the development and use of systems that are concerned with the emergence of forms, from relationships, norms, and generative parameters. The emerging forms are generated by preformulated processes.



Figure 4. Urbano**.** Building 3D models using Open Street Map.

Interaction is a fundamental part of this model, as it enables generative features to be applied to design. For this, it is important to have an interactive design module that enables the designer to manipulate and direct the production of the desired solutions. In short, the generative model is a powerful tool for designers seeking to create complex, innovative forms using pre-established processes and close interaction with the system. (Table 3), highlights the interoperability of the urban cartography of the city of Tunis with the landmarks constructed in the city according to the activities of citizens. This duality is further illustrated in (Figure 5), where the Urbano and Galapagos tools resize the city according to its geographic features and the location of amenities, allowing more accurate visualizations to be designed for obvious constructions. This approach provides a better understanding

of citizens' needs and habits and can help design more appropriate and sustainable urban projects for the city.

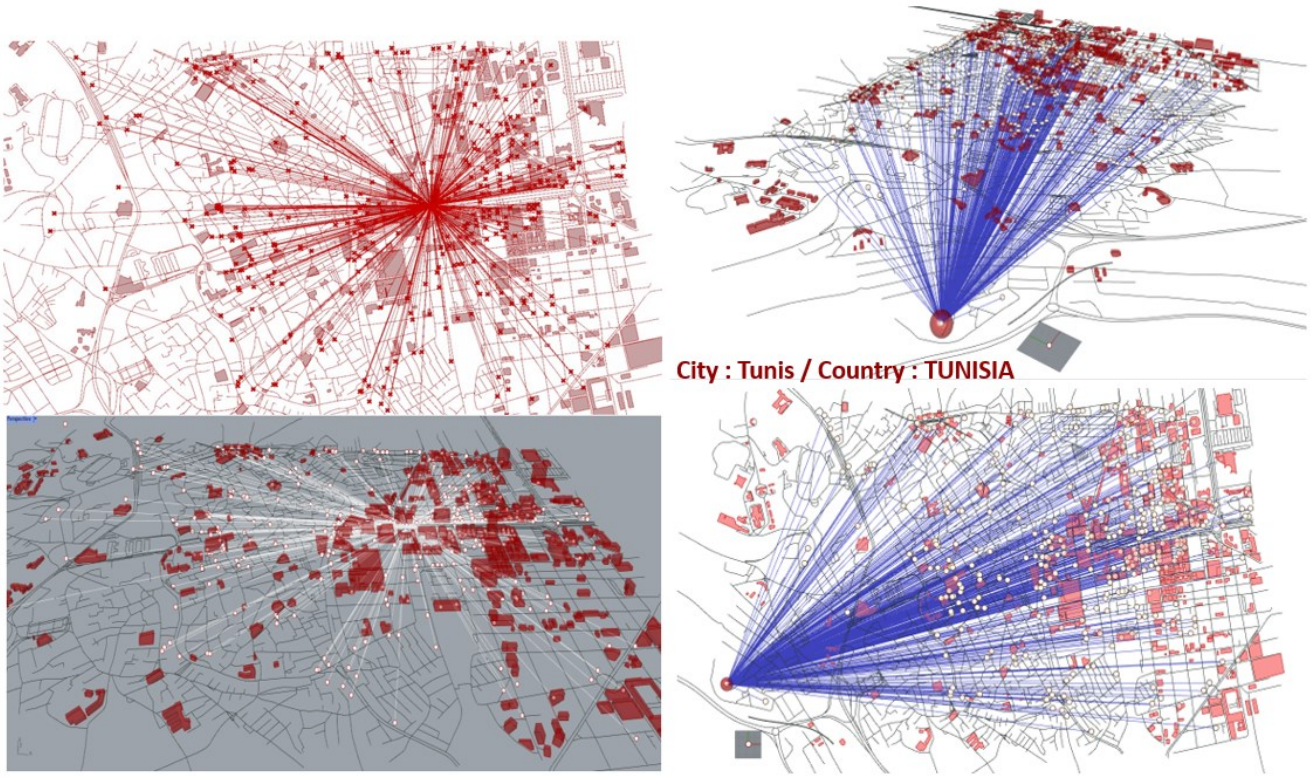


Figure 5. Novel Constructive benchmarks based on distances to commodities.

The generative model is the design of, and interaction with, complex mechanisms that deal with the emergence of forms deriving from generative rules, relations, and principles. Shapes and forms are a result of pre-formulated generative processes. Interaction is a major priority in this model. To employ generative techniques in design, there is a need for an interactive module that provides control and choices for the designer to guide the selection of desired solutions (Oxman & Gu, 2015).

We deduce that parametric architectural design is a reliable [incorporating error correction] and iterative process, [Choose -select- optimize- perform-evaluate] that enhances the results' visibility and connects the user to his future environment through space prototyping. Parameterization increases the complexity of both designer tasks and interface as designers must model not only the artifact being designed but a conceptual structure that guides variation. Parametric settings can have both positive and negative impacts on tasks, performance, and designers' perception of results. On the one hand, parameterization can encourage the search for more context-sensitive designs, encourage the exploration of new forms and types of form creation, reduce the time and effort required for changes and improvements, and enable a better understanding of the object's conceptual structure in the design phase. On the other hand, configuration can require additional effort, increase the complexity of local design decisions, and increase the number of elements to be taken into account when carrying out the requested tasks (Aish & Robert, 2005). To reach a culture of innovation within architectural design, the introduction of these modeling environments provides us with some sustainable perspectives that are ultimately linked to the viability of the city and its future configuration in terms of energy, ecology, and the use of bio-based and even recycled composite materials. In the following section of our research, we will focus on the effects of such parametric models on the creation of a city's identity.

4. Findings: The city's identity, from medium to object

In the beginning, was the city. Or rather, the dream of a city. That's all. [...]. To this we've added poetry: The city palpitates like a heart, the city flies like a breath. An ever-expanding vivacity fills these imaginary cities. Some have mistaken this urban poetry for utopia (Lassave, 1992). This is how

Lassave describes the city, by attributing a connotation linked to a collective imagination. An image that refers to the city's history, inscribed in the memory of its residents, it remains alive by its belonging. This same city today takes care to satisfy the needs of all its users, a modern city, a city of consumption that offers paths, wayfinding, and especially shelter. If we decide to build a sustainable city with historical and cultural values, it should be the city that offers all the amenities needed to lead a comfortable life. A city designed according to the needs of its citizens. The visual appearance of a city is not necessarily perceived in the same way by all those who live in it, approach it, or pass through it; (Figure 6) the mental image they have of it may be forged by different feelings or practical needs: the need to find one's way around, a zest for life, aesthetic imperatives, the desire to belong to a community, etc (Lynch, 1984).



Figure 6. Identity is at the heart of the city's parameters.

4.1 The city identity, a material, and an immaterial construction

The city is a physically and spatially complex entity, combining economic, social, cultural, and environmental aspects. For this reason, urban design is a disciplinary field that links architecture and spatial planning. It is also a meeting hub for designers, engineers, artists, architects, and garden planners, all working together to satisfy human needs and expectations. In describing our results, we refer to two urban design pioneers and theorists, Ildefons Cerdà (Cerdà, 2022), the engineer, and Camillo Sitte, (Sitte & Stewart, 2013) the architect, who proposed two styles of discourse and two types of graphic representation, revolving respectively "The city as an object" on the one hand, and "The city as a medium" on the other. We thus propose to link together the two parametric design environments that we have pre-configured in (Table 1), as follows: a "city as a medium" that identifies itself through lived experience and the image of the drawn city, and an "object city" that builds a relationship with urban space. A constructive vision that defines typology, density, contours, appearance, shapes, and architectural functionalities.

Table 4. Design the city object by perceiving the environment.

Designing The Medium City. [Table 2]		**Building The Object City. [Table 3]**
• Nature, history, culture, society, heritage, the idea of the city through time, the city of the future, the social imagination • The management of accessibility, wayfinding, behaviours, citizenship, participation, comfort, and livability. • The idea of a sustainable city, green design…etc. • Algorithm Thinking	 PARAMETRIC ARCHITECTURAL EXPERIENCE	• Solidity, convenience, and beauty (Alain, 1999) • Typology study • Composition modeling • Measuring the density of occupation • Urban exploitation • Landscape integration • Green architecture…etc. • Building Thinking- Co-conception • Desired, Design-outcomes
Connected Society	**Connecter User**	**Connected City**

Our research findings have enabled us to identify the crucial role of parametric modeling as a design process in the creation of viable, sustainable, and versatile spaces. Indeed, our survey revealed that the use of parametric modeling enables us to generate designs that are better adapted to the specific needs of users while considering environmental and economic constraints. This design approach also enables better integration of the various disciplines involved in the design process, such as architecture, engineering, and construction. In short, our research has shown that the use of parametric modeling can make a significant contribution to the creation of high-quality spaces that meet users' needs while being sustainable and versatile. We thus identify two ideas of the city's sustainability, the first considers that integrating parametric models to design sustainable cities is one of the major solutions for rebuilding and reclaiming a viable space, which is defined as a geographical entity unaffected by economic or other factors. The new concept of sustainability must have the first name “urban”, so that, when we talk about urban sustainability, we will be talking about spatialized sustainability, not a concept that belongs to ecology, economy, or sociology (Feriel, Kitouni, & Sassi Boudemagh, 2018). The second is considered an evolutionary process that takes environmental well-being into account. Sustainable urban development may be defined as a process of synergetic integration and co-evolution among the great subsystems making up a city (economic, social, physical, and environmental), which guarantees the local population an on-decreasing level of well-being in the long term, without compromising the possibilities of development of surrounding areas and contributing by this towards reducing the harmful effects of development on the biosphere (Camagni, 1998). We would also add to this the human factor in the composition of the city: a viable, sustainable, and versatile city relies on the citizenship of its people, and above all on their participation, (Table 4). The city's actors are simply its users. The phenomenon of participation has been an essential component of the globally accepted sustainable city concept since the 1970s. (Turken & Eyuboglu, 2021).

4.2 Discussion: Planning and inventing the city's future, users at the heart of Design Process

The following discussion constitutes both a model, an outline, and a proposed call to action for thoughtful research and applications in parametric design architecture. Indeed, our in-depth analysis has highlighted the importance of using parametric modeling as a design tool for creating innovative and sustainable spaces. We are convinced that this approach can bring real added value to current architectural practice, enabling designs that are more precise, more efficient, and better adapted to users' needs. This is why we are calling for concerted action to encourage research and applications of parametric design in architecture. As classified through (Table 4), we are convinced that this approach can help address some of the most pressing challenges facing our society in terms of sustainability, energy efficiency, and adaptability to environmental change. We therefore encourage architects,

engineers, urban planners, and researchers to explore the possibilities offered by parametric modeling and to work together to develop innovative, sustainable solutions for urban spaces and buildings. In short, our discussion is a call to action for more widespread use of parametric design in architecture, in order to meet the challenges of our time and create a more sustainable, user-friendly future. We want to highlight the necessity of co-designing the city and establishing a new culture of interaction and participation. The right to the city involves two fundamental rights for urban inhabitants: the right to oeuvre (participation) and the right to appropriation (Zeybekoglu, 2022). A culture that reconfigures the city in digital, parametric, and essentially human terms. To satisfy a future space user, parameter synchronization is defined and based on specific needs. The parametric design of architectural environments is based on this concept, using tools and programs to present a model close to reality and to convince consumers of the viability of the space concerned. The parametric design of a spatial configuration considers the usability of both spatial modeling as a prototype and the city itself as an environment and a concrete design context. Architectural space modeling thereby has a dualistic function: one centered on the spatial experience as a model, and another centered on the user experience as a participant. This new architectural space representation and spatial prototyping technique offers an experience that is characterized by the three classic "Ux" factors: system, user, and context. In conjunction with (Fink & Reinhard, 2019) ideas, they suggest that cultural aspects can be incorporated into the design process by involving citizens. Participation platforms, tools, or applications can be developed and integrated into this process to meet citizens' needs. By involving citizens in the design process, professionals can better understand the needs and expectations of the local community, which can contribute to the creation of more suitable and sustainable spaces. Participation platforms can take different forms, such as surveys, focus groups, participatory design workshops, or collaborative mapping tools. These tools enable citizens to share their ideas, concerns, and needs regarding public spaces and buildings, which can help designers create more suitable and effective solutions. In short, this idea suggests that involving citizens in the design process can help create more sustainable spaces that are better adapted to local needs. Cultural aspects can be considered through the involvement of citizens. Participation platforms, tools, or applications can be developed and incorporated into this process to address and screen citizens' needs. It can be concluded that the application of digital tools within the urban planning process is state of the art, in business and research. Towards an efficient workflow in the future, open-source tools will be considered as a driving force to support the research. The collaboration between different institutions and the sharing of knowledge is critical to strive for better solutions (Fink & Reinhard, 2019).

To further develop the discussion around our research we propose future readings that can optimize and revalue parametric design models. Thus, we mention in the following points the fundamental aspects that need to be taken into consideration:

- Exploration of new forms of parametric modeling for architectural design, such as AI-based or generative modeling, which enable greater flexibility and adaptability to user needs.
- In-depth study of the impact of parametric design on the sustainability of buildings and public spaces, examining energy, environmental, and social aspects in particular.
- Development of new citizen participation tools for parametric design, such as mobile applications or online participation platforms, enabling users to actively contribute to the design process.
- Benchmarking the performance of buildings designed with the parametric method against buildings designed with traditional methods, to establish the advantages and limitations of this approach.
- Study of the economic feasibility of parametric design for architectural projects, examining the costs associated with the use of advanced technologies and the involvement of users in the design process.
- Exploring the use of parametric design to create more inclusive and accessible public spaces, considering the needs of disabled and elderly people.

- Studying the impact of parametric design on the health and well-being of users, examining aspects such as daylighting, air quality, and acoustics.

In sum, these prospects for future research can help improve our understanding of the use of parametric design in architectural construction and offer users new opportunities to connect with their immediate environment.

5. Conclusions

This research presents an innovative approach to the architectural design of the city using parametric context as a new paradigm for creation and conceptualization. This approach enables designers and spatial researchers to conceive, plan, and implement changes in the world around us while considering citizens as the main actors in their living environment. Digital modeling is an act of creation that humanizes time through the act of creating, modeling, prototyping, and configuring. This experience suggests that designers and consumers of space should open up to a new culture of designing architectural projects, based on human methods and ways of thinking.

City design strategy must be citizen-centric, it is necessary to recognize that including participatory aspects in the architectural design requires, to some extent, a greater effort than with the authoritarian model (Giuseppe, 2021). By considering the city's history, identity, and sustainability, designers can create a city that reflects the values and culture of its inhabitants. Using parametric design, architects can create buildings that are both innovative and sustainable, while using energy-efficient materials. This approach can also be used to create a coherent identity for the entire city, using similar design principles and materials across multiple buildings. In conclusion, parametric design is a promising approach to architectural design for the city. Using this method, designers can create innovative, sustainable buildings that reflect the values and culture of the city and its inhabitants.

In return, it's important to point out that while parametric design can offer many benefits in terms of sustainability, energy efficiency, and architectural innovation, it can also present limitations in relation to environmental and social change. The results of parametric design can be influenced by factors such as costs, government regulations, and investor preferences. This can limit the ability of designers to create buildings that fully meet the needs of citizens and the environment. What's more, while parametric design can offer benefits in terms of energy efficiency, it can also encourage an over-reliance on automated technologies and systems. This can lead to a reduction in the interaction between people and their built environment, with potentially negative consequences for quality of life and mental health. Ultimately, parametric design must be used with care and in conjunction with other approaches to ensure that the results meet the needs of citizens while being sustainable and environmentally friendly. Designers need to be aware of the potential limitations of this approach and work to find creative solutions to overcome them. Despite these identified limitations, parametric design remains an important approach in defining a city's identity and creating a viable, sustainable space. Using this method, designers can create innovative, durable buildings that reflect the values and culture of the city and its inhabitants, while fostering positive interaction between people and their built environment.

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Original scientific paper

Influence of Urban Street Vending on Pedestrian Experience and Behaviour: A Systematic Quantitative Review

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ABSTRACT

Urban street vending is an integral part of everyday public life and can contribute to vibrant and lively streets. Yet, few cities formally integrate this activity into public space design. This is because street vending is a highly contested, although transformative phenomenon that has complex inter-relationships with other urban entities. This paper systematically and quantitatively assesses the breadth and depth of academic literature that studied such a relationship; more specifically, the influence of street vending on pedestrians' experiences and behaviours and thereby identifies gaps in the existing literature. A systematic review of 25 peer-reviewed journal articles is undertaken to provide an assessment of the geographic extent, disciplinary scope, timeline of publications, keywords, methods, theories, constructs and concepts. This review concludes that the existing research is emerging, but rapidly accelerating and cross-disciplinary. Although the research was predominantly conducted in the Global South, it is largely affiliated with the Global North with limited North-South partnerships. The literature is largely qualitative, indicating a propensity for skewed perspectives. It also lacks theoretical applications exclusive to pedestrian-vendor relationships. Finally, potential areas where future researchers may expand and influence the knowledge domain are identified. This includes developing multi-contextual global perspectives through North-South partnerships and combining or independently applying grounded theory, mixed methods and case study research to broaden theoretical and empirical bases.

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Highlights	Contribution to the field statement
-The research linking street vending and pedestrian experience and behaviour is emerging and rapidly accelerating. -Most of the research is conducted in the Global South, but largely affiliated to the Global North. - The existing research lacks theoretical applications exclusive to pedestrian-vendor relationships. -Grounded theory, case studies and mixed methods approaches can broaden theoretical and empirical bases.	This review draws attention to the often neglected role of street vending in shaping the dynamics of cities, particularly its influence on the everyday urban activity of walking. Furthermore, it underscores the necessity for more comprehensive research in this specific area. This article promotes a deeper comprehension of the current research by analysing trends and patterns, pinpointing gaps and limitations and suggesting potential avenues for future research. This, in turn, may provide valuable insights for urban planning and policymaking, facilitating the optimization of this activity's positive contributions to local economies and communities.

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1. Introduction

Globally, walking is perceived as an essential activity of urban street space. The experiences and behaviours of pedestrians who engage in this activity are determined by how pedestrian-friendly or walkable their environment is. They are influenced by and in return can influence other dimensions of the urban realm such as street vending. Street vending has its importance in making vibrant and lively streets, but is a spatially, economically, politically and socially contested phenomenon. This is because the presence of street vendors can be extensively transformative in urban space. This quality can be perceived negatively by city authorities who consider street vending as a hindrance to other urban activities and processes. However, street vending is a prevalent and persistent force no matter the regulations and policies that seek to curb it. Researchers studying the influence of street vending on essential urban activities such as walking can inform urban authorities, policymakers, planners and designers. However, researchers studying such an influence should first be aware of the gaps in existing literature before undertaking such a study. Therefore this paper in turn seeks to inform such researchers of such gaps and recommend future research directions.

Street vending and walkability have been reviewed consistently in the past. The topic of street vending has been reviewed six times since 2000 across a range of themes. Unique perspectives include a comparative study between Global North and Global South (Recchi, 2020), a comparison between historical and contemporary policies (Morales, 2000), magnitude of vending (Bhowmik, 2005) and financial capital and personality traits (Wongtada, 2014). All the reviews assess policy and regulation, making it the most reviewed theme (Bhowmik, 2005; Bromley, 2000; Morales, 2000; Peimani & Kamalipour, 2022a; Recchi, 2020; Wongtada, 2014). Other common themes include characteristics of vendors (Bhowmik, 2005; Peimani & Kamalipour, 2022a; Recchi, 2020), typology of street vendors (Peimani & Kamalipour, 2022a; Wongtada, 2014), human and social capital (Bhowmik, 2005; Morales, 2000; Recchi, 2020; Wongtada, 2014), working environments (Recchi, 2020; Wongtada, 2014) and health and well-being (Bromley, 2000; Peimani & Kamalipour, 2022a). Peimani and Kamalipour (2022a) also reviewed the literature on technology, linked to other forms of informality and spatiality of street vending for the first time.

There is no dearth of reviews on walkability as reported by Ewing et al in 2015. Since then, a multitude of reviews have emerged discussing varied perspectives related to the built environment (Arellana et al., 2020; Bonaccorsi et al., 2020; Dadpour et al., 2016; Elzeni et al., 2022; Fonseca et al., 2022; Hassen & Kaufman, 2016; Jamei et al., 2021; Nasrollahi et al., 2020; Salvo et al., 2018; Smith et al., 2017; Wang & Yang, 2019; Westenhöfer et al., 2023; Yun, 2019), health and well-being (Baobeid et al., 2021; Bonaccorsi et al., 2020; Klann et al., 2019; Nasrollahi et al., 2020; Salvo et al., 2018; Smith et al., 2017; Wang & Yang, 2019; Westenhöfer et al., 2023), social factors (Bonaccorsi et al., 2020; Dadpour et al., 2016; Hassen & Kaufman, 2016; Herrmann-Lunecke et al., 2020; Iroz-Elardo et al., 2021; Klann et al., 2019; Salvo et al., 2018), context (Jamei et al., 2021; Klann et al., 2019), evaluation tools (Arellana et al., 2020; Blečić et al., 2020; Dragović et al., 2023; Wang & Yang, 2019) and sustainability (Baobeid et al., 2021; Herrmann-Lunecke et al., 2020; Nasrollahi et al., 2020). Pedestrian experience (Arellana et al., 2020; De Vos et al., 2023; Hassen & Kaufman, 2016; Nasrollahi et al., 2020; Salvo et al., 2018) and behaviour (Basu et al., 2022; Feng et al., 2021; Salvo et al., 2018; Yun, 2019) have also been reviewed within the topic of walkability.

However, while both topics of street vending and walkability have been reviewed separately using varying methodologies such as bibliometric analysis, critical review, narrative review, systematic literature review and meta-analysis, none of the existing reviews have sought to understand vendor and pedestrian interaction through a systematic quantitative methodology. This review bridges street vending and walkability literature by reviewing existing research, discussing trends, identifying research gaps and recommending future research directions through a systematic quantitative review methodology.

2. Research Aim, Objectives and Questions

More specifically, this research aims to systematically assess the extent of peer-reviewed academic literature on street vending and its influence on pedestrian experience or behaviour.

The objectives are to: (i) Quantitatively determine the dispersion of literature according to specific and relevant categories and (ii) Identify research gaps that can inform future researchers. To this end, the following questions were asked: (i) What is the geographic extent? (ii) What is the disciplinary scope? (iii) When was the research published? (iv) Which are the most relevant keywords? (v) What are the methods used? (vi) What theories, constructs and concepts have been cited or applied?

The remaining paper will discuss the review methodology (3), method of review (4), analysis of research trends (5), important findings (6), future research directions (7) and conclusions (8).

3. Methodology

A systematic quantitative review follows a 15-step process that has been used across a wide range of disciplines (Cooper et al., 2023; Guitart et al., 2012; Kim & Cuskelly, 2017; Laird-Gentle et al., 2023; Lee et al., 2022; Mahmoudi et al., 2019; Martellotta et al., 2022; Najafi et al., 2022; Parker & de Baro, 2019; Roy et al., 2012; Steven et al., 2011; Takata & Hallmann, 2021; Thomson et al., 2019). This methodology is characterised as being structured, explicit, quantitative, rigorous, comprehensive and reproducible (Pickering et al., 2021; Pickering & Byrne, 2014). The process is broadly subdivided into *"knowledge creation"* and *"text production"* (Pickering et al., 2014, 2021). During *"knowledge creation",* data on a topic is retrieved from existing literature and structured into a database and then reviewed and summarized using tables. The database is structured using relevant categories derived from the research questions. *"Text production"* involves the analysis and discussion of results and the drafting and revision of each section of the review paper. This approach can be used to evaluate the breadth and depth of a research area and thereby identify research gaps (Pickering et al., 2014, 2021; Pickering & Byrne, 2014).

4. Methods

The search, retrieval and structuring of the data to be reviewed followed a four-part process (Figure 1). First, the literature was retrieved using an appropriate search strategy (4.1). Second, records were screened based on exclusion and inclusion criteria (4.2). Third, further literature was retrieved (4.3) through backward tracking (Mohamed Shaffril et al., 2021; Takata & Hallmann, 2021). Finally, a structured database (4.4) was created based on categories identified from research questions.

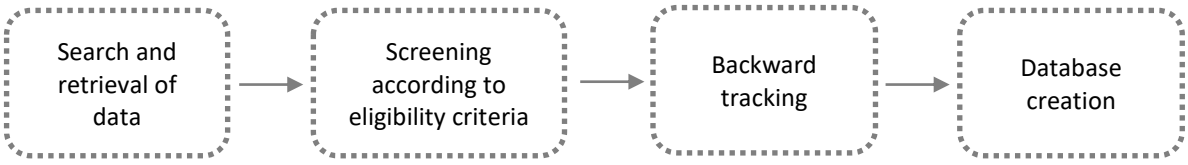


Figure 1. Search, retrieval and structuring of data.

4.1 Search Strategy and Retrieval of Data

The search was conducted electronically through two databases, a search engine and backward tracking. The databases used were ProQuest and Taylor & Francis and the search engine Google Scholar. The search used truncated or full search terms (varying according to the sensitivity of the search platform) and were combined using Boolean operators "OR" and "AND". After some trial and error, the following search terms were selected: "urban", "street", "pedestrian", "experience", "behaviour" and extensions of the words "vend', "hawk" and "walk". The data from Google Scholar was retrieved using Publish or Perish software. The data from ProQuest

and Taylor and Francis were exported as CSV files. The final search was undertaken on 19th December 2022 and a total of 2017 results were retrieved. The retrieved data was copied into Microsoft Excel where 216 duplicates were removed.

4.2 Screening and Eligibility Criteria

The 2020 PRISMA flow diagram was adopted (Figure 2) to systematically assess the literature (Page et al., 2021). The eligibility criteria include only English-language peer-reviewed journal articles. Any articles that did not investigate the influence of street vending on pedestrian experience or behaviour were excluded. Reviews and non-peer-reviewed literature including reports, conference papers and other grey literature were also excluded. Titles and abstracts were screened and when not clear, the full text was also assessed using the eligibility criteria.

Since the first hundred records after the last eligible record from the search engine were ineligible, the remaining records after these hundred records were also excluded. All records from the databases were screened. Of the 211 records thus retrieved, the full text was not available for one article. Of the remaining 210 records, 20 articles were included after screening the full text for thematic eligibility.

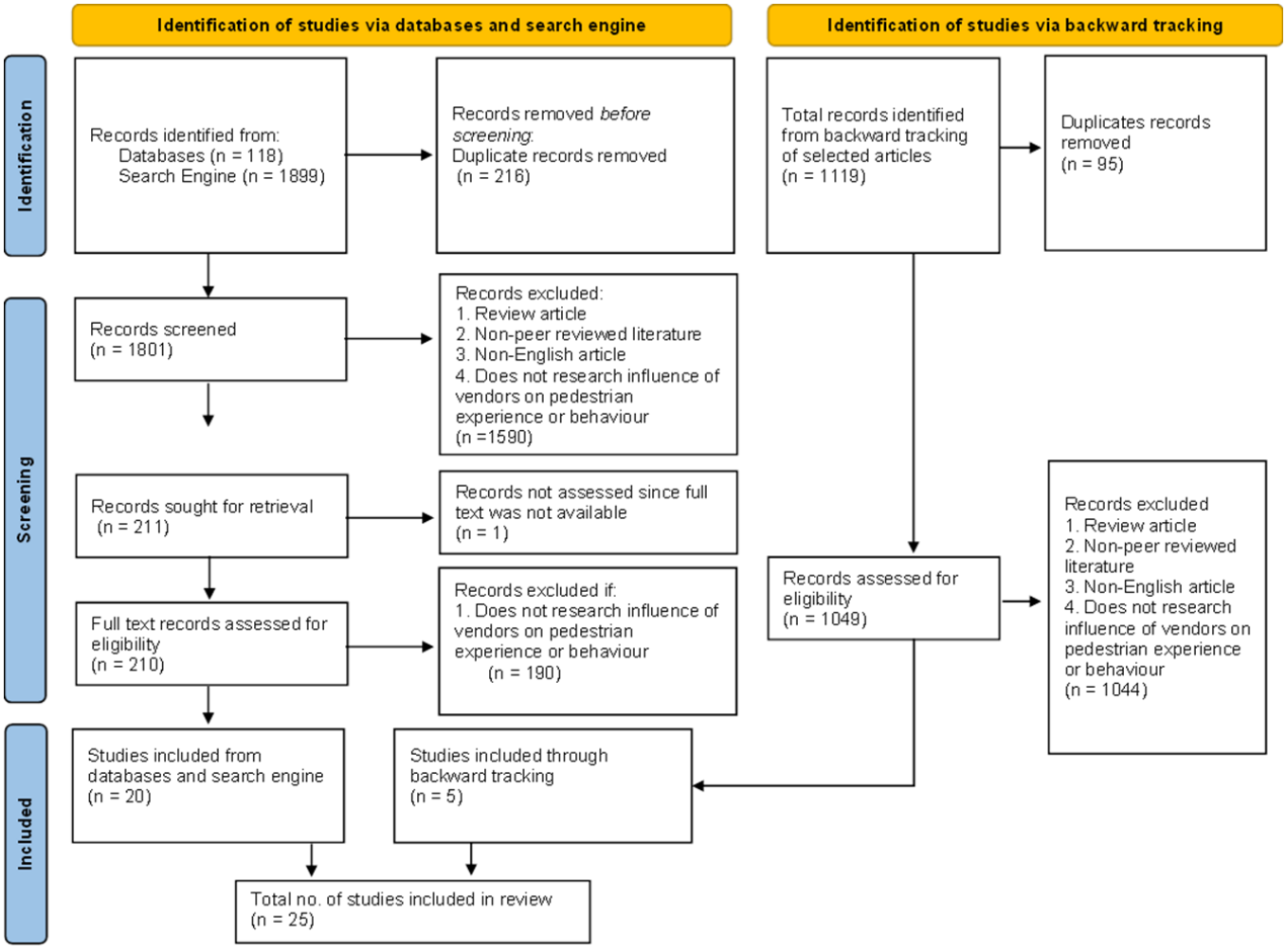


Figure 2. PRISMA 2020 flow diagram.

4.3 Backward Tracking

References from the 20 selected articles were screened for duplicates and eligibility and 4 new records were retrieved. Backward tracking was conducted once more using the new records and one more article was identified. The process was repeated once again, but no new records were identified. A total of 25 articles were retrieved through electronic search and backward tracking.

4.4 Creating the Database

The data extracted from the articles were classified using categories and sub-categories (Table1) that emerged from the research questions and recorded in a Microsoft Excel spreadsheet. Geographical data was recorded as country(s) where research was conducted (context of research), the author's country of affiliation and the global region the country belongs to i.e Global North and Global South. Global North will hereafter be referred to as GN or North and Global South as GS or South. Data regarding disciplinary scope includes publisher, journal, journal discipline(s), plurality of journal discipline, whether an article studied the themes of experience, behaviour or both and whether the topic was approached as a sub-theme or an exclusive study. Data regarding journal discipline was retrieved from the publisher's website. Timeline was recorded by year of publication. Keywords were grouped using themes (eg: cities, space and time, vending, perception etc.). Data for research methods was recorded based on type of data (quantitative, qualitative or mixed) and details of type and number of data collection and analysis methods. The theories, constructs and concepts, hereafter referred to as TCC were categorized as cited or applied. Those applied were then grouped based on theme. This database was used to analyze patterns and trends of the literature.

Table 1. Categories and subcategories of database.

Research Question	**Category**				**Sub-Category(s)**	
What is the geographic extent?	Context of research		Country of Affiliation		Global region	
What is the disciplinary scope?	Publisher	Journal	Experience or Behaviour	Study Exclusivity	Discipline of journal	Cross-disciplinarity
When was the research published?	Year of publication					
Which are the most relevant keywords?	Keywords used				Keyword theme	
What are the methods used?	Type of data				Data collection methods	Data analysis methods
What theories, constructs and concepts (TCC) have been cited or applied?	TCC Applied		TCC Cited		Type & Theme	

5. Results

Data extracted from 25 peer-reviewed journal articles was analyzed and is reported in terms of geographic extent (5.1), distribution across publishers and journals, exclusivity of study, theme of behaviour or experience (5.2), timeline of publication (5.3), keywords (5.4), methods (5.5) and theories, constructs and concepts cited or applied (5.6).

5.1 Geographic Distribution

The research has been conducted across 14 countries by 58 authors who have affiliations to 17 countries (Figure 3). The maximum research was conducted in India (23%), China (12%) and Japan (12%). There was only 1 (4%) paper each that was researched in Bangladesh, Ethiopia, Greece, Iran, Peru, UK & Vietnam and 2 (8%) each in Tanzania, Thailand & USA. Only one paper (Vichiensan & Nakamura, 2021) was researched across multiple contexts of Japan and Thailand. USA (25%), India (16%), UK (11%), China (10%) and Japan (8%) together make up 70% of the affiliations. 4% and 5% of affiliations belong to Belgium and Netherlands respectively while 3% individually belong to Malaysia, Peru, Tanzania and Thailand. Only 1 affiliation (1%) each exists from Finland, France, Indonesia, Pakistan and Vietnam.

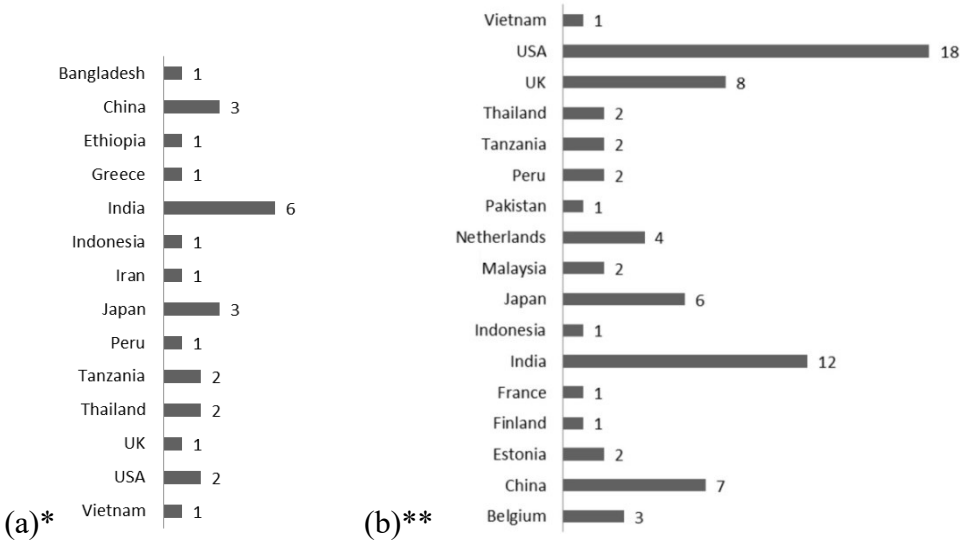


Figure 3. Distribution of research across countries based on research context (a) and author affiliation (b). *Total frequency > 25 as one article researched in multiple countries
**Frequency >58 since authors are affiliated to more than one country

This review also seeks to highlight unique perspectives by comparing the context of research and author affiliation across global regions. 72% (18) of the research was conducted in the Global South, 24% (6) in the Global North and 4% (1) across both regions, while 40% of the articles had authors affiliated to the GN, 32% to GS and 28% across regions (Table 2). Of the 10 articles affiliated to the GN, 6 (24%) conducted research in the North and 4 (16%) in the South. No articles with affiliations to the South conducted research in the North, rather all 8 (32%) articles conducted research in the South. Similarly, the 7 (28%) articles with affiliations to the North and South did not conduct research in the North, but 6 (24%) articles presented research from the South and 1 (4%) from the South and North.

Table 2. Distribution and mapping of literature across global regions.

	Affiliation							
Context	**Global North**		**Global South**		**Global South & North**		**Total Frequency**	**Total %**
	Frequency	**%**	**Frequency**	**%**	**Frequency**	**%**		
Global North	6	24%	0	0%	0	0%	6	24%
Global South	4	16%	8	32%	6	24%	18	72%
Global South & Global North	0	0%	0	0%	1	4%	1	4%
Grand Total	**10**	**40%**	**8**	**32%**	**7**	**28%**	**25**	**100%**

5.2 Study Exclusivity, Theme and Discipline

Only 10(40%) articles exclusively study the topic, while 15(60%) research as a sub-theme (Table 3a). There is an equal distribution of articles that study either behaviour or experience (44% each). 3(12%) articles research both behaviour and experience.

Table 3. Distribution of research papers according to a) theme and study exclusivity and b) journal discipline. * Frequency >25 since some articles are published in cross-disciplinary journals. ** Does not add up to 100% due to rounding.

a) Study Exclusivity	Experience/ Behaviour	Frequency	%	b) Discipline	Frequency	%
Exclusive	Behaviour	6	24%	Arts & Humanities	7	15%
	Experience	2	8%	Social Sciences	5	10%
	Experience & Behaviour	2	8%	Engineering	4	8%
Exclusive Total		**10**	**40%**	Geography	7	15%
Sub-Theme	Behaviour	5	20%	Built Environment	7	15%
	Experience	9	36%	Planning and Development	7	15%
	Experience & Behaviour	1	4%	Urban Studies	7	15%
Sub-Theme Total		**15**	**60%**	Others	4	8%
Grand Total		**25**	**100 %**	**Grand Total**	**48***	**100%** **

The research has been published across 20 journals. The journal *Cities* has the maximum number of articles to be published in any one journal (12%), followed by 2(8%) articles each in the *Journal of Urban Design*, *Sustainability* and *Urban Planning* (Table 4). The remaining journals have all published only 1(4%) article each. Most of the research (32%) is published by Taylor and Francis, followed by Elsevier (16%), MDPI (12%) and Cogitatio (8%). Canadian Centre of Science and Education, David Publishing Company, Emerald, Faculty of Built Environment, University Malaya, OpenEdition Journals, Palgrave Macmillan, Sage Journals and Springer have published only 1(4%) article each.

60% of the articles are published in cross-disciplinary journals. As seen in Table 3b, the disciplines include arts & humanities, social sciences, geography, built environment, planning and development and urban studies which are represented by 7(15%) articles each. 5(10%) articles have been published in journals that fall under the social sciences discipline and 4(8%) each under engineering and other disciplines.

Table 4. Distribution of research papers across publishers and journals.

Publisher	Journal	Frequency	%
Canadian Centre of Science and Education	Journal of Sustainable Development	1	4%
Canadian Centre of Science and Education Total		**1**	**4%**
Cogitatio	Urban Planning	2	8%
Cogitatio Total		**2**	**8%**
David Publishing Company	Journal of Traffic and Transportation Engineering	1	4%
David Publishing Company Total		**1**	**4%**
Elsevier	Cities	3	12%

	Journal of Environmental Psychology	1	4%
Elsevier Total		**4**	**16%**
Emerald	Archnet-IJAR: International Journal of Architectural Research	1	4%
Emerald Total		**1**	**4%**
Faculty of Built Environment, University Malaya	Journal of Design and Built Environment	1	4%
Faculty of Built Environment, University Malaya Total		**1**	**4%**
MDPI	International Journal of Environmental Research and Public Health	1	4%
	Sustainability	2	8%
MDPI Total		**3**	**12%**
OpenEdition Journals	Ambiances: International Journal of Sensory Environment, Architecture Urban Space	1	4%
OpenEdition Journals Total		**1**	**4%**
Palgrave Macmillan	Urban Design International	1	4%
Palgrave Macmillan Total		**1**	**4%**
Sage Journals	Urban Studies	1	4%
Sage Journals Total		**1**	**4%**
Springer	KSCE Journal of Civil Engineering	1	4%
Springer Total		**1**	**4%**
Taylor & Francis	Senses and Society	1	4%
	International Journal of Urban Sciences	1	4%
	Journal of Urban Affairs	1	4%
	Journal of Urban Design	2	8%
	Journal of Urbanism: International Research on Placemaking and Urban Sustainability	1	4%
	Landscape research	1	4%
	Traffic Injury Prevention	1	4%
Taylor & Francis Total		**8**	**32%**
Grand Total		**25**	**100%**

5.3 Timeline of Research

Timeline data is presented as publications per year and grouped by 5 years (Figure 4). The research spans 15 years. The first article published by Imai (2008) exclusively researched walking experience and street vending. In 2012, the first article studying both experience and behaviour was published. Three years since in 2015, the first article studying behaviour was published, but as a sub-theme. The research began with publications in the first two years but was followed by a gap of two years. This trend of a two-year research gap after a publication continued till 2015 after which the gap was reduced to one year. There have been consistent publications since 2019. The research peaked in 2017 when 7(28%) articles were published. 4(16%) articles were published during the 1st five-year interval which doubled to 8(32%) during the second interval and 13(52%) during the third interval.

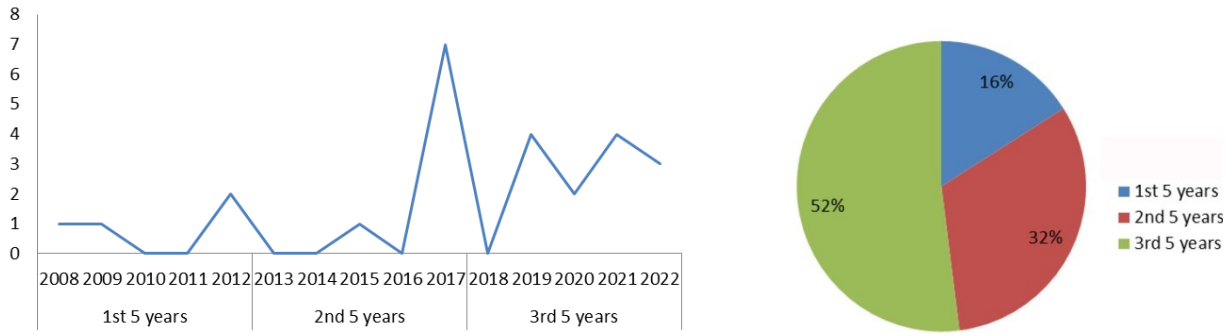


Figure 4. Timeline and distribution of articles every five years since 2008.

5.4 Keywords Used

129 keywords were used across 25 articles. 2(2%) articles had no keywords. Keyword co-occurrence was visualized using VOSviewer software (Figure 5). Keywords were grouped into clusters and linked based on association strength. Each cluster is represented by a different colour. There are 11 clusters, of which 7 are interconnected and 4 isolated. The size of individual keywords and the distance between them represent the frequency of co-occurrence and relative association and thereby the significance of the keyword. Considering these indications, clearly "walking" and "street vending" are the two most significant keywords. Other important keywords are "street vendors", "India" and "public space". "Street vending" is linked to keywords grouped around "walking", "public space" and "India". However, "street vendors" is linked only to "walking".

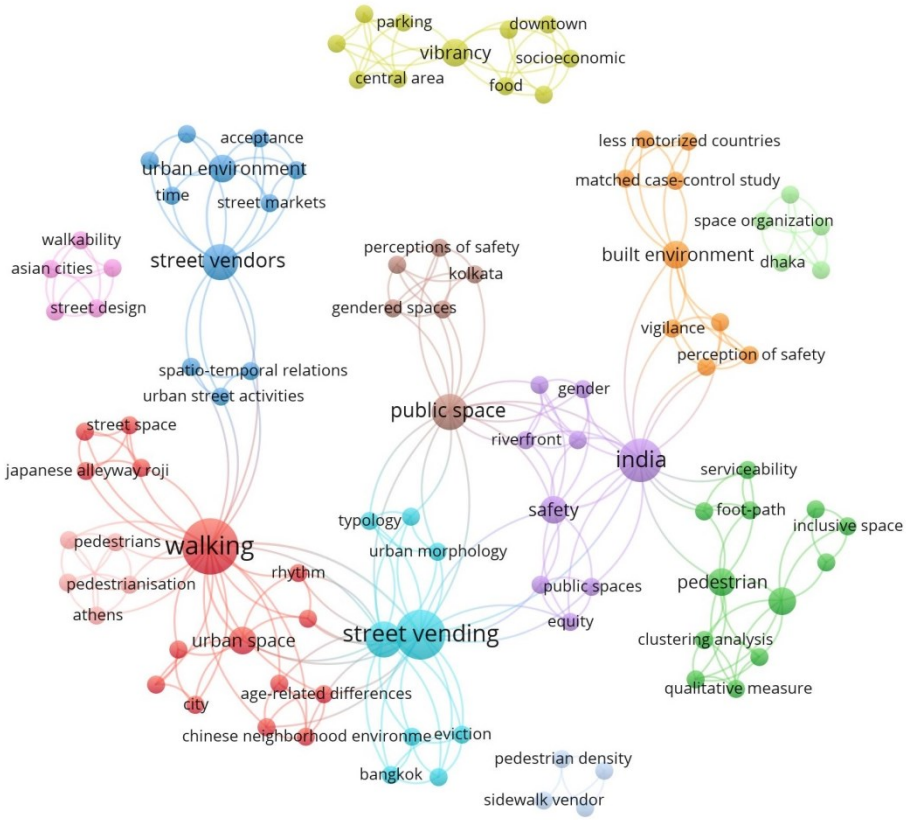


Figure 5. Keywords visualized in VOSviewer.

The keywords were also grouped by the author based on theme as seen in Figure 6. The highest occurring themes are of countries and cities (12%) and pedestrian and walking (12%) followed by theories, constructs or concepts (10%). Public space, vending, methods and streets comprise 9% of the keywords individually. Social factors (7%), built environment (5%) and inclusivity (4%) follow suit. Within the vending group, "street vending" (5) was preferred keyword over "street vendor" (1),

"street vendors" (3) or even "street hawking" (1). Within the pedestrian and walking group "walking" (6) was preferred over "pedestrian" (2), "pedestrians" (1) or "walkability" (1). Keyword occurrences in descending order are "walking" (6), "street vending" (5), "India" (4), "street vendors" (3), "informality" (3) and "public space" (3) followed by "pedestrian" (2) and "built environment" (2). The remaining keywords are all single occurrences. This pattern imitates that of the most significant keyword co-occurrences identified using VOS viewer.

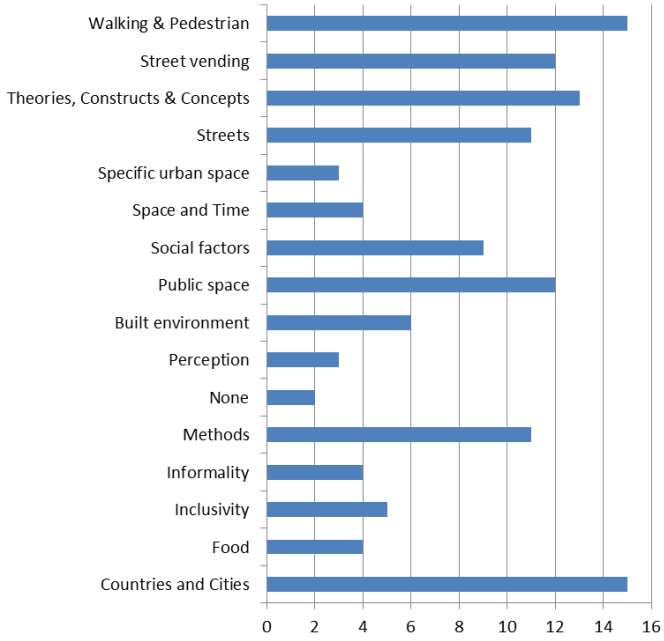


Figure 6. Keywords are grouped according to theme.

5.5 Methods Used

Out of the 25 articles, 15(60%) collected qualitative data, 8(32%) collected quantitative data and 2(8%) mixed data (Table 5). There is an even distribution of articles that study behaviour or experience using quantitative data, while most of the qualitative studies research experience (28%). Only mixed methods are used to study behaviour. The 3(12%) articles studying experience and behaviour used qualitative data.

Table 5. Distribution of type of research data.

Type of Research	**Frequency**	**%**
Mixed		
Behaviour	2	8%
Mixed Total	2	8%
Qualitative		
Behaviour	5	20%
Experience	7	28%
Experience & Behaviour	3	12%
Qualitative Total	15	60%
Quantitative		
Behaviour	4	16%
Experience	4	16%
Quantitative Total	8	32%
Grand Total	**25**	**100%**

Figure 7 represents the number of methods of data collection and analysis used. Most articles (48%) use two methods of data collection, but only one method of analysis. Only Vichiensan & Nakamura (2021) used 4 analysis methods.

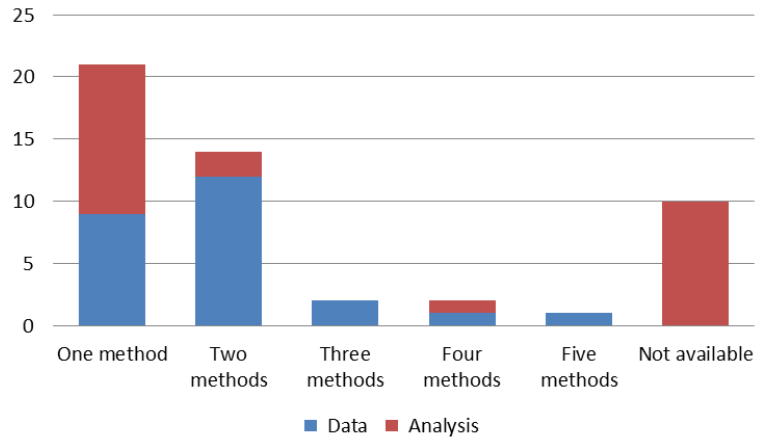


Figure 7. Distribution of the number of methods of data collection and analysis.

10 unique individual methods were used for data collection and 12 for analysis (Table 6). Although all 25 articles reported methods of data collection, 9 (30%) articles did not explicitly report their analysis methods. All of these articles used qualitative data. Focus group was the only method used exclusively for gathering qualitative data, while questionnaires were used to collect only quantitative data. All other methods of data collection were used to gather both quantitative and qualitative data. The most commonly reported method of data collection (used in 11 articles) was semi-structured or in-depth interviews. The interviews collected data on a wider range of aspects such as safety, pedestrian movements and perception of pedestrians or street vendors. Another commonly used method was observation (18%) which was applied to collect data on pedestrian movement. Data on safety and pedestrian movement was also obtained through behavioural mapping (16%). Walking and visual surveys (12%) and photography or videography (10%) were also identified as appropriate methods to collect data related to specific aspects of pedestrian behaviour or experience such as comfort, vibrancy access, and safety. Data on pedestrian's perception was obtained using questionnaire surveys (10%). GIS and ArcGIS (6%) were used to collect built environment data. Focus groups (4%) and archival records (2%) were the least used methods of data collection. Comparative analysis (3%), correlation analysis (7%), descriptive analysis (7%), factor analysis (3%), microsimulation model (3%), multivariable modelling (3%), paired sample T-test (3%), regression analysis (10%) and structural equation modelling (7%) were used to analyze quantitative data. Of the qualitative data studies that reported analysis methods, 10% used spatial analysis, 7% thematic analysis, 3% Lefebvre's rhythm analysis and 1% case study analysis.

Table 6. Details of methods of data collection and analysis.
* Frequency > 25 since some articles use more than one method.

Data Collection	**Frequency**	**%**
Interviews	11	22%
Observation	9	18%
Behavioural mapping, fieldwork notes	8	16%
Walking or visual survey, Point in time survey	6	12%
Questionnaire	5	10%
Photography & Videography	5	10%
GIS/ARCGIS	3	6%
Focus group	2	4%
Archival records	1	2%
Grand Total	**50***	**100 %**
Data Analysis	**Frequency**	**%**
Spatial analysis	3	10%
Comparative analysis	1	3%
Correlation analysis	2	7%
Descriptive analysis	2	7%
Factor analysis	1	3%
Lefebvre's rhythmanalysis	1	3%
Microsimulation model	1	3%
Multivariable modelling	1	3%
Paired sample T test	1	3%
Regression analysis	3	10%
Structural equation modelling	2	7%
Transcription, coding and thematic analysis	2	7%
Case Study	1	3%
Not available	9	30%
Grand Total	**30***	**100 %**

5.6 Theories, Constructs and Concepts

Kim and Cuskelly (2017) first reported the analysis of theories cited or applied. The scope of this analysis has since been broadened by Takata and Hallmann (2021) and Najafi et al (2022) to include concepts and perspectives. In this review, "cited" refers to when the article mentioned specific TCC but had no evidence that they were tested, while "applied" indicates that a study was designed based on a framework derived from TCC and explicitly applied throughout the research. As mentioned earlier in section 4.4, TCCs were grouped based on themes. Table 7a depicts the distribution of articles that cited and applied TCC and the number of TCC applied (7b). As seen in 7a, only 1 (4%) article neither cited nor applied any TCC. Most articles (48%) applied multiple TCC or a single theory (32%). 16% of the articles only cited TCC. There was a total of 40 TCC applied (Table 7b). However, constructs (70%) were applied more than theories (15%) or concepts (15%). The 6 theories that are applied are "Eyes on the Street", "Non-Place Theory", "Sustainable Livelihood Theory",

"Self-Organizing Pedestrian Movement", "Out of Place Elements", and "Lefebvre's Rhythmanalysis". All TCC applications can be grouped as attributes of public space (50%), attributes of street vending (23%) or pedestrian experience or behaviour (18%).

Table 7. a) Distribution of articles that cite or apply Theories, Constructs or Concepts (TCC)
b) Distribution of TCC applied

a) Cited or Applied	Frequency	%
Applied		
Multiple	12	48%
Single	8	32%
Applied Total	20	80%
Cited	4	16%
None	1	4%
Grand Total	**25**	**100%**

b) Applied	Frequency	%
Theory	6	15%
Construct	28	70%
Concept	6	15%
Grand Total	**40**	**100%**

6. Discussion

This section will systematically answer the research questions posed at the beginning of the paper by highlighting the main findings pertaining to the: geographic extent (6.1), disciplinary scope & timeline of research (6.2), most relevant keywords (6.3), methods used (6.4) and theories, constructs and concepts that are cited or applied (6.5).

6.1 The North-South Divide: Conformations & Divergences

Although 28 countries are represented through context and affiliation, the bulk of the research is concentrated within five countries namely USA, India, China, UK & Japan. Nearly half of the research conducted is concentrated in India, China & Japan. There are only 1 or 2 articles that have published research from the remaining 11 countries. India, China & Japan remain visible along with USA & UK because of author affiliations (Figure 3). It is unsurprising that the US and UK figure within the majority as they are considered leaders in academic research (Confraria et al., 2017). This trend is also consistent with other systematic reviews across multiple disciplines that have reported these two countries among the top five affiliations (Guitart et al., 2012; Kim & Cuskelly, 2017; Roy et al., 2012; Takata & Hallmann, 2021). They ascribe one of the main reasons for English being the official language in these countries. While this is true, the greater presence of these two countries and Japan is also reflective of the larger discourse concerning the unequal global distribution of academic knowledge and the North-South divide. However, the greater number of affiliations to India and China is antithetical to this argument. The representation from India, China and Japan may be attributed to 1) interest in the research theme and 2) prevalence of street vending in Asia. China and Japan have also seen positive trends in research funding climate in recent years (Huang & Huang, 2018). The interest from India can be further explained by the fact that India is one of the few countries to regulate and protect street vending (Bhowmik, 2005; The Street Vendors (Protection of Livelihood and Regulation of Street Vending) Act, 2014). This provides scholars with the opportunity to undertake research and encourages street vendors and pedestrians to willingly participate in the research. Also, although English is not the official language in India, it is widely spoken by scholars conducting research, leading to more publications in English-language journals.

The dominating spread of research in the GS and low spread in GN may be attributed to the conception that street vending is predominantly a Southern phenomenon as evidenced by many existing reviews on street vending that focus on the Global South (Bhowmik, 2005; Bromley, 2000; Peimani & Kamalipour, 2022a; Wongtada, 2014). This perception is further evidenced by the large difference between context and affiliation from USA & UK. A quarter of the affiliations belong to

the USA, although only 8% of the research was conducted there. Similarly, the UK represents 11% of the affiliations, but on 4% of the research was conducted there.

The significant occurrence of articles that are affiliated only with GN or across both regions but conduct research in GS can again be attributed to the imbalanced academic production of knowledge between the North and South. Some of these reasons for this imbalance include 1) higher research capacities of Northern countries (Chankseliani, 2023) 2) lack of research funding in GS or more funding in GN (Huang & Huang, 2018; Chankseliani, 2023; Reidpath & Allotey, 2019) 3) *"international academic mobility"* where researchers travel abroad for research and situations where researchers from GS who moved to GN return to conduct research in the home country (Shen et al., 2022; Smeby & Trondal, 2005; Reidpath & Allotey, 2019). The dominance of research in the South and lack in the North by North-South partnerships again reflects the meta-narrative of the global North-South divide and the problems of North-South research collaborations (Binka, 2005; Bradley, 2008; Gaillard, 1994; Jeffery, 2014).

6.2 Existing Literature is Cross-disciplinary, Emerging and Accelerating

Equal distribution across all disciplines (Table 3b) except social sciences, engineering and other smaller disciplines indicates that the topic can generate interest across scholars from multiple disciplines. The positive trend towards cross-disciplinary research is encouraging as this signifies that the topic is complex and diverse perspectives may be considered to generate robust research. The underrepresentation of social sciences is surprising as street vending is very much a societal concern and as Larivière et al's (2015) finding suggests, social sciences as a discipline have had the highest publications when compared to other disciplines. However, considering that articles studying street vending and walkability were reviewed, this finding does align with that of Shields et al (2021) who reported the need for socially informed studies on walkability.

While Taylor and Francis dominate the publishing scenario, most journals (except for Cities) irrespective of the publishers, have published only 1 article each (Table 4). This fact and fewer exclusive studies indicate that this is an emerging topic in research, though important enough to be studied as a sub-theme. The dominance of research published by Taylor and Francis also indicates that they may have a greater range of multidisciplinary journals. Considering that all the articles reviewed in this research were published after 2000, this trend corresponds with the increase in journals and articles published by Taylor and Francis since the inception of online publications (Larivière et al., 2015).

The commencement of research aligns with the peak in walkability research around 2008 (Shields et al., 2023) signifying a diversification in walkability research at the time. There has been a steady decrease in the frequency of gaps in publication culminating in consistent publications over the last four years. The number of publications has also been consistently increasing, having doubled during the second five-year period and the bulk published in the last five years. So, even though the topic is emerging, it is also rapidly accelerating.

6.3 Research is Contextual

As expected, "street vending" and "walking" stand out as the most dominant keywords. The stronger links and predominance (Figure 5) of "street vending" over "street vendors" and "walking" over "pedestrians" indicate that street vending or walking as an activity is considered more significant than street vendors or pedestrians as social groups. Outlier clusters with no connections to the main network are more likely to be generated from articles that researched the topic as a sub-theme.

New trends which could not be interpreted through the visualisation in VOSviewer have emerged by grouping the keywords by theme. The most interesting of which is the use of keywords related to country or city-specific contexts. This combination of this category of keywords along with those of "pedestrian and walkability", "public spaces", "methods", and "theories, concepts and constructs" will be a useful search strategy for academics wishing to gain new knowledge on the topic. The use

of country or city specific keywords also signifies that most of the existing research is contextual and has generated place-based perspectives.

6.4 Lack of Mixed Methods Research and Future Propensities of Skewed Perspectives

The range of methods used for data collection and analysis is quite varied. The higher proportion of qualitative data is not unusual since Recchi (2020) highlighted the use of qualitative data and case study research to study street vending in her review. However, while it was found that most of the data in this review was qualitative, this study contrasts Recchi (2020) in the aspect of case studies being used for research. This divergence occurs because of differing search strategies that were applied in both reviews yielding varying datasets for analysis.

A large portion of the qualitative studies did not explicitly report the analysis methods. Research that is rigorous in reporting its methods can positively influence research replicability and transparency and is less likely to be questioned about its credibility (Closa, 2021). Such a practice also allows other scholars to reproduce and verify findings in comparable contexts and test the applicability of methodologies and theories in varying contexts (Aguinis & Solarino, 2019). Therefore, there is an immediate need for future researchers to be explicitly detailed while reporting their methods. Closa (2021) highlighted how such a practice would allow the research to be more relevant to a wider audience. Considering the scope of the research is cross-disciplinary, this approach will prove useful.

However, considering this same dimension, it is discouraging to note that very few studies employ mixed methods. While quantitative and qualitative studies have their own advantages in answering specific research questions in a field, they are fundamentally different in their approach (Kumar, 2014). The cumulative dependence on a single type of data in the larger research network can generate skewed perspectives in the future.

6.5 The Need for New Theories

Very little theory (Table 7b) is applied in the existing research. All the theories applied can be linked to the domains of public space or place, pedestrian movement and street vending. This is a severe limitation that is further expounded by the trend that most constructs and concepts can also be grouped within the same domains. The relationship between street vending and pedestrian experience or behaviour is very much an urban phenomenon. It is obvious that the research being reviewed reflects this idea since TCC of public space were applied more than those of street vending or pedestrian experience or behaviour. The above conclusions are a clear indication that there is a need for new theories that can interconnect public space, street vending and pedestrian behaviour and experience to be developed. Most of the theories used are also rooted in the global Northern context.

7. Gaps in Existing Research and Future Research Directions

Data from 25 articles studying the influence of street vending on pedestrian experience and behaviour has been systematically reviewed to identify gaps (Table 8) pertaining to geographic extent, disciplinary scope, timeline of publications, keywords and methods used and the theories, constructs and concepts applied.

Table 8. Details of research gaps, recommendations and relevance.

Research Concern	Main Findings	Research Gap	Recommendation	Relevance & Implications
Geographical scope & Keywords	Imbalance of research context and affiliation in Global North	Need for comparative studies between North and South	Case study methodology & North-South affiliations	Nuanced perspectives of the differences and similarities of pedestrian-vending relationships across global
	Dominating spread of research in Global South and	Need for more research from Global North	North-South affiliations	

	the low spread in Global North			boundaries and contexts
	Research is contextual, but negligible research across global regions			
Theory, Methods, Timeline & Disciplinary scope	All the theories applied can be individually categorized under the domains of public space, pedestrian movement and street vending	Lack of applied theory	Integrating assemblage thinking with other relevant theories	Accelerate and broaden empirical research
		Lack of theory related to the specific knowledge domain	Using assemblage thinking as a research methodology	Expand the range of theoretical applications that can interconnect public space, street vending and pedestrians
	Only 6 theories are applied. Existing research is highly contextualized	More perspectives from social Sciences are needed	Grounded theory, case study and mixed methods in integrative or singular forms	Develop new theories pertaining to the research area
				Can address cross-disciplinary research
				Generate comparative and multi-contextual data
				Aid in nuanced interpretations of upcoming research

7.1 Misconception about Street Vending and Implications for Multi-contextual Research

Many scholars direct their efforts towards the Global South when researching street vending (Bhowmik, 2005; Bromley, 2000; Deore & Lathia, 2019; Dovey et al., 2022; Hagos et al., 2020; Peimani & Kamalipour, 2022a, 2022b; Sun, 2021; Sun et al., 2020, 2021; Tafti, 2019; Wongtada, 2014; Yatmo, 2009), creating the conception that street vending is a phenomenon of Southern import. However, street vending is globally primarily considered as a source of income and means of survival (Recchi, 2020). There are consistent occurrences of street vending in wealthy nations too, especially among migrant communities and the unemployed, manifested by the recent increase in migration to developed countries and economic downturns (Martin, 2014; Piazzoni, 2022; Recchi, 2020; Tonnelat, 2007). Recent works from the Global North although few and far between (Devlin, 2019; Martin, 2014; Newman & Burnett, 2013; Piazzoni, 2022; Recchi, 2020) are serving to amend the misconception of street vending as a Southern phenomenon. However, there is still a lack of research that has been conducted in the Global North (Table 2) and even fewer studies exist across global regions. The existing research has already generated contextual data rooted in place, although from mostly single locations. I believe this trend of contextual studies can be leveraged and resonate with Recchi's (2020) and Peimani et Kamalipour's (2022a) suggestions that more comparative studies be undertaken across regions. I especially recommend studies across the North-South context

to gain more nuanced perspectives of the differences and similarities of pedestrian-vending relationships across global boundaries. This can be better achieved by employing a case study methodology and North-South affiliations. While I am aware that such partnerships are complex and may not always be equal (Binka, 2005; Bradley, 2008; Gaillard, 1994; Jeffery, 2014), it is beyond the scope of this review to discuss the details of such partnerships or possible solutions thereof.

7.2 Implications for Cross-disciplinary Research, Theory and Methodology

By identifying and categorizing constructs, concepts and theories used in existing research, this review has identified the lack of theory related to pedestrian-vending relationships. The position so far has been to treat street vending and walkability as two separate entities that theoretically don't engage, though, in everyday life, they do. There is a need to accelerate and broaden empirical research and expand the range of new theoretical applications that can interconnect public space, street vending and pedestrians. New theories can become frameworks that are applied to answer important questions pertaining to the influence of street vending on pedestrian experience and behaviour. Since the research is as emerging one, imminent work in this direction would aid in developing more nuanced interpretations of upcoming research.

Assemblage thinking has previously been suggested by Dovey (2012) to study informal urbanism and Peimani and Kamalipour (2022a) as a theoretical framework to study street vending. However, the debate around assemblage thinking is complex and evolving with varying arguments by scholars about its implementation and appropriateness in urban studies (Acuto & Curtis, 2013; Anderson et al., 2012; Brenner et al., 2011; Dovey, 2011; Dovey et al., 2018; Farías, 2011; Kamalipour & Peimani, 2015; McFarlane & Anderson, 2011; Taufen et al., 2022; Wachsmuth et al., 2011; Yadollahi, 2017). I explore Peimani and Kamalipour's suggestion further to understand the implications for studying the topic of this review using assemblage thinking by evaluating two articles that have applied assemblage thinking to discuss street vending.

Using assemblage thinking, pedestrians and street vendors can fit into the larger network of heterogeneous agents that generate urban processes (Dovey et al., 2018; McFarlane & Anderson, 2011). Previous research (Tafti, 2019) that applied assemblage as an ontology to explain the transformative nature of street vending in specific contexts, while successful in navigating the complexities of the relationship between street vendors and other urban entities, did not explicitly report details on the role of pedestrians in the network. I attribute this to a lack of a theoretical framework and the consideration of pedestrians as mere passers-by rather than as an engaging force in the assemblage. Dovey et al., (2022) are more successful in this regard when they try to answer the question of what factors may be interconnected to and influence street vending in the urban realm. They do not consider assemblage thinking as a theory, but simply as a tool for engaging with urban space at multiple scales (Dovey et al., 2018, 2022). Although they consider the relationship between the intensity of street vending and pedestrian flows as axiomatic, they still aid this thinking with constructs derived from literature and apply a conceptual framework throughout the research. In doing so, they were able to develop substantially deeper interpretations of data concerning the network of street vending and other urban factors including pedestrians. Therefore, I believe that it is important to integrate relevant theoretical or conceptual frameworks when using assemblage thinking to study the topic of this review.

There is still, however, a need to address the lack of theoretical knowledge and empirical studies exclusive to the research area. I recommend applying grounded theory, case study and mixed methods in integrative or singular forms.

Although the topic of this review is cross-disciplinary, very few studies use mixed methods. This poses a challenge as research conducted within silos of an individual discipline may have a predisposition of accepted research paradigms and thereby not fully explore all perspectives of the study. The mixed methods approach is paradigmatically plural and provides the opportunity to develop richer data and more nuanced perspectives of complex topics by combining the strengths of both quantitative and qualitative studies and negotiating the differences generated thereof (Cresswell,

2022; Creamer, 2022; Kumar, 2014; Doyle et al., 2009; Greene, 2005; Teddlie & Tashakkori, 2012). This approach can also be applied across a diverse range of topics, making it suitable to study the topic of this review.

Case study research can provide the holism required to investigate the topic as it provides the opportunity to conduct thorough, in-depth investigations, generate comparable empirical data and explain phenomena and causal links across multiple contexts (Yin, 2018; Kumar, 2014; Groat & Wang, 2013; Walton, 1972). This approach is highly flexible and when applied singularly (Eisenhardt, 1989, 2021) or integrated with mixed methods (Carmona, 2015; Cook & Kamalodeen, 2020) can generate data and theory concerning complex topics that are rooted in place.

Street vending is a dynamic and transformative process, calling for a holistic approach of study. Grounded theory can be used to document this quality, develop contextual theories and explain associations. Grounded theory is not a new approach to theorising street vending (Jamme, 2023; Keswani, 2019; Uddin, 2021; Zamani & Babaei, 2021). This approach can aid in generating theory embedded in data (Charmaz, 2006) and be applied across multiple disciplines, making it ideal for cross-disciplinary research (Creamer, 2018; Milani & Hashemi, 2020). The mixed methods-grounded theory approach can combine the advantages of methods predominant in individual disciplines to develop more *"complex"* and *"multilayered"* theories (Creamer, 2018; Guetterman et al., 2017; Milani & Hashemi, 2020). Case study integrated with grounded theory (Fernandez & Lehmann, 2011; Lehmann, 2010) has been previously applied in IS research and can be used to generate new theories in emerging research areas such as the topic of this review. To the best of my knowledge, this methodology has not been applied in urban studies so far. However, this approach can help answer questions about specific developments within and across contexts, generate contextual theories, and highlight similarities and differences between the Global North & Global South. This approach can also generate comparative perspectives rooted in diverse contexts (Robinson, 2016; Ren & Luger, 2015) that become useful in developing theories. Applying grounded theory, case study, and mixed methods in integrative forms has the potential to *"rupture"* (Walsh, 2015, pp 531) existing theories and challenge the predominant flow of knowledge from Global North to South.

8. Conclusion

This paper has evaluated 25 peer-reviewed English articles studying the influence of street vending on pedestrian experience or behaviour using a systematic quantitative review methodology for the first time. The findings of the review have been analyzed to assess the limitations and gaps of the existing research and recommend directions for future researchers. It has been found that the research, although in its nascent stages, is cross—disciplinary and rapidly accelerating, especially in the Global South. However, research conducted in the Global North is comparatively lesser. These findings, while serving as limitations in some ways, also present opportunities for future research. The most apparent limitations are the clear lack of multi-contextual perspectives and lack of research from the Global North which can be improved through affiliations between the North and South and case study methodology. Few attempts have been made to bridge the boundary between research on street vending and that on walkability in the past 15 years and there is still a pressing need for richer empirical data exclusive to the research area. While assemblage thinking can be operationalized to achieve this, there is first a need to develop new theories exclusive to the research area to be developed. Adopting an integrative approach of grounded theory, mixed methods and case study methodologies can aid in developing more nuanced multi-contextual understandings of the influence of street vending on pedestrian experience or behaviour.

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Can Urbanization Influence Carbon Dioxide Emissions? Evidence from BRICS–T Countries

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ABSTRACT

Climate change is one of several issues confronting the planet today. Addressing this problem will create a safer environment for humans and other species. Thus, this study explores how the urban population (UBNP) influences carbon dioxide emissions (CO2e) levels in BRICS–T from 1990–2021 (192 observations) using Pooled OLS and Fixed Effects techniques. In addition, energy intensity (ENIT) and economic growth (GDP) are utilized as control variables. The Pooled OLS result demonstrates that UBNP growth reduces CO2e by 0.19%; a rise in ENIT levels spurs CO2e by 1.10%, and an increase in GDP enhances CO2e by 0.61%. The Fixed Effects outcome shows that an upsurge in UBNP reduces CO2e by 1.19%, while ENIT and GDP rise boosts CO2e by 1.19% and 1.04%, respectively. This study recommends continuous urban planning, rural area development, renewable energy integration, and the use ofenergy–efficient buildings.

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Highlights	Contribution to the field statement
- BRICS–T economies were employed in this research. - The Pooled OLS and Fixed Effects methods were utilized in this study. - Urban population growth reduces carbon dioxide emissions. - A rise in energy intensity levels drives carbon dioxide emissions. - GDP growth spurs carbon dioxide emissions.	This study investigates the impact of urbanization on carbon dioxide emissions in BRICS–T countries. Other studies have focused on BRICS economies alone. This study fills the gap by including Turkey because of its significant position in the Middle–Eastern region, Asia, and Europe. In addition, contrary to other studies, this research found that urban population growth reduces carbon dioxide emissions. In conclusion, this research contributes to the social/economic dimensions of contemporary urbanization by recommending policies that promote sustainable urbanization, such as investing in public transportation and green spaces.

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1. Introduction

Climate change is an essential issue discussed globally. This is because of climate irregularities such as rising temperatures, a decrease in snow cover, rising sea levels, increasing storms, droughts, loss of species, and increased poverty and displacement (United Nations, 2023). In addition, climate change can also affect people's living standards. Greenhouse gases (GHGs) drive climate change, and carbon dioxide emissions (CO_2e) is the most significant contributor. CO_2e is caused mainly by human activities using fossils. Diverse economic variables can spur CO_2e or reduce it. This includes technological progress, governance, foreign direct investment, trade, economic policy uncertainties, and institutional quality. This study focuses on urban population (UBNP), energy intensity (ENIT), and economic growth (GDP) because these channels are essential to achieving a low–carbon economy. The Environmental Transition Theory (ETT) explains the UBNP and CO_2e nexus. The ETT postulates that UBNP initially harms the environment but later contributes to environmental soundness. Also, the association between UBNP and CO_2e has been widely debated, but the outcome remains inconclusive (Dutta & Hazarika, 2023; Liu et al., 2023a; Raihan et al., 2023; Salahuddin et al., 2019; Shen et al., 2017; Suhrab et al., 2023). In addition, reducing ENIT levels is a significant pathway to achieving net–zero by 2050. ENIT refers to the energy needed to produce a given output level. ENIT measures energy efficiency. Higher ENIT levels mean energy inefficiency, while lower ENIT levels depict energy efficiency. In recent times, ENIT improvement levels have declined due to weak ENIT policies and increased energy demand in energy–intensive economies (IEA, 2022). Significant research findings have demonstrated that ENIT contributes to environmental worsening due to the utilization of fossils (Danish et al., 2020; Islam & Rahaman, 2023; Liu et al., 2023b; Shokoohi et al., 2022; Somoye et al., 2023).

The link between GDP and CO_2e has been highly debated. Grossman & Krueger (1991) asserted that an economy grows in three phases: *scale* (first stage), *composite* (second stage), and *technique* (third stage). The *first stage* relates to emerging economies using fossils to power economic activities. At this stage, environmental degradation occurs. On the other hand, the *second* and *third stages* are peculiar to developed economies. As the economy grows, technological innovation and clean energy sources improve environmental quality. In addition, the connection between GDP and CO_2e has remained inconclusive (Cetin et al., 2018; Chandra Voumik & Sultana, 2022; Raihan, 2023; Sikder et al., 2022; Sreenu, 2022).

Why BRICS–T? According to Ullah et al. (2023), BRICS–T collectively contributes to increased CO_2e globally. From 1990–2021, the CO_2e per capita ranking of the BRICS–T economies from the highest to the lowest are as follows: Russia, South Africa, China, Turkey, Brazil, and India. It is also observed that CO_2e in each country is becoming flat. This shows that BRICS–T economies are creating environmental policies that reduce CO_2e. Ullah et al. (2023) further stated that BRICS–T are working towards improving the quality of their environment by reducing CO_2e and expanding clean energy sources in their energy portfolio. In addition, the year 2020 showed a general decline in CO_2e due to theCOVID–19 pandemic (Energy Institute, 2023).

Urbanization can be defined as the movement of people from areas that are not developed to areas that are developed within a country. People transit to urban areas because of job opportunities, education and healthcare access, location of industries, infrastructural benefits, and improved quality of life. Although urbanization is frequently viewed as a sign of progress, it also has a variety of drawbacks, including overpopulation, neglect of rural areas, socioeconomic disparity, and ecological challenges. It is observed that the urban population in the BRICS–T economies showed an increasing trend (World Bank, 2023).

This study investigates the impact of UBNP on CO_2e in the BRICS–T countries from 1990 to 2021 using ENIT and GDP as control factors. This research enhances the existing scholarly work by adding Turkey to the BRICS economies. *First*, most studies have focused on BRICS economies alone. Turkey is included because of its significant position in the Middle–Eastern region, Asia and Europe. Turkey is one of the top 20 emitters of global CO_2e. Turkey has a US$1.1 trillion economy and a GDP per capita of US$13,990. In addition, the population of Turkey is 85.3 million, which has tripled since

1960 (World Bank, 2023). A growing population means more energy is needed for economic activities. Most of Turkey's energy consumption comes from oil and gas (Adebayo, 2023). Turkey has pledged to reach net–zero by 2053 (The World Bank, 2022). The economic characteristics of Turkey make it suitable for further investigation. *Second*, this research uses ENIT data to proxy for energy use. Other studies have employed energy use data. *Third*, this research employed Pooled Ordinary Least Square (Pooled OLS) and Fixed Effects methods. The Pooled OLS is simple to implement, while the Fixed Effects controls for unobserved heterogeneity. *Fourth*, unlike other studies, this research found an adverse link between UBNP and CO_2e. *Fifth,* this research contributes to the social/economic dimensions of contemporary urbanization by recommending policies that promote sustainable urbanization, such as investing in public transportation and green spaces. This can help to improve overall public health and make cities more habitable. In addition, revenue generated from carbon pricing can be used for social programs, such as affordable housing and job training. This could eliminate poverty and inequality while fostering a more inclusive economy. The study structure is presented in Figure 1.

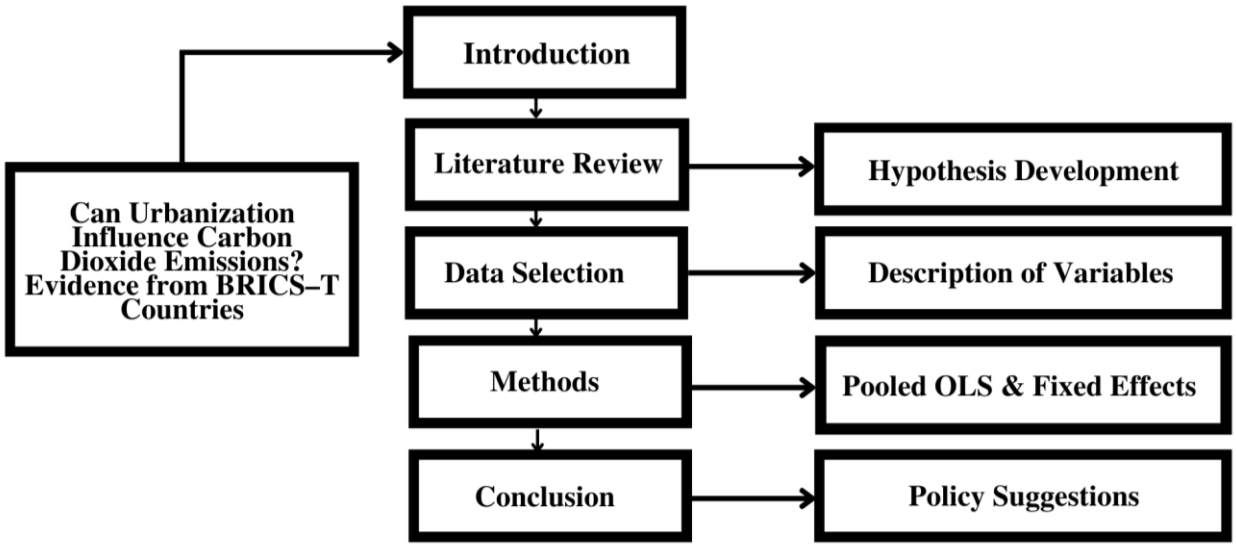


Figure 1. Study Structure.

2. Literature Evaluation & Hypothesis Development

2.1 UBNP & CO_2e *link*

In 16 emerging economies, Sadorsky (2014) established that the effect of UBNP on CO_2e is negative but statistically insignificant. The study also found that ENIT and GDP drive CO_2e. In Malaysia, Bekhet & Othman (2017) found that UBNP drives CO_2e at the early stages of urbanization. However, this association becomes negative in higher stages. Shen et al. (2017) confirmed mixed results for BRICS. Salahuddin et al. (2019) revealed that UBNP spurs CO_2e in South Africa. In Pakistan, Ali et al. (2019) opined that UBNP drives CO_2e and that it is crucial for the energy stakeholders to promote adopting renewable energy (RNW) technologies. In BRICS, Chen et al. (2022) and Chandra Voumik & Sultana (2022) ascertained that UBNP and GDP boost CO_2e. In 54 African Union countries, Hussain et al. (2022) confirmed that UBNP increases CO_2e. Thus, UBNP should be planned. Sikder et al. (2022) established the same outcome for 23 developing economies. Amin & Song (2023) discovered that GDP drives CO_2e in South and East Asia, while UBNP increases CO_2e in East Asia. Balsalobre-Lorente et al. (2022) revealed that UBNP decreases CO_2e in BRICS. In China, Cheng & Hu (2023) and Lee et al. (2023) found that UBNP increases CO_2e. Based on these assertions, this study suggests that:

Hypothesis 1: UBNP can either have a favourable or unfavourable environmental impact.

2.2 ENIT & CO_2e *link*

The majority of the existing literature has affirmed that ENIT increases CO2e. This is attributed to using fossils and the essentiality of meeting daily energy needs. Abban et al. (2020) revealed that ENIT drives CO2e in BRI economies. Namahoro et al. (2021) opined that in 50 African economies, ENIT serves as a factor that boosts CO2e across regions and income levels. Yang et al. (2022) found a similar outcome for China. Khan et al. (2022) stated that ENIT spurs CO2e in Canada. Koilakou et al. (2023) found a negative ENIT–CO2e nexus in the USA and Germany. Khan & Liu (2023) also discovered an adverse association in Australia. In 26 EU countries, Hodzic et al. (2023) asserted that ENIT is the primary driver of environmental deterioration. This occurs because there is an extensive reliance on fossils during the early phases of development, resulting in a rapid increase in pollution emissions (Harbaugh et al., 2002). Zhang et al. (2023) for Morocco and Chen et al. (2023) for top–ten efficient economies also discovered the enhancing effect of CO2e. Thus, this research hypothesizes the following:

Hypothesis 2: ENIT has an enhancing effect on CO_2e.

2.3 GDP and CO_2e *link*

The connection between GDP and CO_2e has remained inconclusive. A positive GDP–CO_2e nexus is established in the findings of (Adebayo et al., 2021; Ayhan et al., 2023; Karaaslan & Çamkaya, 2022; Naseem et al., 2023; Xue et al., 2023). Conversely, these investigations have identified an inverse association between GDP and CO_2e levels (Khan, 2019; Namahoro et al., 2021; Narayan et al., 2016). Consequently, this study puts forth the hypothesis that:

Hypothesis 3: GDP will spur CO_2e.

The following gaps were identified in these discussions: First, the connection between UBNP and CO_2e has not reached a definitive conclusion, necessitating further examination. Additionally, the correlation between GDP and CO_2e remains uncertain. Likewise, the research on ENIT across the global economy is scanty. Second, this study extends the BRICS economies to include Turkey, which other countries have omitted. Conducting more research on these gaps can lead to improved knowledge about the interconnections of the variables. This understanding can support policy development on how to cut CO_2e and combat climate variation.

3. Data and Method

3.1 Data

The data employed is from 1990–2021. CO_2e measured in metric tons per capita is the dependent variable, while UBNP (total urban population), ENIT (Exajoule/GDP), and GDP (Per capita constant US$2015) are the independent variables. CO_2e and ENIT were extracted from (Energy Institute, 2023), while UBNP and GDP were extracted from (World Bank, 2023). Therefore, an extended model proposed by Ali et al. (2019) is adopted and specified as follows:

$$\mathrm{CO2e_{it}} = \mathrm{f(UBNP_{it}, ENIT_{it}, GDP_{it})} \quad \text{.....(1)}$$

Logs of the variables were carried out to control for outliers and instability in the model (Somoye et al., 2022). Thus, the model is expressed in Equation 2.

$$\mathrm{LCO2e_{it}} = \emptyset_1 + \emptyset_2 \mathrm{LUBNP_{it}} + \emptyset_3 \mathrm{LENIT_{it}} + \emptyset_4 \mathrm{LGDP_{it}} + \mu_{\mathrm{it}} \quad \text{.....(2)}$$

$\emptyset_1$: Intercept; $\emptyset_2 - \emptyset_4$: Explanatory Variables Coefficients; μ: Error Term; i: Countries; t: Time.

3.2 Methods

3.2.1 Pooled OLS & Fixed Effects

The Pooled OLS method is a regression technique used to analyze panel data. Panel data is a blend of cross–sectional and time series dimensions. It is a common technique used to examine the overall relationship between variables while ignoring specific unit or time effects. The Fixed Effects approach, on the other hand, controls for unobserved heterogeneity, improves model fit, addresses time–invariant variables, solves the problem of endogeneity and is well–suited for causal inference.

4. Analysis and Discussions

4.1 Cross–Section Dependence Test

Before conducting the unit root test (second–generation), it is paramount to determine if cross–dependency exists within the model. Table 1 indicates the existence of cross–sectional dependency as evidenced by P–values below the 5% threshold.

Table 1. Cross–Section Dependence Test.

Test	**Statistic**	**Prob.**
Breusch–Pagan LM	318.7918	0.0000
Pesaran scaled LM	55.46454	0.0000
Pesaran CD	17.52678	0.0000

4.2 Unit–Root Test

In Table 2, the CIPS test proposed by Pesaran (2007) shows that LCO_2e, LENIT, and LGDP are stationary at level. For the CIDF test, LCO_2e, LUBNP, LENIT, and LGDP are stationary at level. CIPS and CIDF are second–generation unit root tests.

Table 2. Unit–Root Test.

	CIPS		**CIDF**	
	I(O)	(1)	I(O)	I(1)
LCO2e	–2.26415***	–3.59072*	–3.82592**	–5.82854*
LUBNP	–2.29340	–1.83948	–3.88947**	–3.37263**
LENIT	–3.31315*	–3.95465*	–4.84794*	–6.26308*
LGDP	–2. 47856**	–2.76702*	–5.32994*	–5.41996*

Note: * denotes P <0.01, ** denotes P <0.05, *** denotes P< 0.10

4.3 Descriptive Statistics

Table 3 confirms that LUBNP has the highest mean (18.65) and median (18.61). Conversely, LCO_2e has the lowest mean (1.31) and median (1.34). LCO_2e, LUBNP, and LENIT are platykurtic because they are less than 3, while LGDP is leptokurtic because it is more than 3. In addition, all variables are not normally distributed. There are 192 observations, which is sufficient for a panel data analysis.

Table 3. Descriptive Statistics.

	LCO_2e	**LUBNP**	**LENIT**	**LGDP**
Mean	1.315445	18.65758	1.774770	8.405932
Median	1.342851	18.51779	1.748398	8.712844
Maximum	2.717340	20.59872	2.843164	9.498642
Minimum	–0.371064	16.84811	0.955511	6.270796
Std. Dev.	0.837429	1.047222	0.498622	0.831746
Skewness	–0.187868	0.048456	0.193695	–1.160077
Kurtosis	1.788859	1.879063	1.841684	3.151966
Jarque-Bera	12.86431	10.12713	11.93413	43.24966
Probability	0.001609	0.006323	0.002562	0.000000
Sum	252.5654	3582.255	340.7559	1613.939
Sum Sq. Dev.	133.9460	209.4648	47.48721	132.1340

4.4 Pooled OLS Analysis

Table 4 shows the result of the Pooled OLS analysis. The outcome demonstrates that LUBNP growth reduces LCO_2e by 0.19%; a rise in LENIT levels spurs LCO_2e by 1.10%, and an increase in LGDP enhances LCO_2e by 0.61%. The R–R-squared and Adjusted R–R-squared are 99%, respectively, which shows how well the explanatory variables explain the dependent variable. In addition, the model is normally distributed (0.39>0.05).

Table 4. Pooled OLS Analysis.

Variables	**Coefficient**	**Standard Error**	**T–Stat**	**Probability**
LUBNP	–0.192957	0.004898	–39.39767	0.0000
LENIT	1.106786	0.005937	186.4245	0.0000
LGDP	0.611302	0.003862	158.2999	0.0000
C	–2.187003	0.104346	–20.95913	0.0000

Diagnostic tests	
R–squared	0.99%
Adjusted R–squared	0.99%
F–stat (23503.90)	Prob (0.00000)
Jarque–Bera (1.840765)	Prob (0.398367)

4.5 Fixed Effects Analysis

The Fixed Effects outcome in Table 5 shows that an upsurge in LUBNP reduces LCO_2e by 1.19%, while LENIT and LGDP rise boosts CO_2e by 1.19% and 1.04%, respectively. The R–squared and Adjusted R–squared are 99%, respectively, demonstrating how well the explanatory variables explain the dependent variable. The normality test also shows normal distribution because the probability value exceeds 5% (0.47992). The Redundant Fixed Effect–Likelihood Ratio also shows that the Fixed Effects method is appropriate because it is significant at 1% (0.0000). The Residual Cross–Section Dependence test also showed that there is no cross–dependence because the probability values are more than 5% (Breusch Pagan LM (0.9994) and (Pesaran CD (0.5008).

Table 5. Fixed Effects Analysis.

Variables	**Coefficient**	**Standard Error**	**T–Stat**	**Prob**
LUBNP	–0.053523	0.012564	–4.260201	0.0000
LENIT	1.191023	0.014347	83.01504	0.0000
LGDP	1.040176	0.008383	124.0880	0.0000
C	–8.543383	0.200042	–42.70790	0.0000

Diagnostic tests	
R–squared	0.99%
Adjusted R–squared	0.99%
F–stat (61860.65)	Prob (0.00000)
Jarque–Bera (1.468265)	Prob (0.479922)

4.6 Discussion

First, the result that an increase in UBNP reduces CO_2e is supported by the studies of (Balsalobre-Lorente et al., 2022; Khan & Liu, 2023; Koilakou et al., 2023; Sadorsky, 2014; Shen et al., 2017; Somoye et al., 2023). In contrast, these studies found that urbanization increases CO_2e (Chandra Voumik & Sultana, 2022; Cheng & Hu, 2023; Chen et al., 2022; Lee et al., 2023). The negative

relationship between UBNP and CO_2e shows that the BRICS–T economies are engaging in sustainable urbanization practices. In addition, Somoye et al. (2023) identified some factors responsible for the negative association between UBNP and CO_2e in Brazil. They include economic and political crisis, demographic changes, government policy effectiveness, effective allocation of resources, and control of pollution. Brazil has encouraged clean energy use through its economic policies, such as hydropower and biofuels. Currently, the decoupling of UBNP–CO_2e is slow in Russia because of its geopolitical challenges and heavy reliance on fossils. As such, Russia has continued to take steps to reduce its CO_2e by investing in renewables, encouraging natural gas use, and driving energy–efficient buildings through its policies. Even though India is going through rapid UBNP, the policymakers in India have developed several projects to promote sustainable urban development. Such projects include the Smart Cities Mission and Jawaharlal Nehru National Solar Mission. Despite China's rapid UBNP growth, established goals have been set by the Chinese government to increase energy efficiency, develop renewable energy generation, and support environmentally friendly transportation options such as electric automobiles and public transportation. In South Africa, coal is the main source of energy supply. The country has implemented some policies to decouple UBNP from CO_2e, such as the creation of the National Development Plan (NDP), support for the Sustainable Cities Network (SCN), and the signing of the Green Economy Accord (GEA). Turkey also depends on fossils for its economic activities, and it has implemented The National Urbanization Strategy (TNUS) to promote sustainable urbanization.

Second, a positive link between ENIT and CO_2e is expected because BRICS–T economies still rely heavily on fossils. This assertion is confirmed in the findings of (Chen et al., 2023; Hodzic et al., 2023; Namahoro et al., 2021; Narayan et al., 2016). Third, this study also anticipated a positive GDP– CO_2e nexus, which is acknowledged by (Amin & Song, 2023; Naseem et al., 2023; Sikder et al., 2022) and opposed by (Khan, 2019; Namahoro et al., 2021; Narayan et al., 2016).

5. Conclusion and Policy Suggestions

Climate change is one of several issues confronting the planet today. Addressing this problem will create a safer environment for humans and other species. Thus, this study explores how the urban population (UBNP) influences carbon dioxide emissions (CO_2e) levels in BRICS–T from 1990–2021 (192 observations) using Pooled OLS and Fixed Effects techniques. In addition, energy intensity (ENIT) and economic growth (GDP) are employed as control factors. The Pooled OLS result demonstrates that UBNP growth reduces CO_2e by 0.19%; a rise in ENIT levels spurs CO_2e by 1.10%, and an increase in GDP enhances CO2e by 0.61%. The Fixed Effects outcome shows that an upsurge in UBNP reduces CO_2e by 1.19%, while ENIT and GDP rise boosts CO_2e by 1.19% and 1.04%, respectively.

Policy suggestions are as follows: (i) To decouple UBNP from CO_2e, urban planning, and rural area development are essential. Urban planning entails designing and managing the physical growth and development of cities and towns. Urban planning also includes expanding and improving public transportation systems. In addition, developing rural areas will decongest the urban areas, put less pressure on urban infrastructure, and reduce CO_2e. (ii) To reduce ENIT levels, renewable energy integration and using energy–efficient buildings are essential. Renewable energy integration entails the installation of solar panels on rooftops and the utilization of geothermal or wind energy where feasible. Incorporating renewable energy into urban development can reduce reliance on fossil fuels and lower CO_2e. Renewable energy use can be enhanced through renewable energy education and awareness. (iii) To decouple GDP from CO_2e, tax policies, and subsidies can be employed. An increase in carbon tax will discourage the use of fossils, while tax incentives and subsidies will encourage renewable energy investments and consumption. In addition, the adoption of new technologies can also reduce CO_2e. Finally, this study has drawbacks by focusing on BRICS–T economies. Other studies can further research other countries for more robust policy formulation.

Conflict of Interests
The Authors declare that there is no conflict of interest.

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Data availability statement
The authors confirm that the data supporting the findings of this study are available within the article, and data is available upon request.

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Abbreviations

BRI	:Belt and Road Initiative
BRICS–T	:Brazil, Russia, India, China, South Africa, and Turkey
CO2e	:Carbon Dioxide Emissions
ENIT	:Energy Intensity
EU	:European Union
GDP	:Gross Domestic Product
IEA	:International Energy Agency
Pooled OLS	:Pooled Ordinary Least Square
RNW	:Renewable Energy
UBNP	:Urban Population

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Original scientific paper

Exploring the Contemporary Challenges of Urbanization and the Role of Sustainable Urban Development: A Study of Lagos City, Nigeria

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ABSTRACT

As urbanization accelerates, sustainable approaches are necessary to counter the adverse environmental impacts. The study investigates the multifaceted challenges of Lagos City due to urbanization and evaluates the effectiveness of sustainable urban development in tackling these problems. It employed a mixed-methods approach to provide informed decisions for liveable urban environments. Census data, satellite imagery, interviews, surveys, and focus group discussions provided a comprehensive understanding of Lagos's urbanization and its effects. Findings reveal pressing problems such as housing shortages, infrastructure strain, traffic congestion, waste management difficulties, and socio-economic disparities in Lagos City. Local authorities and NGOs have implemented sustainable urban development initiatives, including transport upgrades, green space promotion, waste management, and housing solutions. Such case studies have revealed various interventions, such as informal settlement transformation, renewable energy integration, and urban regeneration. However, persistent issues still exist due to the city's urbanization. Therefore, Integrated urban planning, inclusivity in policy-making, and technological advances are essential for tackling these challenges. The findings contribute to the academic discourse by providing insights into Lagos City's urbanization and practical implications for sustainable urban development. It also highlights the need for comprehensive strategies to build a prosperous, equitable, and eco-friendly city.

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Highlights	Contribution to the field statement
- The study delves into the multifaceted challenges of rapid urbanization in Lagos City, Nigeria. - It underscores the role of sustainable development strategies in mitigating various environmental challenges. - The research provides valuable insights and recommendations that could be utilized in rapidly urbanizing cities facing similar challenges.	This study advances the discourse on 21st-century urbanization by examining contemporary challenges and emphasizing the crucial role of sustainable urban development in Lagos City, Nigeria. It highlights the intricate interplay of social, economic, and environmental factors in a dynamic African metropolis. The findings underscore the significance of sustainable urban development for creating resilient, equitable urban environments amid rapid urbanization.

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1. Introduction

Urbanization is an irreversible global trend reshaping cities into vibrant centers of economic, social, and cultural activity (Bibri, 2021). The rapid influx of people from rural to urban areas has triggered unprecedented urban expansion, presenting opportunities and challenges for urban planners, policymakers, and residents alike. Nigeria, ranked as the 32nd largest country worldwide in land area, encompasses approximately 923,768 square kilometres (Koko et al., 2020). In addition, the country is the 7th most populous nation, having a population of around 213 million (National Bureau of Statistics, 2019). Projections indicate that Nigeria's population will reach 239 million by 2025 and is expected to increase to over 440 million by 2050. This increase will make the country the 4th most populated globally (United Nations Department of Economic and Social Affairs, 2019). Urbanization, highlighted as a critical factor by Pickett et al. (2001), exerts significant pressure on the socio-economic development and environmental sustainability of developing countries such as Nigeria. Consequently, Temi and Champika (2018) have identified factors like politics, trade, industrialization, state creation, and infrastructure development as primary drivers of urbanization in Nigeria. These factors, in turn, have driven rural-to-urban migration, urban population growth, convergence of lifestyles, and economic expansion linked to urbanization.

The 21st century has witnessed urbanization's indelible imprint, with over half of the world's population now residing in urban areas, particularly in developing nations. Lagos, Nigeria's foremost urban center, is at the forefront of the nation's urbanization, with a historical legacy extending back to the 14th century. It is recognized as one of the world's fastest-growing cities (United Nations Department of Economic and Social Affairs, 2019). This growth trajectory is emphasized by the projection that Lagos City's population will grow at a rate of 77 people per hour between 2010 and 2030, cementing its position as Africa's fastest-growing city (Hoornweg & Pope, 2016).

Recently, Lagos has experienced rapid urbanization and a complex web of interconnected challenges. As the population grows, concerns intensify over inadequate infrastructure, environmental degradation, social inequality, and resource scarcity. The United Nations Department of Economic and Social Affairs (2019) characterizes Lagos City as a renowned urban hub with a remarkable transformation in the last two decades. From being a city marked by alarming development trends in the late 1990s, Lagos has evolved into a vibrant hub of economic and industrial activities (Aliyu & Amadu, 2017). This transformation is attributed to several researchers, including Olajide et al. (2018), who have highlighted Lagos's role in driving over 65% of Nigeria's commercial and industrial activities (Auwalu et al., 2021). This positions Lagos as an economic powerhouse within Nigeria and the broader West African region (Akiwumi & Onyekwena, 2022). Presently, Lagos is one of the most urbanized cities in Africa (Merem et al., 2018). The city boasts a population density of 7,530 individuals per sq. km and urban dwellers of 14.6 million in 2018, spanning an area of 1,943 sq. km.

The high urban population of Lagos, propelled by the city's rapid urbanization, has given rise to various challenges, including housing shortages, the proliferation of slums, transportation and mobility issues, urban poverty, and environmental concerns (Adedeji, 2023; Badmos et al., 2018; Olajide et al., 2018). Consequently, sustainable urban development emerges as a comprehensive strategy to address these multifaceted challenges, aiming to foster cities that are resilient environmentally, inclusive socially, and vibrant economically. Therefore, the present study aims to comprehensively examine the contemporary challenges posed by urbanization in Lagos City, Nigeria, and critically assess the role of sustainable urban development strategies in addressing these challenges. By scrutinizing the challenges confronting Lagos City and evaluating the efficacy of sustainable development initiatives, this paper contributes to the ongoing discourse on urban planning and policy formulation in the context of global urbanization trends. To achieve this, the study's objectives include:

1. Examine the factors responsible for Lagos City's urbanization and rapid population growth.
2. Identify and analyze the key challenges that have arisen due to the rapid urbanization in Lagos City.
3. Evaluate the sustainable urban development initiatives local authorities and organizations undertake to address these challenges.

4. Provide valuable insights and recommendations for policymakers, urban planners, and stakeholders regarding the effectiveness of sustainable urban development strategies in Lagos City and beyond.

2. Study Area and Data

2.1 Study Area

Lagos lies between Latitude 6°15′N and 6°41′N and Longitude 2°42′E and 4°14′E on the West Coast of Africa and is located on the Atlantic coast in South-Western Nigeria as shown in Figure 1~~Figure 1~~. It is Nigeria's smallest state, covering approximately 3,577 square kilometres (sq. km), or 0.4% of the country's total landmass (Auwalu et al., 2021). Lagos is divided into 20 Local Government Areas (LGAs), with 16 designated as high-density metropolitan areas (Ndidi & Nduka, 2014). Also known as Greater Lagos or the Lagos Metropolitan Area, Lagos is located on a vast lowland and island, with approximately 220.6 square kilometres of the city comprising water bodies, mangrove swamps, and wetlands, making it a busy port city. Lagos, together with its neighbouring metropolis, is Nigeria's largest city and the country's most important economic centre, having the country's major seaports. According to Gbenga (2023), Lagos accounts for 10% of Nigeria's Gross Domestic Product (GDP) and over 90% of Nigeria's trade flow. The city is the fifth largest economy in Africa, having 65% of Nigeria's manufacturing sector. Lagos has a dense and vast network of urban settlements and towns interconnected by various road networks (Lawanson & Agunbiade, 2018). With an astronomically growing population, Lagos City is characterized by unplanned and chaotic urbanization and infrastructures considered inadequate and deteriorating (Wang & Lu, 2018).

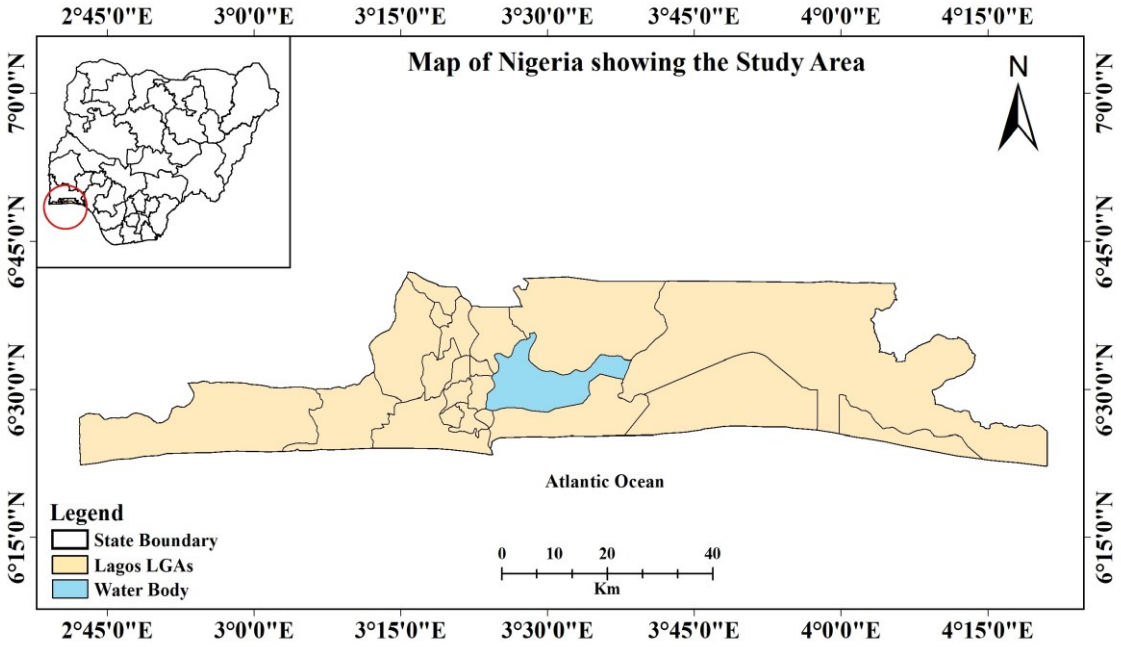


Figure 1. Location Map of the Study Area, i.e., Lagos, Nigeria.

2.2 Demographical Data

Despite several controversies trailing the population figures of Lagos, there is a collective consensus that the population of Lagos has increased tremendously during the last decades (Asuquo Enoh et al., 2023; Gandy, 2006; Kookana et al., 2020; O'Connor, 1998). According to Nigeria's population census reports, the city's population is estimated to be approximately 22 million. This makes Lagos a mega-city, with a substantial proportion of the city's population living in urban areas. Data from UN-Habitat and other international development agencies indicates Lagos has an urban population of approximately 14 million as of 2018, as shown in Figure 2~~Figure 2~~(A). This high urban population is mainly due to industrialization, leading to Lagos's designation as an urbanized city.

The population of Lagos is growing ten times faster than that of New York and Los Angeles, which is also more than the population of 32 African countries put together, with the city's population likely to be over 35 million populace by 2050. According to Güneralp et al. (2017), Lagos is the third-largest mega city in Africa, after Cairo and Kinshasa, having an urban population of over 10 million populace. However, the city's population growth rate shows a decreasing trend from 1990 to date, as shown in Figure 2~~Figure 2~~(B), which indicates a reduction from 6.36% in 1980 and 1990 to about 3.24% in 2019. This decreasing population growth rate highlights that it is not the only reason for urbanization but also migration as a significant contributing factor to the growth. Most of the people who migrated to Lagos settled in urban areas, thereby exerting much pressure on existing urban infrastructures. This increased influx of people to the city of Lagos has contributed to the increasing number of squatter settlements and slums in the city.

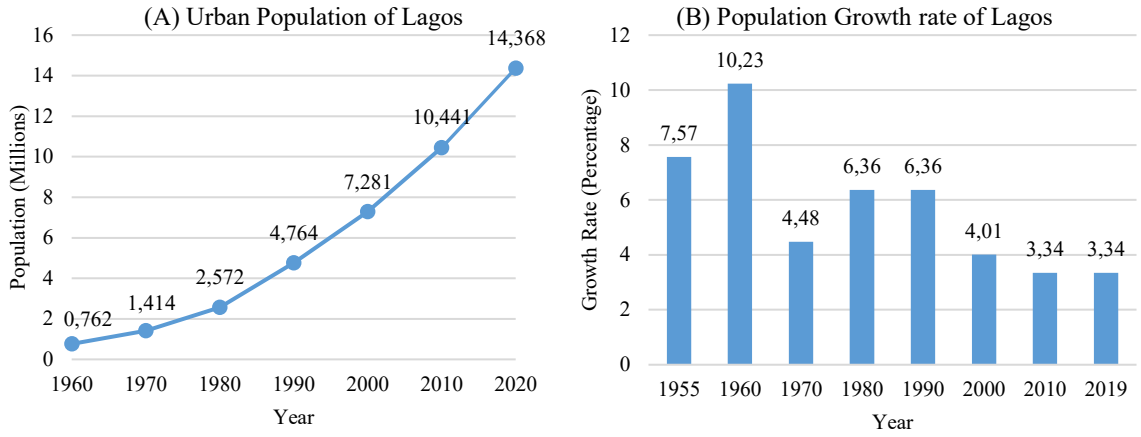


Figure 2. (A) Urban Population and (B) Population Growth Rate of Lagos from 1950 to 2020.

2.3 Classified Land Cover Data (CLCD)

We acquired the classified land cover of the study area from the previously published decadal classified land cover data of Lagos. These data, retrieved from the studies of Auwalu et al. (2021), covered the period from 1990 to 2020 and consisted of four land cover classes. The spatial resolution of the land cover data was 30 m. The classification accuracy was assessed by sample validation, and results presented an overall accuracy above 85% and a Kappa index above 0.7. The result indicates unbiased data that could be utilized in further analysis of urbanization.

3. Methodology

The research adopted a comprehensive and mixed-methods approach to analyze the challenges posed by urbanization in Lagos City and assess the effectiveness of sustainable urban development initiatives. The methodological approach integrates quantitative and qualitative techniques to understand complex urban dynamics better.

3.1 Research Design

The research design comprises the quantitative and qualitative phases.

- In the quantitative phase, census data and satellite imagery were utilized to assess the extent and patterns of urban growth in Lagos City. Population data spanning several decades were used to analyze the rate of urbanization and its demographic implications. GIS tools were employed to assess urban expansion and examine its challenges.
- The qualitative phase involves interviews and focus group discussions conducted with key stakeholders. These stakeholders include urban planners, policymakers, community leaders, and residents. The interviews helped us understand their perspectives on urbanization challenges, sustainable development initiatives, and their perceived impacts on the city, while the Focus group discussions facilitated open dialogue on critical issues.

3.2 Data Collection

Census data from multiple years were obtained from the relevant governmental agencies and supplemented with information from international databases. Remote sensing techniques were used to assess changes in land use and land cover over time, which helped to understand urban expansion trends. Also, a semi-structured interview was conducted with urban planners, policymakers, and NGO representatives to gain insights into policy formulation, implementation challenges, and future directions. Focus group discussions with community members will provide a grassroots perspective on the effects of urbanization and sustainable development initiatives on their daily lives.

3.3 Data Analysis

For the data analysis, we subjected the data from the interviews and focus group discussions to thematic analysis. Common themes and patterns related to urbanization challenges and sustainable development strategies were identified to provide a holistic understanding of the research questions and inform policies and practices for creating sustainable urban futures.

4. Results and Discussion

4.1 Factors Responsible for Urbanization and Population Growth in Lagos, Nigeria

Several factors have been identified to be responsible for urbanization globally. These factors include economic and industrial growth, infrastructural development, population increase, and rural-urban migration (Cohen, 2006; O'Neill et al., 2012; Thomas, 2008). Thomas (2008) asserts that about 60 percent of the global population growth can be attributed to natural increase and maintains that such a population still continuously increases. Similarly, Turok and McGranahan (2013) believe that global population growth contributes significantly to urban development and urbanization. In Nigeria's context, urbanization is primarily a result of economic growth due to industrialization and the migration of people from rural areas to urban centers. The main factor responsible for urban development in Nigeria is rural push combined with urban pull. These 'Push factors' are accountable for the migration of people to urban centers such as Lagos city. Some of these rural push factors include but are not limited to poor living conditions, poverty, political neglect, environmental degradation, poor healthcare, inadequate educational facilities, and lack of essential infrastructural services. Due to this, other urban 'pull factors' attract the rural population to urban centers such as Lagos in Nigeria. These pull factors include better employment opportunities, living conditions, infrastructures, and educational and healthcare services. According to Olajide et al. (2018), the city's physical configuration and socio-economic structure have contributed significantly to the urban growth and expansion of Lagos, leading to urbanization. Rural-urban migration has also increased as a result of better employment opportunities in Lagos, which signifies the influence urban centers have on the rural hinterland and also conforms with the assertion of Ventriglio and Torales (2021), which identified urbanization to be a process that leads to the growth of urban centers due to economic development and industrialization. As such, some factors primarily responsible for urbanization and population growth in Lagos can be attributed to employment opportunities, industrialization, modernization, and other social factors. These factors have contributed to the city's rapid urban expansion, as shown in Figure 3~~Figure 3~~.

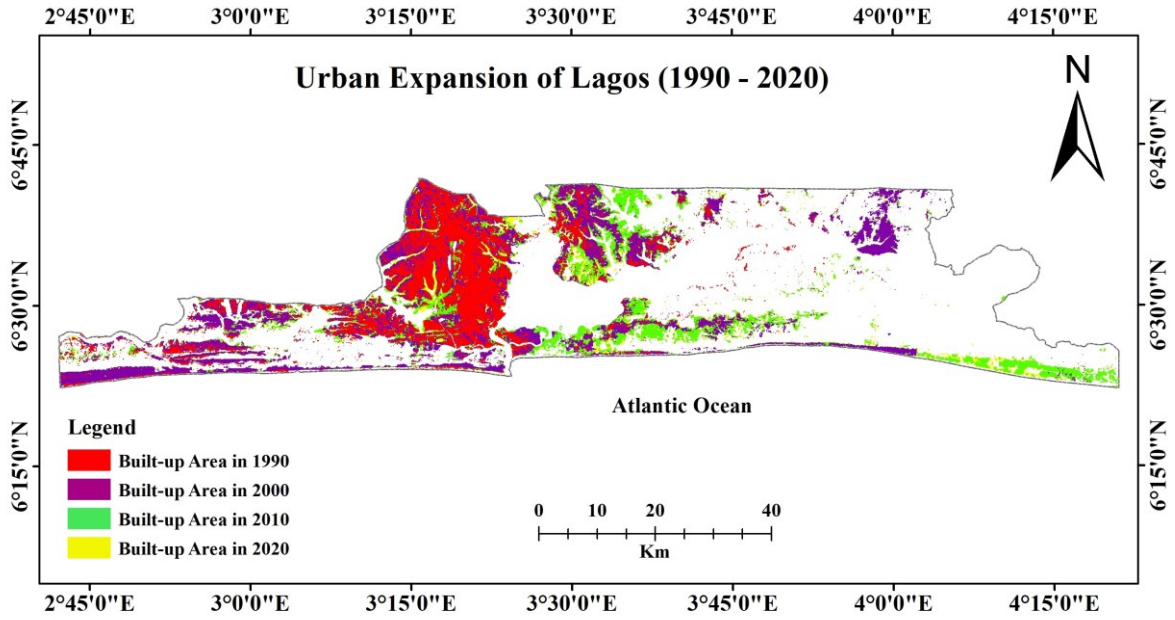


Figure 3. Lagos City's Urban Growth Map.

4.2 Challenges of Urbanization and Population Growth in Lagos, Nigeria

The rapid urbanization and population growth in Lagos has been tremendous and has led to undesirable consequences for the city as evidently in the increased number of slums and informal settlements, the inadequate number of affordable housing, the city's urban mobility and transportation problem, the city's solid waste management problem, environmental pollution, and declining job opportunities, poverty, and other social problems.

4.2.1 Housing, slums, and informal settlements

The increase in the number of slums and informal settlements in Lagos is one of the main challenges of urbanization and population growth in the city. Housing, also referred to as human settlement, is generally considered one of the basic needs of life and an essential priority for survival (Ademola, 1990; Adepoju, 1995; Fang et al., 2022). Perrucci et al. (2016) describe housing as the provision of well-designed shelters in a neighbourhood sustained by a built environment for the daily activities of residents residing in such communities. On the other hand, the United Nations slum indicators described slums as contiguous settlements with inadequate housing and other necessary infrastructures and services (UN-HABITAT, 2002). Public authorities usually do not recognize them as integral to the city. The depiction of slums and informal settlements in Lagos is evident in the low-income houses with poor living conditions in some areas of the city, in addition to the traditional slums of Lagos, which have old houses and settlements that have deteriorated over time due to neglect. Such categories of houses are typically partitioned and rented out to less privileged families. Slums and informal settlements in Lagos often evolve due to the government's inability to provide adequate and affordable housing for the city's growing urban population. They usually serve as settlements for most rural populace migrating to Lagos. These settlements have evolved indiscriminately in vulnerable areas prone to erosion, flooding, rising dampness, fire outbreaks, building collapse, and other environmental and social epidemics. Therefore, Slums and informal settlements in Lagos are manifestations of a growing population without a corresponding increase in the provision of adequate and affordable housing. According to Ibem (2011) and Olugbenga and Adekemi (2013), the current housing shortage in Lagos is anticipated to be over 5 million housing units, accounting for approximately 31% of Nigeria's estimated national housing deficit. This high shortfall contributes significantly to the subsequent increase in the development of slums and informal settlements in Lagos. Similarly, the urbanization process of Lagos, coupled with the city's inadequate urban planning policies, strategies,

and initiatives, has continuously contributed to inadequate housing and other necessary infrastructural services. This promotes the growth of slums and other informal settlements. Over the years, the slums in Lagos have increased from 42 slum districts to over 200, ranging in size from shacks clusters beneath highways to entire neighborhoods (Ifeoma et al., 2023). An example of such a slum settlement is the Makoko floating settlement shown in Figure 4~~Figure 4~~.



Figure 4. Makoko floating slum settlement in Lagos, Nigeria.

A critical factor in overcoming the challenge of inadequate housing, slums, and informal settlements in Lagos is modifying the city's urban planning and development approach by retrofitting slums and informal settlements with sustainable, contemporary, and smart housing types. This can be achieved through strategies such as slum upgrades through site and services schemes, Public-Private Partnership (PPP) estate developments, homeownership through mortgage systems, development of neighborhood urban renewal policies, and the promotion of multi-story mixed-used and residential developments.

4.2.2 Urban Mobility and Transportation Problem

One of the challenges faced by most fast-growing cities in Africa due to urbanization is providing infrastructure and managing the increasing transport demand. Urban Mobility and transportation problems in most African cities are mainly due to inadequate transport infrastructure that will meet the growing cities' demand. The condition is not different from the system in Lagos, where the transport infrastructures have been neglected for many years, coupled with the increasing urban population, resulting in an unsustainable and chaotic transport system due to traffic congestion, as shown in Figure 5~~Figure 5~~ (A) and (B). The predominant transport system in Lagos is road-based, with approximately 90% of the city's inhabitants utilizing the roads as a means of transportation. Lagos has more than one million vehicles plying the city's roads daily, with a public transport density of 3 buses per 1000 people and a high car density of 222 vehicles per roadway kilometre as compared with Nigeria's national average of 11 vehicles per kilometre (Ibitayo, 2012). Lagos also has about 7,598 km of roads with a high road density of 2,972 persons per kilometer, as against Seoul and Tokyo, which have a road density of 1,358 and 544 persons per kilometer, respectively. Therefore, the road networks in Lagos are grossly inadequate to meet the city's travel demand. As a result, Lagos is usually congested compared to other cities due to these transport sector conditions and the state of road infrastructures in the city. The challenge of urban mobility and transportation in Lagos ranges from social and human problems, inadequate infrastructures, non-standardization, and upgrade of the transportation system, as well as institutional issues like poor management and implementation of policies and projects.



Figure 5. (A) Traffic congestion on Lagos city's highway and (B) Mini-buses (Danfos) parked on roads.

Other contributing factors to the problem of urban mobility and transportation in Lagos include the insufficient number of primary corridors and interchanges and the insufficient bus stations to accommodate the city's traffic. This has led to the poor outlook of the public transport system in Lagos and has subsequently affected the city's living and working alongside the economic development of Lagos. It has also contributed to the reduction in the city's quality of life due to environmental pollution caused by traffic congestion, mainly due to the high utilization of private vehicles and reliance on informal transportation modes like mini-buses, popularly called Danfos and shared taxis. Therefore, the solutions to the challenge of urban mobility and transportation in Lagos due to urbanization and population growth include but are not limited to the re-development and revitalization of the city's urban center through people-oriented urban renewal strategies. Such strategies involve having pedestrian-friendly facilities that encourage non-motorized transportation and developing and integrating various transportation systems such as Mass Rapid Transit Systems (MRTSs) and Light Rail Transits (LRTs) to cover the whole of Lagos City. Also, the land use policy of Lagos needs to be revised to introduce policies that would assist in decongesting the city center through activity decentralization. This will subsequently reduce the pressure on existing transport networks due to the movement of people to the city center.

4.2.3 Solid Waste Management Problem

The management of solid waste in urban centers, which includes various aspects such as storage, collection, transportation, treatment, and disposal, is one of the challenges faced by most growing cities due to urbanization and rapid population growth. This scenario is similar to Lagos in Nigeria, with most people adjudging the city's poor waste management practice to the unprecedented growth of Lagos. The problem of solid waste management in Lagos began in the early 1970s due to the oil boom in Nigeria, which led to urbanization and rapid population growth in the city. This resulted in a high volume of daily waste, which became overwhelming for Lagos city administrators to effectively manage, as presented in Figure 6~~Figure 6~~. As a result, Lagos became one of the world's dirtiest cities in 1977. However, hosting the second World Black and African Festival of Arts and Culture in 1977, known as FESTAC '77 in Lagos, catalyzed the establishment of the Lagos State Refuse Disposal Board (LSRDB) to address the problem of solid waste management in the city. Powell Duffen Canadian Pollution Control Consultants supervised the LSRDB. Later, in 1981, it was renamed to Lagos State Waste Disposal Board (LSWDB) to reflect its additional responsibilities, including handling commercial and industrial waste, drainage clearance, and collection and disposal of scrapped and derelict vehicles within Lagos.



Figure 6. Refuse dumps along Motor Parks and Roadsides in Lagos, Nigeria.

In 1991, the LSWDB was transformed into a Lagos State Waste Management Authority (LAWMA) agency. This agency was responsible for ensuring efficient collection and disposal of residential and industrial waste, providing waste management services to commercial institutions, and managing government-owned dumpsites in Lagos. LAWMA operates four dumpsites in Lagos, covering a total of 63.67 hectares, and are strategically located within the Quaternary lateritic clay deposit of the city, with each dumpsite receiving an average waste of about 3,250m³ per day of the city's 13,000 metric tons of waste generated daily, however, despite creating and transforming these boards and agencies to improve and combat the threat posed by solid waste management practices in Lagos. These efforts are still unsuccessful due to the high rate of environmental pollution in Lagos, which is caused by poor solid waste management practices. Therefore, more efforts are needed by various stakeholders in addressing the problem of solid waste management in a multifaceted and dynamic urban center such as Lagos, which has rapid population growth. Hence, this can be managed from the point of resident's waste generation by providing adequate waste disposal points and dumpsites by relevant authorities and improving the city's evacuation and management system through initiatives such as waste-to-wealth. All these are geared towards having a city with a sustainable waste management system.

4.2.4 Environmental pollution

Environment pollution due to urbanization and rapid population growth is also a problem facing Lagos as an urban center in Nigeria. This is of great concern to the city due to its health implications. The environmental pollution in Lagos predominately occurs due to the emission of greenhouse gases (GHGs) and their wastes into the environment, as shown in Figure 7~~Figure 7~~. These greenhouse gases, such as carbon monoxide, are primarily produced through industrial activities or vehicular exhaust emissions from transportation. The continuous emission of such greenhouse gases in Lagos has significantly contributed to global warming, a critical issue affecting every nation. Several researchers believe that environmental pollution in Lagos is primarily caused as a result of the unprecedented growth of the city due to urbanization. The growth in the city's population due to rural-urban migration has decreased the city's air quality and various environmental consequences (Adedibu & Okekunle, 1989). Similarly, other studies highlighted this problem's implications to include several health challenges. Okebukola (2001) observed that a prominent contributing factor to the spread of parasitic and gastro-internal diseases in Lagos includes the haphazard handling and disposal of gaseous chemical waste. Likewise, a study conducted by Alo et al. (2014) suggests that a significant amount of pollutants are discharged into Lagos Lagoons. This results in the daily contamination of the city's water, shortage in the potable water supply, other waterborne diseases, and threats to aquatic life. The increasing cost of treating this contaminated water for domestic and industrial use in Lagos has been detrimental to the city's urban productivity.



Figure 7. Air Pollution of Lagos, Nigeria.

Adekunle et al. (2021) further identified other sources of environmental pollution in Lagos, comprising noise pollution from moving vehicles, religious centers with high-volume amplifiers, households, and industrial power generators. This has led to various impairments like difficulties in hearing and other ailments, particularly for residents living or working around such areas. Therefore, environmental pollution due to urbanization and rapid population growth in Lagos poses a significant threat to the health and well-being of the city's residents due to the various adverse effects of air, water, and noise pollution. This problem can be solved through deliberate policies and strategies to prevent and control multiple sources of pollution. It can be attained by developing initiatives and laws to achieve an environmentally friendly and sustainable urban atmosphere. Also, upgrading the city's energy use and providing alternative transport methods that enable traffic calming will significantly help reduce the amount of GHG emissions to the environment due to exhaust emissions from vehicles. These solutions are not only beneficial to Lagos city's environment but will also improve the health and well-being of the city's inhabitants.

4.2.5 Unemployment and Urban Poverty

In most developing countries, such as Nigeria, there is an increased shortage of jobs in urban centers due to the migration of people to urban areas without a corresponding increase in new job opportunities by both the public and private institutions. Data from Nigeria's Bureau of Statistics (NBS) reveals that Nigeria's unemployment rate increased from 18.8 percent in the third quarter of 2017 to about 23.1 percent in the third quarter of 2018. Lagos has continued to witness an increasing unemployment rate since the aftermath of the 1980s oil crises, which led to the systematic deviation of the country's currency, partial removal of subsidies on fuel, and the increment in taxes and tariffs. This forced many industries to shut down or cut down jobs due to the economic downturn and resulted in the inadequacy of job opportunities required to actively engage the large percentage of the teeming urban job seekers, leading to urban poverty. Hence, making much of the urban population, especially the youths, unemployed with no jobs to meet their daily needs, resulting in challenges such as increased criminal activities, theft, robbery, kidnappings, and many others. As a result of the increasing rate of unemployment in Lagos, most urban populace work in informal sectors such as home-based and small-scale businesses, providing the necessary and additional means of social protection. The continual growth of this informal sector in Lagos is mainly due to the city's decline in formal sector job opportunities. This has also resulted in a large urban populace engaging in multiple livelihood strategies, utilizing the informal sector by both employees of public and private organizations to sustain livelihood. Therefore, developing rural areas by creating agricultural-based industries that will provide job opportunities for the rural populace is vital in reducing the pressure on urban jobs caused by rapid population growth due to rural-urban migration in Lagos. Also, the government should provide private investors with grants, subsidies, and tax holidays to encourage the creation of job opportunities for both skilled and unskilled urban residents. This will promote utilizing labor-based technologies, creating more employment opportunities that will subsequently increase self-dignity, self-reliance, and standard of living.

5. Conclusions

This study examined the nature and challenges of urbanization and population growth in Lagos, Nigeria, as well as the factors responsible for these challenges. As a case study, the study explored the global and regional concepts of urbanization, focusing on Lagos in Nigeria. The motivation of this study is the prediction of the United Nations, which forecasts a rapid population growth in Nigeria's urban centers, particularly Lagos, which, if not properly managed, will lead to the deterioration of living conditions in such urban centers. Therefore, this study analyzed Lagos, the largest urban center in Nigeria and the fastest-growing city in Africa. The study conforms to various literature, archival sources and subsequently identified the multiple challenges of urbanization and rapid population in Lagos to include the proliferation of slums and informal settlements, inadequacy of affordable housing, urban mobility and transportation problems, solid waste management problems, unemployment and declining job opportunities; poverty; environmental pollution and other social problems. The study identified Lagos City's challenges in Nigeria due to various urban pull factors contributing to the city's continuous population growth. Lagos, the most urbanized city in Nigeria, has a highly complex system with solutions to the city's challenges requiring an integrated approach. The study, therefore, advocates better environmental and waste management practices in managing the environmental challenges in Lagos. It also suggests the development of initiatives, policies, and laws that encourage public-private partnerships through grants, subsidies, and waivers to create more employment opportunities and boost economic prospects while managing the city's ever-increasing population. This will help improve the city's living conditions and create a conducive environment. The study concluded that the various challenges due to urbanization and rapid population growth in Lagos could be reduced to the barest minimum through different urban renewal strategies and developmental approaches that are sustainable, environmentally friendly, and people-oriented.

Limitations and Areas for Future Studies

While this study offers valuable insights through its comprehensive analysis, certain limitations require attention. The research's scope, although extensive, may not fully capture all possible dimensions of the challenges posed by urbanization in Lagos. Additionally, the study relies on historical and archival data, which may not adequately reflect the complexities of current urbanization trends. To address these limitations and further contribute to the discourse, future research could:

i. Undertake in-depth qualitative studies to gain insights into Lagos residents' experiences, perceptions, and aspirations amidst urbanization.
ii. Employ advanced modelling techniques to project and analyze future urban growth scenarios and their associated challenges.
iii. Delve into comparative analyses with other rapidly urbanizing cities to glean insights into practical strategies for managing urban challenges.
iv. Examine the role of technology and innovation in enhancing sustainable urban development and addressing urbanization challenges in Lagos.

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Conflict of Interests

The Author(s) declares(s) that there is no conflict of interest.

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Data availability statement

All the relevant data from this study are available from the corresponding author upon request.

CRedit author statement

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Beneath the City: Unearthing Naples' Archaeological Underground for New Urban Continuity

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ABSTRACT

This study explores the potential of connecting the visible cityscape with concealed subterranean spaces, aiming to reshape urban continuity. It departs from the traditional perception of underground areas as purely technical domains, seeking fresh perspectives on inhabiting these concealed environments. Using three Naples locations as case studies, we develop a methodology applicable to similar urban contexts, emphasizing the archaeological underground's ability to trigger socio-economic transformations. Accordingly, it advocates for deliberate design interventions to reintegrate the archaeological underground into contemporary urban dynamics, offering strategies to redefine the relationship between city dwellers and their urban environment. Through case studies and visual representations, the study presents design solutions that enhance the use of subterranean spaces, fostering accessibility, community engagement, and cultural preservation. These initiatives promote enduring economic sustainability, potentially benefiting other cities facing similar challenges, and creating a harmonious connection between archaeological underground layers and the modern urban fabric. In summary, this research underscores the vast potential of subterranean spaces for future urban development, requiring innovative methodologies and technological integration to shape a unified and adaptable cityscape.

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Highlights	Contribution to the field statement
- Separation from the technicalistic view of the subsurface, experimenting with well-oriented approaches aimed at the valorisation of assets - Looking for new interpretations of the archaeological underground starting from three case studies in Naples -Excavations, engravings and labyrinths as project actions between the Poggioreale hill, the Sanità district and Monte Echia -New urban continuities through architectural design between above and below.	This paper identifies, in the archaeological underground, a potential space for the socio-economic development of the city, a space that must be, through the design, reinserted into contemporary urban dynamics. The project makes it possible to identify strategies over time, capable of defining new relationships between inhabitants and the city.

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1. Introduction

In ancient times, the underground and the surface were parts of a single complex system that constituted the city. In the present, this condition appears to be completely changed: burdened by a heavy historical past, the city artificially splits into an above and a below (Sacripanti, 1973).

The condition of the city's stratified division lays the foundation for research in architectural and urban design, which aims to experiment with strategies to reverse the separation between the above and the below, revealing the hidden potential in the subterranean world. The research's objective is not to interpret the underground as a space subordinate to the visible world (Lambertucci, 2019) devoid of any archetypal value that traditionally associated the hypogeum with humanity's first refuge. Instead, it is seen as a space with precise and recognizable architectural characteristics, a true urban space within which the contemporary city can expand.

Starting from the analysis of ancient ways of inhabiting the underground, the research explores solutions to reclaim the subterranean world, starting from those *points of exchange* between the above and the below, understood as spaces for dialogue between the contemporary city, the landscape, and the chthonic city.

In recent years, the academic world has begun to question the design potential of the underground, developing studies such as those related to *archeomobility,* which seek to consider the transformation of the hypogeum from a technical space, mostly used for transportation or utility networks, into a public space open to the city. In this regard, numerous European cities, including the exemplary case of Naples, emphasize the issue of new infrastructures intersecting underground archaeology: these subterranean spaces, created by excavation activities, display archaeology found in situ, amidst the *daily flows of subway commuters* (Farris, Grimaldi, & Lambertucci, 2019), blending the functional aspect with the quality of an archaeological space connected to the upper layers of the city.

Based on these considerations, the research aims to expand the scope of investigation and design experiments for the underground, moving away from the purely infrastructural use of hypogeal space, and attempting to discover new ways of inhabiting the subterranean (Marini, 2021) in continuity with the contemporary city, unveiling the hidden archaeological potential (Cellini, 2023) for a socio-economic urban renewal that starts from *human spatial behaviour* (Aiello, 1987, p. 385). Establishing a new continuity between the layers of the city is possible by bringing back, vertically, *the ancient city that lies beneath the city* (Fred & Gubler, 2021), which has almost been entirely erased from contemporary memory.

The research thesis applied experimentally to the city of Naples allows for the verification of different objectives. On one hand, the project for the archaeological underground aims to enhance, make accessible, and showcase the chthonic archaeological spaces, which are often invisible and little known. On the other hand, the project intervenes in the archaeological section, vertically, triggering an urban transformation that creates new public spaces where urban archaeology takes centre stage (Linazasoro, 2017). The proposed design experimentation for the city of Naples can, therefore, serve as a research tool and a guide for further experiments. It can act as a catalyst to promote new solutions for continuity between the underground and the surface, starting from the archaeological potential hidden in the invisible layers of stratified cities (Franciosini, 2021).

2. Interpretations to overturn the condition of the archaeological spaces of the Neapolitan underground

The research begins with an analysis of the various manifestations of the underground through explorations aimed at understanding how the concept of the underground has evolved and how the role of this space has changed from the past to the present.

An initial investigation is conducted through psychological and imaginative explorations that attempt to delve into the underground through the mind, as a place of the subconscious, an imagined realm, of terror and fantasy, of mystery and magic.

The presence of a mysterious world, in fact, dates to the period of the architect Le Corbusier and served as the basis for a new geometry. An emblematic example is the Swiss Pavilion (1930), in which Le Corbusier represents the two worlds, the mysterious underworld and the sunny above-ground, as two hands that intertwine and make contact in an unusual manner. The contact between the upper world and the lower world can also occur through different interpretations.

A second exploration can be derived from the practice of excavation in ancient times, namely, archaeological studies aimed at understanding the architectural characteristics of the underground. By reinterpreting ancient practices, original uses, and respective architectural typologies, it is possible to grasp the significance and value of the heritage hidden beneath the ground. An interesting example is provided by the spectacular underground spaces of the *Domus Aurea*, in Rome, which remained largely unexplored for a long time.

Archaeological reconnaissance of these locations has, on one hand, allowed for the understanding of the sequence of events and the recovery of ancient testimonial memory. On the other hand, it has also served as a catalyst for new design projects that have created a spectacular underground museum. In this museum, the archaeology found *in situ* is "displayed" like artefacts in a museum room. Lastly, the research into contemporary practices that can be realized in a way that is compatible with the geometry of the underground allows for the overcoming of the widespread interpretation of the underground as merely a functional space in service to the city above.

The possibility of returning to inhabit the underground is indeed a modern trend in architectural design, opening new and varied explorations of underground space. Spaces for *underground living*, such as the well-known cave created by *Janya Ishigami* in 2018 in Yamaguchi, places for healing and cave therapy, widespread in Northern Europe, or spaces in which to reconnect with nature, such as *Ca'n Terra* in Menorca, a project completed in 2021 by the *Ensemble studio*, which offers an inner journey into the matter by digging into the chthonic world.

All these different inspirations and interpretations provide valid points of reflection for the city of Naples, where the coexistence of very different underground spaces prompts experimentation with various solutions for continuity between the layers of the city. As Aldo Loris Rossi asserts, among the cities whose radiograph is most extraordinary of all the cities is Naples (Liccardo, 2019).

The city boasts numerous cavities and excavated archaeological spaces, both in the historic centre, sometimes already valorised and made accessible, interconnected with a tourist network that promotes their enhancement, and in the underground areas of urban peripheries.

The contribution presents specific project strategies for three locations in the city, situated on the outskirts of the historic centre but united by a rich archaeological underground: the Poggioreale area, where the archaeological underground layer has been overlaid with a monumental cemetery over the years; the Rione Sanità area, known for having some of the most spectacular cavities in Naples but currently facing significant issues related to crime and social unrest; the ancient Mount Echia area, whose archaeological underground features numerous quarries and tunnels constructed in very different periods (Fig.1).



Figure 1. Urban strategy for the three case studies of Naples, Chiara Barone.

Given this heterogeneity, the previously mentioned experiments serve as valuable starting points for proposing specific solutions that can explore the relationship between contemporary architecture and subterranean archaeological spaces. Exploring the relationship between the surface and the excavated *submerged rooms* involves experimenting with strategies to overcome the disconnection of archaeological spaces. This can be achieved by breaking through the *current ground* through operations like soil erosion, and material removal through cuts, excavations, and incisions, which facilitate the recognition of new *continuities* between the layers of the city and which activate hidden layers for an urban socio-economic revitalization. Starting from the study and previous research on the city of Naples (Miano & Bernieri, 2020); (Miano, 2021), different design approaches can be derived depending on the initial condition of the underground space and its relationship with the layers above. This leads to concrete practices that constitute successful solutions applicable in other stratified cities with similar starting conditions. Guiding this design experimentation is what Sergio Polano defines as the "chthonic," mining, ablation, a vein that "would allow for a broader and more objective appreciation of human constructive ability. Tunisian matmata and Sicilian dammusi; Matera's ravines and stones; Mycenaean and Perugia's hypogea; Rome's Cloaca Maxima; catacombs in Naples and Rome; the well of St. Patrick in Orvieto; the Paris sewers; the London Tube; the Simplon Tunnel; the Maginot Line; U-Boat shelters in France and the Atlantic Wall; physics laboratories at Gran Sasso; the Eurotunnel under the English Channel. And, if we reflect on contemporary events, architectural and urban interventions such as the Shinjuku shopping centre in Tokyo and the more recent one in Toronto; the Fosse Ardeatine monument in Rome; the Treasure Museum of San Lorenzo in Genoa; the Louvre Pyramid" (Polano, 1998, p. 2). This list, which can potentially grow longer, of underground

design experiments offers a broad canvas for further exploration. It represents a field of research that has always existed and, as Sergio Polano points out, is a unique vein capable of appreciating human construction skills and versatility.

3. Materials and methods. Explore the underground spaces through the design

The design exploration presented in this contribution, focusing on three case studies in the city of Naples, addresses emblematic and influential examples that serve as real demonstrators of the significant role that underground spaces can play as catalysts for the revitalization of larger urban areas. The design experimentation on specific areas of the city of Naples, identified as sample areas, allows for a better understanding of the issues to be tackled and the methodological processes to be employed. The choice of sample areas of comparable size stems from the desire to analyse limited urban contexts, and neighbourhoods characterized by specific social, economic, and cultural traits that are inherently part of the project. These sample neighbourhoods were selected with the aim of exploring highly diverse urban scenarios, both from an anthropological and geomorphological perspective. To comprehensively understand the urban fabric, the research relies on bibliographic sources, surveys, and projects related to the underground cavities of Naples, participation in conferences on the topic, as well as fieldwork involving interviews with residents and site visits. This approach seeks to gain a deep understanding of the context, not only as a physical space but also as a cultural, social, anthropological, and political dimension that defines it. The intersection of data resulting from the analysis phase allows for the generation of alternative proposals, gradually leading to the project solution that best meets the needs of Naples. The research process, which includes *turning points* and modifications along the way, makes it possible to derive a methodology and tools. The project is not just an end but rather a research endeavour that engages with reality, affirming certain processes from which a method can be extracted and applied in similar cases in other cities. This implies that through the project, the methodology adopted can be revisited wherever the presence of underground archaeological spaces can be seen as the starting point for urban processes capable of revitalizing entire sections of a city **(Fig.2).**

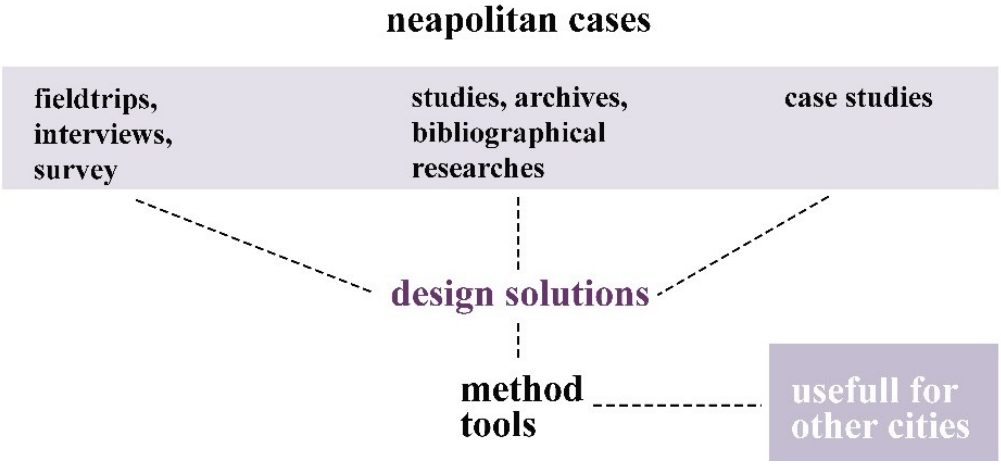


Figure 2. Methodological map of the design research.

In the case of the city of Naples, such as the Poggioreale hill, the Sanità district, and Mount Echia, the intersection and verification through similar case studies demonstrate the practical applicability of the proposed design strategies. These strategies can engage with contextual components like history, local culture, contemporary city dynamics and development, politics, geography, anthropology, and the economy.

Compared with the *Lascaux IV project* (2017) by *Snøhetta , Duncan Lewis Scape Architecture* in Périgueux for the underground cavities of the Poggioreale hill is highly significant. It guides the valorisation of Naples' cave spaces, which, like the French underground, are rich in ancient graffiti, offering the potential for an open-air museum. Similarly, the idea of enhancing not only specific

excavated spaces but the entire urban surroundings find grounding in Toni Girones' project for the *enhancement of the "Illa De La Pietat".* In this project, like the Sanità district, the overlaid layers are repositioned within a unified perspective of contemporary design.
The comparison with analogous cases and reference projects allows for the delineation of concrete scenarios and configurations that can stimulate architectural and urban planning for the city's future. This approach aims at reconnecting the hidden underground layer with the emerging and constantly evolving city. It also serves as a guide for the iterative process of design research in cities with similar starting conditions.

4. Design strategy: A proposal for three undergrounded spaces in Naples

The theme of overcoming the atopy of the archaeological underground and the "breaking" of the *current ground through excavation* (Benjamin, 2003, p. 112) to enable a continuous vertical reading of the city is of great significance. It has been explored in various publications and many architectural and urban projects. The desire to explore the city of Naples through design stems from an interesting design debate that began in the 1980s. In 1988, during the *SottoNapoli* exhibition and the international workshop Napoli Sotterranea (Lampugnani, 1988), held to promote the underground spaces of Naples, seven prestigious professional architects were invited to develop design proposals for the chthonic city. This design exercise proved to be genuinely useful and interesting, providing a range of solutions that, although specific to the location, retained a degree of generality that made them methodologically transferable into possible actions in the urban underground space (Dell'Aira, Grimaldi, Guarini, & Lambertucci, 2015).
Carlo Aymonino, for instance, proposed not to transform the caves into architecture by altering the original material but to insert sculptural and architectural pieces capable of explaining their contemporary use. Through a system of punctual and widespread grafts, it became possible to transform the cave system into places of archaeological knowledge beyond the *museum aura*, with the broadest possibilities for experimental integrations and variables over time. This approach aligns with the proposal made by Francesco Venezia the previous year, to use the underground spaces of Mount Echia as an extension of the city's Archaeological Museum.
Francesco Venezia displayed significant interest in Naples' underground and proposed, as part of the *17th Milan Triennale* in 1987, titled "*Imagined Cities: A Journey in Italy. Nine Projects for Nine Cities*", a section dedicated to the city of Naples, specifically focusing on "Interventions for the Pozzuoli Project." He collaborated with other designers such as Guillermo Vasquez Consuegra, Uberto Siola, and Alvaro Siza.
"Exposed in equal measure to the dominion of the sun and darkness, the city experiences the dialogue between the surface and the underground" (Venezia, 2006, p. 119). The visible form of the city is merely the emergence of what lies hidden underground: caves, grottoes, and tunnels crisscross the city in every direction, intertwining at different depths. The goal of the project presented at the Triennale was to make at least a part of Naples' underground spaces accessible, connecting them through an underground itinerary that would include some artefacts from the *National Archaeological Museum of Naples* (MANN).
In this way, archaeological remains returned to their original space, narrating the city in a mobile manner. Many were the project ideas proposed during the experimental design workshop for Naples' underground. Bohigas and Botta perceived the subterranean space as a symbolic, useless, and grotesque space where alternative solutions and fantastic uses could be experimented with, stimulating the imagination of the visitor, such as an aquatic itinerary. De Sola-Morales suggested stimulating the imagination by enhancing the understanding of the underground and increasing its intersection with the city above through vertical grafts into the material thickness of the ground. Rossi, on the other hand, argued that the excavation of new traces and underground paths allowed for an understanding of what lies beneath while simultaneously increasing one's awareness of the city above (Rossi, 1988, p. 98). Zanuso interpreted the Neapolitan caves as a space of nature, a space that returns to naturalness, starting from the fertility of the soil that, with native plant species, reappropriates the long-abandoned

underground rooms. These design experiments are crucial as they represent an initial archive of ideas and define a first transformative approach aimed at overturning the logic of separation between the city above and the city below, attempting to imagine new physical and visual relationships, new uses and interconnections between currently fragmented interstitial spaces. Building on the foundation of these design considerations, the research proposed in this contribution continues the exploration of ways to overturn the existing separation logic between the different levels of the city through innovative design solutions.

The pervasive reality of Naples' underground city, a dual city filled with cavities, passages, grottoes, aqueducts, cisterns, and archaeological remains, must be interpreted in continuity with the surface, through design interventions that can reconnect the layers of the city vertically (Varriale, 2004). The separation between the surface and the underground is not only a "physical" barrier but also a "temporal" one, often stemming from a lack of knowledge and information about what is not visible.

The breaking of the vertical limit necessitates a renewed relationship between different temporal layers of the city, a new connection between diachronic layers, ancient and new, coming back into contact, as seen in the city of Cartagena with the intervention by Rafael Moneo. His project proposes to incorporate and connect existing buildings and voids within the urban fabric of the city, creating a museum pathway that "leads from low to high levels, unfolding through exhibition spaces illuminated by a complex system of skylights, and develops by providing visitors with mechanical means of elevation, including stairs and elevators, guiding the presentation of the remains found during excavation campaigns. It is, therefore, a *museum promenade*" (Moneo, 2008, p. 60). The idea that the design process can take the form of a *museum promenade* allows for the overcoming of the notion of separation between above and below, between archaeology and the city, experimenting with intriguing solutions to include subterranean ruins in the contemporary dynamics of the city (Segarra Lagunes, 2017). In this regard, even the vertical limit begins to be seen differently, not only as a contrasting element but also as a place for potential dialogue between architectural and urban spaces from different eras.

Andreina Ricci suggested that "the boundaries that currently encircle areas of the past, like borders that were sought to be advanced during times of war through military actions, could become jagged boundaries that reconfigure themselves from one project to another, marked as they also are during times of peace, negotiation, legal, political, diplomatic relations, and above all, dialogue with neighbours, exchange, conversation" (Ricci, 2006, p. 147).

The *space of conflict* between the contemporary city above and the ancient city below is the space of design, which, in a unified vision, must bring together the layers of the diachronic urban system. This is clearly visible in many contemporary projects of *public archaeology*, as in the horizontal redefinition project of the archaeological margin of the *Temple of Diana* in Mérida by José María Sánchez García, or in the vertical archaeological section design of the *Machado de Castro Museum* in Coimbra by Gonçalo Byrne, where the subterranean archaeological layer, in its complexity, constitutes the primary material for a unified project (Byrne, 2022). Therefore, the project must emphasize the internal/external relationship, as well as the above/below perspective, both physically by allowing direct connections and increased accessibility, and emotionally by stimulating the curiosity of residents and tourists, who are not accustomed to the idea of something hidden beneath their feet.

"But Naples is not only what can be seen in glory or decay. One can almost feel, beneath one's feet, the breath of an invisible or hardly visible world that for many centuries has been building the current city. An enormous and fragmented foundation of many layers, materials often superimposed, placed there by people from different regions and religions. So magnificent monuments emerge, which sometimes men discover by digging. This accumulated material conditions and directs what is being built today" (Siza, 2005, p. 24). The project, as an articulated process, envisions a progressive construction that unfolds over time, gradually establishing *new urban relationships* (Acocella, 2021), with the aim of unveiling the accumulated material beneath the surface that is not visible. As Agamben writes, archaeology is the only way to access the present, due to its intrinsic ability to permeate "every level of stratification, but also to stand outside in order to grasp all together and discern the intricacy

of the relationships of reciprocity and correspondence that bind them together and with what surrounds them" (Carlo, 1995, p. 19). Understanding these palimpsests is a complex but necessary action to build knowledge, memory, and identity of places without compromising them (Padovan, 2009). On one hand, there is the need to delve into the *repressed layers of the city* to permeate the different strata; on the other, there is a need to work with a multiscale approach that allows for the repositioning of scattered interventions and ancient fragments within a larger, complex, and systematic framework.
In this regard, for the city of Naples, reflection has been made on a broader strategic system founded on micro-interventions located in specific areas that are particularly relevant to the theme and can act as driving areas: Poggioreale, Sanità district, and Mount Echia.

4.1 Under the cemetery of Poggioreale Hill

The area of the Poggioreale cemetery hill, which is complex and multi-layered, is currently at the centre of the debate regarding Naples' future urban projects due to its condition as a cultural landscape at risk. The atopic and temporal suspension characteristics of the place create a significant criticality, stemming from the interruption of relationships between the contemporary city and the ancient fabric, between the exterior and interior **(Fig.3)**.

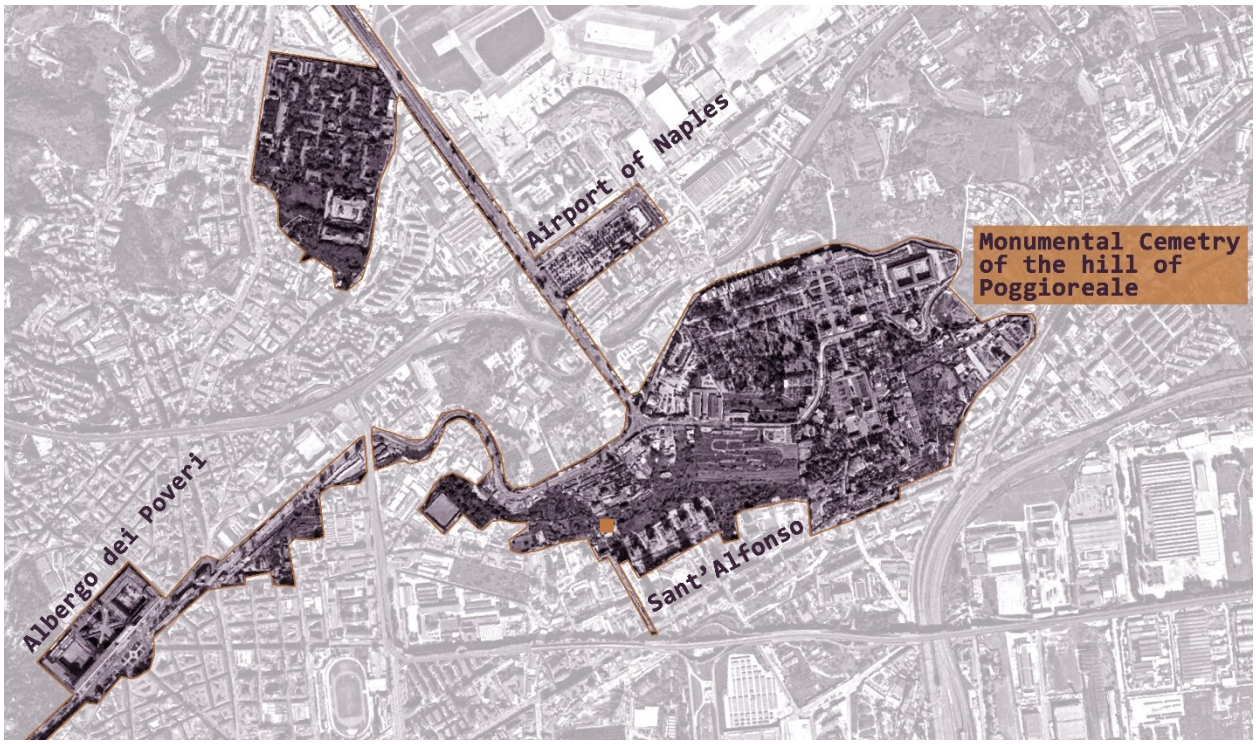


Figure 3. Interpretative map for the area of Poggioreale Hill, Chiara Barone.

The project idea proposed for this area is driven by the desire to strengthen the existing relational processes between Poggioreale Hill and the urban centre to overcome the separation that has led to considering Poggioreale as a peripheral area for years.
The project proposal aims to emphasize the continuity between the hills of the metropolitan park of Naples, a continuity found in both architectural-monumental and landscape characteristics. What is of considerable interest is that this continuity between the Poggioreale hill and the other hill of the city is also manifested at the subterranean level: there are numerous ancient cavities, such as the Grotta degli Sportiglioni, which, both in their articulation and in the historical period of their construction, can be considered an extension of the complex system of Naples' archaeological underground, hidden and underappreciated.
The project, therefore, intends to start from the system of elements scattered underground, with the intention of integrating them into a single large multi-relational complex, nourished by open multi-level intersections capable of reconnecting the layers of the city.

This connection between the layers begins in the Sant'Alfonso district, a residential district south of the cemetery area, where the pre-existing retaining wall becomes a design element: the decomposition of the wall, seen as an inhabited element with variable thickness, allows for incorporating access to the underground system from the urban level while also reconnecting this space with the higher elevation of the park.

The subsoil of the hill has only been recently explored by Neapolitan speleologists, including Clemente Esposito (Esposito, 2018), when numerous collapses and sinkholes occurred following the construction of the tunnel for the metropolitan subway network.

This necessitated an investigation of the soil and any potential *interferences* between the cavities (Farris, Grimaldi, & Lambertucci, 2019). It is precisely from the condition resulting from the primitive "colonization" of the hill that the project aims to start, using a subtraction-based approach to promote the opening of "cuts" capable of reconnecting the subterranean level to the upper park level and providing access to the underappreciated cave system. Access to the caves and tunnel system, as well as the connection with the metropolitan tunnel that will cross the area at the subterranean level, becomes the driving element for a dual connection: vertical and horizontal. The desire to create new continuity between urban layers, the subsoil system, and the upper park system is expressed within the interpretive drawing, where a system of gradual squares and specific entrances to the cave system allows for the crossing of the hill from bottom to top and from the outside to the inside of the ground **(Fig.4)**.

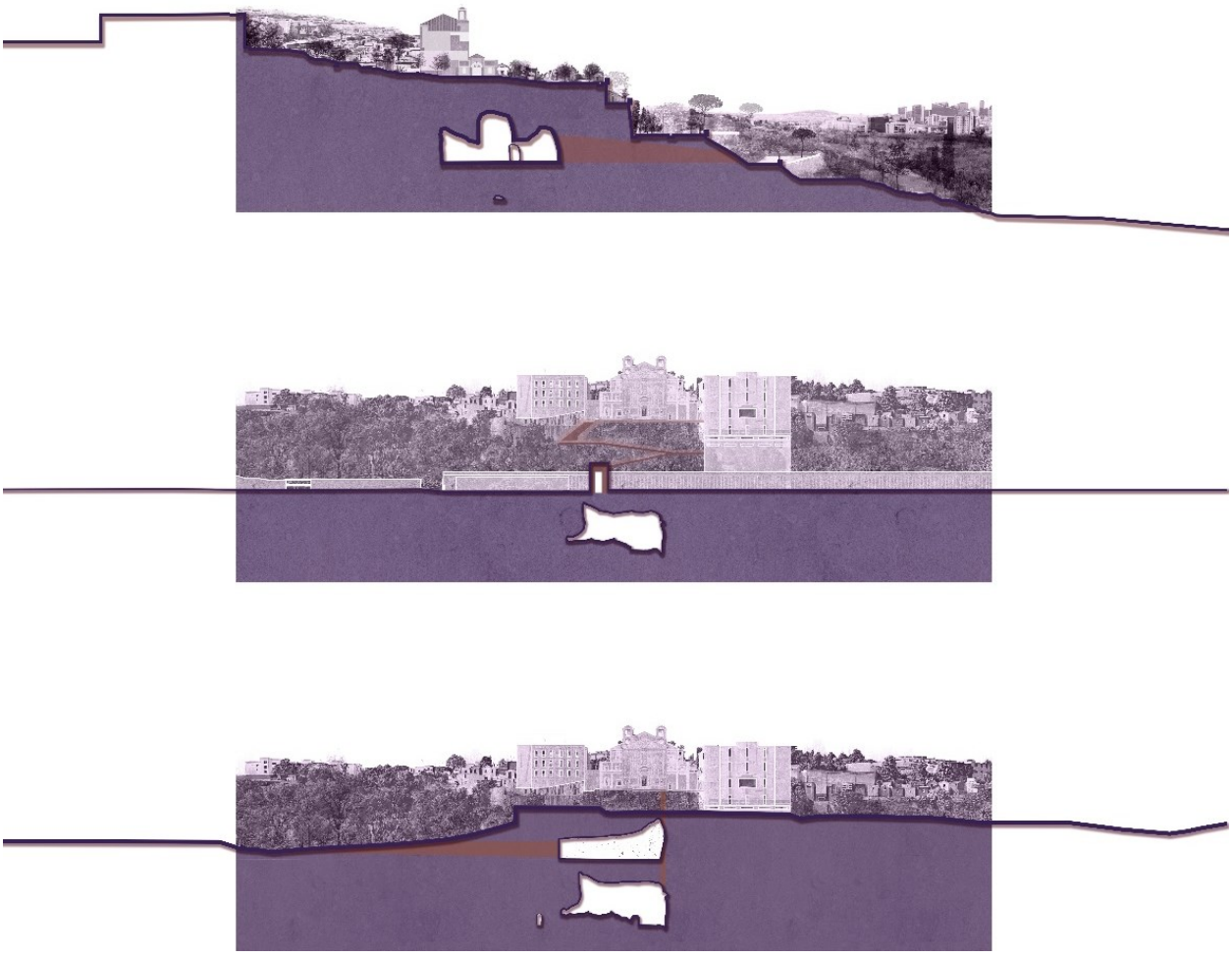


Figure 4. Sections of the underground caves of Poggioreale Hill, Chiara Barone.

The second connection is the vertical one: through discussions with speleologists, it emerged that there is a possibility to introduce a vertical design element that reconnects the layers of the soil by traversing them. This idea draws inspiration from the project proposal made by De Sola Morales for the

experimental workshop *SottoNapoli* in 1988. This vertical element would penetrate the ground at the point where geological surveys and investigations have already determined an opening. It would establish continuity and provide access to various ancient caves located at different elevations, ultimately leading to the square in front of the Church of Santa Maria del Pianto. From the square, one can access the new high/low connection element to reach the intermediate elevation, which is the urban level of the Rione Sant'Alfonso **(Fig. 5)**.

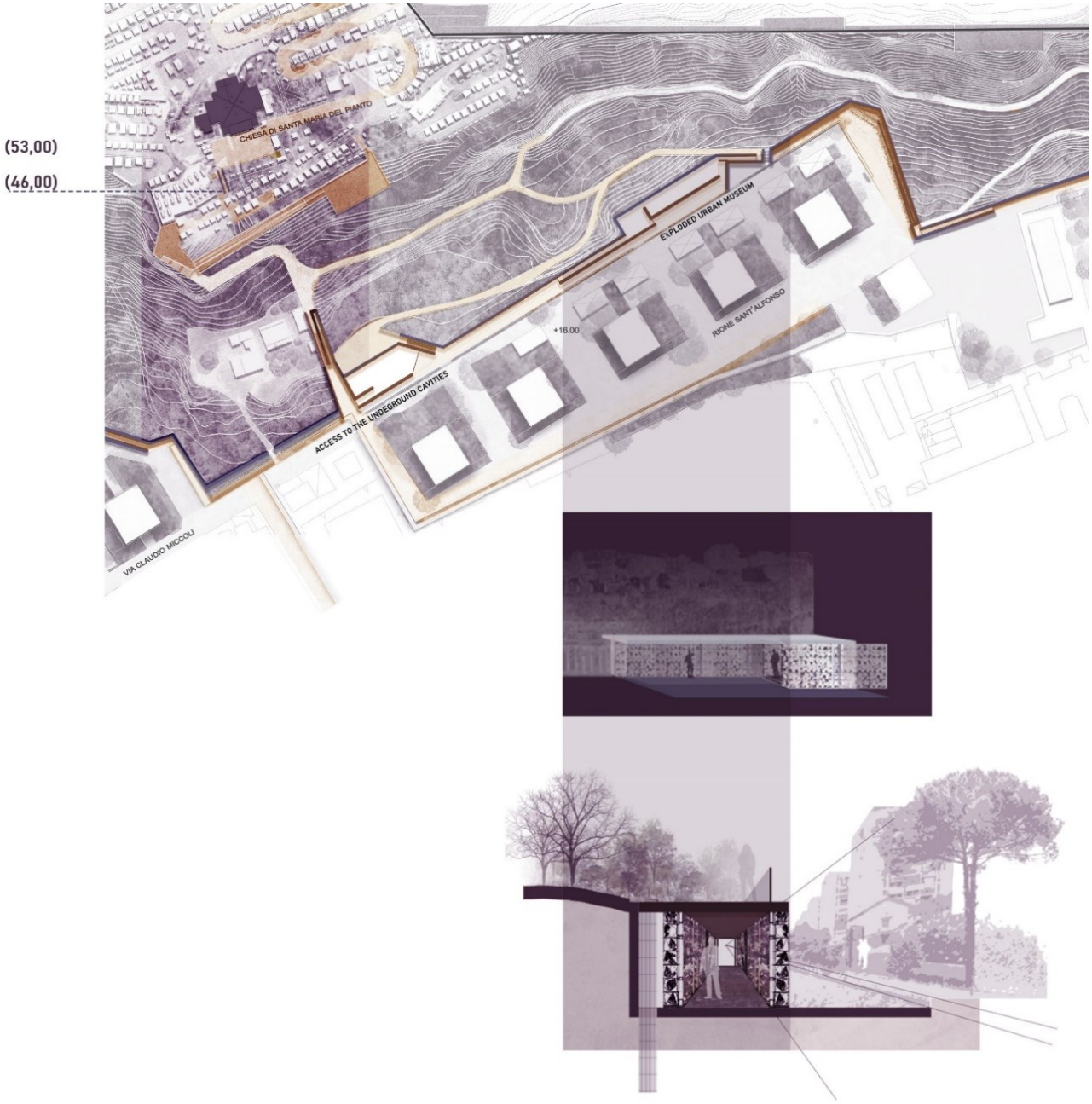


Figure 5. Vision from the level of S. Alfonso's district, Chiara Barone.

From there, one can descend further into the heart of the city to reach a second cavity located at an even lower elevation. This cavity is rich in ancient graffiti, making it a *spectacular underground museum space* in the city. The design element, therefore, intervenes by reconnecting the three levels of the city. It makes the ancient cavities accessible and usable while also providing a new horizontal passage that extends to the underground metro tunnel that is under construction **(Fig.6)**.



Figure 6. Vision from underground: crossing Poggioreale's hill, Chiara Barone

4.2 Under the Sanità district

The second area of interest is the Sanità district, located north of the historic centre, where underground structures like the Hypogeum of the Togati, Hypogeum of the Pomegranates, and the Hypogea of Vico Traetta have been discovered since 1685. These underground sites are distributed in a well-defined area just outside the city walls. The last discovery dates to 1888 when excavations from Vico Traetta to Vergini continued towards Porta San Gennaro, bringing to light some tombs in the Hypogeum of the Cristallini, four contiguous rooms entirely carved into tuff, consisting of a vestibule and an underlying hypogeum (Esposito, 2018).

These archaeological fragments, belonging to different eras, can be reconnected both physically and figuratively, involving the urban public space. The numerous hypogea found here, such as those of the Togati, Pomegranates, and Vico Traetta, or even the Hypogeum of the Cristallini, can be made more attractive through an archaeological setup connected to the *National Archaeological Museum of Naples* (MANN), by integrating archaeological exhibitions into the urban space. Continuing along the historical axis of the district, the ancient Via Sanità, it is possible to reach the complexes of the catacombs of San Gaudioso, San Severo, and Santa Maria della Vita, which can become additional points for archaeological exhibitions and displays related to archaeology and the city.

The project intervenes through a hybrid path, which oscillates between the above and the below, ensuring continuity between the scattered spaces in the archaeological underground, the contemporary city above, and its monuments, to unveil the archaeological areas of Sanità in new ways **(Fig 7)**.

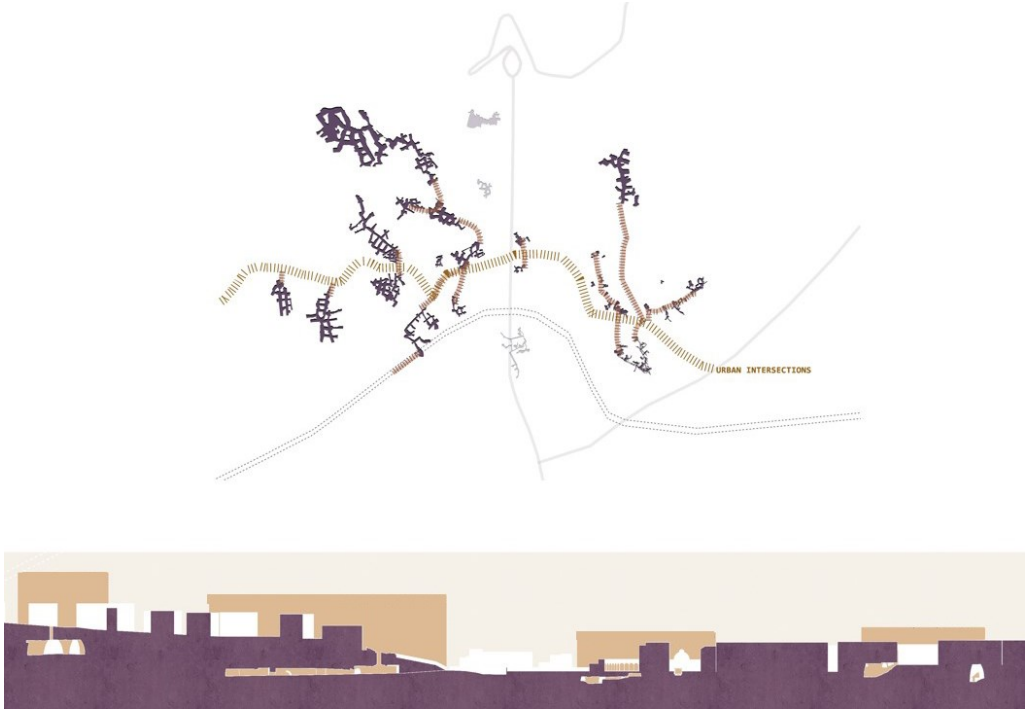


Figure 7. Interpretative map for the Sanità's district, Chiara Barone.

The contemporary grafts act punctually to ensure the up-down connection and access to the archaeological caves, which constitute an identity for the neighbourhood and can promote socio-cultural and economic revitalization by attracting new tourist flows.

These specific insertions are held together by a continuous path, that guides the user in visiting all the catacomb systems, expanding to the city level to create high-quality public spaces to be returned to the local population. In this perspective, the design process is not just an archaeological route but an urban crossing: within the courtyards of historic Neapolitan buildings, new specific elements can be inserted to allow access to the underground, serving the community.

The Neapolitan model is similar to many other European and Italian cities. An example is the city of Siena, where the former Santa Maria della Scala, ex-hospital complex has been transformed into an archaeological museum open to the city, traversable on multiple levels and capable of reconnecting two different urban levels. From Piazza Duomo, through the historic hypogea, it is possible to reach Via Fosso di Sant'Antonio, where additional exhibition spaces can be found. Like Siena, in Naples, the project intervenes not only in urban connections but also within the underground, through an exhibition system that enhances the ancient spatiality and engages the senses of the visitor, who will be emotionally involved in discovering a place that was previously unknown.

Absolutely, the exhibition serves as a strategic and design tool for appropriating archaeological space, promoting a full understanding, and gradually opening these spaces to the city **(Fig.8)**.



Figure 8. From the public space to the underground museum in the Sanità district, Chiara Barone.

4.3 Under the Echia hill

The third area of interest is the underground of the Echia hill, the foundational area of the city with a highly stratified palimpsest: ancient cavities, water cisterns, a long Bourbon tunnel, important squares like Piazza del Plebiscito all interlace to form a complex continuous system (Caterina, 1987).
From Piazza Municipio, with the project by Alvaro Siza and Souto de Moura for the archaeological-metropolitan station and its square, you reach Piazza del Plebiscito, with the Royal Palace and its garden.
From there, crossing Mount Echia, you reach the Chiaia district, with the municipal villa, a public park that extends along the seaside promenade to the Vergiliano Park, at the foot of the Posillipo hill. The two hills, Echia and Posillipo, are intersected by underground tunnels, no longer used for city transportation but still existing.
Establishing a new connection between these two diachronic underground systems involves new excavation work that facilitates the opening of an underground urban passage, always accessible below ground level, with the dual function of unveiling the ancient cavities and reconnecting two pieces of the city, reducing travel times: from the historic centre at Piazza del Plebiscito, the subterranean path allows you to reach Piazza Vittoria, the opening to the public park system of the Neapolitan villa, and then, through the *Crypta Neapolitana*, it is possible to cross the Posillipo hill, reaching the Fuorigrotta district **(Fig. 9).**

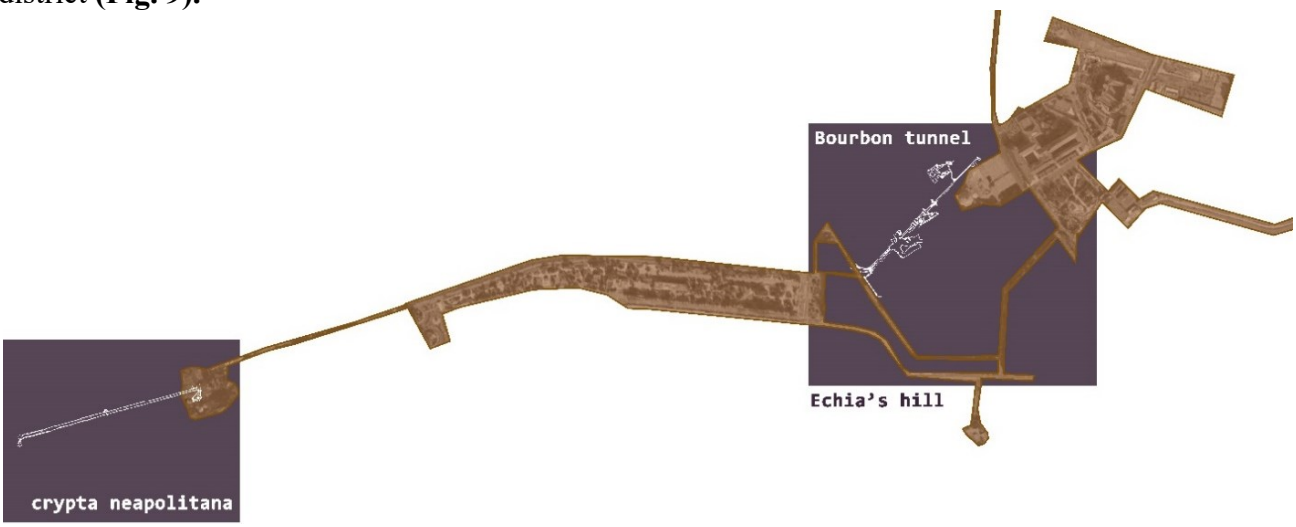


Figure 9. Interpretative map for the underground cavities of Mounts Echia and Posillipo.

The design exploration has focused on the area of the Mount Echia, where there is a significant presence of underground infrastructures. The possibility of providing continuity to these incomplete and disconnected cave systems leads to the proposal of creating a unified system that, from Piazza Plebiscito, through the underground of the Church of San Francesco di Paola, allows direct access to the Bourbon gallery in Via Morelli, currently used as a parking lot and for exhibitions and events.
A continuous system, supported by the blending of various public functions, promotes the intersection of heterogeneous uses, resulting in hybrid itineraries. The idea of transcending the typological and formal paradigm of the tunnel as a space for transit, solely functional for urban mobility, leads to the discovery of new correlations with the forms of residential space and exhibition space, to showcase the submerged archaeology in the soil.
The design logic to be adopted is like that described by Moneo for the creation of the museum in the archaeological areas of Cartagena, where the project is an urban path capable of systematizing the subterranean spaces along with the contemporary city above **(Fig.10)**.

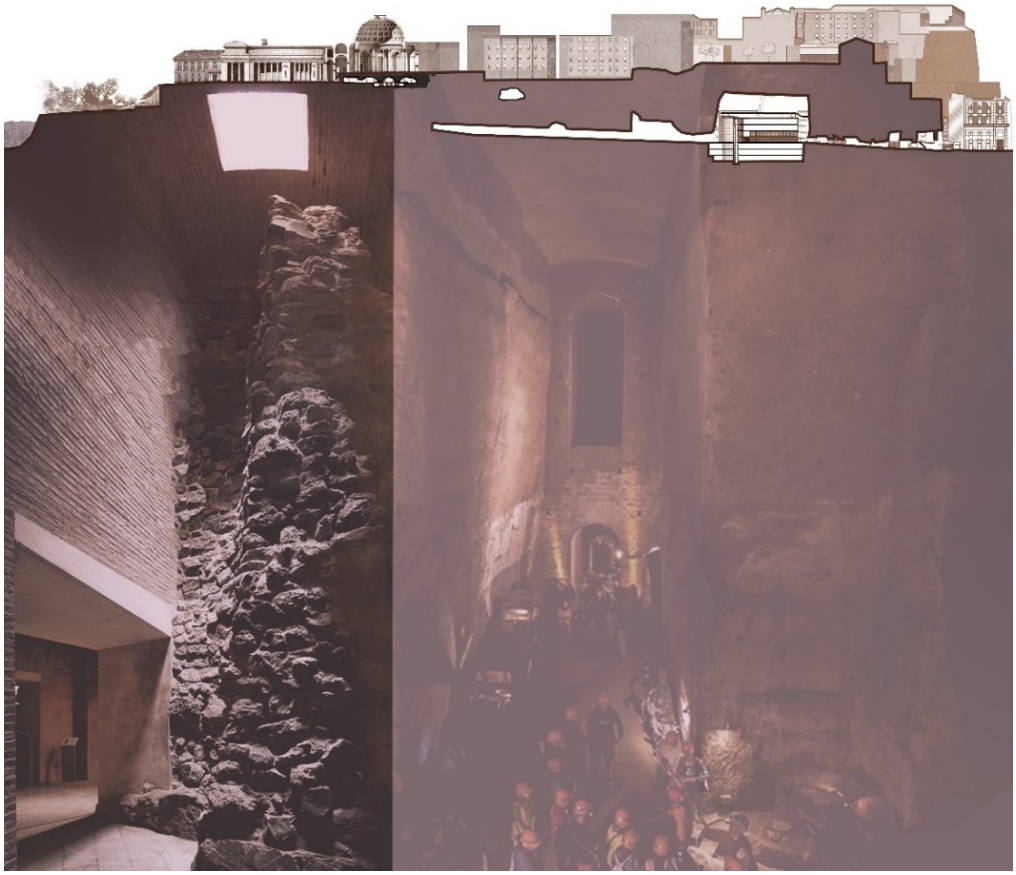


Figure 10. Vision for Mount Echia: between strata, Chiara Barone.

Pathways, tunnels, and galleries for urban transit connect excavated spaces from different eras: from the narrow section of the transit space, one enters very spacious areas where, like in a catabasis process, the visitor loses contact with the outside world, entering a state of *sensory deprivation* (Ustinova, 2009, p. 154), i.e., a loss of senses due to the interruption of contact with external stimuli.
In the specific case of Mount Echia, underground cavities such as the ancient aqueducts and cisterns, the Bourbon tunnel, as well as spaces intended for contemporary use like parking, are connected in a unified vision with public spaces, bridging the gap between the surface and the underground (Cervini, 2023), for a journey through the body of the earth that moves from the contemporary urban scene.

5. Discussions. Open visions and possible configurations for a new continuity between urban strata: from Naples to other cities

The previously described case studies, related to specific areas in the city of Naples, are important, as they demonstrate the validity of the research question and provide real-world solutions that can be applied in a specialized manner to other cases with similar conditions.

The research, which primarily aims to demonstrate how the space of the archaeological underground can serve as a strategic starting point for bridging the gap between the above and below while highlighting the hidden archaeology beneath the Earth's surface, is proven in all three cases in the city of Naples, despite their heterogeneity **(Fig.11)**.

Whether in the case of a specific intervention in the underground, as in the area of Poggioreale, or in the case of a chain of interventions defining an archaeological-urban path that moves between above and below, as in the Sanità area, or the case of more extensive infrastructure development of the ground with the continuation of excavation and the systematization of diachronic underground elements, archaeological cavities can, in different ways, stimulate a reversal of the city's spatial dynamics.

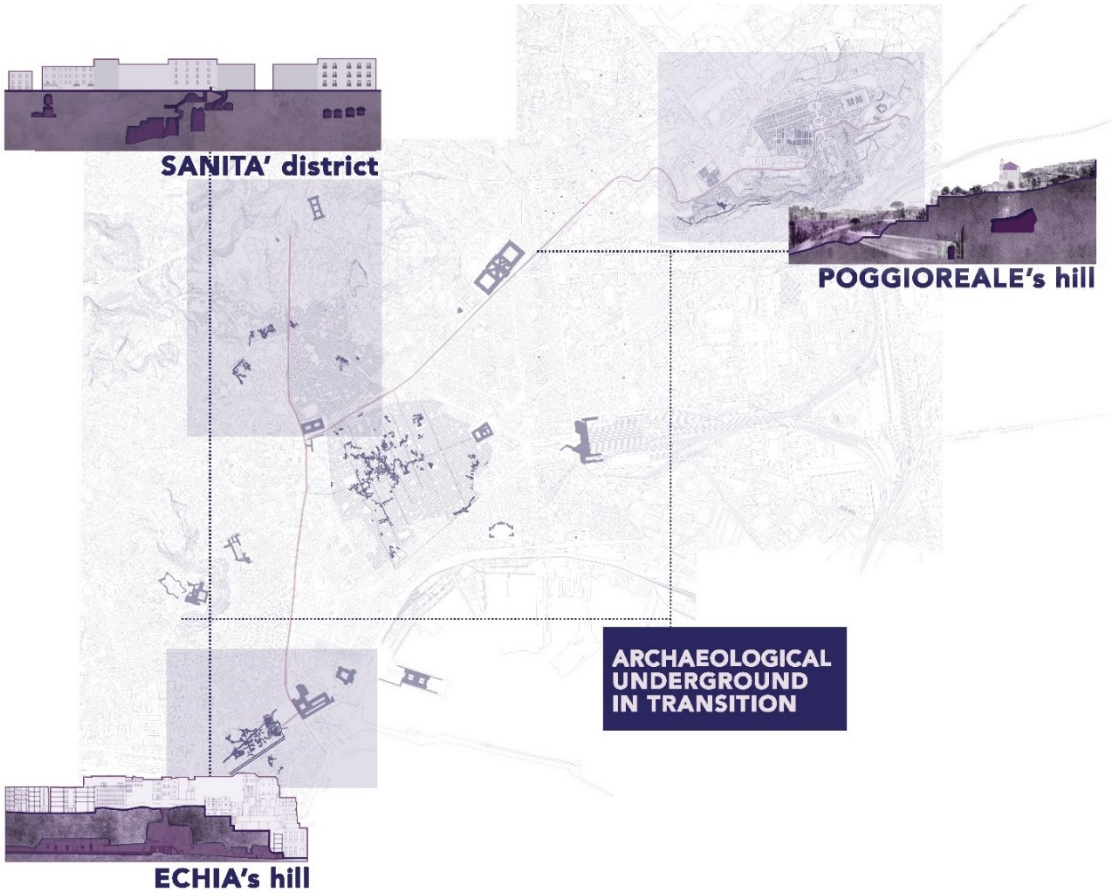


Figure 11. Urban strategy and architectural grafts for the underground in Naples, Chiara Barone

The choice to analyse very different cases from each other has allowed for the development of highly varied design solutions, all capable, however, of reversing the condition of isolation of the underground compared to the contemporary urban scene.

The three projects, described also through visualizations, are useful for deriving a research process and for understanding the tools that have contributed most to achieving effective applicable solutions.

The search for design solutions, the comparison with similar cities and reference case studies, along with a deep understanding of the location, undoubtedly constitute the main tools of this experimentation aimed at enhancing the ancient underground space.

This enhancement aims not only to enable accessibility and use but also to stimulate the local economy through new tourist networks and to convey the social, cultural, and historical values of the place through a *community-based* approach that involves the local population fully.
Economic sustainability, local involvement, and integration with broader tourist routes allow for the development of a project capable of *self-financing* over time, activating processes that operate over the long term, driving new chain reactions that gradually move these places away from oblivion and abandonment.
"First, temporary or settled occupation of the cave as a refuge, [...], then 'very specific paths, double volumes, intersecting views, targeted openings to the outside, everything thought out, everything imagined, everything designed: from the mere reuse of existing places or the realization as the sum of works and interventions capable, only at a later stage, of giving rise to a system, to an *urban idea of the underground*" (Boschi, 2015, p. 30). The design methodology identified can be applied to other situations where the contemporary city has taken precedence over the archaeological underground: accessibility, usability, visitability, enhancement and understanding of spaces, as well as innovative uses, local participation, tourist networks, exhibitions, and staging, are all project themes that methodologically guide an intervention to reconnect the archaeological underground layer.
The three design interpretations related to archaeological spaces in the urban underground of Naples are therefore just some of the possible *trajectories* to explore through design, with the common goal of investigating achievable solutions to overcome the separation between the underground and the surface and to reactivate underground spaces, preparing for the city of the future a unified and continuous scenario, as it was in the past.

6. Conclusions: Design approach to overturn the separation between the city above and the underground

The research contribution experiments with design solutions for ancient spaces underground, proposing actions of reconnection that intervene in the interstitial spaces between the above and the below. The strategies for the three sample areas in Naples define open and evolving processes, capable of triggering multiple transitions both for the archaeological space underground and the urban space.
The proposed solutions are all very current and consistent with the real data. In the case of the Poggioreale hill, the project aims to be a connection between urban layers, but also as a filter for entering the chthonic world, to be protected and enhanced.
The blending of public spaces that are always accessible, such as the Cemeteries Park, and spaces to be enhanced with controlled access, such as the ancient Greek cavities, allows for the achievement of a dual project approach that has proven very successful in the Neapolitan case. It also allows for interventions in subsequent stages through step-by-step project actions.
The phased approach to project solutions defines a valid method even in the intervention for the Sanità district, where the social and cultural issue necessitates a slow and gradual involvement of the population for a complete acceptance of the changes implemented. Authorities, organizations, citizens, and specialists involved can thus gradually support the transformations introduced by architecture, between what is visible and real and what is invisible and can be imagined, proposing modifications and adjustments where necessary. In this regard, numerous associations currently work actively in the Sanità area, proposing substantial processes to valorise the architectural heritage.
The research method and tools adopted define a holistic approach that can also be applied to similar cases, with the common goal of overcoming the existing separation between the underground and aboveground aspects of the city. However, the applicability and feasibility of the solutions implemented must also confront technical constraints.
The architectural space underground is inherently difficult to fully understand from a formal and geometric perspective. The lack or insufficiency of ground-penetrating radar surveys and graphic representations or surveys of these spaces poses a significant challenge for architectural design, which inherently requires a thorough understanding of the spaces it operates in.

Therefore, the research can orient itself towards finding new ways to understand space and new processes capable of making more rapid and technologically advanced modifications, like the use of BIM for most aboveground architectures. Expanding the research field to include technologies can lead to greater integration between knowledge, surveying, and design, enabling a more rapid adjustment of proposed architectural solutions during the knowledge phase. In conclusion, the subterranean city should be interpreted as a palimpsest of opportunities and new principles, offering fresh perspectives in architectural terms and new methodological approaches and research tools. These approaches draw from contemporary trends that increasingly view underground living as an ideal housing model for the city of the future.

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The Author declares that there is no conflict of interest.

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Individual Work. The Author has read and agreed to the published version of the manuscript.

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Original scientific paper

Urban Form and Real Estate Value in Msheireb Downtown Doha, Qatar

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ABSTRACT

In the late 20th century, Doha's rapid urbanization and globalization led to the loss of housing and the compact, traditional urban fabric in the old city center. The Qatari government and Msheireb Properties developed Msheireb Downtown Doha to bring urban living back with a contemporary re-interpretation of the traditional urban fabric and modern life conveniences. Our study's primary objective is to investigate the relationship between urban form and the rental value of residential units, identifying factors that might influence rental asking prices. The paper examines morphological characteristics through field surveys and the real-estate variables such as location, floor area, number of bedrooms/bathrooms, and asking price collected from publicly available real estate websites. The findings indicate that the residential units' layout and adjacent streets' morphological characteristics clearly define specific targeted user groups. Larger residential units target Qatari families via more bedrooms/bathrooms and quieter urban settings, emphasizing Islamic cultural values. Smaller units target ex-pat workers (especially Westerners) using open-plan layouts in more lively urban environments of the development. The price per square meter also increases for residential units closer to the Doha Metro station. The study reiterates the success of compact living for improving urban living in other neighborhoods of old Doha.

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Highlights	Contribution to the field statement
- The findings indicate that the residential units' layout and adjacent streets' morphological characteristics clearly define specific targeted user groups. -User groups are targeted via the layout of residential units, number of bedrooms/bathrooms, quality of the urban setting, and emphasizing Islamic cultural values. - The price per square meter also increases for residential units closer to the Doha Metro station. -Mshereib Downtown Doha provides a new model of urban living in the Gulf Cooperation Council (GCC) and Middle East regions.	The article contributes to academia by providing insights into the relationship between urban form, real estate values, and societal factors, offering valuable knowledge for urban planners, economists, and researchers interested in sustainable urban development and its socio-economic implications.

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1. Introduction: Urbanization in Qatar

During the mid-twentieth century, Qatar began to experience urbanization fed by a natural gas and oil boom. Over the past few decades, this has led to significant physical, cultural, and economic development in its capital city, Doha (Scharfenort, 2012). It increased job opportunities and the number of workers migrating (expatriates or ex-pats) to Qatar, especially males, during the 1960s and 1970s. Many moved into the old city center. These demographic changes coincided with many Qatari families leaving the historic city center and moving to the new city suburbs due to lifestyle preferences for new contemporary two- and three-story villas (Wiedmann et al., 2012; Wiedmann & Salama, 2013; Ibrahim et al., 2019; Furlan et al., 2019; Al-Mohannadi et al. 2019; Al-Mohannadi et al., 2020). From the mid-1990s, Doha witnessed a mega-project phase of urbanization with significant urban developments such as Education City and the Qatar Science and Technology Park (Rizzo, 2014). Mega-events accelerated the city's rapid and vast built environment growth, including the 1995 World Youth Cup, the 2005 West Asian Games, and the 2006 Asian Games (Furlan et al., 2019). In this way, massive investments fed the infrastructure, real estate, hospitality, and tourism industries, resulting in unprecedented urban innovation. The 2008 Global Financial Crisis drove a momentary pause in urbanization, marked by excess housing and declining oil and gas prices (Rizzo, 2014). Awarding of the International Federation of Association Football (FIFA) World Cup 2022 to Qatar fed a development renewal beginning in 2011, the creation of stadiums, infrastructure, and a new public rail transport system (e.g., Doha Metro) over the last decade. Throughout all of this, the country's ex-pat population continued to grow, which is currently 89.5% of the country's total population (Ibrahim et al., 2019).

With rapid growth and modernization came a perceived loss of Doha's identity in terms of architectural style and its traditional urban fabric. A predominant Western influence is evident in the building language of urban developments such as West Bay, a new business district of Doha, and exclusive residential areas such as the artificial island of The Pearl-Qatar (Al-Amadi et al., 2022). Multi-story housing with commercial developments and ancillary services replaced the traditional courtyard-type houses (*Figure 1*), attached wall to the wall forming a *fereej* (neighborhood), creating a sense of community by delivering space for communal activities and gathering (Wiedmann & Salama, 2013; Al-Mohannadi, 2019; Al-Mohannadi et al., 2020). The cultural continuity formed by the spatial arrangement of the traditional urban fabric, preserving social traditions from the private domain of the home to the public realm of the traditional souq (market) and mosques, began to fade away. Doha's urban spaces became dispersed and unsociable. The cityscape became dominated by cars, large highways, and parking lots, which encourages people to stay in their vehicles, making it difficult for people to stroll around neighborhoods (Wiedmann & Salama, 2013). Exclusionary zoning practices keep residential activities away from social and commercial uses and discourage gathering in public places outside of air-conditioned hotels and shopping malls.



(a) (b)

Figure 1. (a) Traditional urban fabric of Qatar and (b) the automobile-dominated cityscape of Doha (Source: Msheireb Properties).

Like other countries in the Gulf Cooperation Council and Middle East region, Qatar shares Islamic principles as a foundation for its core beliefs. Among them are residential privacy, the interrelationship between mosques, souqs, and homes in the urban environment, and some cultural barriers like gender segregation (Al-Khani, 2018). These ideas served as the factors for the urban expansion of Doha. Some have transformed or disappeared in the modern metropolis, resulting in the disappearance of the local Qatari identity, where a key goal of sustainable communities is identity preservation.

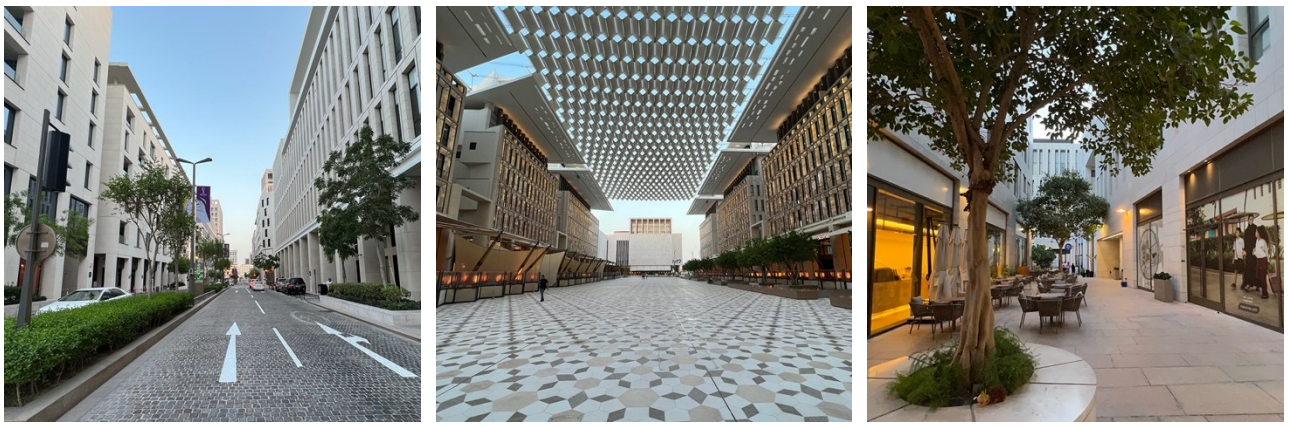


Figure 2. Views of the Msheireb Downtown Doha development in old Doha in 2022 (Source: Authors).

1.2 Development of Msheireb Downtown Doha

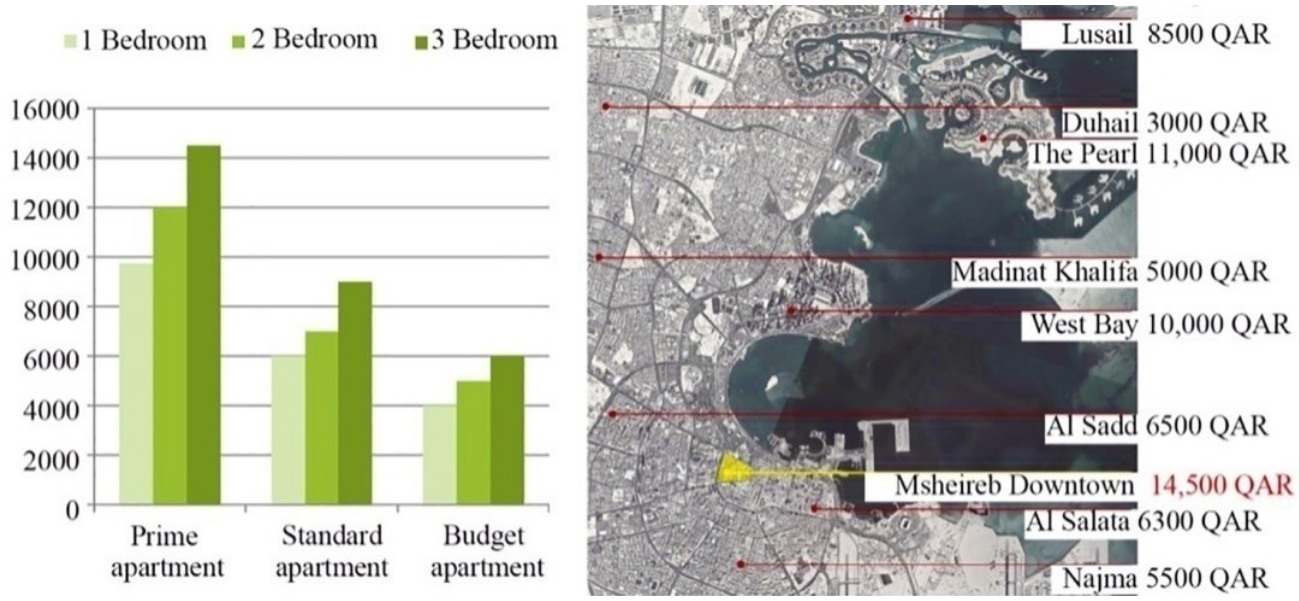
The master plan of Msheireb Downtown Doha (MDD) was developed to address these effects and re-establish a Qatari culture and traditional style of architecture in an innovative re-interpretation for the urban regeneration of the city center (Tannous et al., 2021). MDD attempts to revitalize the inner city's downtown area and restore a way of life built on communities, trade, and a sense of togetherness for contemporary life (*Figure 2)* (Al-Khani, 2018). Msheireb Properties is the developer of MDD, a real estate group and a division of a state-led organization called Qatar Foundation. MDD is an outcome of the Qatar National Vision (QNV 2030), which emphasizes expanding and developing cities in a more sustainable manner, striking a balance between modernization and heritage or cultural identity at the center of urban development in an Arab and Islamic nation. According to Msheireb Properties, the MDD regeneration project aims to bring Qatari families back to the historical neighborhood by providing a sense of community as the backbone of traditional Islamic society. It includes mixed-use land planning, accommodating residential, commercial, cultural, retail, and entertainment facilities spread across 0.31 square kilometres (sq. km). The project's construction was planned in separate phases, beginning in 2010 (Al-Fadala et al., 2021). MDD strongly emphasizes sustainability, preserving natural resources, and the calibre of its architecture, with all the buildings in MDD achieving LEED-certified status.

In the face of Doha's existing urban fabric and traditional housing stock, our study aims to gain a deeper understanding of the urban form of MDD with a focus on its relation to the real estate value of the residential units, if any. Furthermore, the main objective is to investigate the connection between the urban form of MDD and the property value of its residential units and identify factors that influence the rental asking prices (e.g., estimated monthly rent). This study contributes to our understanding of improving urban living in other neighborhoods in old Doha.

1.3 Real Estate Trends of the Doha Residential Market

The real estate sector is one of the fastest-growing industries in Qatar, which is clear from Doha's position among the Top 80 cities in worldwide price ranking based on the cost per square meter (sq.m) of a residential unit (Source: Numbeo, 2022). The real estate market in Qatar was already booming in the early 21st century between 2003 and 2006, when the GDP increased by an average of 24.6%, tripling within only four years (Al-Amadi et al., 2022).

Qatar offers diverse types of accommodation facilities for rent and sale for Qatari citizens and ex-pats, including apartments, villa compounds, and free-standing villas (Alattar et al., 2021). According to a leading international real estate firm, Cushman & Wakefield (2020), about 59% of all occupied residential units in Qatar are rentals. The apartments in Qatar have an estimated average monthly rent of QAR 9,500-14,500 for a prime apartment, QAR 6,000-9,000 for standard apartments, and QAR 4,000-6,000 for budget apartments. According to data collected from the popular real estate website Property Finder Qatar in early 2020, the most expensive apartments are in MDD, The Pearl-Qatar, and West Bay, which offer some of the city's best locations along the Arabian Gulf coastline (*Figure 3)*. Among them, MDD is quickly gaining popularity. In recent years, Qatar securing the right to hold and stage the FIFA World Cup 2022 significantly increased market demands.



(a) (b)

Figure 3. (a) Rental comparison of Qatar's prime, standard, and budget apartments. (b) Average monthly rent in various places in Qatar (Source: Authors Compiled via Property Finder/Property Portal Qatar/Cushman & Wakefield).

1.4 Real Estate Variables of Residential Units

According to Marthya & Major (2022), real estate is viewed as a wise investment due to its ability to provide solid returns and protection against inflation. They describe the primary and transient factors that impact residential property values. The primary factors represent changes that influence house values over an extended time, frequently resulting from a more extensive process, like immigration patterns or economic cycles (Marthya & Major, 2022). The latter has short-term effects with local variations resulting from unique qualities, for instance, winning the bid to host the FIFA World Cup 2022. Both have favored the growth of the real estate sector in Qatar.

Furthermore, the property values of housing units can be influenced by three major factors: (1) characteristics of the building, including the type, quality of the built environment, number of bedrooms, and bathrooms; (2) characteristics of the neighborhood, including the location, nearness to recreational facilities or public transit, perceived safety of the neighborhood, and economic status within the country, and (3) availability of amenities and services, such as water, electricity, and presence of comparable properties (Wickramaarachchi, 2016). Since the attributes of neighborhood characteristics and the availability of amenities and services are constant for the entire MDD area, building characteristics are considered the primary factor for analyzing the real estate value of its residential units. Based on this, researchers used data from Property Finder to analyze monthly asking prices for residential units in MDD, which we will discuss later.

2. Material and Methods

This section presents the research design and methodology adopted for this study (*Figure 4)*. To achieve the study's objectives, an in-depth literature review was conducted by exploring relevant literature, including journal articles and academic research papers about the past urbanization progress in Qatar, the elements influencing the formation, growth, and redevelopment of MDD's urban environment, and the shift in Qatar's demographic data arising out of rapid urbanization, which has been discussed in the introduction. The data collection contains two parts. First, surveying data for analyzing the form and function of MDD, and second, compiling data for evaluating the real estate variables of residential units. The first part was studied from a morphological perspective using graphic mapping representations based on factors like urban morphology of the built form and block sizes/shape, ground floor land use patterns, active/ inactive frontages, and pedestrian sheds. The authors conducted on-site surveys to collect data during Spring 2022 to analyze the physical and functional features of MDD that might correspond to the cultural and socio-economic factors contributing to its urban morphology.

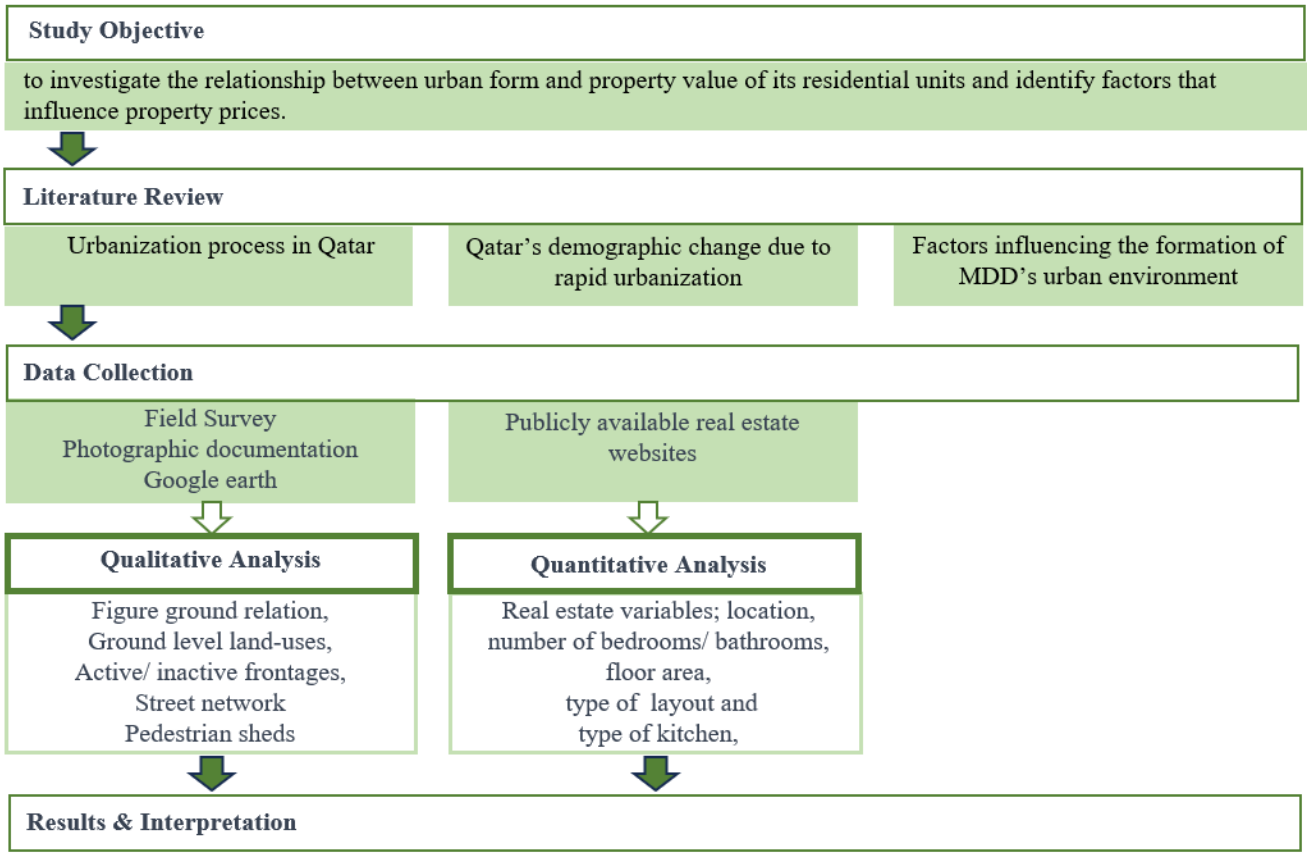


Figure 4. Diagram outlining the research design and methodology (Source: Authors).

Graphical representations of the design and layout of MDD were developed based on on-site surveys and maps available from Google Earth/Google Maps. Using photographic documentation, researchers surveyed and recorded the active/inactive frontages for each existing building in MDD concerning the ground-level land uses. We define active frontages as building facades that interact by providing visual or physical access between the building interior and the ground-level public street via windows, doors, or glass curtain walls. In contrast, inactive frontages are building facades that do not provide visual or physical access to the public realm of ground-level streets, i.e., blank walls. Figure-ground mapping allows us to assess block sizes, street networks, and building patterns to determine the functional connections between streets and buildings. Mapping ground-level land use patterns helps us understand how MDD is organized and functions as an urban environment. Pedestrian sheds using a 400 m radius from the MDD mosques provide us with a picture of the center of each residential core, considering the mosque as the focus of everyday life in the Islamic culture of the Qatari society.

The latter stage of data collection compiled information in early 2022 from publicly available real estate websites in Qatar, such as Qatar Property Finder, Qatar Property Portal, and data from the Msheireb Properties. Generally, our study combines qualitative and quantitative approaches to analyze the collected data. A qualitative approach was chosen to review the form and function of MDD. A quantitative strategy was selected to check the real estate value of the residential units in MDD and how it might be related to the neighborhood's physical characteristics and spatial layout.

The quantitative analysis was done by compiling the information about the real estate variables of the residential units in MDD against the background of Doha. It included an evaluation of the current market trends for the asking monthly prices of residential units in Qatar, focusing on MDD. During the data collection, it was observed that some parameters other than the ones selected from the literature review played a contributory role, such as the level of furnishing and kitchen layout. Based on this, the available data about residential units of MDD were categorized according to the number of bedrooms and bathrooms, the unit's design, kitchen type, furnishings, and location in the development. We studied the relationship between these variables to determine whether any pattern could be discerned for the housing prices in MDD. However, it is essential to note that this study has limitations, as only a small number of residential units in MDD (46) were available on these websites (Appendix A). Asking prices may not be the actual prices. Since the actual prices were not available, asking prices were considered for this study. No specification about the exact location of residential units is provided on the websites. Therefore, a detailed comparative analysis between neighborhood residential clusters is impossible here due to only a general understanding of their location in MDD, i.e., by residential quarter and the small number of dwelling units.

3. Data Analysis and Results

3.1. Morphological, Land Use, and Spatial Analysis

The location of MDD at the center of old Doha, adjacent to Souq Waqif, defines its importance within the city. The northern side of the neighborhood is surrounded by Amiri Diwan, which is Qatar's statehouse and the Ruler's Palace, and the eastern side comprises the Souq Waqif, which is the cultural and heritage origins of Doha, whose character is reflected in the design and land use of the adjacent outer layer of MDD. Based on the Qatar National Vision 2030, the MDD master plan takes the essence of the traditional Qatari settlement and urban fabric, developed over time to address the region's hot, humid climatic conditions. This creates a tight urban grain, like the traditional urban fabric, formed by more than 100 buildings on the site. The urban blocks in MDD are arranged and oriented to cool down the neighborhood's interior parts by shading each other and the streets by channeling breezes from Doha Bay. They jointly impact the high-density urban form on the climatic variables of the outdoor areas in the neighborhoods with hot, dry cities to improve living conditions within such spaces (Qaoud Rami et al., 2022).



(a) (b)

Figure 5. (a) Figure-ground representation indicating public spaces, mosque, squares, and pedestrian and vehicular paths, and (b) Ground-level Land Use map of MDD (Source: Authors).

The neighborhood's primary streets shape the four quarters of MDD with distinct characteristics (blue-coloured streets in *Figure 5a*). Sequential connectivity between open spaces is maintained throughout

the site to increase walkability; for example, the mosque squares (red-coloured public square in *Figure 5a*) are integrated with other nearby public squares (yellow-coloured public squares), forming a grouped square. Public squares relate to streets and blocks, which allows permeability for people to access the internal open spaces within the blocks and create route choices for pedestrians. We can also see a hierarchy in the arrangement of public squares ranging from the most prominent, central square (the Barahat) to the smallest internal courtyards within the urban blocks.

MDD emphasizes that buildings are not just objects that limit our paths and accessibility. The pedestrian crossways and streets form the spaces to access the buildings, which can be seen throughout the street layout. The MDD street layout is designed to be a pedestrian-oriented environment by providing everything in proximity, encouraging social gatherings and interactions, slowing down the cars, reducing the need for on-street parking, and bringing the service corridor to a basement level with underground parking garages, which allows for narrower streets at ground level. This replacement of car-oriented street parking typology with narrow streets creates shaded sidewalks and pavements, making the neighborhood more people-friendly and adaptive to the regional climate. Historically, routes kept after regeneration, such as Al-Khahraba Street and the Sikka-al-Wadi, connect significant surrounding areas in the city, including Souq Waqif and Al Corniche. Many pedestrian routes, known as *sikkas* (narrow alleyways in traditional Qatari settlements), run parallel to the main routes to increase connectivity and permeability. They invite more people by incorporating activities such as outdoor dining, informal seating, water fountains, art installations, etc. These pedestrian areas enhance people's active and passive engagement with spaces and other people, making the neighborhood livelier throughout the day, especially during the evenings after the sun sets. The site primarily comprises low- to medium-rise buildings, with a few high-rise buildings on the southern edge. There is a general increase in building height from north to south. This also helps block the harsh sunlight on the interior parts of the neighborhood and enhances the long-range and short-range city-wide legibility.

MDD's land use strategy seeks to foster an active, vibrant city environment by promoting an integrated community in the neighborhood, in which everything is close and convenient enough for walking (*Figure 5b*). The local surroundings, mostly historic and civic buildings, influence the land usage on the northern and eastern sides. The area's western part is a mixed-use of residential, commercial, retail, cultural, leisure, and community facilities, provided with mostly active frontages. This encourages people to meet in public spaces, making it more vibrant and crowded during peak times. Retail facilities for food and cafes concentrate along primary vehicular and pedestrian routes at ground level to increase the number of users and maximize visibility. The retail uses for day-to-day needs, like a department store and medical facilities, are provided towards the western part of the site, where the residential units are concentrated. Open spaces for gatherings and social events come hand in hand with the buildings. Thoroughly segregated parking and service facilities are provided in the basement, helping the functional efficiency of the streets at ground level. The community facilities include a school, nursery, health services, community center, and mosques. There are three prominent mosques in MDD, so access is equally distributed throughout the neighborhood *(Figure 6a).*

These mosques serve public spaces within the city, playing a crucial role in the urban environment of Doha, particularly at the micro-scale of the street layout (Al-Khani, 2018). Historically, a mosque is a place for community worship, an intellectual hub of its region, and a socio-political attractor. The mosque holds a special significance in Islamic culture. Residents and visitors use these mosques within the boundaries of MDD daily. Each MDD mosque has a courtyard surrounding the façade. It is designed as an integral part of the public squares so worshippers can continue their conversations after exiting the mosques in adjacent public spaces. Some mosques, like the northwest one, even have traditional integrated wall seating. This enabled the area's inactive frontage to be utilized for activities.

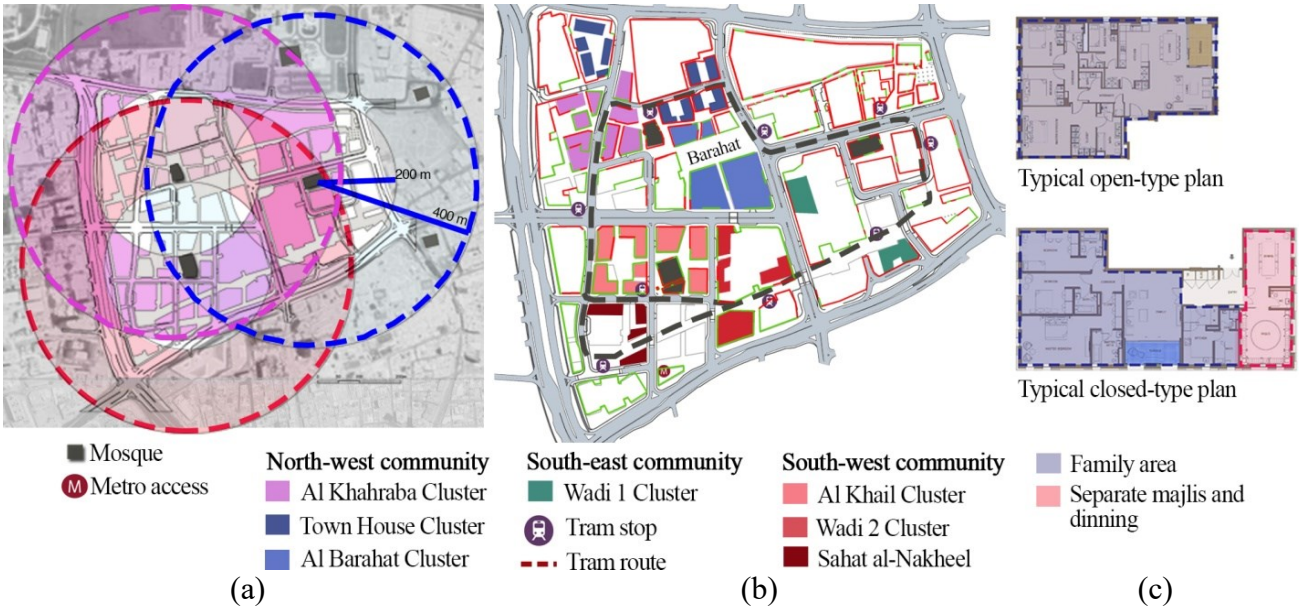


Figure 6. (a) Pedestrian shed of 200 m and 400m radius from mosques in MDD, (b) Residential map with the active (green lines) and inactive frontages (red lines), and (c) Typical apartment layouts in (top) (d) Al-Barahat and Al-Khahraba clusters and (bottom) Al-Khail, Wadi-2, and Wadi-1 clusters (Source: Authors/Msheireb Properties/Arch Daily).

Most of MDD is within a 400 m walking distance from these mosques. Many routes are designed as car-free environments where everything is accessible on foot. A physical setting promoting walking increases the likelihood of people connecting, fostering a sense of community (Boyle et al., 2013). There are other existing methods of transport, like the local tram, which is free of charge and circulates through the different quarters of MDD. The southwest community also has direct access to the Msheireb Terminal Station, the Doha Metro system's central hub.

3.2. Residential Area Overview

According to Msheireb Properties (2022), about 26% of the neighborhood is reserved for residential areas with 820 dwelling units. The residential area is organized into three core areas in the northwest, southeast, and southwest areas of MDD, offering a range of accommodation facilities (*Figure 6b*). The residential typologies include luxury apartments and townhouses arranged in clusters to provide a sense of community living, respecting the cultural values of society and privacy. Except for the townhouses, residential units are above the ground floor retail units, which give a substantial street frontage to foster safer streets, according to Jacobs (1960). Considering the Islamic culture of the society, mosques have been provided at the center of each residential core.

The northwest part of the neighborhood consists of townhouses and apartment clusters on Al-Khahraba Street and Al-Barahat (*Figure 6b*). The townhouse cluster is the least dense area in MDD, away from the hustle of the most intense urban activities. It is introverted in design, providing the most privacy by employing inactive street frontages. The Al-Barahat cluster surrounds the central plaza, which is active throughout the year. Most of the apartment clusters in the northwest face Al-Khahraba Street, one of the oldest streets and a cultural link to the area's history. Most are three- and four-bedroom apartments, while Al-Barahat offers more two- and three-bedroom apartments. These clusters are designed with separate entries for guests and hosts, a separate majlis, and a closed kitchen with a maid's facility (*Figure 6c*). This part of the site is characterized by gardens, courtyards, rooftop terraces, semi-public and public plazas, and narrow shaded sikkas that do not affect residential unit privacy. The mosque serves the community in Al Khahraba North, strategically located along with the community plaza, the Barahat. There is no clear distinction between the mosque site and its surroundings, encouraging people to gather and form part of the public space.

Apartment clusters in Al-Khail Street, Wadi-2, and Sahat al-Nakheel form the southwest community (*Figure 6b*). It is always busy and vibrant, with good accessibility to Msheireb Train Station, retail, cultural, and leisure facilities along Sikkat Al-Wadi (the most used pedestrian street in the neighborhood that runs across the site in the east-west direction connecting its edges to the Souq Waqif) with active frontages. The Al-Khail cluster creates a diverse community, offering a range of options of one-, two-, three-, and four-bedroom apartments and favors medium-sized families. At the same time, the Wadi-2 cluster offers more one- and two-bedroom apartments and a smaller number of three-bedroom apartments. Wadi-2 cluster is the only area without any four-bedroom apartments. These have an open kitchen plan with a single entry for the dwellers and guests (*Figure 6c*). The southeast community of the Wadi-1 cluster faces the Sikkat Al-Wadi, which is highly active, with both Qataris and ex-pats enjoying the outdoor life most evenings during pleasant weather. The Wadi-1 cluster also offers one-, two-, three-, and four-bedroom apartments, with a larger majority of one- and two-bedroom apartments. The design of the apartments is like that of Al-Khail and Wadi-2 clusters, with an open kitchen layout and a single entrance for residents and guests (*Figure 6c*).

3.3. Real Estate Aspects of the Residential Area in MDD

The potential of a neighborhood in the real estate market depends on the location (He et al., 2021). MDD is in the 'heart of Doha' with the privilege of location adjacent to Souq Waqif. Researchers analyzed the asking prices of residential units available in the market in 2022 before hosting the FIFA World Cup using different websites, as discussed in the methodology section.

Since the occupant rate is not 100%, and there is no publicly available data regarding the population within the neighborhood, the projected population was estimated to understand the demography of MDD. Data from the Msheireb Properties website about the number of residential units in each cluster was used to estimate the average household number in MDD. Furthermore, some assumptions regarding the household size were made to facilitate the calculations, such as the household size for one- and two-bedroom apartments is 2.5; for three-bedroom apartments, it is 4; for four-bedroom apartments, it is 5, irrespective of nationality. The household size of townhouses with five or six bedrooms is 6.5; for seven or eight bedrooms, the number is 8.7, the average Qatari family size (Qatar Planning and Statistics Authority, 2020). Based on these assumptions, we estimate that the average household size is 3.2 people per household in MDD, which could vary according to the abovementioned assumptions. Furthermore, the population density of the neighborhood can be estimated using the following equation:

$$p = \frac{x * y}{a}$$

Where 'p' is the projected population density, 'x' is the total number of residential units in MDD (820), 'y' is the average household number (3.2), and 'a' is the area of MDD in square kilometers (0.32 km2). This gives a projected population density of 8,200 people/sq.km in MDD at 100% occupancy.

4. Residential Characteristics of MDD

MDD is an urban regeneration project that harnesses the cultural values of the Qatari society through its careful utilization of New Urbanism design and planning strategies (Khalil, 2012). It has attained the local identity of traditional Qatari culture via its compact traditional urban form and unique architectural vocabulary (Tannous et al., 2021). It has elements of traditional Qatari architecture in the functional characteristics of residential units, especially the Qatari units. It provides a sense of community and maintains the transition from the private to the public realm by connecting the traditional sikkas and mosque squares to the residential units. It contrasts with today's contemporary Qatari villas in suburban developments, segregated from the city and public life, enclosed within high compound walls and large yards around the house. MDD creates compact villas and apartments for the Qatari population while respecting socio-cultural factors.

4.1 Correlation between Residential Unit Features and Cultural Targeting

In Qatar, conventional residential design contributes to preserving its architectural identity, grounded in its socio-cultural heritage. According to Al-Mohannadi et al. (2020), Qatar's housing development is significantly influenced by socio-cultural aspects, evident from the traditional Qatari courtyard houses to the contemporary villas of the modern city. The different spaces in a Qatari home are determined by privacy, gender division, and hospitality, as demonstrated in space syntax studies (Al-Mohannadi et al., 2021, 2022, 2023). A similar pattern can be seen in the development of the MDD master plan with a degree of exclusivity incorporated into the design of residential units, provided facilities, and the surroundings regarding specific user groups. Considering the cultural aspects and privacy in the design of residential units in Al-Khahraba and Al-Barahat clusters and townhouses with different guest and host areas, closed kitchens, and separate maid entry, they can be reasonably classified as Qatari residential units. The provision of more bedrooms and bathrooms also indicates the expected user groups with larger household sizes, like that of Qatari families (Qatar Planning and Statistics Authority, 2020). Al-Barahat cluster is an exception, possessing more one- and two-bedroom apartments (*Figure 7*). At the same time, the open-space layout of Al-Khail, Wadi-1, Wadi-2, and Sahat al-Nakheel apartments classify them as ex-pat residential units. This is also evident from the higher availability of one- and two-bedroom apartments, except in the Al-Khail cluster. It has a more balanced mix of apartments for smaller and larger families.

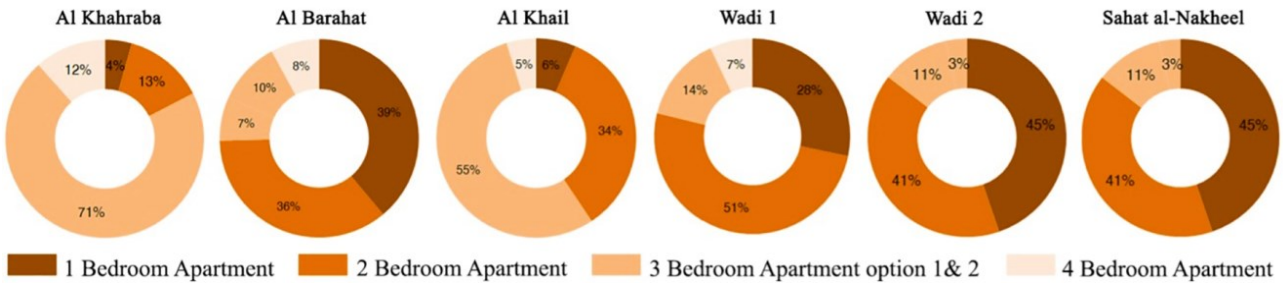
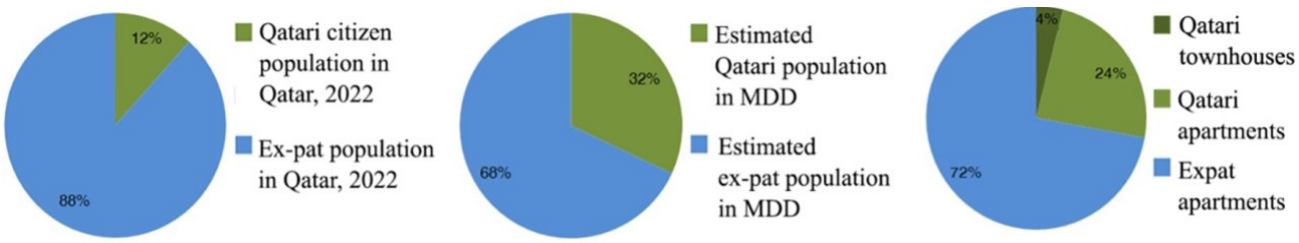


Figure 7. Number of 1-, 2-, 3-, and 4-bedroom apartments in each residential cluster (Source: Authors/Msheireb Properties).

4.2 Correlation between the Number of Units and User Group

The average rent of the apartments in MDD ranges from QAR 10,000-25,000 per month, which is higher than the average monthly rent in Qatar from QAR 5,000-10,000. It shows that the targeted consumer group of these apartments is high-income professionals, usually Westerner ex-pats in Qatar (Cushman & Wakefield, 2020). The high-income professionals generally in the Middle East are the ex-pats from the West, typically from Europe or North America, as they are thought to have better benefit packages and higher pay than trained immigrants from Asia or Africa (Al-Mohannadi et al., 2023).

On comparing the number of apartments reserved for Qataris and ex-pats and the estimated total number of households in each category, there are 1,772 ex-pat residential units and 845 Qatari residential units based on our earlier assumptions, Qatari households form 32%, and ex-pat households 68% of the total projected residential population in MDD (Msheireb Properties, 2022). This ratio does not correspond to the current population in Qatar, which has 88% ex-pats and only 12% Qataris, meaning the prime focus of the residential units at MDD is to increase the Qatari citizen population in the city center (Qatar Planning and Statistics Authority, 2020) *(Figure 8)*.



(a) (b) (c)

Figure 8. (a) Population ratio of Qatari citizens and ex-pats in Qatar, (b) Estimated population ratio of Qatari citizens and ex-pats in MDD, and (c) Relation between Qatari and ex-pat residential units in MDD (Source: Authors Compiled via Msheireb Properties/Cushman & Wakefield/United Nations).

4.3 Correlation between Residential Unit Features and Monthly Asking Price

One of the general trends in the real estate sector is that price tends to be proportional to floor area and number of bedrooms (Marthya & Major, 2022; Al-Amadi et al., 2022). However, there are fluctuations in rates. For example, the asking price of a two-bedroom apartment in the northwest MDD quarter, with an average area of 167 sq.m, has a lower rate than that of a two-bedroom apartment with an average size of 158 sq.m *(Figure 9a)*. It is like that also for MDD three-bedroom apartments *(Figure 9b)*. Another factor is the level of furnishing, i.e., fully furnished, semi-furnished, or unfurnished. By comparing fully furnished apartments to semi-furnished apartments of similar areas, we noted that the rent is only slightly higher with floor area for semi-furnished apartments. There is a significant increase in rent related to the floor area for fully furnished MDD apartments. It is a trend common for both two and three-bedroom apartments in MDD. The type of kitchen is a driving factor for rent in MDD when comparing open-space kitchen designs with the more enclosed-space kitchens in the two- and three-bedroom apartments with comparable floor areas. The closed kitchen units have a higher rental asking price due to the domestic roles of females and servants *(Figure 9c)*.

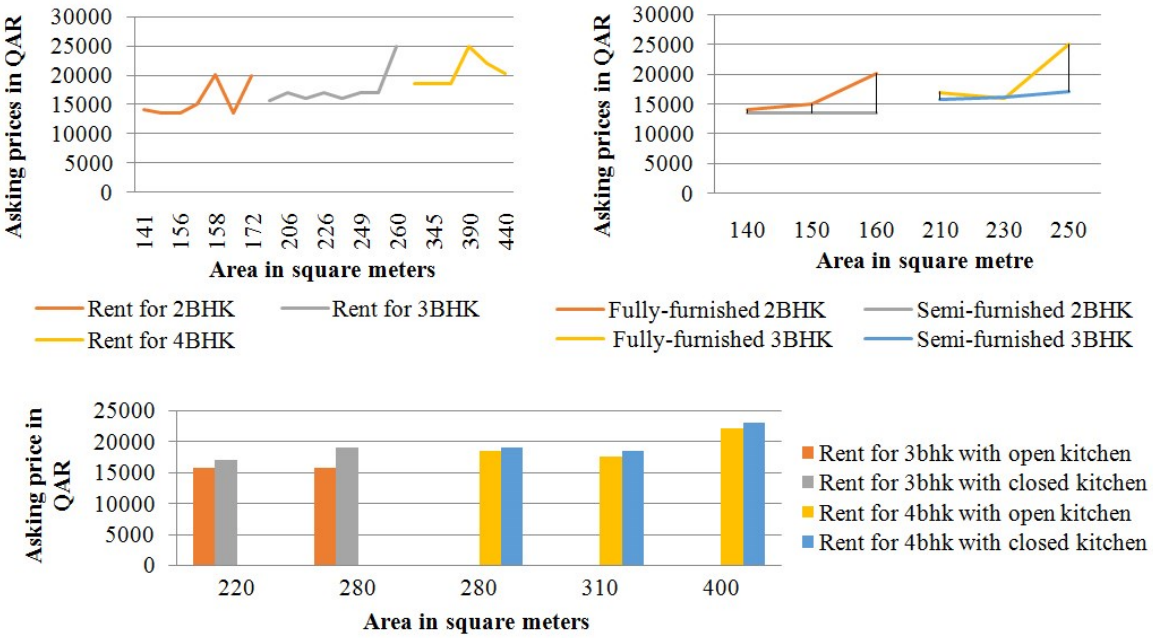


Figure 9. (a) Relation between rent and area (top left), (b) rent and level of furnishing in the northwest community (top right), and (c) Relation between rent and type of kitchen for 3 and 4-bedroom apartments (bottom) (Source: Authors Compiled via Property Finder/Property Portal Qatar/Msheireb Properties).

4.4 Comparative Analysis of Monthly Asking Prices in Each Residential Cluster

Asking prices are highest for the Qatari apartments and townhouses in the Al-Khahraba and Al-Barahat clusters. The variation in rent among the clusters is more for two- and three-bedroom apartments, while four-bedroom apartments have similar prices in all clusters *(Figure 10)*. Even though the Al-Khahraba and Al-Barahat clusters provide the most prestigious residential units in MDD, they do not possess the highest asking price per sq.m. It is the Wadi-2 cluster with the highest asking price per sq.m for one-, two-, and three-bedroom apartments. It is also the most intermediate and accessible location for walking between Souq Waqif and the Msheireb Station on the Doha Metro.

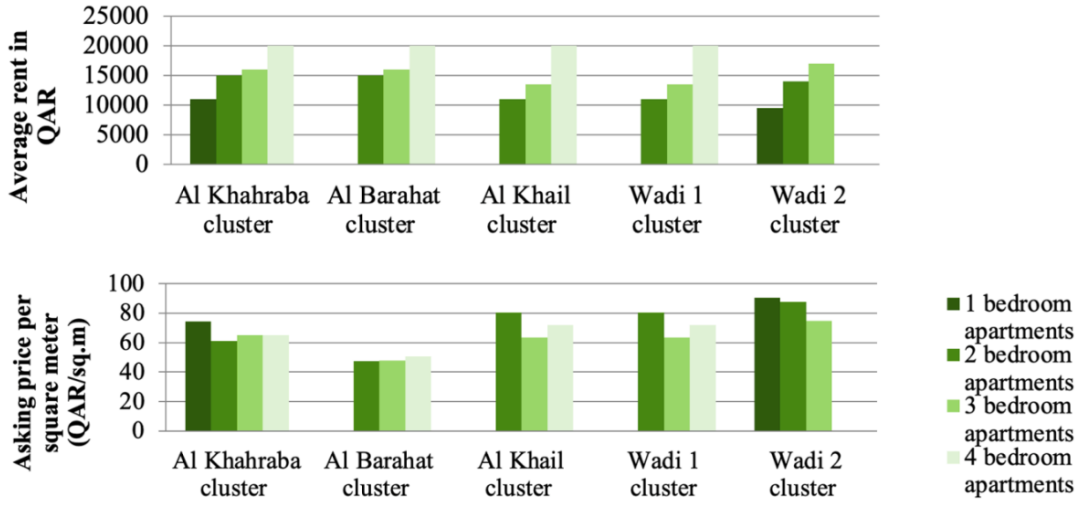


Figure 10. (above) Relation between the average asking price for apartments in each residential MDD cluster and (below) Relation between the average asking price per sq.m of residential units in each residential cluster (Source: Authors Compiled via Msheireb Properties).

4.5 Comparison of Monthly Asking Prices in 2020 and 2021

The MDD occupancy rate was 92% in early 2022 before the FIFA World Cup, a significant increase from the previous year (+19%). According to the number of listings of available apartments in Qatar in 2021 and 2022 on Property Finder, there has been an increase in the asking prices of apartments for rent leading into the World Cup, which is unsurprising. Also, there is a considerable increase in the listings, addressing the high demand for accommodation for the FIFA World Cup 2022. As for MDD, since it is gaining popularity very quickly, the number of listings between 2020 and 2021 has skyrocketed. MDD experienced the most meaningful change in median advertised prices from one year to the next, moving from QAR 13,500 to QAR 14,500, i.e., +7.5%. The reasons for this increase in value may include the FIFA World Cup 2022 and an increasing aspiration for the 15-minute city lifestyle, in which the day-to-day needs of the dwellers are available within a travel distance of 15 minutes or less.

5. Discussion

MDD is the new face of Qatari architecture, with luxury and technology in the old city center. The study aimed to investigate the relationship between the urban form of MDD and the rental value of its residential units, identifying factors that influence asking rental prices. Considering the uniqueness of the MDD regeneration project in the region, it is essential to understand the real estate principles behind its design. It could help develop similar neighborhoods in the region in cities that have also undergone suburban sprawl and rapid urbanization, resulting in a poorer quality of urban fabric. The study's findings indicate clearly how the development of residential units in MDD is aimed at the Qatari community and the high-income ex-pat community, mostly Westerners, with an asking price ranging far above the average in Qatar (QAR 5,000- 10,000). There is a clear distinction between Qatari and ex-pat residential units, considering the difference in the facilities of residential units and their overall distribution. Qatari households form 32%, and ex-pat households include 68% of the total

projected residential population of MDD. It does not correspond to the current population demographics of Qatar, which has 88% ex-pats and only 12% Qataris. From this, it is perceptible that the prime focus of the residential facility in the neighborhood is to increase the Qatari citizen population in the heart of old Doha. After analyzing the asking prices, there is no significant price difference in each residential community in MDD. However, the Qatari residential units have a higher asking price than the ex-pat residential units. This is due to more floor area and more bedrooms/bathrooms, with the additional privacy features of traditional Qatari neighborhoods.

Furthermore, the highest price per sq.m is for the ex-pat residential units of the Wadi-2 cluster intermediate between Souq Waqif and the Msheireb Station. It is also nearest to Wadi Msheireb Street, one of the essential arterial roads leading to Souq Waqif and Al Corniche. Another conclusion from the study is the lowest price per sq.m for the residential units is in the Al-Barahat cluster for the apartments targeting Qataris. The Al-Barahat cluster apartments offer more area at a lesser price than other residential units of MDD. This difference could be purposefully made to negotiate the effect of overcrowding and noise from the cultural events and programs often occurring in the Barahat. Generally, the floor area is usually the driving factor of rental value in real estate. However, we also found an increase in rental value with the level of furnishing and type of kitchen, i.e., closed kitchens have a higher price than open-space kitchen plans. Due to the unavailability of enough rental data, further reasoning about the rental value fluctuation was not feasible.

Even though the main aim of MDD is to bring back the Qatari population to the core city, the urge for privacy and comfort of larger contemporary villas in larger plots of Qatari citizens raises the question of the feasibility of their stay in MDD. This forms a research gap for future studies. Furthermore, a more detailed analysis could not be accomplished due to the unavailability of sufficient datasets for research, which can also be studied further once MDD occupancy reaches nearly 100%. Such a study could focus on finding out the most and least significant factors affecting housing prices in MDD.

6. Conclusion

In the late 20th century, rapid urbanization and globalization in Doha led to the loss of housing and the traditional urban fabric in the old city center. The Qatari government and Msheireb Properties developed Msheireb Downtown Doha to bring urban living back with a contemporary re-interpretation of the traditional urban fabric and modern life conveniences. Our study's objective was to investigate the relationship between urban form and the rental value of residential units, identifying factors that influence rental asking prices. The paper examined the morphological characteristics through field surveys and various real estate variables such as location, floor area, number of bedrooms and bathrooms, and the asking price collected from publicly available information. We found that the residential units' layout and adjacent streets' morphological characteristics define targeted user groups in the development. Larger residential units target Qatari families via more bedrooms and bathrooms and quieter urban settings emphasizing cultural values. Smaller units target ex-pat workers (especially Westerners) using open-plan layouts in lively urban locations. We also found that the price per sq.m increased for residential units closer to the Doha Metro mainline terminal station in MDD. The findings of this study reiterated the success of compact living and how it can contribute to improved urban living conditions in neighborhoods of old city centers.

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Conflict of Interests

The Authors declare that there is no conflict of interest.

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Appendix A

Table 1. Datasets of residential units in MDD for rent collected from Qatar's publicly available real estate websites.

Sl No.	Property type	Bed	Bath	Area in sq.m	Rent in QAR	furnishing	Type of kitchen	maids service	pet	car parking	Pool, gym, spa
1	Luxury Apartment	1	1	100	10000	fully furnished				☑	
2	Luxury Apartment	1	1.5		11000						
3	Luxury Apartment	1	1.5	100	11000	fully	☑			☑	☑
4	Luxury Apartment	1	1	111	10000	semi				☑	
5	Luxury Apartment	2	2	141	14000	fully furnished					☑
6	Luxury Apartment	2	2	143	13500	semi					☑
7	Luxury Apartment	2	2.5	156	13500	semi					☑
8	Luxury Apartment	2	2.5	156	15000	fully	closed				☑
9	Luxury Apartment	2	3	158	20125	fully		☑			☑
10	Luxury Apartment	2	2	167	13500	semi					☑
11	Luxury Apartment	2	3	172	20000	fully		☑	☑		☑
12	Luxury Apartment	2	3	220	15000	semi			☑		☑

13	Luxury Apartment	2	3	220	13847	semi					☑
14	Luxury Apartment	2	3	227	15000	semi					
15	Luxury Apartment	3	3	206	15692	semi	open				☑
16	Luxury Apartment	3	3	206	17000	fully furnished					☑
17	Luxury Apartment	3	3	220	16000	semi					☑
18	Luxury Apartment	3	3	226	17000	semi					☑
19	Luxury Apartment	3	3	231	16000	fully furnished					☑
20	Luxury Apartment	3	5	249	17000	semi	closed	☑	☑		☑
21	Luxury Apartment	3	5	250	17000	semi					☑
22	Luxury Apartment	3	4	261	15693	-	closed	-	-	-	-
23	Luxury Apartment	3	4	261	15693	semi					☑
24	Luxury Apartment	3	4	270	17000	semi					y
25	Luxury Apartment	3	3	280	17539	semi	closed				
26	Luxury Apartment	3	4	280	19000	semi	closed		☑		☑
27	Luxury Apartment	3	4	284	17000	semi	closed		☑		☑
28	Luxury Apartment	3	4	287	17000	semi	closed				☑
29	Luxury Apartment	3	4	287	15692	semi	open				☑
30	Luxury Apartment	3	4	287	17000	semi		☑			☑
31	Luxury Apartment	3	3	297	15693	semi					☑

32	Luxury Apartment	3	3	307	18461	semi		☑	☑		☑
33	Luxury Apartment	3	3	315	16615	semi	close d				
34	Luxury Apartment	3	3	315	16616	semi	close d				
35	Luxury Apartment	4	4	278	18461	semi	☑	☑			
36	Luxury Apartment	4	4	278	18461	semi	☑	☑			☑
37	Luxury Apartment	4	4	278	20000	semi					☑
38	Luxury Apartment	4	4.5	293	17538		☑				`
39	Luxury Apartment	4	5	307	19000	semi	☑				☑
40	Luxury Apartment	4	5	307	19000	semi	☑				☑
41	Luxury Apartment	4	6	340	18500	semi	☑	☑	☑		☑
42	Luxury Apartment	4	5	345	18500	semi					☑
43	Luxury Apartment	4	5	345	18500	semi					☑
44	Luxury Apartment	4	5	390	25000	semi	☑	☑	☑		☑
45	Luxury Apartment	4	6	395	22000	non	☑		☑		☑
46	Luxury Apartment	4	4	440	20308	semi	☑			☑	☑

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Urban Design Evolved: The Impact of Computational Tools and Data-Driven Approaches on Urban Design Practices and Civic Participation

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ABSTRACT

In recent years, the changing pattern of human activities, increasing data regarding the spatial environment, and the possibility of collecting and processing this data allowed us to reconsider how we approach urban design, with a focus on a digital-oriented and data-driven perspective. In this study, we examine the evolution of urban design by analyzing the roles of designers and citizen empowerment. Our analysis includes a literature review and semi-structured interviews with computational design experts. In this sense, the literature is reviewed to investigate previous discussions and findings about the topic, and semi-structured interviews were carried out with seven computational design experts. The experts were selected by considering two criteria: (1) their experience with computational urban design subjects in practice and (2) their academic research background. This study concludes that technology-driven urban design solutions change designers' relationship with data, opening new avenues for objective, data-driven & data-informed decision-making. There are few differences between traditional and computational design practices regarding user empowerment and participatory design. Moreover, technology-driven urban design tools and methods are still in their early stages and are rarely used in actual projects.

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Highlights:	Contribution to the field statement:
This study seeks to answer the following question: "How do technology-driven design tools and strategies alter the role and agency of actors and user empowerment in urban design?" - This study analyses the literature to gain a deep understanding of the conceptual and theoretical background and synthesize the basic concepts and critical insights about technology-driven urban design.	The use of computational design methods in urban design is a relatively new research topic. This article contributes to academia by exploring the impact of computational tools and data-driven approaches on urban design, shedding light on how technology-driven solutions change designers' relationship with data, promoting data-informed decision-making, and highlighting the evolving role of citizens rights in urban design processes.

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1. Introduction

The studies of computational design methods in architecture can be traced back to the 1960s (Caetano & Leitao, 2020). Over time, these methods have advanced from the use of Computer-Aided Design (CAD) to code-based design allowing for a transition from top-down modeling to more generative, bottom-up systems. It causes interest in nature-inspired systems that have led to the creation of new design ecosystems around morphogenetic design systems and evolutionary software (Verebes, 2013). On the other hand, in an urban design context, the use of computational design methods is still in the experimental and research phase (Miao et al., 2020). Urban environments can be better managed, controlled, and designed with the increasing amount and variety of data generated by cities in the last decade (Kitchin, 2015). Moreover, with the increasing mobility of residents, studying cities has become more difficult and so researchers need to utilize different data sources to gain new insights (Balaban, 2021).

In contrast, traditional urban design methods that rely on static and sectoral approaches reach their limits in adapting to the increasing complexity and dynamics of cities (Miao et al., 2017). To overcome these limitations, designers need to find new ways to incorporate different data sources and cutting-edge design approaches into their work. This will enable them to make more objective and data-driven decisions in an effective way.

The use of computational design methods in urban design practices is a relatively novel research topic, and most of the studies show that their use is still in the early stages. However, there is a significant gap in the literature concerning the integration of participatory design approaches in these practices and the changing roles and agencies of designers in the computational design process. Therefore, this study aims to review the evolving urban design process in the digital age in terms of the role of designers and the affordances of these tools and strategies for user empowerment. To do this, we critically examine the paradigm shift in urban design practices in the digital age and provide some suggestions for successful urban design practices. With these goals in mind, this study's primary research question is:

- How do technology-driven design tools and strategies alter the role and agency of actors and user empowerment in urban design?

With this primary question in mind, we identify several secondary research questions as follows:

- What effects have computational urban design tools and technologies had on the traditional roles and agencies of designers?
- In what ways have these tools affected the decision-making process in urban design practices?
- How technology-driven urban design solutions can change citizen empowerment and participation in city-making practices?
- Lastly, what are the limitations of technology-driven urban design methods in urban development practices?

In methodology, we analyzed the literature to gain a deep understanding of the conceptual and theoretical background and synthesize the basic concepts and critical insights about technology-driven urban design. Moreover, we interviewed seven computational design experts using a semi-structured format to gain further knowledge[1].

In the next part of our research, we provide a state-of-the-art critical overview of traditional design and technology-driven design processes. We also briefly present the theoretical and conceptual background of "Technology-Driven Urban Design." The third section of our study will focus on the technology-driven design process and will examine the roles of the designer and citizen empowerment. In the fourth section, we will discuss our research findings and explore key factors and directions for future research.

[1] In this study, all information about interviewee are coded in order to protect their personal data.

2. Technology-Driven Urban Design

Urban design is a vast field of activity, encompassing numerous processes from building site's physical design to participatory planning processes. Urban design is the tool for reshaping urban space to accommodate new urban conditions (Madanipour, 2006, p. 191). In this study, we use the term "urban design" as a study and practice area located at the intersection of architecture, urban planning, and urban studies (Gün et al., 2020). Cozzolino et al. (2020) analyzed the 12 urban design scholars to define urban design and its primary dynamics. After in-depth analysis, they define "urban design" as: "a creative and purposeful activity with collective and public concerns that deal with the production and adaptation of the built environment at scales more significant than a single plot or building." As Steino et al. (2013) argue, urban design practices should be situated as an interdisciplinary and inter-scalar design activity. Urban design has been accepted as one of the collaborative design atmospheres where architects, planners, landscape designers, and other disciplines work together.

Urban design processes involve different design and action phases. In literature, there is a different kind of urban design phase classification. For instance, Carmona (2014, p.6-11) identifies the urban design process as a "four active place-shaping process": (1) design; (2) development—shaping the physical public realm for use; (3) space in use; and (4) management—shaping the social public realm through use. Boyko et al. (2005, p. 120) also identify four different urban design phases: forming goals (1); design (2); evaluating/selecting/creating a plan; and finally implementing/monitoring and following up on design solution (4). However, these steps can be useful for the traditional urban design process. Thus, a new classification is required to include both traditional and technology-driven urban design processes. In this study, we focus on the early stages of the urban design process (ideation and conceptual design phases), where the collected data is analyzed, the main design criteria and evaluation parameters are addressed, and the main design goals are identified accordingly.

2.1 Traditional Urban Design vs. Technology-Driven Urban Design

With the development of urban analytics and computational design tools, the types and amount of urban data are increasing, and new possibilities to design cities emerge. The technological developments in GIS, Big Data, Urban Analytics, the Internet of Things, and the possibilities of collecting different kinds of data like authoritative, crowdsourced, and remotely sensed data open new avenues for data-driven urban design practices (Gil, 2020). It is possible to track individually produced data via sensors and mobile phones, social media posts, online activities of humans, and volunteered crowdsourced data. Furthermore, the behavior and movements of residents are different compared to the past, and cities need to be shaped with more complex objectives coming from industry, public, and environmental requirements. Kitchen (2015) argued that this new era changes the structure of "data-informed urbanism" that is replaced by "data-driven, networked urbanism."

All of these changes require to rethink of urban design from the "digital age perspective." This study defined "traditional urban design" as a design process based on drafting-based (CAD) techniques that are more heuristic, designer-oriented, and non-discursive. On the other hand, "technology-driven urban design" can be defined as a design process that combines designers' creativity with digital computational techniques through rule-based systems involving measurable constraints, parameters, and relations.

In this period, traditional urban design techniques have been criticized for being based on static and sectoral approaches (Miao et al., 2017), non-dynamic, and time-consuming (Steino et al., 2013). This approach also regards city-making as a non-flexible and static design process (Verebes, 2013). In this sense, it is argued that traditional urban design techniques reach their limits to keep up with cities' complex dynamics and growing demands from multiple stakeholders.

In the computational design process, the designer does not directly model the design object; instead, he develops a graph or script whose operation/execution generates the model, and if a minor edit is executed to the graph or script, it could have a significant effect on the generated object that enables to the exploration of a wide range of design alternatives (Aish, 2013). For instance, the designer does not expect to draw the line directly in the parametric design process. Instead, the designer specifies the

editable attributes of the line (the length, initial point, and direction of the line), and the model generates its associative geometry (Çalışkan, 2017). In this process, urban designers are expected to be involved in two primary design operations:

(1) Devising the core setting of the generative algorithms by design rules,
(2) Evaluating the emergent design forms in terms of the constraints set by the context and the preliminary design criteria (Çalışkan, 2017, p. 436).

Thanks to computation, it is possible to produce contextual and actionable data that can be shared across systems, enabling a more holistic and integrated view of urban areas. In the era of the digital age, the computational design process offers many benefits in the city-making process, such as managing complexity, optimizing specific criteria, incorporating a wide variety of data and information layers from past projects, and offering a "live model" for post-occupancy adaptation (Walmsley & Villagi, 2019). It also enables parallelizing design tasks, managing large amounts of information, incorporating changes quickly and flexibly, and assisting designers via automated feedback, such as mapping simulation results (Caetano et al., 2020, p. 290). Several tools have been used in computational design practices as follows:

- Generative modeling interfaces such as Grasshopper 3D and Dynamo,
- Parametric urban design software such as CityCad and CityEngine,
- Optimization plugins to guide the generation of solutions such as *Galapagos*, *Silvereye*, *Radical*, *Opossum*, and *Goat* (for single-criteria optimization) and *Wallacei* (for multicriteria optimization) (Lima et al., 2021)
- Several analysis and simulation tools/plugins, such as *EnergyPlus* (for simulating energy consumption), *Ecotec* (for analyzing daylight), Ladybug (for analyzing weather data), *Radiance* (for lighting simulation), and *Butterfly* (for fluid dynamic simulations).

As explained above, the technology-driven design approach alters design practices in terms of many aspects. To sum up, while traditional urban design relies on heuristics and capabilities of designers and computer-aided design (CAD) techniques, technology-driven urban design integrates digital computational design methods with objective & and measurable constraints and parameters. Table 1 summarizes the differences between traditional and technology-driven urban design approaches.

Table 1: The comparison between traditional urban design and technology-driven urban design approaches (Prepared based on Verebes, 2013; Kitchin, 2015; Deutsch, 2015; Çalışkan, 2017; Caetano et al., 2020; Gil, 2020).

	Traditional Urban Design Approach	**Technology-driven Urban Design Approach**
The relationship with computer	Computer-Aided	Computer-Oriented
Design object created with	Shapes, geometric relations	Parameters, constraints, algorithms, rules, mathematical relations, data structures
Design Process	More heuristic, non-discursive, draft-based	Discursive, script-based
The relation with data	Data-informed & Data-enabled	Data-oriented & Data-centric
The Generation of Design Object	Anticipated	The generation of unanticipated design objects is possible.

In this study, we focus on using one of the computation-based design approaches: generative design. Compared with architectural design, using generative design solutions at an urban scale is a relatively new approach (Miao et al., 2020). Its potential has yet to be comprehensively explored. This process

is based on several technologies involving: (1) parametric design software to model the space of possible solutions, (2) simulation software to derive metrics for evaluating each potential design, and (3) optimization solvers, e.g., Genetic Algorithms, that can automatically search through the design space to find the most optimal designs (Nagy et al., 2018). Until now, a limited number of studies have explored the application of the generative design approach at the urban design scale.

In recent years, there has been an increase in digital tools for urban design that apply computational design methods and data analytics strategies, such as *SpaceMaker*, *Giraffe*, *Digital Blue Foam*, and *Scout* (Calixto et al., 2021). The phases of generative design processes have been tried to be classified in several studies. Wilson et al. (2019) developed a methodology for applying computational urban design in four steps: 1) Define Inputs & Design Space, 2) Procedural Geometry Generation, 3) Performance Evaluation, and 4) Analysis, Communication & Stakeholder Engagement. In literature, a few design experiments have been conducted to show the potential of the generative urban design process. One of the practice-based generative urban design studies was done in 2017 by the Dutch development and construction company Van Wijnen. Nagy et al. (2018) presented this generative design experiment in four steps as follows:

Step I. Creating a design space model that can generate various design solutions subject to the problem's constraints (Figure 1).

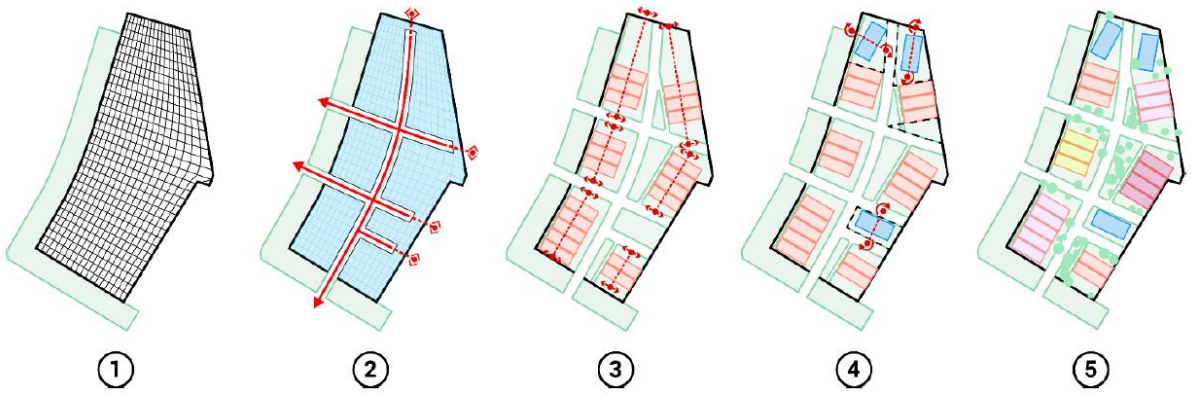


Figure 1: Five steps of describing a parametric design model for generating each design option: (1) create a mesh from the boundary; (2) generate streets; (3) subdivide into lots; (4) place housing units; (5) place apartment buildings (Walmsley & Villaggi, 2019).

Step II. Defining design goals to evaluate the performance of each design. In this phase, the design space model needs to include one or more metrics that can be used as objective targets during optimization: the profitability of the project for the developer (financial goal) and the potential solar energy that can be captured by the roofs of the residential buildings (environmental goal) (Figure 2).

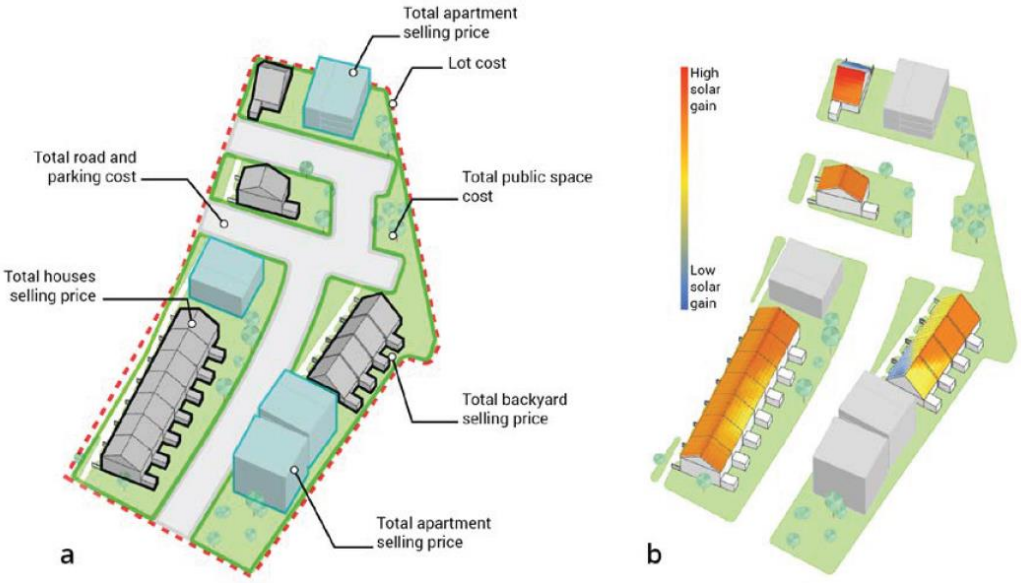


Figure 2: The definition of goals through metrics, development profitability (a), and potential for solar gain (b) (Nagy et al., 2018).

Step III. Design space analysis through the use of metrics.

Step IV. Design optimization to find the best alternative that maximizes the values of the determined objectives. In this phase, the optimization trial consisted of 200 generations with 200 designs in each generation using the Genetic Algorithm (Figure 3).

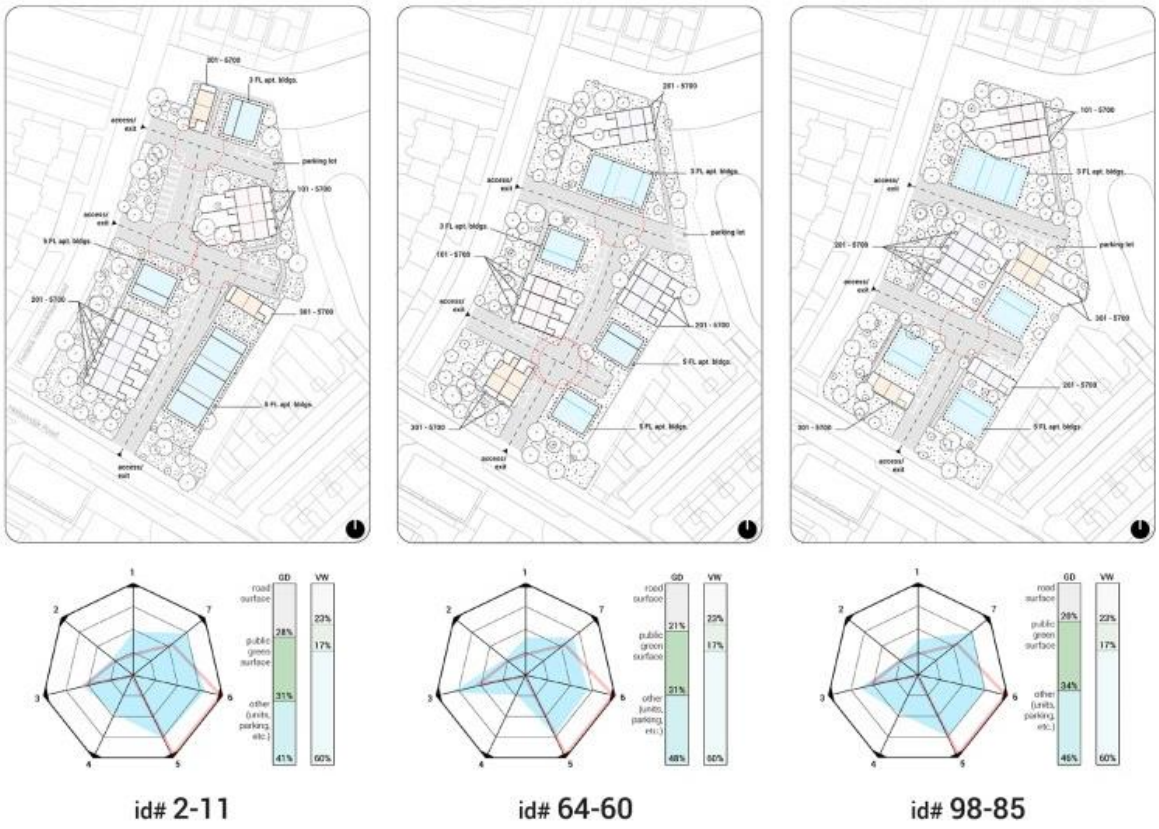


Figure 3: Selected and refined high-performance design based on identified metrics (Gerfen, 2018).

2.2 Previous Studies in Literature and Filled Gaps by This Study

To review the literature, we did a state-of-the-art critical overview of using the computational design approach in urban design processes. In this context, we reviewed the research to find out what is already known about our study area by doing a systematic search of several databases (Scopus and Web of Science) and some proceedings books relating to computational design, e.g., eCAADe (Education and research in Computer-Aided Architectural Design in Europe) and CAADRIA (Computer-Aided Architectural Design Research in Asia). A wide range of researchers have studied computational urban design with a variety of purposes: (1) testing novel generative and analytical methods in urban design practices (Bielik et al., 2022); (2) integrating participatory approach in computational urban design (Daher et al., 2018; Knecht et al., 2019); (3) examining the effect of ICT in professional urban design practices in terms of decision-making (Al-Douri, 2022); (4) critically reviewing the use of parametric design in urbanism (Çalışkan, 2017).

One of the prominent works regarding applying generative design solutions in urban design is done by Koenig et al. (2020). They developed a data structure accommodating flexible urban design problems to overcome the challenges of integrating urban analytics and generative methods. This study also generated urban design variants by combining urban analysis and evolutionary multi-criteria optimization (EMO) methods.

Several authors have explored the use of optimization methods in urban design processes. Miao et al. (2020) presented design optimization methods by reviewing them from historical development and future trends, and they showed the advantages and challenges of design optimization methods. Lima et al. (2021) conducted a series of case studies to evaluate and present the benefit of using optimization tools to improve urban performance. This study compares the effectiveness of various optimization algorithms in solving urban design problems and assesses generative approaches. Nagy et al. (2018) showed the potential of the generative design approach for solving complex urban design problems through a series of workshops for designing a residential area in the Netherlands. Knecht et al. (2019) developed a computational approach that allows designers to share a subset of the design space with citizens via an online interface named *Beta.Speckle*. This study evaluated the tool's usability in participatory urban design processes.

As seen in the literature, although the use of several generative design methods, e.g., design optimization, dates back to the 1960s in architectural design, most of the research and experiments have been carried out in the last years in urban design processes, so we can conclude that the use of these methods in an urban design context is still in infancy phase. In literature, many studies have carried out pilot studies to test and evaluate the affordances, limitations, and potentials of the computational urban design process. As mentioned, a few studies focus on integrating a participatory design approach in the computational urban design process. In addition, the studies in the literature have yet to evaluate the role of urban designers and their agencies in computational urban design processes. In this study, we aim to fill the gaps in the literature by tracing the changing pattern of the urban design process in terms of (1) the role of designers and (2) citizen empowerment.

2.3 Methods of Data Collection

This research has been pursued in two phases: a literature review and interviews followed by a discussion of the findings. This study aims to review the changing pattern of the urban design process in the digital age in terms of the role of designers and the affordances of these tools and strategies concerning user empowerment. We also aim to critically examine the paradigm shift in urban design practices in the digital age. To do this, we need to review research findings in the existing literature and address research gaps concerning selected research topics. To do this, we firstly conducted a literature review as the first phase of our research methodology. The literature review has focused on reviewing secondary sources to construct theoretical propositions. The second phase involves a semi-structured interview with seven computational design experts. In this sense, we identified two criteria for the selection of experts for the interviews: (1) having experience in using computational design tools in design practices and (2) having academic expertise in computational urban design.

Based on the introduced research questions in the first section, in semi-structured interviews, the experts were asked some questions under thematic topics as follows:
(1) how do computational design tools, methods, and strategies change the urban design process? What are these novel methods' key similarities and differences with the traditional urban design process?
(2) the potential of cutting-edge computational tools in urban design practices;
(3) how the computational design approach changes the role of urban designers;
(4) their effect on citizen empowerment and design collaboration.
As the literature is not rich in the focus research area, we use expert interview notes as a complementary source.

3. Toward a Technology-Driven Urban Design: Critical Reflection

Based on the theoretical literature review, similar research findings, and expert interview notes, we critically discuss how the technology-driven urban design approach has altered the designers' role and actions in the design process and their relations with data. Finally, we examine whether this approach changes the urban design process regarding user empowerment and participation.

3.1 The Designer's Role and Responsibilities in the Design Process

Designers are expected to gain new capabilities and be responsible for carrying out new actions to keep up with the recent developments in the "digital age". Leach (2009, p.35) argues that the designer's role evolved from creative "form-giver" to the controller of generative processes in the digital age. Due to the complex nature of computational urban design processes and their multitude of interests, this process inherently requires complex workflows and a collaborative design approach (Steino et al., 2013). In this sense, the following questions come to the fore:

- How do technology-driven urban design tools and methods change urban designers' roles and responsibilities in the design process?

Although the discussions regarding technology-driven urban design have yet to mature, we discuss this issue in light of several arguments proposed to answer this question. Liao (2015) argued that as the clients demand more value from the projects and cutting-edge technologies, the designers are expected to gain skills like data mining, automation, coding, etc. In this context, Deutsch (2017) introduced a new kind of designer entitled "super-users" who is expected to take a role that is the convergence of designer, data scientist, and algorithm builder (Figure 4).

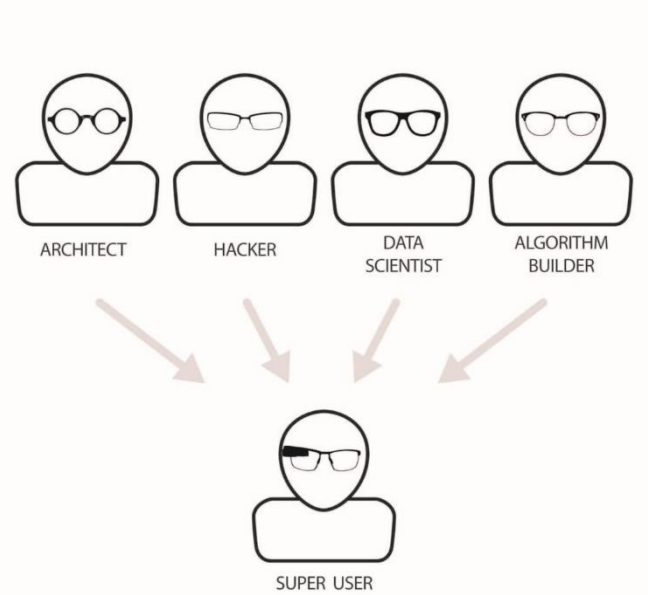


Figure 4: New roles that are expected to be taken by designers (Deutsch, 2017).

However, for now, when it comes to the urban design context, which is inherently based on a collaborative design process, urban designers rarely take on this new responsibility for several reasons.

Firstly, suppose urban designers try to take on a new role like an urban data scientist or a computer programmer by processing different data layers or writing a script. In that case, they may not sustain their inherent and heuristic design capabilities, and they need to reconstruct their way of design thinking (Expert 3, personal interview). Instead, urban designers are expected to rationalize design through explicit computational design elements, e.g., parameters, constraints, and design rules, to be integrated into the algorithm by programmers, so urban designers are expected to have basic operational knowledge of computation (Çalışkan, 2017).

Urban designers also need to collaborate and communicate with actors such as computer engineers and urban analytics experts to write scripts and collect and process data (Figure 5). Moreover, urban designers are required to learn to design processes through algorithms. For this purpose, they are expected to develop their algorithmic thinking skills and externalize the design process by leaving abstract definitions. In addition, as technology-driven urban design processes inherently depend on structuring "well-defined problems", urban designers need to divide design problems into sub-thematic problems (Expert 1, personal communication).

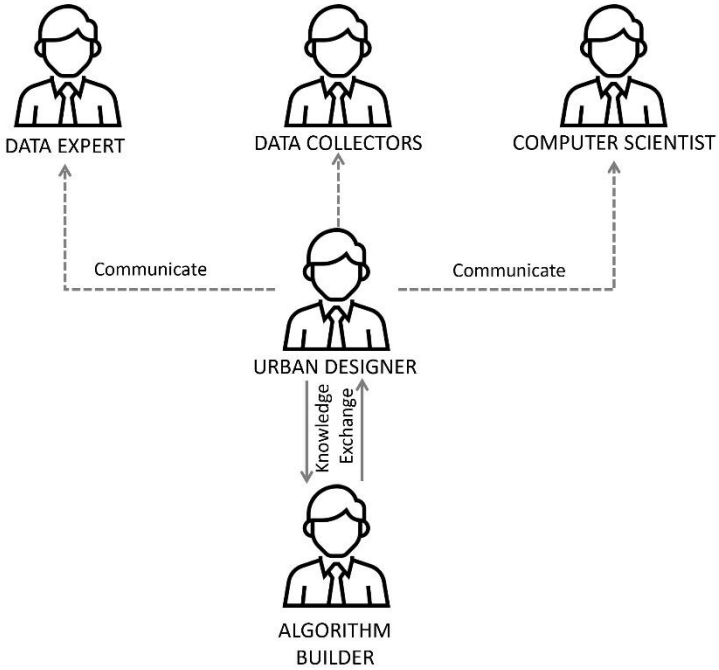


Figure 5: The expected actions from urban designers in the digital age.

The urban design process requires using a wide variety of data sources. Traditional and technology-driven urban design processes are expected to gather thematic data layers in different areas such as walkability, liveability, physical environmental conditions (wind, thermal, etc.), urban morphology, circulation, and accessibility. In the digital age, it is also possible to make use of novel types of data in the design process, such as monitoring citizens' unanticipated behaviour patterns in urban spaces, tracing the quantitative data from apps and sensors (Balaban, 2021), and collecting users' expectations from the project (Jutraž & Le Moine, 2016; Falco & Kleinhans, 2018). The involvement of these kinds of data requires using cutting-edge data analysing techniques. Thus, urban designers must communicate with data scientists and find the best ways to integrate this data into urban design.

In addition, one of the main challenges of computational urban design processes is a suitable representation of urban design problems. To overcome this challenge, categoric data classification is needed to address problems (Koenig et al., 2020). The design of urban areas requires the involvement of many design goals that influence urban development, and these goals are inherently conflicting and necessitate preference-based decisions (Showkatbakhsh & Makki, 2022). As seen in the example shown in the previous section, it is possible to face conflicting design parameters such as profitability, sustainability, and interest of different stakeholders. It is a challenging task and responsibility to

identify, filter, and select design objectives for the urban designer. Especially in the "definition of goals" phase and to identify each thematic subject's objectives, constraints, and metrics, urban designers need to communicate and collaborate with different expert groups to make decisions. In this process, they are expected to use these data and information sets to create a design solution space. After that, they determine the "satisficing" solutions based on the predefined metrics and their experience.

In this process, the most challenging situation faced by urban designers is sustaining their experience and intuitive and heuristic way of design thinking and adapting themselves to the language of "computational design thinking" simultaneously. It is difficult to carry out a meaningful urban design process "just" based on successful data processing operations and well-integrated computational design tools (Expert 4, personal communication). As seen in the example shown in the previous section and generative design processes, urban designers actively create a design space model, define and control design goals, and analyze the design space by using their intuitive power. Furthermore, the urban design process is inherently based on solving many "wicked" problems that cannot be addressed discursively, so computational design approaches can not be used easily in these cases.

One of the wrong assumptions about technology-driven urban design is that computational design tools will take over the role of the designers. The question then arises as to whether the computational design process, in which large portions of the design process could become automated, meets all criteria plus common sense (Deutsch, 2017). The experiences gained from the practices show us that urban designers will always be responsible in the design process by designing systems, defining rules, and building algorithms. By doing these actions, designers formalize the design process and use built algorithms for their design objectives (Dino, 2015). Unless urban designers build algorithms sufficiently and involve required data layers in the design process, the computational tools will not generate high-quality design output (Expert 7, personal communication). Even though designers may take advantage of the full power of computation, their responsibilities will exist forever.

3.2 User Empowerment & Participation

Different from architectural design practices, many people are affected by urban design decisions, and a wide variety of public issues are expected to be involved in urban design. However, traditional participation methods, e.g., referenda, public hearings/inquiries, citizens' jury/panel, consensus conferences, public opinion surveys, and focus group meetings (Rowe & Frewer, 2000), are sometimes criticized since their ability to the engagement with the public and the encouragement of exchange of ideas were limited that reduce the effectiveness of tools and difficulty in evaluating decisions (Fares et al., 2018, p. 1822). These methods generally depend on a particular place and time, and they are generally insufficient in terms of time, economy, and user satisfaction (Innes & Booher, 2004).

Technology-driven urban design tools and methods bring new opportunities for user empowerment and participatory design by removing the barriers of space, time, and technical issues in carrying out participatory design actions and facilitating the analysis and evaluation of collected data. Today, a range of digital media affect our lives and are increasingly embedded in the urban fabric, which monitor or reproduce urban rhythms and be instrumental in reshaping and regulating the interactions and practices of everyday urban life (Papangelis et al., 2023). These technologies also affect public participation and design empowerment in urban design practices. Therefore, new concepts have emerged with the effects of these developments within the intersection of participatory design and Information and Communication Technologies (ICT). We use the term "technology-driven participatory design" to define the use of ICT-enabled tools for the involvement of citizens in design processes. Technology-driven participatory design activities range from the passive participation of users through the involvement of their data, called "participatory sensing," to the collection of their desires from the projects and involving them in the inquiry of design alternatives.

Participatory sensing can be defined as the integration of users in the collection and acquisition of datasets about urban areas through the use of mobile devices and personal data sources to enable public and professional users to gather, analyze, and share local knowledge (Burke et al., 2006; Höffken &

Streich, 2013). Through this approach, it is possible to collect people-centric sensing, such as documenting activities and understanding the individuals' activities and behaviors by registering their location information, such as GPS location and activity information (Keseru et al., 2019). While the users have a more passive role in the participatory sensing approach, they can actively involve the design process in other technology-driven participatory actions.

With the use of mobile participation apps, e.g., FixMyStreet and FlashPoll, and web-based platforms, e.g., Maptionnaire and Qua-kit, citizens can enable to submit their desires and expectations from the project (Hasler et al., 2017; Falco & Kleinhans, 2018). In addition, users can experience design alternatives and contribute their design ideas to the process via immersive environments such as Virtual Reality, Augmented Reality, and Mixed Reality apps. Some studies show us that using these environments enables us to benefit from spatial and contextual cues and motivate more citizens in urban design processes (Saßmannshausen et al., 2021). They are useful in negotiating design decisions, discussing the quality of design alternatives (van Leeuwen et al., 2018), and increasing users' willingness to participate in the process (Boos et al., 2022). Additionally, the use of digital games is effective in supporting civic learning (Devisch et al., 2016), useful in the co-creation of urban areas and public places, motivates a broad audience (youth in particular) to participate in the design process, and enables participants to develop and present their own opinions on the 3D environment (de Andrade et al., 2020; Delaney, 2022). Table 2 shows a distribution of technology-driven participatory tools by actions involving data types and examples.

Table 2: Participatory design actions and the type of data involved, possible tools and technologies used in technology-driven urban design processes.

Participation Action	**The Type(s) of Data Involved**	**Possible tools and technologies**	**Example**
Participatory Sensing (Kanhere, 2011; Balaban, 2021)	Users' Locations & Actions Measure Urban Behaviour Sensor data collected from public areas	Static Sensors (e.g., Automated Counting and Other Sensors) Mobile Sensors (GPS, Accelerometer, Mobile Phone, Specialized Sensor Device) Big Data (e.g., Mobile Phone Positioning (MPP) Location Based Services (LBS), Social Media)	BeWell Project BlueStates CenceMe WideNoise
Collecting Desires and Expectations from the Project (Ertiö, 2013; Hasler et al., 2017; Falco & Kleinhans, 2018)	Users' placemarks and descriptive data Tagged content based on predefined categories Text-based comments	Mobile Participation Apps Web-based Participation Platforms	FixMyStreet FlashPoll Maptionnaire Qua-kit
Collecting/Developing Design Proposals (Devisch et al., 2016; Delaney, 2022; Alonso et al.)	Drawing users' polygons on maps Describe ideas on 3D models	Digital Games Mixed Reality Platforms	Participatory Chinatown CommunityPlanIt BlockByBlock CityScopeAR
Public Inquiry about Design Alternatives (de Andrade et al., 2020; Boos et al., 2022).	Text-based feedback & tagged content on experienced design Reactions and reflections of users on design alternatives	Digital Games Virtual Worlds Mobile augmented reality apps	NextHamburg Second Life platforms (Terf) UrbanCoBuilder

However, technology-driven urban design approaches have several shortcomings regarding user empowerment. First, the technology-driven participatory tools and methods are often ill-connected to computational design processes due to the lack of common platforms and difficulties in integrating this input (Knecht et al., 2019). Similarly, as computational design practices are based generally on

contextual and physical related constraints, the participation of users, which depend on the inclusion of non-physical factors about human preferences, cannot be realized sufficiently (Daher et al., 2018).
In addition, expert interview notes reveal the other drawbacks concerning integrating participation input in computational design processes. For instance, optimization methods depend on searching for the "perfect fit solutions" based on predefined metrics. This kind of approach prioritizes effectiveness and efficiency. However, the performative logic of technology-driven design may cause a conflict with the desires and habits of citizens. In this context, several questions come into prominence regarding urban life (Expert 2, personal interview). For instance, how effective is the creation of a cul-de-sac in the city-making process, which is an essential element for privacy and security in Islamic cities, regarding the metrics of accessibilities? Similarly, how efficient is planning organic city patterns and designing blank walls regarding perceptibility, walkability, and visibility metrics? Moreover, what if the users' expectations and desires from the project contradict the rational logic of technology-driven urban design?
Technology-driven urban design approaches still have some limitations in using "non-discursive" data, e.g., socio-cultural data of citizens and non-visible/grounded values of the area, which can not be easily parameterized (Expert 1, personal interview). Unless these data are integrated into the design process, a technology-driven approach may reduce urban design to the basic optimization process where only structured discursive problems can be solved through identified metrics. This may cause the creation of generic cities where the unique characteristics of the cities are lost, and citizens' space usage habits, needs, and desires are excluded. As a result, the cities will possibly be developed and transformed based on the goals defined by the collaboration of corporations and urban designers entitled "corporate urbanism" (Expert 7, personal communication).

4. Discussion

Thanks to the increasing capabilities of computational tools, urban analytics techniques, and possibilities to collect and process a wide range of urban data, technology-driven urban design approaches have provided many opportunities to urban design professionals. Technology-driven urban design tools enable examining the performance of existing areas or simulating produced urban design solutions based on defined objectives and parameters. While the traditional urban design approach is mainly based on more heuristic, non-discursive and draft-based design process, technology-driven urban design lies on the script-based and discursive design process. While the former is a data-informed and data-enabled approach, and the latter adopts a data-oriented and data-centric approach. In this sense, it incorporates digital computational design methods with objective and measurable constraints and parameters.
In the digital age, it is possible to involve many people in participatory design actions without space and time-related barriers. Nevertheless, many new issues regarding urban designers' role and user empowerment in technology-driven urban design processes need to be discussed. In this section, based on our research questions introduced in Section 1, we critically discuss how technology-driven design tools and technologies alter urban design practices and give some suggestions.

The Roles and Agencies of Designers in the Decision-Making Process: Urban design is a collaborative practice where architects, planners, landscape designers, and social scientists exchange opinions and deliberate on project issues. In the digital age, the urban design process incorporates different data sources such as physical and socio-spatial analysis of the area, environmental, authoritative, crowdsourced, remotely sensed, and social media data. Urban designers need to communicate and collaborate with urban data scientists and algorithm builders to extract meaningful information from the collected data. In addition, urban designers need to collaborate with experts from different areas so that they can properly define problems, identify goals through metrics, and create design solution space.
Furthermore, it is possible to encounter problems in identifying design goals when some conflicts happen in defining different parameters, such as environmental, economic, and social issues. Hence,

there is a need to provide a collaborative workspace; we use the term "expert collaboration platform" in this study that not only (1) provides a data panel allowing different expert groups to upload data and access the data pool, including different thematic data layers that collected by different actors in the design process and take decisions based on the deliberations but also (2) ensures urban designers to collaborate with data experts to extract meaningful information and knowledge from collected data in one shared interface like data dashboards. This platform can open new avenues to juxtapose and superimpose different data layers for data visualization and analysis. It can also be used for project management by enabling responsible actors to monitor data flows and manage workflows (Gün et al., 2021).

Defining design solution space based on identified problems and metrics is essential to carry out successful technology-driven urban design practices. Urban designers must try to address urban design problems discursively and identify thematic parameters accordingly. However, urban design inherently involves many "non-discursive" issues that cannot be entirely codified by explicable parameters (Çalışkan, 2017). For instance, citizens' sociocultural data, the area's local context, and citizens' needs and desires from the project cannot be easily defined as goals through metrics.

"*Only "well-identified problems" can be solved perfectly through computational design methods. What about the other types of problems? In this context, the leading role of the urban designer in creating a solution space for overcoming "non-discursive" problems is important*" (Expert 3, personal communication).

Moreover, urban designers should avoid structuring urban design processes based on "only" quantitative data because this approach may reduce the urban design process to an "engineering optimization process" (Expert 4, personal communication).

"*It is essential to benefit both from the discursive & rational power of computation and the non-discursive, heuristic & intuitive way of design thinking*." (Expert 2, personal communication).

In this sense, it is necessary to balance them, so urban designers are expected to move between traditional and computational design approaches like a pendulum (Figure 6).

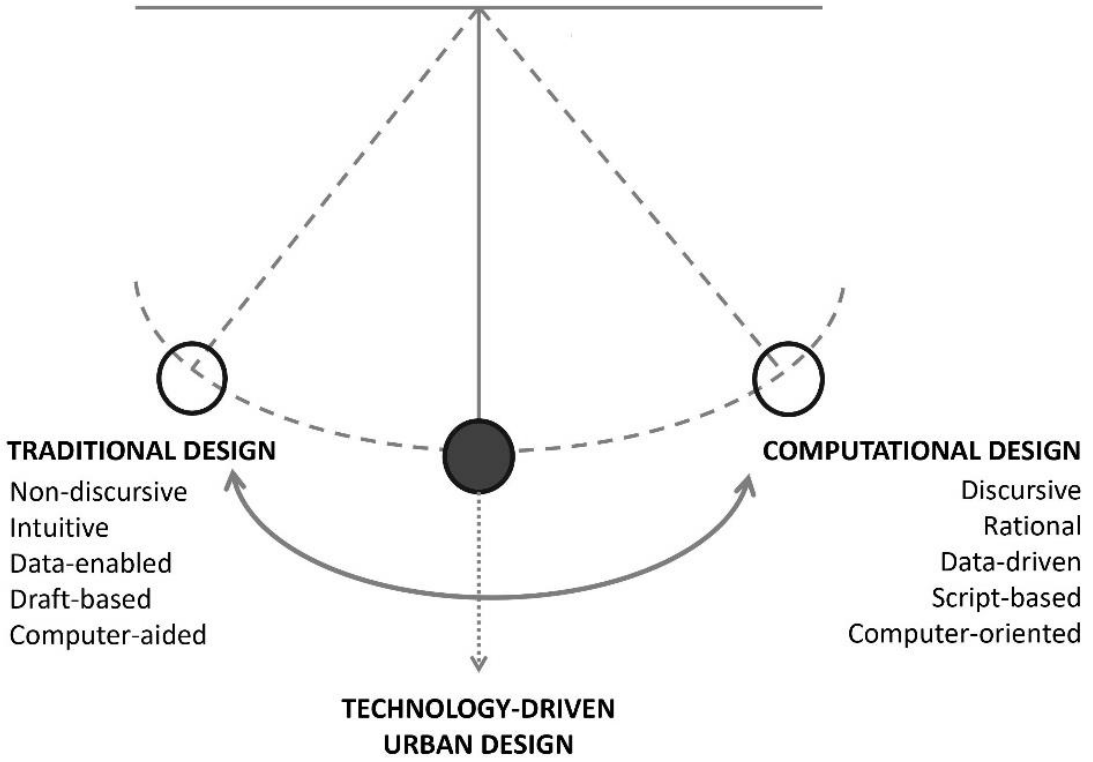


Figure 6. The situation of technology-driven urban design: The pendulum moving between traditional and computational design.

User Empowerment and Participation: As mentioned in the previous section, even though it is possible to involve citizen input through different kinds of technology-driven participatory design actions, e.g., participatory sensing and public inquiry about design alternatives, urban designers have faced some problems in integrating participation input in computational design processes (Knecht et al., 2019). Moreover, the nature of non-physical factors related to participation data can not be easily parameterized (Daher et al., 2018). This may cause the exclusion of these data types in urban design practices. In addition, as an interviewed expert noted:

"*It is possible to encounter conflicts between the performative logic of the computational design process and human desires and their daily living habits*" (Expert 2, personal interview).

Thus, urban designers need to find new ways to integrate non-structured data in the process and control the consistency of computational design inputs with user expectations and socio-cultural values of the areas in the early design phase.

Based on these findings, developing an integrated collaborative and participatory framework that can be used in technology-driven urban design practices is necessary. First, before creating a design space model, both thematic physical data layers, such as walkability, physical environmental conditions, accessibility, and non-discursive data sets, e.g., users' actions and space usage habits, should be collected and analyzed based on the consultation between experts. In defining design goals, the participation of users is very critical. In this phase, users' expectations and desires from the project can be collected through technology-driven tools, e.g., web-based platforms, mobile participation apps, and traditional participation techniques. This data should be used as one of the dimensions in defining design goals. Additionally, design alternatives can be shared with participants in the design optimization phase. Citizens can experience design alternatives by using digital games and immersive environments and give feedback based on this experience. Therefore, urban designers can control the consistency of their design solutions from the users' perspective.

5. Conclusion

Technology-driven urban design tools empower urban designers by (1) helping the decision-making process and enable reasoning, (2) producing a vast amount of design alternatives that would not be possible through traditional ways. As a result, these tools also assist designers in finding data-driven design solutions for complex situations. More people can participate in different participatory design actions through ICT-enabled participation tools. As a result, the role of urban designers has changed, requiring them to make decisions more collaboratively and possess a basic understanding of computational design elements to identify design problems and goals. They need to find new ways to integrate non-discursive data, e.g., unique characters of the urban areas that are not identified as metrics, or participation data, in the computational design process. In addition, they are also expected to examine the consistency of design output produced by computational design tools with participants' satisfaction and unique characteristics of designed urban areas based on their intuitive design ability as stated by Expert 2 in a personal interview.

Effective and inclusive urban design practices have faced challenges due to the lack of interaction environments that enable urban designers to collaborate with other expert groups in identifying design goals and creating design scenarios. Moreover, there has not been enough identification of how the participants' data and grounded values of the urban areas into computational design practices have not been sufficiently identified yet. Currently, the incorporation of non-discursive data into computational design practices is not well-established. Therefore, it is important to use a combination of intuitive design methods and computational power. As pointed out by Çalışkan (2017), instead of considering computational design tools as "Design Machine" they should be used as a "Design Support System" to empower urban designers to create urban areas in a more holistic, integrated and consistent way.

An overall conclusion, it is currently too early to effectively and inclusively make use of the full potential of technology-driven solutions in urban design practices due to several reasons:

- A lack of a comprehensive design ecosystem for data integration to extract meaningful insights
- Challenges in identifying specific design problems

- Potential inconsistencies in arising between the logic of computational design and participation data
- Limited application of technology's full potential in urban design practices

This study critically examines the paradigm shift in urban design practices in the digital age and projects the future components of the urban design process in a general way. The critical perspective and arguments presented in this study can be useful for future research. This critical discussion should be held regularly because the affordances and potentials of technology-driven urban design solutions evolve. There are limitations to this study. Firstly, it addressed the issues to some extent because it is based on declarative knowledge: computational design experts' experiences and previous research findings. Secondly, collaboration with urban design professionals was needed to carry out in-depth field studies like protocol analysis to document their reactions and experiences. Thus, our future research direction is to carry out an in-depth field study in collaboration with actual stakeholders to examine varying cutting-edge urban design tools and methods, document the actors' reactions, and propose key success factors for developing an effective and inclusive urban design ecosystem driven by technology for future practices.

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The Author(s) declare(s) that there is no conflict of interest.

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A Review of the Meaning of Home in Multi-Ethnic Settings

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ABSTRACT

This paper explores the meaning of home from multiple regions and the factors that influence the definition of home from multi-ethnic perspectives. A hypothesis derived that each ethnicity of a household practises cultural values and that reconfiguring physical spaces provides greater knowledge of their definition of home. This study employed a systematic review to gather the most relevant papers in the existing literature from the year 2000 to 2023, to address the gaps in knowledge in conceptualising the meaning of home in multi-ethnic settings. The findings respond to the hypothesis of this paper, that each household practises privacy and social boundaries in line with their belief systems and that reconfiguring physical space is part of homemaking tactics. This study outcome contributes to the development of a new conceptual framework that clarifies a comprehensive cause-effect relationship between key variables, ethnicity as the social aspect, built space as the physical aspect and practice as the personal or psychological aspect, resulting in a greater understanding of the meaning of home in multi-ethnic settings from three scenarios; the home as socio-spatial, psycho-spatial and emotive space entity.

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Highlights	Contribution to the field statement
- Elucidate the interweaving relationship between the disciplines of sociology, psychology, emotions, architecture and urbanism. - Introduce a new framework as a guide to investigating human intervention in the transformability of spaces and physical settings. - The outcome of the systematic review responds to the hypothesis of this paper that each household practises cultural values, privacy and social boundaries in line with their belief systems and that reconfiguring a physical space defines the meaning of home.	The primary contribution of this article to academia is the development of a new conceptual framework that synthesizes the meaning of home in multi-ethnic settings, incorporating ethnicity, home practice, and physical spaces. This interdisciplinary framework is essential for understanding how cultural values and privacy influence individuals' definitions of home, particularly in contemporary housing design and policy. Additionally, the article highlights the importance of examining research methods and tools and acknowledges the role of digital spaces in redefining the meaning of 'home' in today's world.

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1. Introduction

In the context of architecture and urbanism, a physical home or a house is an architectural typology that provides shelter and protection for the members of households to perform their daily domestic activities (Cuerdo-Vilches et al., 2020; Özçetin & Rottmann, 2022). A house is a fundamental aspect of human life and provides provisions to support basic physical survival needs (Muhammad Koderi et al., 2020). In socio-economic research, ownership of a house usually indicates an individual's living standard, status and social standing (Mohan & Twigg, 2007). Functionally, a house stands as a tangible structure that demarcates distinct spatial zones within which household members operate (Hu, 2008). One of the fundamental objectives of house design strategies is to differentiate between public and private areas (Hu, 2008; Rahim & Hashim, 2012). In essence, a house assumes the role of a 'human habitat' as articulated by Lefebvre (1991, p. 12).

Phenomenological inquiry further elucidates the notion of inhabiting a space or dwelling, drawing parallels to the scholarship of Heidegger (Handel, 2019), who forged connections between architectural concepts, dwelling, and the idea of home. Heidegger posited that 'We do not dwell because we have built, but we build and have built because we dwell, that is, because we are dwellers' (Heidegger, 2001, p. 146). Throughout the early stages of human history, when individuals sought transient safety at specific locations while also migrating to meet their survival needs, dwelling was inherently transient. However, as human settlements became more permanent, the notion of 'home' underwent an evolutionary transformation (Easthope, 2004; Özçetin & Rottmann, 2022).

Crucially, the concept of home transcends its physical permanence, expanding to encompass the constructive interpersonal relationships crucial for human well-being (Werner et al., 1992; Morrison, 2013; Al-Tarazi, 2021). Home assumes a central role as a social setting for establishing and nurturing interpersonal bonds among household members, as well as fostering friendships with neighbours and guests (Werner, 1987, p. 170).

The interaction between people (individually or in groups), setting (physical home) and time (linear or cyclical) (Case, 1996), expressed the need for psychological comfort, social interactions, spatial attachment and recognition (Abu-Ghazzeh, 2000; Rioux et al., 2017; Rosbrook & Schweitzer, 2010). Consequently, the field of domestic architecture assumes the role of a symbol, reflecting identity and cultural expression (Abdelmonem & Selim, 2012; Vale, 1999; Woodward, 2003). Nonetheless, within the context of domestic architectural evolution amid globalisation, the construction of physical home or houses becomes substantially influenced by factors such as construction efficiency, cost considerations, political agendas, and the representational identity of corporate entities. This emphasis on practical considerations often diminishes the attention afforded to the profound significance of the concept of home and its suitability for domestic practice (Lah et al., 2015; Mallett, 2004; Samanani & Lenhard, 2019; Ureta, 2007).

Several international case studies have unequivocally exemplified that contemporary housing, particularly in the form of row houses, tends to adopt a standardised, generic approach to housing design. This approach, however, gradually erodes the socio-cultural practices of indigenous populations, as social and personal needs inherently vary across ethnicities (Abed et al., 2022; Al-Mohannadi et al., 2023; Al-Thahab, 2016; Suryadi et al., 2022). These issues, with global ramifications, have necessitated adaptation and appropriation strategies within the physical dwelling unit to facilitate sustainable living for its occupants (Abu Bakar et al., 2016; Al-Thahab, 2016; Mackay & Perkins, 2017; Ureta, 2007). It is crucial to recognise that a house, considered solely as a physical structure, can transcend its mere physicality and evolve into a 'home' over time through experiences and acts of appropriation (Abdelmonem & Selim, 2012; Aziz & Ahmad, 2012; Graham et al., 2015; Samanani & Lenhard, 2019).

In the practice of everyday life (Certeau, 1984), the dynamism of practices may influence the physical configuration of spaces; constructing an appropriate domestic space over time in response to personal and social needs can be perceived as a dynamic homemaking 'tactic' (Özçetin & Rottmann, 2022). A home reflects the culture, social convention and values, manifested in people's habits, practices and

predispositions towards their homes, which Bourdieu (1977) referred to as "habitus." These values and dispositions are acquired through the cultural history we carry across contexts, thus enabling us to respond in various ways towards cultural rules and contexts, even though where and who we have been largely determines and regulates our responses to the setting.

In Chile, low-income households domesticated their interior homes as a way to find a balance between their sense of identity and their inclusion into the Chilean community, always concerning policymakers' and developers' perceptions, as reflected in estate architectural design on how low-income families should reside in urban settings (Ureta, 2007, p. 132). For it to feel like a 'home', these families appropriated the physical configurations of their new domestic space to suit their perceived needs (Ureta, 2007).

A similar challenge was faced by Muslim dwellers when occupying contemporary Australian houses as they are required to adapt to the extroversion design despite gender and social boundaries being constantly stressed in Islamic practice (Othman, 2014).

Vale (1999) identified continued evidence for this practice in politicised urbanism in developing countries such as Malaysia. Since the early development of contemporary row houses in the 1970s, Malaysian scholars have criticised the design of contemporary homes, calling it a 'forced architectural identity' (Rasdi, 2007).

Numerous research on identical and mirror-image built forms in contemporary row housing led to physical modifications by dwellers, describing issues concerning privacy tensions and social conflicts which are inefficient to their home practice and experience (Omar et al., 2016; Razali & Talib, 2013; Samsudin & Idid, 2016).

In sum, the studies on the meaning of 'home' from Western, Middle-Eastern and Eastern scholarships are vast; however, there is a knowledge gap in conceptualising the meaning of home in multi-ethnic settings. A systematic review is required to explore the existing empirical studies from diverse ethnic backgrounds and the factors that influence their meaning of home. To fill in the gap, the following questions must be researched:

1. How do we conceptualise the meaning of home in multi-ethnic settings?
2. What is the definition of home and the factor(s) that influence the meaning of home?
3. What are the key variables that can be included in the new conceptual framework of the meaning of home in a multi-ethnic setting, particularly in the Malaysian context?

This article is a reviewed paper that explicitly identifies the meaning of home from multiple regions and the factors that influence the definition of home from multi-ethnic perspectives. The objective is to comprehend the definition of 'home', not only bound to the physical aspect but also how various ethnicities construct the meaning of home from social and personal aspects. This paper derived a hypothesis that each ethnicity of a household practises cultural values and that reconfiguring physical spaces provides greater knowledge of their definition of a home.

This article is divided into five sections. Section 1 introduces the definition of a physical home and the research problem. Section 2 explains the methodology this paper used is a systematic literature review to gather the existing publications related to the meaning of home in multiple contexts.

Section 3 reveals the results on the definition of home and the factors that influence the meaning of home from each related publication's context study. In Section 4, this paper analyses and discusses the key variables that contribute to the development of a new conceptual framework that describes the meaning of 'home' for a multi-ethnic setting, particularly in the Malaysian context. Section 5 concludes with contributions to the study and suggestions for future research.

1.1.Background: Socio-demographic in Malaysia

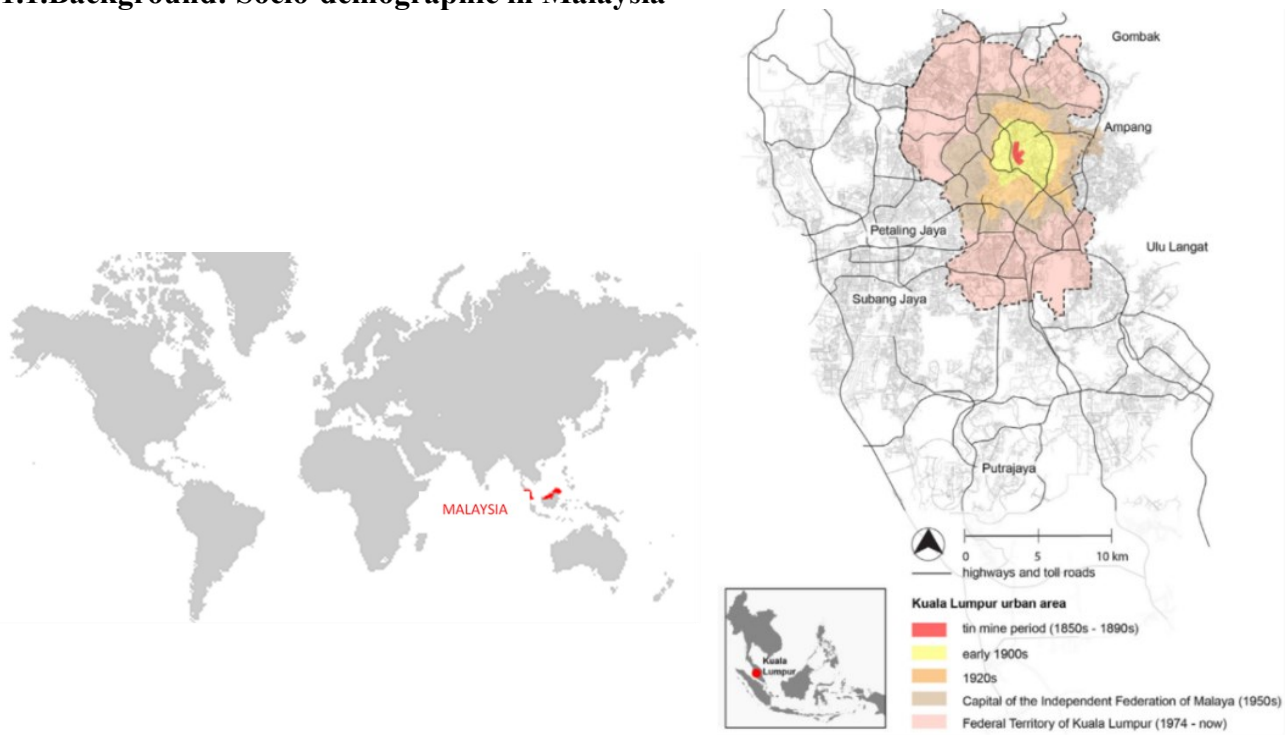


Figure 1. World map (left) and location map of Kuala Lumpur, the capital city of Malaysia (right).

Malaysia is a region near the tropic, located at the centre of South East Asia and mixed with Malay, Chinese, Indian and European cultural influences. Malaysia is not only a region where monsoons meet but is also a transit centre hub for major civilisations. For decades, the population of Malaysia had experienced turbulent events, such as wars, decolonisation, migration and occupation, before the country achieved independence in 1957 (Abdullah et al., 2022; Suryadi et al., 2022).

This phenomenon has drastically transformed the nation from a homogeneous socio-demography into a heterogeneous society that speaks and practises different languages, traditions and cultures. The Malay-Muslim ethnic group constitutes the majority of Malaysia's population, followed by Chinese Buddhists, Taoists or Christians and Indian Hindus or Christians (Abdullah et al., 2022).

During post-war British Malaya, Kuala Lumpur's capital city experienced overpopulation with immigrants, as well as significant migration of people from rural areas, who flocked to the city, the nation's centre of business and commerce, to gain jobs and achieve a better standard of living (Suryadi et al., 2022). The sudden population growth led to the rapid development of contemporary row housing in 1970 and spread across the Selangor state (Ju et al., 2011). As time passed by, the transformation of these contemporary houses started to take shape differently (Omar et al., 2016).

Mohamad (1992) looked at how the transition of Malaysian households use their homes to support their belief system and practises in traditional homes, squatters and contemporary flat dwellings. Intriguingly, this research discovered that Malay and Indian households appropriated domestic spaces to preserve gender domains (male: public; female: private), Chinese homes delimit between public for outsiders and family domains as private (Mohamad, 1992).

All three households gradually appropriated the physical configurations of their interior homes to adapt to their perceived needs, a similar case to Chile’s low-income families. Malaysian housing policies advocate home ownership based on the anticipated socio-psychological benefits to its citizens. However, there is less emphasis on the distinctly Eastern cultural characteristics that support the locals' lived experience and spatial practice. (Hamzah & Adnan, 2016).

2. Materials and Methods: Systematic Literature Review

A systematic literature review is a scientific exercise, a tool to gather existing literature reviews and identify evidence where it may be lacking, whether contradictory or inconclusive. The principal objective of this work is to identify features or connections between major concepts from previous research that are pertinent to the issue, which is also the aim of a systematic review (Aromataris & Pearson, 2014).

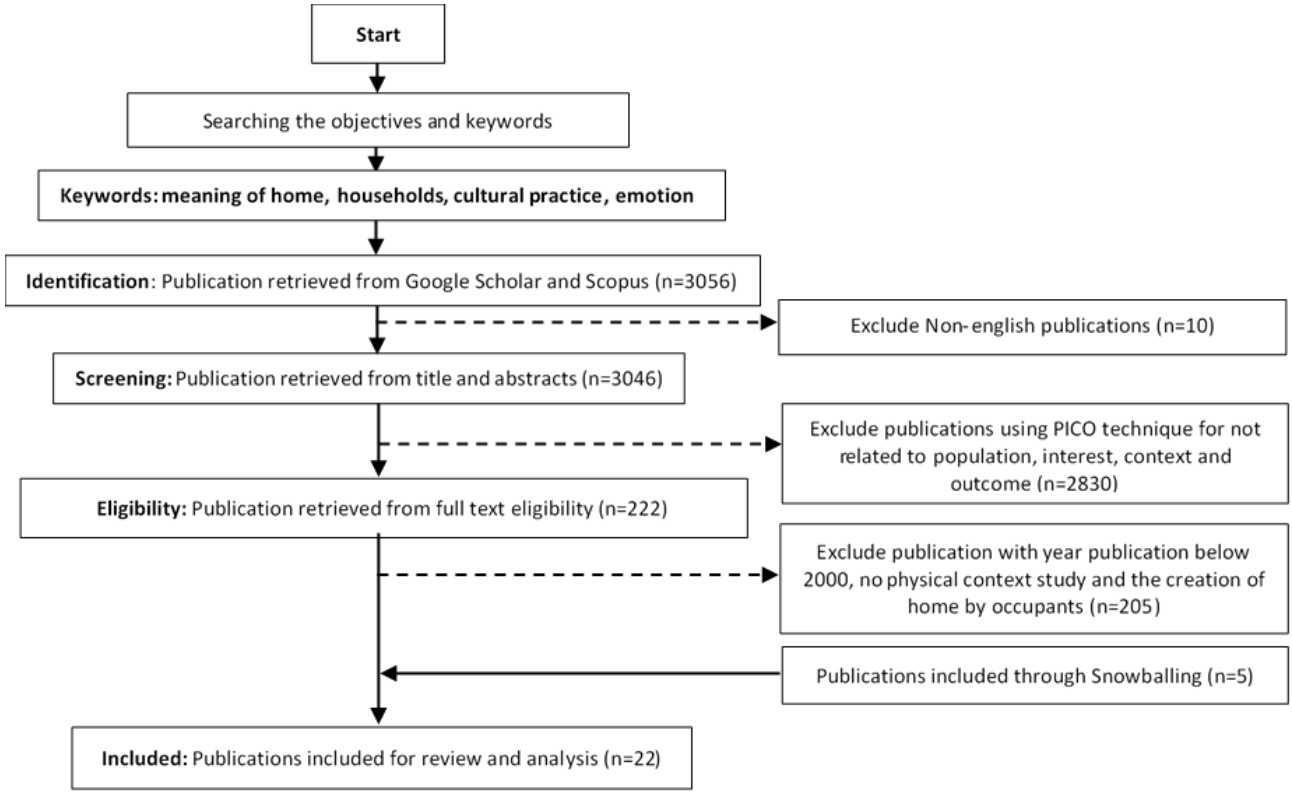


Figure 2. Publication selection process.

The works of literature associated with 'the meaning of home' were gathered from a corpus of both theoretical and empirical literature from various disciplines. However, the focus of this review is to gather empirical studies with diverse ethnic backgrounds. A set of search strings using the keywords and synonyms were identified through primary literature review and were finalised TITLE-ABS-KEY ('meaning' or 'concept' or 'interpretation') and ('home' or 'house' or 'dwelling*') and ('family*' or 'household*' or 'domestic*') and ('ethnic*' or "culture*" or 'practice') and ('emotion' or 'feeling*' or 'attachment').

A search in the academic databases of Google Scholar (n=2990) and Scopus (n=166), from the 1980s to the present (31st March 2023) revealed 3,056 publications. This was followed by the selection process of identification, screening, eligibility and final inclusion. Ten papers identified as non-English publications were excluded from the selection process.

To assess the eligibility of the chosen papers, a PICO Qualitative technique was utilized (Methley et al., 2014), which included the following four review criteria: (1) the papers studied a population that focused on home dwellers who have experienced and modified their physical homes (structural or objects), (2) interest/intervention: the discourses on the definition of home and the practice of home; (3) context/setting: households from regions with multicultural backgrounds and a focus within South Eastern context; (4) outcome: theoretical results on the meaning of home from empirical studies.

222 publications were found to be relevant and selected for the full-text eligibility process. Empirical studies with actual physical context are highly preferable and publications published before the year 2000 were excluded since the focus is primarily on the target population in recent years (2000 – 2023). Studies from Malaysia are mainly selected and included for its multi-cultural context.
Hence, only 17 publications are found to be relevant. Another five most relevant papers were selected through a snowballing procedure to collect other highly relevant sources of the empirical literature and were recognised through citation and reference lists. Ultimately, 22 scientific publications ranging from 2000 to 2023 were selected for analysis. Figure 2 above illustrates the overall selection process.

2.1 Data Analysis

Initially, a thematic analysis was utilised to review and synthesise data from experimental and non-experimental literature. A qualitative research approach to examine textual data permits the extraction of main themes and subthemes from a complex and rich dataset, thereby rendering it suitable for the development of a conceptual framework (Crowe et al., 2015).
A semantic approach was applied to the specific content data in the primary literature study to identify common themes and concepts concerning the meaning of 'home'. A content analysis was then conducted on the selected 22 publications to identify and categorise home definitions and the factors that influence the meaning of home from each context.
The data were then examined holistically and in-depth by utilising the primary themes, which resulted in secondary coding to develop subthemes. Such introspective theme analysis provided a solid structure for conceptualising the meaning of home which was then included in the initial development of the conceptual framework. The following are the primary themes identified as a result of data analysis: 1) the physical home, 2) the social home, and 3) the personal home.

3. Results: Conceptualising the Meaning of Home

A home is a synthesis of physical, social and personal aspects that include everyday notions of living within architecture and urban experience (Al-Tarazi, 2021; Graham et al., 2015; Watkins, 2005). Subthemes that emerged from the data analysis are the factors that influence the home's physical, social and personal aspects following the context of each publication.
Table 1 below presents the physical aspect consisting of six subthemes; the social aspect has six subthemes, and the personal aspect has eight. These classifications should not be considered in separate entities, but rather as a whole that reflects how each of these categories (social, personal and physical) impacts and is affected by the other two, in line with the argument made by Al-Tarazi (2021).

Table 1: Conceptualisation of the Meaning of 'Home'.

		Definition of a 'Home'		
Themes	**Physical**	**Social**	**Personal/ Psychology**
Subthemes	1 Portrayal of architectural style and preference	1 Neighbours and Multigeneration relations	1 Belonging and material attachment
	2 Quality of material structure and neighbourhood	2 Family bonding and interactions	2 Responsible, ownership and status
	3 Suitable and Convenient Services	3 Cultural adaptation and acceptance	3 Permenance, belief and values
	4 Appropriation and the use of space	4 Positive atmosphere and caring	4 Privacy and refuge
	5 Boundary and status indicator	5 Friendships and celebration	5 Domestic practice and experiences
	6 Physical characteristics and identity	6 Gender role and domain	6 Transformability and control
			7 Memories and retreat
			8 Notions of comfort and familiarity

No	Author	Year	Region			
1	Woodward	2003	Australia	(1);(4);(5)	(2);(4);(5);(6)	(2);(3);(5);(6);(8)
2	Hand et al.	2005	UK	(1);(3);(5);(6)	(1);(3);(5)	(2);(5);(8)
3	Hu	2007	China	(1);(4);(5);(6)	(1);(2);(4);(6)	(1);(3);(5);(6);(8)
4	Ureta	2007	Chile	(2);(3);(4);(5)	(3);(4)	(1);(2);(5);(8)
5	Zohri	2010	Malaysia	(1);(4);(5)	(1);(2);(5);(6)	(3);(4);(5);(8)
6	Rahim and Hashim	2012	Malaysia	(2);(4);(6)	(2);(5)	(3);(4);(5);(8)
7	Abdelmonem	2012	Cairo	(4);(5);(6)	(1);(2);(4);(5);(6)	(3);(4);(5);(6);(7)
8	Morrison	2013	New Zealand	(4);(5);(6)	(2);(4);(6)	(1);(3);(5);(7);(8)
9	Othman	2014	Australia	(1);(5);(6)	(3);(6)	(3);(4);(5);(8)
10	Lah et al.	2015	Malaysia	(1);(4);(6)	(3);(6)	(3);(5);(7);(8)
11	Hamzah	2016	Malaysia	(2);(4);(5);(6)	(2);(4);(6)	(1);(2);(3);(4);(5);(7);(8)
12	Omar et al.	2017	Malaysia	(2);(4);(5);(6)	(2);(3)	(3);(4);(5);(6);(8)
13	Razali and Talib	2017	Malaysia	(2);(4);(6)	(2);(3);(6)	(4);(5);(6);(7)
14	Masran	2019	Malaysia	(2);(3);(5)	(1);(2)	(3);(4);(5);(6)
15	Al-Tarazi	2021	UK	(1);(2):(3):(6)	(2);(3)	(1);(2);(4);(6);(8)
16	Oczentin	2022	Syria	(1);(4);(6)	(3);(4);(6)	(1);(3);(4);(5);(7);(8)
17	Okeyinka	2022	Africa	(3);(4);(6)	(2);(3):(4)	(3);(4);(7);(8)
18	Kottman	2022	Japan	(2);(4);(5)	(2);(3);(6)	(1);(4);(5);(6)
19	Suryadi et al.	2022	Malaysia	(1);(4):(6)	(6)	(5);(8)
20	Soligbo	2022	Australia	(1);(4);(6)	(1);(2);(3);(4)	(1);(2);(5);(6);(8)
21	Abed	2022	Jordan	(3);(4);(5);(6)	(1);(2)	(1);(2);(4);(5);(8)
22	Lordoğlu	2023	Istanbul	(2);(3);(4)	(3);(4);(6)	(1);(4);(6);(7):(8)

The definition of 'home' can be found at the centre of human life and is heavily influenced by the inhabitants' lived experiences (Watkins, 2005). The interpretation of home inherently varies across ethnicities and is related to lived experiences and acts of appropriation towards their home environment.

3.1 Home in Multi-ethnic Settings: Ethnicity, Practice and Physical Space

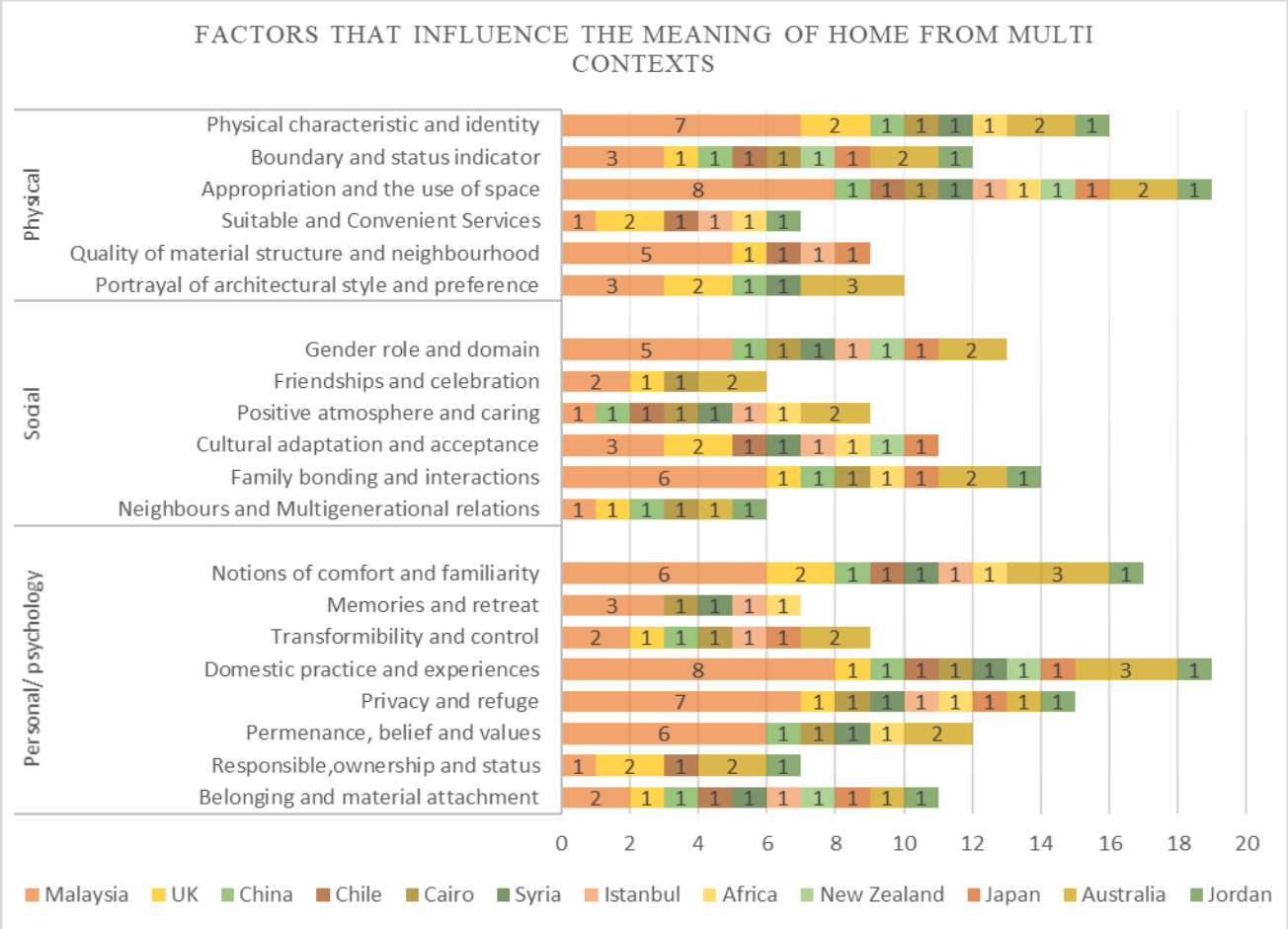


Figure 3. Subthemes emerged from content analysis: key factors that influence the meaning of home by regions (Developed by the Authors).

'Home' is a realm where things are 'culturally and socially bounded' and it becomes 'the centre of our experience of space' (Case, 1996, p. 2; Woodward, 2003), which induces a sense of 'home', either individually or collectively (Terkenli, 1995). The aspect of home experience is an interaction between people (individually or in groups), setting (physical space) and time (linear or cyclical) (Case, 1996). According to Figure 3 above, all reviewed papers from multiple regions interpret home as a dynamic 'homemaking' tactic of appropriation and the use of physical space.

From a personal or psychological aspect, home is a psycho-spatial entity and almost all regions associate home with domestic practices and experiences, the notions of comfort and familiarity and the need for privacy and refuge (Kottmann, 2022; Lordoğlu, 2022; Özçetin & Rottmann, 2022).

From a social aspect, there is the necessity of a clear gender role and domain within the physical home setting. Furthermore, cultural adaptation and acceptance within a community are critical for sustainable living in a multigenerational and multicultural society (Al-Mohannadi et al., 2023; Okeyinka & Amole, 2012; Soligbo, 2020). As there is a consensus that a physical home is an environment for socialising (social space), scholars view homes as a socio-spatial entity (Hand et al., 2007; Morrison, 2013; Woodward, 2003).

The results also revealed that the characteristics of a physical home are equally significant since they reflect the identity, social group or individual's architectural style and preferences within the self or self-expression (Ureta, 2007). Thus, home is a space for an expression of feelings involving the occupants' mood and desire for personalisation that profoundly impact the psychological mind (Graham et al., 2015; Rowles, 1983). Emotional appropriation occurs within the home environment through behavioural tactics such as creating partitions to define boundaries, repainting to suit colour

preference and incorporating DIY products and material belonging that signify family relationships and accomplishments (Graham et al., 2015; Mackay & Perkins, 2017; Morrison, 2013).

In other words, the concept of 'home' is a complex amalgamation of people's perception of space, experience of space and daily use of space that shaped their meanings and cultural values within it (Boccagni & Kusenbach, 2020).

In socio-psychology, community living or togetherness within a neighbourhood context is equally vital to the meaning of 'home' (Soligbo, 2020). The feeling of comfort and safety does not solely rely on the physical or material structure of a home, but also on the relationships with the family and neighbours (Abdelmonem, 2012; Soligbo, 2020; Werner et al., 1992).

Researchers also describe home as a social realm defined by their daily interaction with others and their code of behaviour (Case, 1996, p. 2). It is determined by a belief system that outlines rules and regulations regarding a way of living, whether individual or part of a congregation, and hence, influences the home arrangement for psychological well-being (Lah et al., 2015) and socio-cultural practice (Mohamad, 1992). Sacred rituals, such as praying, religious services and ceremonies, are actions and activities that can shape the meaning of home as a way to sustain family relationships and lineage (Hu, 2008).

Malaysian homes, according to Hasniyati (2016), are connected with substantial female participation in the homemaking process, and the home is described as an emotional appropriation of lived space evolving around family-centred activities. The 'home' becomes a woman's domain when a woman fulfils the nurturing and caring roles that are traditionally associated with mother figures. It is an emotional attachment an individual has to the meaning of 'home' (Aziz & Ahmad, 2012; Graham et al., 2015; Zohri, 2010).

Spatial quality and privacy are personal needs and have been significantly discoursed by the Middle-eastern and Asian scholars in contemporary houses (Al-Mohannadi et al., 2023; Hamid et al., 2017; Masran, 2019; Rahim & Hashim, 2012; Razali & Talib, 2013). A study in Old Cairo examined how daily interactions between homes, friends, extended family and the historic neighbourhood affect people's daily lives. The study developed the idea of multi-use outdoor spaces that are also maintaining the intangible heritage of sociocultural practices across time. Social interaction occurs in temporal arrangements resulting in 'part-time' space produced according to time, gender associations and social class activities by its community (Abdelmonem, 2012).

In a quantitative study on space utilisation in a low-cost flat unit, the living hall and kitchen are the dominant spaces with the highest space integration value to the entrance hall (Suryadi et al., 2022). From a graphic perspective, the layout appears to provide easy access and better connectivity between the rooms and space relations. Then again, setting up this inside and outside border varies by ethnicity; when it is crossed, individuals feel as though their privacy has been invaded (Abed et al., 2022; Musa et al., 2021).

Today, domestic wares and utensils are replaced with new technology and machinery for comfortable and compact living. However, from another ethnic perspective, the new machinery may not be a utilitarian practice to prepare traditional cuisines along with its culinary techniques, particularly within Eastern cultures (Hand et al., 2007; Zohri, 2010).

The findings support the theory of practice by Certeau (1984a) and Bourdie (1977) that the dynamism of home practice influences the physical configuration of spaces; constructing an appropriate domestic space over time in response to personal and social needs is a dynamic 'tactic.'

Home experience is an interaction between people (individually or in groups), setting (physical space) and time (linear or cyclical). The experience can be enhanced through home practice, which involves the occupant's affordance for a place or material belonging, social rules and interactions defined by their belief system, and the act of appropriation through daily use and way of living (Case, 1996).

4. Discussion: The Influences of Ethnicity on Physical Spaces

From the results, the concept of home is not only a physical shelter for physiological needs; it also refers to the practice of 'home', regardless if the home is a concrete structure (e.g. housing), less concrete (e.g. a neighbourhood or hometown) or something intangible (e.g. a spiritual/personal home). When a home is perceived as a physical entity, the dynamism of cultural practice inspires human habits for the appropriation of spaces (Al-Tarazi, 2021).

It is a 'homemaking' process between people, physical space and notions of home (Sixsmith, 1986) that can be formed into a dynamic tactic of 'creating or making' spaces (Mallett, 2004), 'for space is never empty but embodies meaning' (Lefebvre, 1991, p. 154). The desire to appropriate or create has been perceived as an effort to establish social boundaries (Aziz & Ahmad, 2012).

Those who have 'authority' of decision in making space hold the power to shape the activities within spaces as they define home (Mallett, 2004). The following are the aspects of 'home' that describe the relationship between ethnicity, physical space and practice. Hence the definitions can be understood from this theoretical perspective.

Ethnicity as the social aspect

This element refers to the households' ethnicity and belief system within the physical space and describes how people interact with one another within their homes. According to this viewpoint, ethnicity has the power to impact the configuration of the physical spaces.

Space as the physical aspect

This element refers to a building structure or space in which the social and personal/psychological aspects may take place. This aspect is the focus of this study since the presence of the other two elements has the ability to reconfigure and transform it.

Practice as the personal aspect

This aspect focuses on the household's definition of home. Their home perceptions, experiences and emotions are a result of household practices that take place inside the actual physical home. Personal aspects refer to the outcome that we are trying to understand, which alludes to how individuals constructed meanings and defined spaces as home based on their lived experiences and practices.

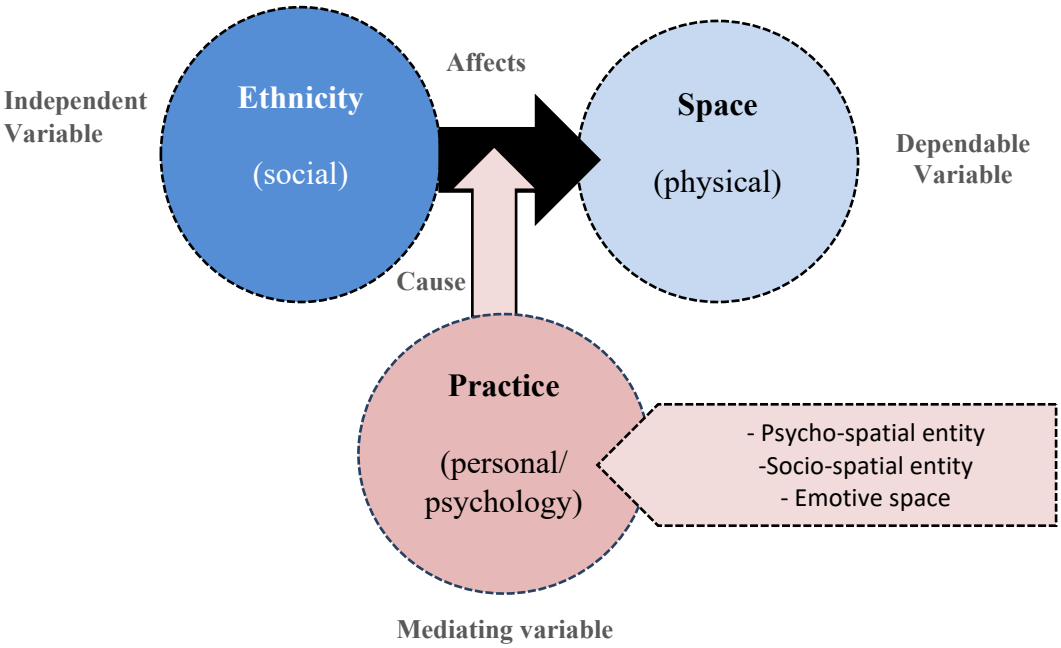


Figure 4. An initial development of a conceptual framework with combined theories. (Developed by the authors).

Figure 4 above illustrates an initial conceptual framework describing the cause-effect relationship between ethnicity, space and practice as initial steps to answer the hypothesis of this paper.
All reviewed papers were examined on how ethnicity influences physical space and how space is produced culturally. This includes 'nonspecific-functional spaces'(Hu, 2008), 'transitory spaces' (Özçetin & Rottmann, 2022), 'in-between' spaces (Masran, 2019), 'part-time' spaces (Abdelmonem, 2012) and 'negotiated' spaces (Othman, 2014; Rahim & Hashim, 2012), revealing a rich variety of cultural and social influences in the physical home settings, to which housing policymakers are oblivious (Abed et al., 2022; Suryadi et al., 2022; Ureta, 2007).
Table 2 below presents the contributions of reviewed papers and their views on home from each context of their studies.

Table 2. Contribution to the understanding of the meaning of home in multi-ethnic settings.

No.	Author	Year	Region	Key Contribution (Space appropriation)	Home approach
1	Woodward	2003	Australia	Middle-class households placing objects for comfort use or aesthetics and style, create space for socially mediating symbolic boundaries of self	Psycho-spatial
2	Hand et al.	2005	United Kingdom	A comparison study on the 1980s and small modern homes with accumulating domestic technologies. Modern kitchen becomes a multifunctional space and the bathroom is multiplying.	Psycho-spatial
3	Hu	2007	China	Spatial boundaries: all rooms have multifunctional uses across the time and life course of the families: nonspecific-functional space and family hierarchy.	Socio-spatial
4	Ureta	2007	Chile	DIY: domesticate home strategies on homogeneous spaces for a sense of identity	Psycho-spatial
5	Zohri	2010	Malaysia	Flexible expansion system on physical space for privacy and Muslim women's comfort use	Psycho-spatial
6	Rahim and Hashim	2012	Malaysia	Negotiation/shared space: Living and dining become interchangeable spaces based on affordance	Socio-spatial
7	Abdelmonem	2012	Cairo	Part-time space: The use of private/outdoor according to time and social practice	Socio-spatial
8	Morrison	2013	New Zealand	Domestic space and material objects embodied the intimacy and relationships of a household	Emotive Space
9	Othman	2014	Australia	In-between space: the balancing factor to provide hospitality and achieve optimum privacy in Muslim homes	Psycho-spatial
10	Lah et al.	2015	Malaysia	Spiritual space: The influence of 'metaphysic' on the design of physical buildings in ancient Asian cultures	Psycho-spatial
11	Hamzah	2016	Malaysia	Feelings, perceptions, relations and attachment to lived space is a homemaking process	Emotive space
12	Omar et al.	2017	Malaysia	'Mirror' arrangement of terrace housing is visually exposing and leads to reconfiguration of home material	Psycho-spatial
13	Razali and Talib	2017	Malaysia	Imbalanced space: the Malay women's domain and visual privacy are conflicted in a tiny flat housing	Psycho-spatial
14	Masran	2019	Malaysia	In between space: Home frontage distance to achieve the optimum privacy	Psycho-spatial
15	Al-Tarazi	2021	United Kingdom	Personalising: assessment of human psychological well-being in the physical homes and general life	Psycho-spatial
16	Oczentin	2022	Syria	Redecorated home in Istanbul and reminisced home in Syria: transitional space for a sense of belonging	Emotive space

17	Okeyinka	2022	Africa	Comfort and security in physical home features are most preferable in the Yoruba culture to develop a sense of belonging	Psycho-spatial
18	Kottman	2022	Japan	'New' space of relating and belonging: diversification of living arrangement in 'hyper solo society' practice	Emotive space
19	Suryadi et al.	2022	Malaysia	Integration of domestic spaces: space connectivity and accessibility of dominant spaces	Psycho-spatial
20	Soligbo	2022	Australia	Homemaking for migrants in vertical housing and seeking a sense of community is a multi-staging process of home experience	Socio-spatial
21	Abed	2022	Jordan	Home designs with sociocultural considerations produce different architectural forms, it is never a static home layout.	Psycho-spatial
22	Lordoğlu	2022	Istanbul	Gendered space: women conflicts to feel a sense of belonging in the foreign cultural environment	Emotive space

According to the findings, setting boundaries and safety are always associated with the physical aspect of a home (Abu-Ghazzeh, 2000; Masran, 2019; Woodward, 2003). However, these elements can be found through the aspects of social and personal needs (Abdelmonem, 2012; Kottmann, 2022; Woodward, 2003).

For example, a 'tactic of belonging' was utilised by Syrian female occupants to recreate kitchen space in their new homes in Istanbul by placing objects that provide them good use for cooking practice and memories of their homes in Syria (Özçetin & Rottmann, 2022). This act of demarcation defines a space for home dwellers as a 'safe' and 'functional' place that supports their daily activities and practices (Kottmann, 2022; Rosbrook & Schweitzer, 2010).

Meanwhile, the spatial meaning of Chinese traditional family dwellings mirrors their family hierarchy and Confucianism practice. There are numerous courtyards in the traditional Chinese house to accommodate 4–5 generations of family members. Consequently, maintaining privacy and social boundaries is possible with wall-segregated areas. However, interestingly, all rooms are multipurpose and offer flexibility of usage across time and the life course of the family. Except for the kitchen and main hall, the homes were never functional spaces. The sacred and safest space is for the eldest family members and is located at the innermost space within this traditional home (Hu, 2008).

All reviewed papers focus on a single ethnic group, a single belief system, social class and migration, from elderly, gender, student and refugee perspectives. Thus, the outcome discovered few studies on the cultural practice of multi-ethnic households within a home setting. More research studies on multi-ethnic homes are required in contemporary housing policy because the primary emphasis is on house supply, and the design is focused heavily on supplying practical rooms based on population affordance. (Hamid et al., 2017; Im & Fah, 2018; Suryadi et al., 2022). Therefore, it is vital to develop a conceptual framework as a guide to explore the meaning of home from this perspective.

4.1 The Development of Conceptual Framework: The Practice of Home in Multi-Ethnic Settings

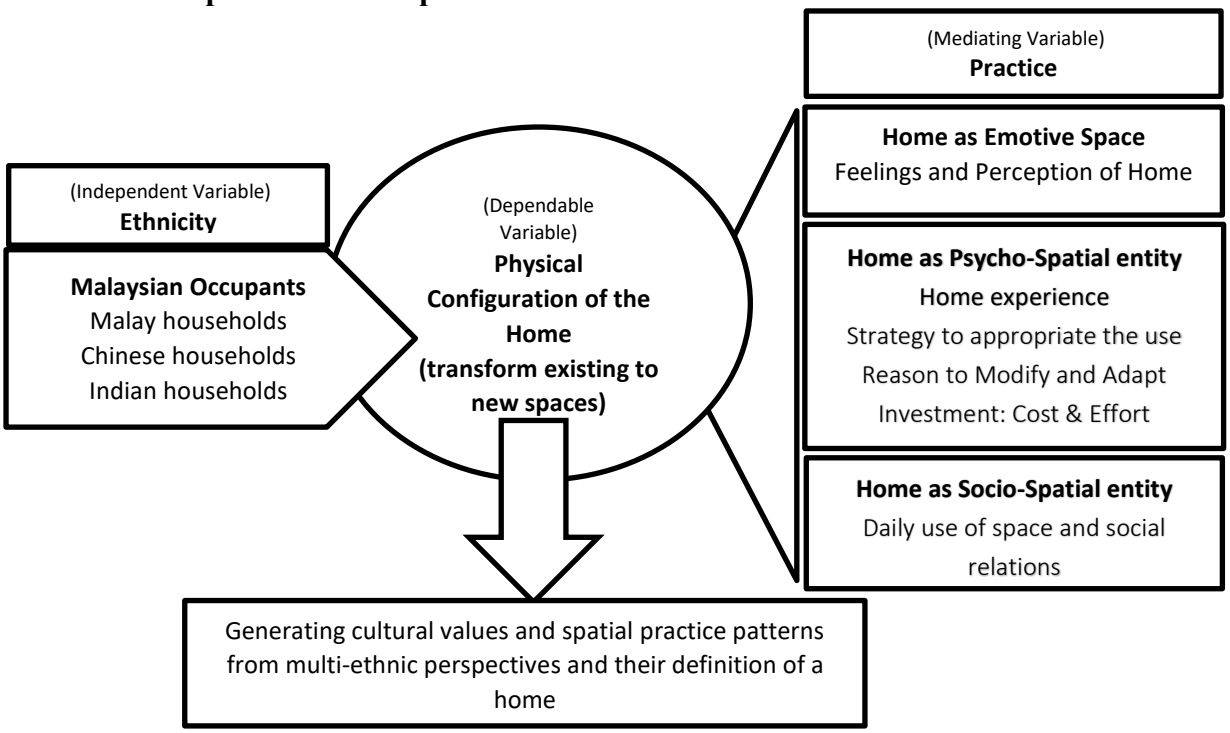


Figure 5. A Conceptual Framework on the Meaning of Home for Multi-Ethnic Settings (Developed by the authors).

A new conceptual framework is constructed in Figure 5 utilising all the combined theories on ethnicity, space and practice, and how they can be applied to an investigation in a multi-ethnic home setting.
The ethnicity of a household is an independent variable that can affect the physical home settings as a dependable variable over time, experience and appropriation (Easthope, 2004). Each household has a different set of family structures and belief systems. It is important to identify the target group of a household structure before conducting an experimental study. In the context of Malaysia, a single neighbourhood may comprise multi-ethnicities—Malay, Chinese and Indian households. Their belief system and practices may influence the use of spaces in a home setting.
The practice of home is a mediating variable explaining how and why the effect occurs in the physical home settings. Based on the literature, this practice can be divided into three parts, following the three approaches to defining home as 'emotive space', 'socio-spatial entity' and 'psycho-spatial entity' (Easthope, 2004). The first portion examines the occupants' perceptions and feelings of their homes due to their experience within their physical homes and the neighbourhoods. The experience depends on the household structure and belief system that regulates their lifestyle.
The second portion concerns the occupants' lived experience and way of living, concerning the home as a psycho-spatial entity. It explores the occupants' daily use of space and their strategies to appropriate the house. This section elaborates on the transformability of existing rooms, their involvement and inspiration to transform spaces, the reason to modify and the effort to produce, consume and adapt indoor, outdoor and in-between spaces in a home.
The final portion discusses the daily use and social relations of households. This portion focuses on the use of space in a home, as well as their daily and social activities, which include personal activities (hobbies or interests), family activities, religious activities, neighbourhood activities and social, and celebratory activities according to the time of day, weekend and special events (Abdelmonem, 2012; Al-Mohannadi et al., 2023; Rahim & Hashim, 2012). It is an indication of how frequently they engage in these activities, as well as what significant activities take place in their homes, a socio-spatial approach.
This is a holistic approach to home practice that develops spatial practice patterns to explain how an ethnicity's ideas, cultural values and practices influence the physical configuration of a home and

regulate its spatial boundaries and privacy. In a multi-ethnic home setting, there is a need to understand how they perceive each space and in-between space to perform their domestic activities comfortably and respectably (Abdullah et al., 2022).

5. Conclusion

This article is a review paper that explicitly identifies the meaning of home from multiple regions and the factors that influence the definition of home from multi-ethnic perspectives. This comprehensive review identifies that the notion of 'home' is a synthesis of three aspects of home: physical, social and personal. From an extensive content analysis, subthemes emerged as the factors that influence the meaning of home from the context study of each publication.

A new conceptual framework introduces three key variables: ethnicity (household structure and belief system), home practice (emotions, experiences and daily use) and the physical spaces (appropriated or transformed space) and how the interactions of key variables are applicable to investigate the meaning of home in a multi-ethnic setting. This study clarifies how people practising and define home as a dynamic ‘tactic’ of homemaking.

Consequently, this review paper made the following contributions. First, this study is significant for interweaving the gap between the disciplines of sociology, psychology, emotions, architecture and urbanism. The purpose of this new framework is to guide research that involves human intervention in the transformability of spaces and physical settings, which is vast from territorial, psychology, socio-psychology and phenomenology studies. Hence, this study provides a full grasp of ‘home’, where physical homes are constantly appropriated inside and outside following the behaviours of occupants towards their living environment.

Second, the outcome responds to the hypothesis of this paper that each household practises cultural values, privacy and social boundaries in line with their belief systems, and that reconfiguring a physical space defines the meaning of home. Most occupants, for example, define home as a 'safe' place, but how they practice safety in their living environment demonstrates varied interpretations that have yet to be investigated. Thus, this study suggests further research with households of different belief systems in a contemporary housing design. This knowledge is vital and can contribute to the contemporary housing policy that is less attentive to the design of houses with cultural characteristics for multi-ethnic homes.

Third, this systematic review utilised a qualitative research method. As much as the study revealed a greater meaning of home, there is a need to examine the methods and tools utilised by related empirical papers and the outcome of their methods for future investigations.

Lastly, the digital world has opened up a new ‘place’ where people, particularly the young generation, can find the meaning of ‘home’ virtually. This research focuses on physical places, while social media platforms are abstract spaces where social and personal needs can be appropriated and evolved for personal presence, intercultural and social networking and preservation of memories.

Within art and humanities, the new framework is highly recommended to all local architects, designers, developers and urban planners to guide overall design practices and policies for all housing types. The purpose is to ensure a comprehensive understanding of the meaning of 'home' incorporating the actual home practises of occupants within multi-ethnic neighbourhoods or countries, similar to Malaysia.

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Conflict of Interests
The authors declare no conflict of interest.

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Data availability statement
The authors confirm that the data supporting the findings of this study are available within the article [and/or] its supplementary materials.

Credit author statement
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